7.5 Economic Trends And Opportunities

- Tourism; is a significant driver of the local economy, accounting for 25% of employment in Cornwall. North Cornwall, including Wadebridge, benefits substantially from tourism;
- Sector Growth (2008-2011): increase in Accommodation and Food Services employment by 14%.
- Sector Decline (2008-2011): The Public Administration and Property sectors saw a 22% reduction in employment.

7.6 Infrastructure And Development Needs

- Employment Needs: more local employment opportunities are needed with the availability of high-quality jobs that offer career progression.
- Adequate space for business growth is needed.
- Infrastructure to support home working included improved connectivity.

7.7 Training And Skills Development

- Improvement in local skills and training opportunities
- Better job prospects for young people, for those with special needs, and underrepresented members of the community.

7.8 Policy And Strategic Framework

- Cornwall and Isles of Scilly Local Economic Partnership (LEP): focuses on enhancing prosperity and addressing poor economic performance; and emphasises the need to increase per capita GDP and leverage natural assets.
- National Planning Policy Framework (NPPF): supports sustainable economic development and the viability of town centres.

- Cornwall Local Plan: aims for sustainable development, balancing economic, social, and environmental needs; targets include 8,000 sq. metres of additional employment floor space for Wadebridge and Padstow.

Seaweed farming has the potential to provide many benefits to the economy of Wadebridge notably through job creation and providing an opportunity for educational experiences and potential application research in various industries such as food, pharmaceuticals and biofuel. Seaweed farming also has the potential to promote economic diversification and offers an opportunity for local farmers and fishermen to diversify their income by engaging in seaweed cultivation. This can help reduce dependence on traditional agricultural or fishing practices and create new revenue streams and so boosting the local economy, all of which Biome and Camel Fish is fully committed to supporting.

8.0 Fishers

Income diversification in fisheries is recognised as a vital strategy to mitigate risks for fishers and facilitate adaptation to climate change and regulatory changes. Although expanding wild fishing opportunities is constrained by marine resource availability and catch allowances, aquaculture has exhibited significant growth, with an average global growth rate of 4.5% from 1986 to 2018. In the EU, aquaculture produced approximately 1.1 million tonnes of finfish species and molluscs in 2018, valued at EUR 3.7 billion. Between 2008 and 2018, aquaculture production in the EU increased by about one-third in both value and weight. The EU's blue growth strategy highlights aquaculture as a potential driver for economic growth and new employment opportunities across Europe. National plans, such as the Welsh National Marine Plan and the UK's 25-year Environment Plan, also emphasize supporting aquaculture to ensure sustainable sea use

Small-scale aquaculture has been proposed as a suitable maritime activity that offers viable technology and an economically appealing alternative livelihood for fishers facing declining fishing opportunities. However, economic, social, and cultural factors may impede fishers from transitioning from wild-harvest fishing to aquaculture. Despite these challenges, there is growing evidence that aquaculture can complement commercial fishing, with successful fishers integrating both business models and practical skills. For example, Jeffery et al. (2019) provides instances where UK fishers have successfully diversified or combined fisheries with aquaculture.

Nevertheless, there remains a lack of comprehensive evaluation of the potential opportunities and challenges associated with fishers diversifying into aquaculture. By directly engaging with fishers, particularly small-scale fishers, Biome and Camel Fish have sought to better understand their perspectives on the barriers they face in integrating aquaculture into their operations. Biome firmly supports the diversification of fishers and has spent time analysing inshore fishers' views on the integration and diversification into aquaculture, examining perceived barriers and opportunities for adopting aquaculture activities alongside traditional fishing, all of which Biome is aiming to address and support in the adoption of their aquaculture partnership with established fishers, Camel Fish.

Biome and Camel Fish are fully committed to supporting the diversification of UK fishers.

9.0 Summary

Seaweed farming in Cornwall, or any coastal region, can offer several economic benefits:

- Job Creation; seaweed farming requires a range of skills, from farming and harvesting to processing and marketing. This can create employment opportunities for locals, offering career progression and training and thereby boosting the local economy.
- Diversification of Income; for coastal communities that traditionally rely on fishing or tourism, seaweed farming offers a new source of income, reducing reliance on single industries and making the economy more resilient to fluctuations in those sectors.
- Export Potential; seaweed products have a growing global market, especially in industries such as food, cosmetics, pharmaceuticals, and agriculture. Cornwall's reputation for high-quality produce could position it well to tap into these markets, leading to increased exports and revenue.

- Environmental Benefits; seaweed farming can have positive environmental impacts, such as absorbing excess nutrients and carbon dioxide from the water, improving water quality, and providing habitat for marine life. These benefits can indirectly support other sectors like fishing and tourism, which rely on healthy marine ecosystems.
- Value-added Products; seaweed can be processed into various value-added products such as food ingredients, cosmetics (skincare products), and biofuels. This diversification of product offerings can increase the profitability of seaweed farming operations.
- Research and Innovation; investment in seaweed farming can spur research and innovation in related fields, leading to the development of new technologies such as pharmaceutical or nutraceutical applications, cultivation methods, and product applications. This can attract investment and funding into the region's research institutions and stimulate further economic growth.
- Tourism and Education; seaweed farming activities can also become attractions for tourists interested in sustainable agriculture and marine ecosystems. This could lead to the development of educational programs, tours, and visitor centres, generating additional revenue for local businesses.
- By capitalising on these economic benefits, Cornwall can position itself as a leader in sustainable seaweed farming, driving economic growth while also promoting environmental stewardship and innovation.

10.0 How Biome And Camel Fish Can Help To Address Low Wages In Cornwall And Boost The Local Economy

The report on low wages in Cornwall and the Isles of Scilly (CIoS) provides a detailed analysis of the factors driving low pay, the extent of the issue, and at Biome and Camel Fish, we believe we can offer a solution to improve wages and productivity in notably the Padstow and Wadebridge areas close to the location of the farms.

10.1 Key Findings

- Prevalence of Low Pay; almost 40% of workers in Cornwall are affected by low pay, compared to 24% nationally.
- Sectors with the highest prevalence of low pay include retail, hospitality, and cleaning and maintenance, which together account for around one-third of all jobs in Cornwall.
- Economic Structure and Employment; many low-paying jobs are found in micro and family-run businesses with limited opportunities for wage and career progression.
- The 'gig' economy, characterised by self-employment and zero-hours contracts, has contributed to the prevalence of low pay and job insecurity.
- Demographic and Geographic Factors; low wages disproportionately affect women, with 40% earning below the Real Living Wage compared to 33% of men.
- Part-time workers are particularly affected, with 51% earning low wages.
- Rurality, housing costs, and poor public transport are significant barriers to accessing better-paid work.
- Productivity and Job Creation; Cornwall has seen weaker employment growth compared to the national average, with a significant portion of new jobs being low-paid.
- Productivity in Cornwall remains lower than the national average, despite improvements supported by EU funds and UK grants.

10.2 Recommendations For Tackling Lower Wages

Tackling low pay for underrepresented people in the community requires a multi-faceted approach that addresses various structural and systemic issues. Here are some strategies that can be implemented and are aligned with our ESG values as a company:

- Strategic Approaches: we can develop a multi-faceted strategy that includes employer initiatives, place-based campaigns, and employee development programs.
- We will focus on increasing productivity through innovation and adoption of basic business management technologies, career progression, and training.

- We will offer employer Initiatives; to encourage better leadership and management practices and to drive firm-level productivity growth within the aquaculture industry.
- We are committed to adopting - and promoting the adoption of the Real Living Wage by local employers – the applicants are fully committed to this.
- Employee Development; we intend to implement skills development programs targeting those at risk of low pay and unemployment.
- We plan to develop an aquaculture sector-specific approach to improve productivity and wage levels and we are committed to supporting the growth of higher-paying sectors such as marine and digital technologies.
- Leveraging Funds and grants; we will utilise any remaining EU funds and available UK grants to support productivity-boosting projects and innovation, ensuring a focus on creating high-quality jobs and improving wages.
- Education and Training; we are committed to offering targeted training and educational programs to equip underrepresented groups with in-demand skills. This could include vocational training, apprenticeships, and adult education classes.
- Scholarships and Grants; we will where possible provide financial support for education and training through scholarships and grants aimed specifically at underrepresented communities.
- Employment Opportunities; we are committed to adopting inclusive hiring practices that focus on diversity and equity. This will include implicit bias training and the setting of diversity targets.
- Part of our employment initiative is to increase management and leadership opportunities along with digital training, research opportunities, and use of AI Agri-Tech innovation; we want to support earnings progression among low-paid earners by developing local partnerships with local businesses.
- We aim to connect skills demand within our company to opportunities for Cornish residents and offer clear pathways to progression. We are committed to supporting individuals, graduates, and underrepresented members of the community; such as more women into STEM, and helping those with disabilities or individuals with a

protected characteristic as defined in the Equality Act 2010, to improve their skills and earning potential.

- Our goal is to ensure that the local workforce has the necessary skills and qualifications to meet the demands of existing and emerging industries within and outside of aquaculture which is crucial for Cornwall's economic development. Investment in education and training programs, as well as initiatives to attract and retain talent, will help address skill gaps and support economic diversification. Our focus is on promoting inclusive growth, boosting productivity, and improving the quality of life for residents.
- Internships and Mentorships; the applicants will create internship and mentorship programs that provide underrepresented individuals with work experience and professional guidance.
- Wage Policies and Legislation; the applicants will advocate for policies that ensure all workers are paid a living wage, which is higher than the minimum wage and reflects the cost of living.
- Equal Pay Legislation; the applicants will strengthen and enforce laws that mandate equal pay for equal work, regardless of gender, race, or other characteristics.
- Supportive Services; the applicants will support the provision of affordable childcare services to enable parents, especially women, to participate fully in the workforce.
- Transportation Assistance; the applicants will commit to supporting the provision of transportation subsidies or services to help individuals access job opportunities that are not within easy reach.
- The applicants will support campaigns to raise awareness about the importance of fair pay and the challenges faced by underrepresented communities.
- The applicants will advocate for policies at the local and national levels that address wage disparities and support economic equity.
- Community and Economic Development; as the applicants evolve, they will help support the growth of other local businesses owned by underrepresented individuals through the adoption of grants, loans, and business development services.

- Partnerships and Collaboration; the applicants will commit to partner with community organisations that have strong ties to underrepresented groups to ensure initiatives are relevant and effective.
- The applicants will collaborate with businesses, government agencies, and non-profits to create comprehensive solutions that address multiple aspects of wage disparity.

By implementing these strategies, communities can create a more equitable economic landscape that offers fair pay and opportunities for all individuals, regardless of their background or identity. The applicants are committed to supporting these initiatives.

Low pay is a significant issue in Cornwall and the Isles of Scilly, affecting a large proportion of the workforce and exacerbating in-work poverty. A comprehensive and strategic approach involving employers, employees, and policy initiatives is essential to address the underlying causes and improve wage levels and productivity in the region. The implementation of targeted interventions, supported by grants and local initiatives, can help create a more sustainable and prosperous economy for Cornwall, all of which the applicants are fully committed to.

Chapter 16: Navigational Safety Assessment And Emergency Response Plan

Preface

This chapter is in response to a FIR by the MMO. Questions relate to the Navigational Safety Assessment and Emergency Response Plan. This can be found, in full and updated in **Appendix V** and includes an evidenced safe anchorage assessment. Through answering the FIR questions and updating the NSR and ERP, both applicants conclude all safety risks have been brought to ALARP, for both farms cumulatively.

The following MMO FIR questions were addressed.

2.1 There is an incorrect reference in the submission to International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) documentation which has been superseded since 2013 by IALA G1162 2021. The MMO request that you correct this.

We have updated this incorrect reference with the correct one and have updated Table 5 (within Appendix V) to match the 2021 version of the recommended marking and considerations for Aquaculture offshore structures.

2.2 The MMO note that Trinity House requires the mid points of the sides of the site to be marked with unlit, yellow pillar-shaped special marks with yellow St Andrew's Cross topmarks. In addition, the corners of site are to be marked with lighted, pillar-shaped special mark buoys with yellow St Andrews cross topmark, and a characteristic of Fl Y 5s. The MMO would likely condition these on any determination we are minded to make.

We have incorporated this into the section 6.3 of Appendix V.

2.3 The MMO note concerns from Trinity House over any liability if the project goes into administration, or is not decommissioned fully, as it could fall on Trinity House, as the General

Lighthouse Authority for England, Wales and the Channel Islands, to ensure the area is safely marked until made safe for other marine users with associated costs having to be covered by Trinity House and the general lighthouse fund. The MMO is minded to address this on any determination we make to ensure any future owner, or receiver, is liable to make the area safe and not abandoned.

We have incorporated this into the section 7.0 of Appendix V.

2.4 The MMO are minded to include the following advisories and conditions on any marine licence we determine for these applications:

All following advisories and conditions (a-f) the MMO are minded to include have been added to section 9.0 of Appendix V:

a. An advisory to state that "During the period from the commencement of construction of the authorised project, to the completion of decommissioning seaward of Mean High Water Springs, exhibit such lights, marks, sounds, signals and other aids to navigation, and take such steps for the prevention of danger to navigation as Trinity House may from time to time direct."

b. In case of damage to, or destruction, or decay of the authorised project or any part thereof, the MMO, MCA, Trinity House and the UKHO should be notified as soon as reasonably practicable and no later than 24 hours following the awareness of any such damage, destruction or decay.

c. All buoys should be maintained to IALA Category 3 Availability of 97%

d. An advisory to state that "Reports must be provided to Trinity House on the availability of aids to navigation using the reporting system provided by Trinity House."

e. A notification must be sent to The Source Data Receipt team, UK Hydrographic Office, Taunton, Somerset, TA1 2DN (Email: sdr@ukho.gov.uk) of completion of the licenced activities, no later *than 10 days after their completion. A copy of the notification must be sent to the MMO within one week of the notification being sent.*

f. Trinity House and UKHO are to be provided with accurate positions of buoys in Latitude/Longitude WGS84 within 24 hours of buoys being established.

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Appendix I: Port Of Quin Kelp Farm: Mooring Design (May 2024)

Preface

This report was prepared and written by an independent company. It has been provided as an independent report alongside this FIR report and is titled *'Appendix X: Port of Quin Kelp Farm Mooring Design'*.

Appendix II: Original Water Framework Directive Assessment

1.0 Introduction & Background

Following the individual WFD scoping assessment, Biome and Camel Fish have taken the decision to provide a full cumulative WFD Assessment with aspects of ecology included to build on the information provided within the Habitats Regulatory Assessments and within the Marine Mammals Assessment and the Fisheries Assessment.

This chapter was prepared by Dr Angela Mead, an experienced marine biologist, researcher and active seaweed farmer within the South West region. Dr Mead's specialisms include coastal ecosystems, human drivers of change, INNS and aquaculture.

The project has been assessed under the Water Framework Directive (WFD) criteria. This is to identify any significant impacts on the immediate water body which could impact the quality and status of the water body. The WFD states '*water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such*.' Humans interact directly and indirectly with water within transitory and coastal water bodies. This is mainly through recreation and/or fishing activity. Therefore, a low or lowered water status could lead to negative direct and indirect impacts on human health.

1.1 Farm Location

The site locations for the proposed seaweed farms are located inshore, in Port Quin, Cornwall. Port Quin is within the Cornwall North water body GB610807680002. The water body is 19160.19 Ha of water in total. Therefore, the proposed 50.4 Ha farm (100.8 Ha combined) would occupy an equivalent of 0.26% (0.52% combined) of the Cornwall North water body. The proposed farms in Port Quin Bay will be situated adjacent to one another.
A map of the farm locations can be seen in Figure 1. The specific site coordinates are within

Table 1 below.

Proposed Biome Algae corner coordinates:

Farm Corner	Latitude	Longitude
Northwest	50.597784	-4.891862
Northeast	50.59801	-4.881677
Southeast	50.591715	-4.881306
Southwest	50.591518	-4.891385

Proposed Camel Fish corner coordinates:

Farm Corner	Latitude	Longitude
Northwest	50.597496	-4.90274
Northeast	50.597764	-4.892561
Southeast	50.591496	-4.892087
Southwest	50.591242	-4.90231

Table 1. Farm corner coordinates (in WGS84) for the proposed farm locations in Port Quin Bay.

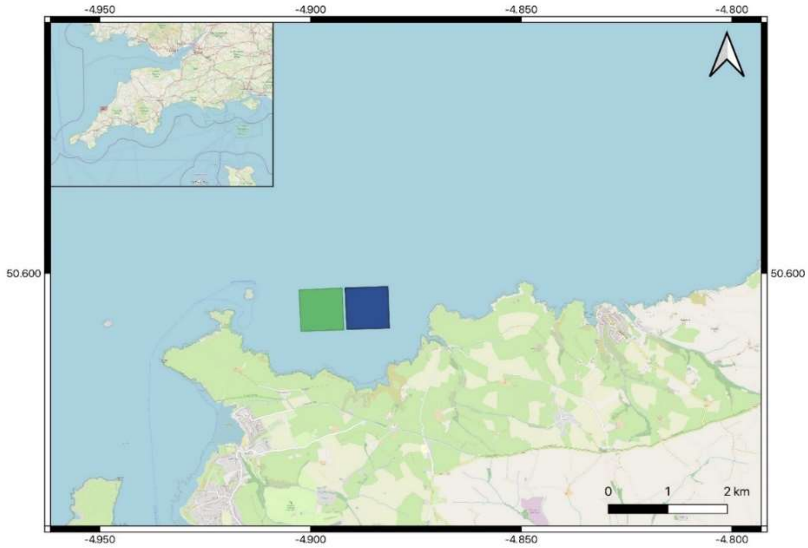

Figure 1: Location of the proposed farms in Port Quin Bay.

The applicants have both fully engaging with the MMO's marine licensing process. An initial 28-day public consultation process was undertaken, with the projects individually advertised in a local newspaper, within the Padstow Bay Harbour Masters Office window and on Harbour notice boards (evidence supplied, these Marine Notices were pinned between 16.10.23 to 13.11.23). The applicants also individually published marine notices in Fishing News (evidence supplied).

Following the initial 28-day public consultation period the applicants were asked to reopen their applications by the MMO for another 28-days which both parties complied with. During this 28-day period the applicants did not have to publish marine notices in newspapers. However, they did have to post the marine notices in two car parks; one in Port Quin and one in Port Isaac (evidence supplied). A further 28-day public consultation period will be completed in parallel with further assessment by Primary Assessors before licence decisions are made. This represents a total of 84 days public consultation.

During the second period of public consultation the applicants were involved in a meeting with the public to present and discuss their proposals and to answer questions. This took place in St. Minver Hall, Wadebridge on 27th February 2024. At least 130 + people attended.

In terms of responses from the public, there were both supportive comments and concerns covering a range of topics. The applicants have been working internally and with external and independent support/experts to address all concerns raised by the public and MMO, for further consideration by Primary Assessors and to inform a licence decision (2 x further information requests completed (FIR's) and an FIR completed on 18th December 2023, which included information for Trinity House).

Prior to submitting applications to the MMO, the applicants pre-engaged active stakeholders that operate in the proposed area of works. This included but isn't limited to: fishers (potters and trawlers), charters, boat tours, Harbour Masters, sailing clubs, and divers. When submitting the initial pre-engagement log there were no objections from the listed stakeholders. Since submitting the applications, the applicants have conducted surveys and interviews with active fishers operating in the area of works (specifically for under 12 m vessels). Please refer to Appendix VIII which discusses the fisheries activities in ICES30E5 with vessel operators in this size category and which builds on initial pre-engagement. Stakeholders were aware that there are two proposed seaweed farm sites.

During the licensing process the applicants have had several meetings with the Crown Estate. In part, this was to establish a conflict plan to ensure the farm has no conflicts with any other marine licence applications – there were no conflicts. These were provided by the Crown and have been submitted to the MMO as evidence for both farm sites. Further discussions with the Crown Estate are related to site planning, due diligence and decommissioning arrangements for the sites.

The applicants reached out directly to sailing clubs (evidenced) and received responses: they had no objection to the proposed site. The applicants also contacted the RYA for sailing data from seaTRK and Coast Atlas. Sailing data has been collected for this application through direct communication with the sailing clubs that operate out of Padstow, Camel Fish's experience of marine traffic in the Bay (50+ years' experience) and from Electronic Navigational Charts (ENCs) such as EMODnet. Evidence of our engagement with the sailing clubs and the RYA can be seen in the 'Pre-engagement log' and 'Pre-engagement Evidence'.

1.2 Key Water Framework Directive Baseline Facts For Port Quin Bay

The water body status of Cornwall North is high, as is the ecological status. The chemical status is good. It has high hydromorphology and is not heavily modified. Phytoplankton status is high. The history of harmful algae has not been monitored. Bathing waters are of excellent quality.

15,717.32 Ha of the sediments found within the Cornwall North water body consist of low sensitivity habitats. This includes cobbles, gravel and shingle, intertidal soft sediment, rocky shore, subtidal boulder fields, subtidal rocky reef and subtidal soft sediments, which dominate (12140.60 Ha).

32.64 Ha of the sediments found within the Cornwall North water body consist of high sensitivity habitats. This includes mussel beds, polychaete reef, saltmarsh and subtidal kelp beds.

At the proposed farm location, the benthic environment is coarse substrate. This was established using several resources: **EMODnet** seabed habitat mapping for Europe, **MarineTraffic.com s**eabed habitat mapping and **DEFRA Magic Maps** (Figure 2: Sediment type). Accurate bathymetric maps are also available through electronic navigational charts (ENCs) such as Navionics ChartViewer and Orca and MarineTraffic.com.

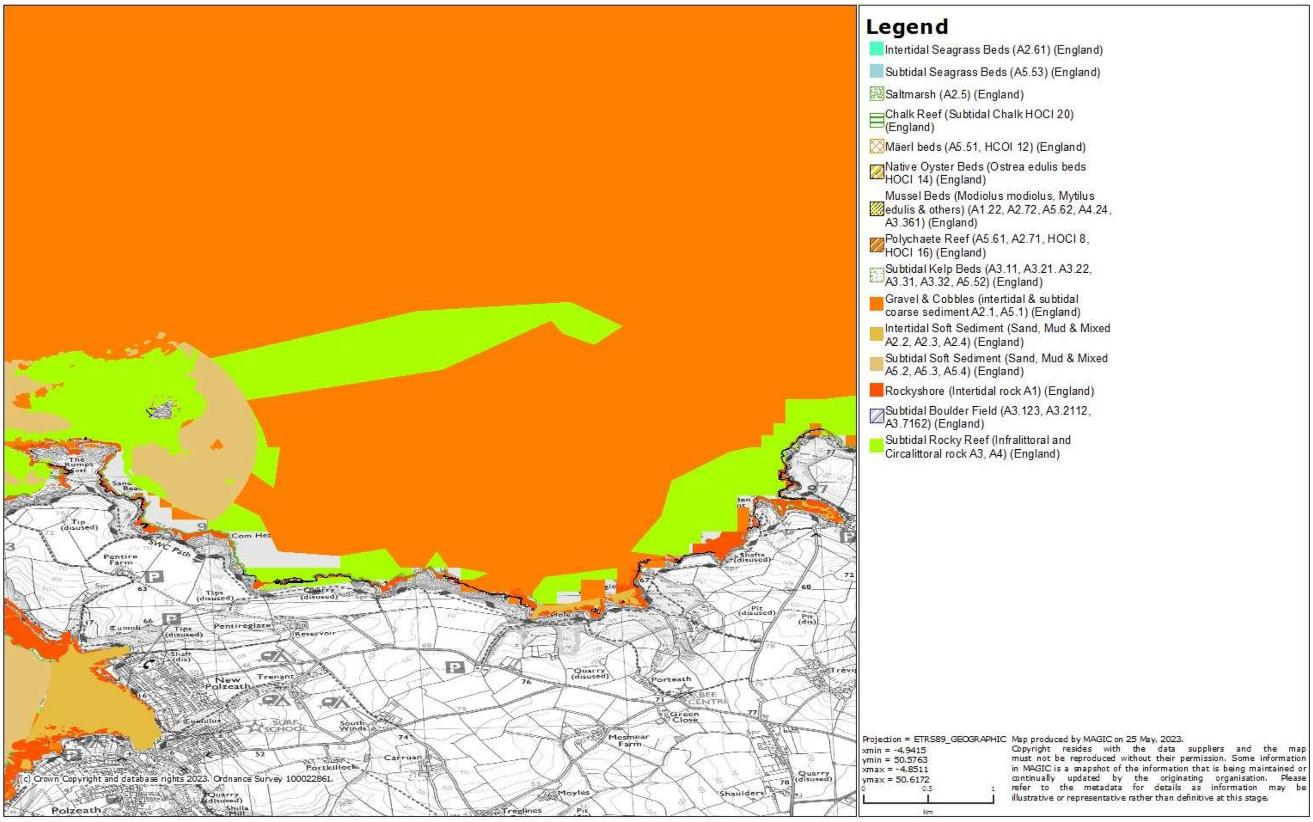

Figure 2. Sediment type. Source: Defra, MAGiC

1.3 Protected Areas And Species

The proposed site is within the Bristol Channel SAC, set up to protect porpoise. The proposed sites are located near, but not within, the Padstow Bay and Surrounds MCZ and the Hartland Point to Tintagel MCZ, protecting habitats and species including pink sea fan.

Impacts on the marine environment, marine species and seabirds will be monitored.

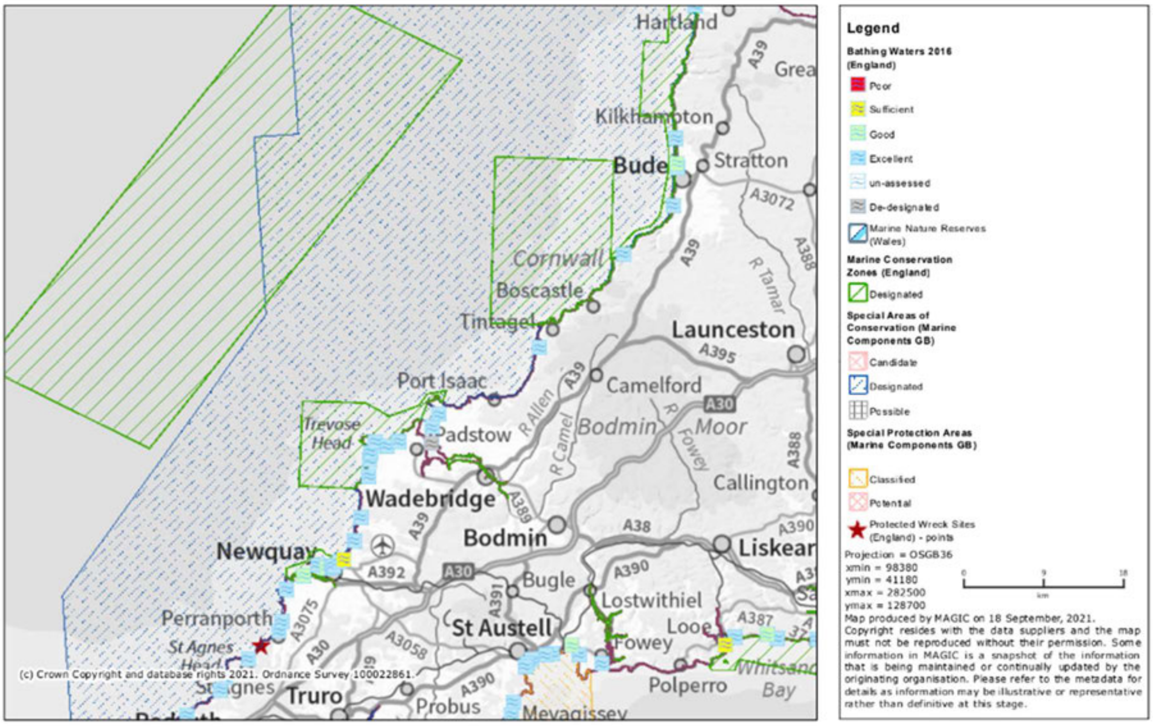

Figure 3. Designated Marine Areas. Source: Defra, MAGiC

1.3.1 Fish

The applicants have produced a full assessment regarding fish. Please refer to Chapter 12.

1.3.2 Marine Mammals

The applicants have produced a full assessment regarding marine mammals. Please refer to Chapter 7.

1.3.3 SAC Features

The applicants have produced a full assessment regarding the SAC. Please refer to Chapter 9.

1.3.4 Shellfish Waters

Figure 4. indicates that shellfish waters are at a significant distance from the proposed licenced

farm sites (more than 2.4 NM).

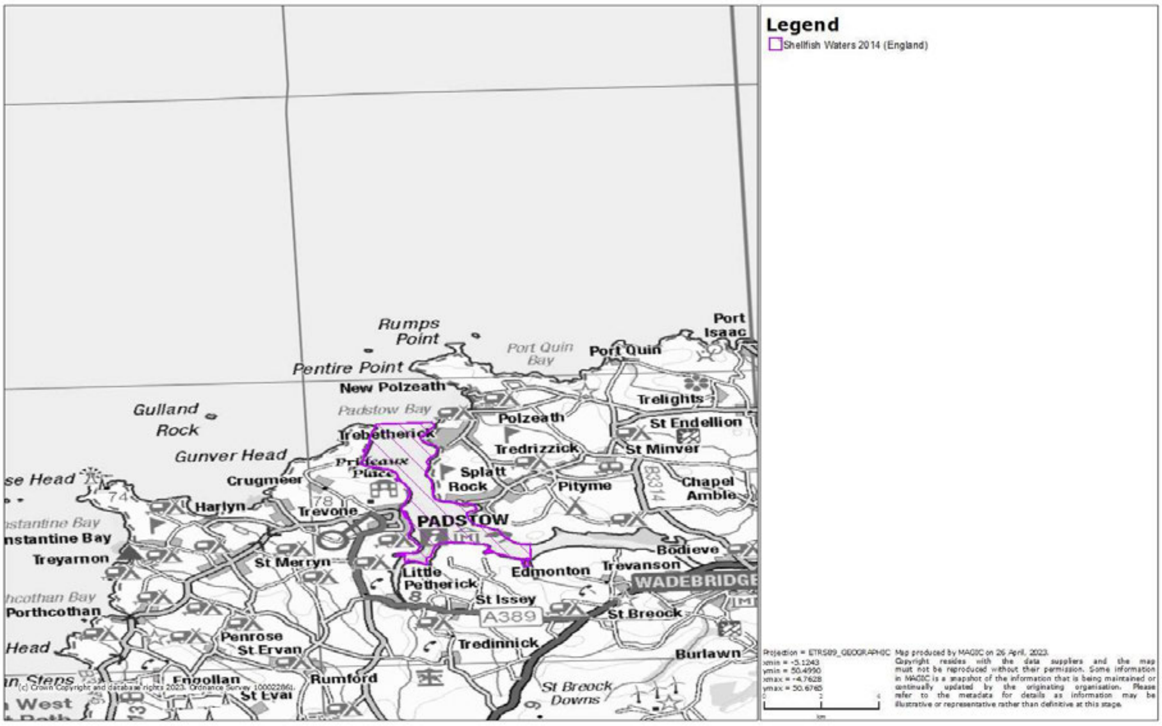

Figure 4. Shellfish waters more than 2.4 NM from the proposed sites. Source: Defra, MAGiC

Figure 5. indicates that the proposed farms are at a significant distance from bathing waters (more than 2.4 NM). It is well documented that seaweed farms can bioremediate water through excess nutrient uptake. Farming seaweed requires no freshwater input, no feed, no fertiliser and it produces significantly less waste than other aquaculture.

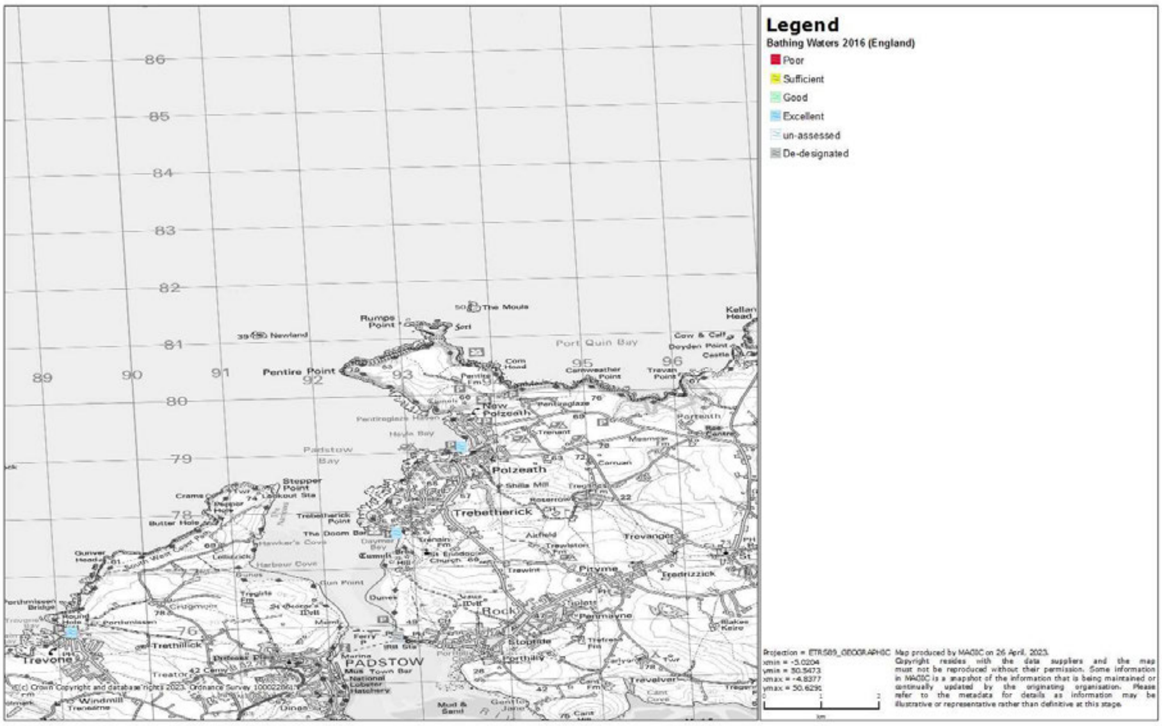

Figure 5. Bathing waters around Port Quin Bay, more than 2.4 NM away from the proposed sites. Source: Defra, MAGiC

1.3.5 Noise

When considering boat access to the farm and potential noise generated onsite it is expected that trips to and from the farm will be minimal and concentrated around deployment and harvesting with weekly monitoring in-between when weather permits. Effort will be taken to reduce vibration and underwater noise from the boat. It is possible to turn off the engine when working on sections of the farm. The types of boat servicing farms are slow moving work boats and do not generate noise in the same range as speedboats, for example. They are lower frequency (Hz). In addition, Biome's vessels will be full electric or hybrid and engines will be turned off whilst working off lines. Therefore, they will generate significantly less noise than conventional marine vessels. Engines are turned off when working on sections of the farm.

The farm infrastructure is well spaced out and suspended in the water in depths of 10m - 15m (only occupying the top 1-6 m). Please refer to the 'Mammal Assessment' for further assessment of Noise.

1.3.6 Waste

Unlike shellfish and fish farming, seaweed cultivation is not intensive (hence not listed on Annex I, II or III of the EIA Directive and does not require an EIA) (McCold, 2001). Seaweed farming does not lead to nutrient loading, smothering, changes in siltation rate and deoxygenation of waters (Gunning, Maguire and Burnell, 2016). Some parts of the plant may die and float to the seabed creating "waste". However, this is actually a positive feature as it creates a carbon sink for excess CO^2 and food for herbivorous fish, whelks and other benthic feeders (Israel, Einav and Seckback, 2010, Froelich *et al.* 2019). Seaweed does not require feed of any kind. In other aquaculture industries feed may lead to nutrient loading of waters. Macro algae actually assist in the uptake of excess nutrients in the water column (Seghetta *et al.*, 2016).

In conclusion, there are no clear pathways to impact, or pathways are mitigated. Impact is assessed as low to no impact on the protected areas or species.
This section is further supported by the following additional chapters provided with the licence application document:
'Fisheries Impact Assessment'
'Biosecurity Plan'
'Marine Monitoring Plan'
'Marine Mammals Assessment'
'Birds Assessment'
'Fisheries Assessment'
'National Landscape Assessment'
'Habitat Regulations Assessments'

2.0 Farm Description

The area of each proposed farm is 50.4 Ha (Figure 6). The site maps provided with the application indicate the proposed locations, with precise coordinates in Table 1. At full operational capacity, each site will consist of 144 longlines of 160 m length each, arranged in a matrix (refer to Figure

6). In total, an individual farms infrastructure occupies 5.04 Ha of the 50.4 Ha licenced site. The rest of the licenced sites are open water to allow for safe access by our vessels. The overall farm plan can be seen in the 'Marine Navigational Safety Assessment and Emergency Response Plan'. Figure 7 indicates a typical longline design. Longlines will be held to the seabed by eco-blocks. One line requires 2 eco-blocks. Therefore, a total of 288 eco-blocks will be required per site. The eco-blocks have been chosen due to their fast deployment using an ROV, minimal impact on sediment (disturbance), habitat benefits, ecological benefits, and structural soundness. They are produced by a marine business in South West England. More information can be found within the 'Marine Navigational Safety Assessment and Emergency Response Plan'.

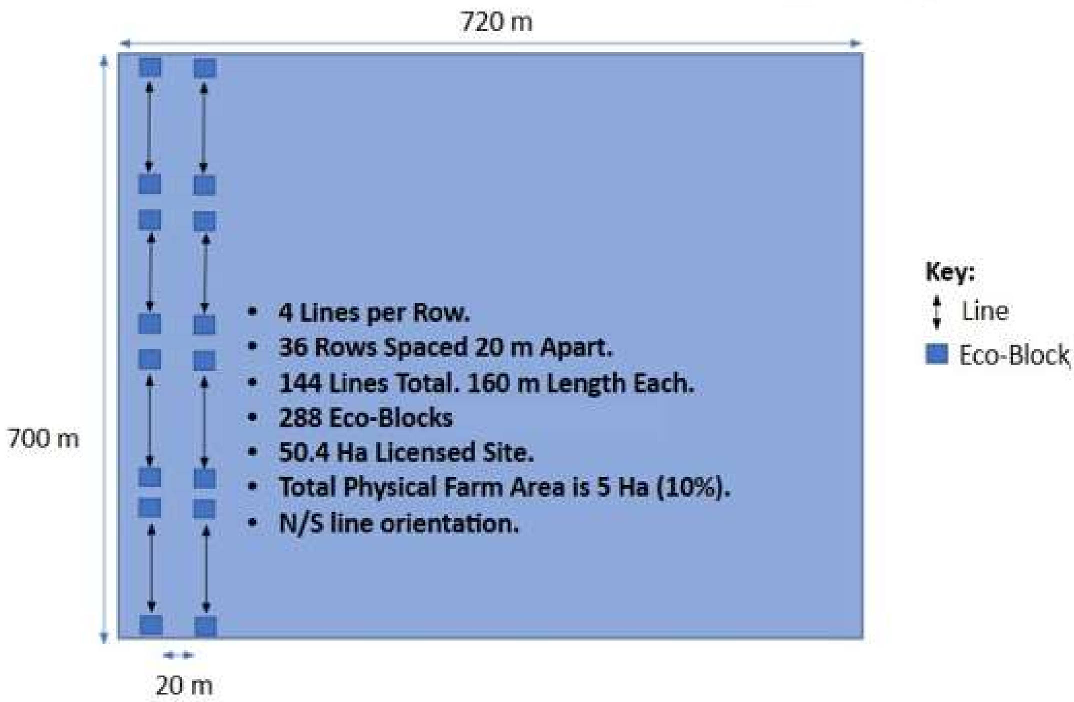

Figure 6. Proposed farm plan (both sites are identical)

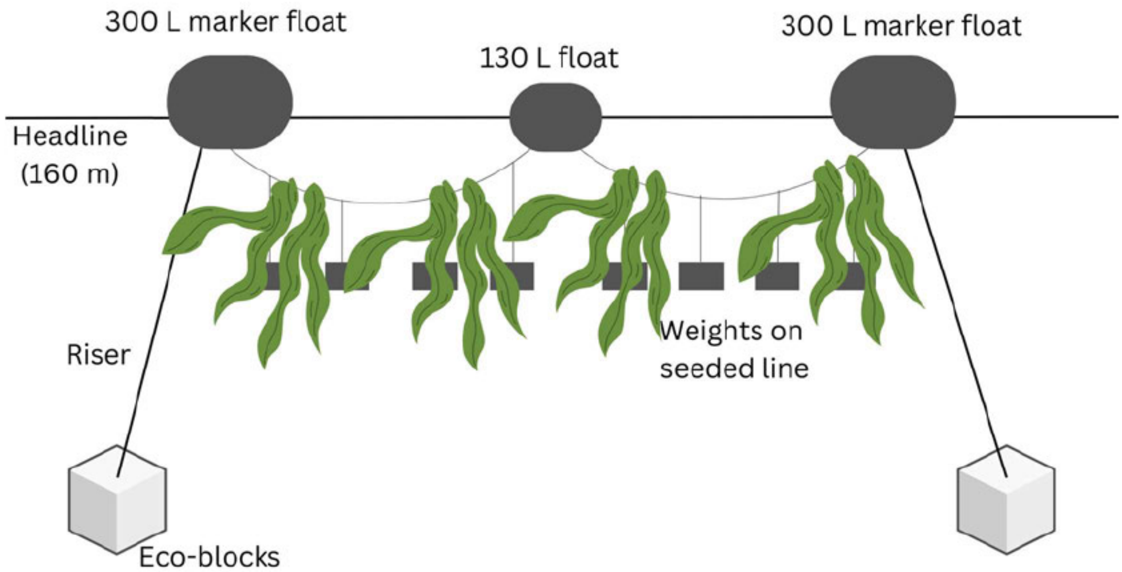

Figure 7. Typical longline (headline) will be 160 m long with eco-blocks designed for sediment type.

The farm system to be implemented is a tried and tested system that is used successfully in offshore shellfish farms located in South West waters. The system is proven to withstand high-energy sea conditions, storms, and sediment shifts over time. There are no recorded incidents of significant infrastructure failure both at St Austell Bay and Torbay sites that Biome has used for seaweed cultivation. The system has been proven to be highly stable throughout the year.

The applicants are currently researching the use of BioGears ropes and hopes to implement them in 2025. These are biodegradable ropes made specifically for Aquaculture with the aim of reducing old ropes going to landfill (*Greene, 2020*). The majority of structures are submerged (sat between 2-6 m) in depths of 10-15 m and therefore not visible from the surface. Furthermore, the applicants select buoys that are of a shape and colour that minimisers disturbance to migratory birds and visual disturbance generally.

2.1 Site Suitability

A range of variables are needed for healthy seaweed growth. These include appropriate current speed and direction, ideal sea temperature, natural presence of seaweed and no freshwater intrusion. According to the Environment Agency (EA), the water quality at the proposed location is good. This is in accordance with the Water Framework Directive (WFD) standard. Data sets have been used to assess these important factors. These combined factors will allow for seaweed to be grown for various purposes including human consumption, fertiliser, animal feed, bioplastic, and biofuel (Evans and Critchley, 2014; Kim *et al.*, 2017). The bay offers a degree of shelter to both the seaweed farm infrastructure and the personnel servicing the farm during deployment and monitoring.

The cumulative impacts of developments within Port Quin Bay are minimal (see assessment within this chapter). Due to the scale of the proposed projects, it is unlikely that any detectable negative influences on the marine environment will take place (Campbell *et al.* 2019). Based on previous research on the operating farm in St Austell Bay, operating farm in Torbay, and the results from analysing scientific data collated by Exeter University and CEFAS, it is believed that the seaweed farm will provide benefits for the local marine environment. However, the applicants will first consider site suitability, which will form an environmental "baseline".

2.2 Current

To better understand the potential impacts of the macroalgae farm an environmental "baseline" must first be established for the area surrounding the proposed site. Mean current speeds of the area were based on data collected by the FaBTest site. The mean (depth-averaged) current speed is 0.2. m/s. This can be considered low water motion (Kerrison *et al.*, 2015). The maximum current speed is 1.4 m/s and the maximum tidal range is 5.5m (Table 1).

2.3 Waves And Sea Temperature

Following wave and sea temperature data was obtained through the National Network of

Regional Coastal Monitoring Programmes, produced by the directional waverider buoy program. Also, the CEFAS Wavenet system was referred to (https://www.cefas.co.uk/data-and-publications/wavenet/).

On average, wave height remains below 5 m (Figure 8, Figure 9). On occasion during winter months (December to February) storms will result in wave heights exceeding the storm alert threshold. We will not operate during these months unless it is safe. The use of eco-blocks will further mitigate these occasional storm events.

2.3.1 Waves

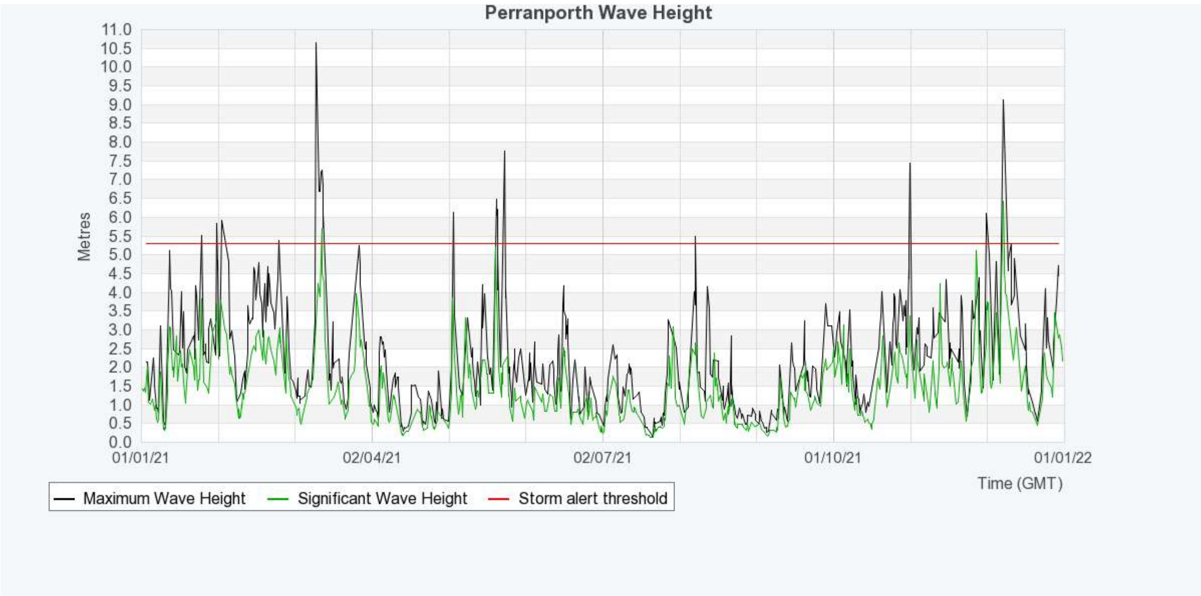

Figure 8. Average monthly wave heights, North Cornwall (2021). NNRCMP

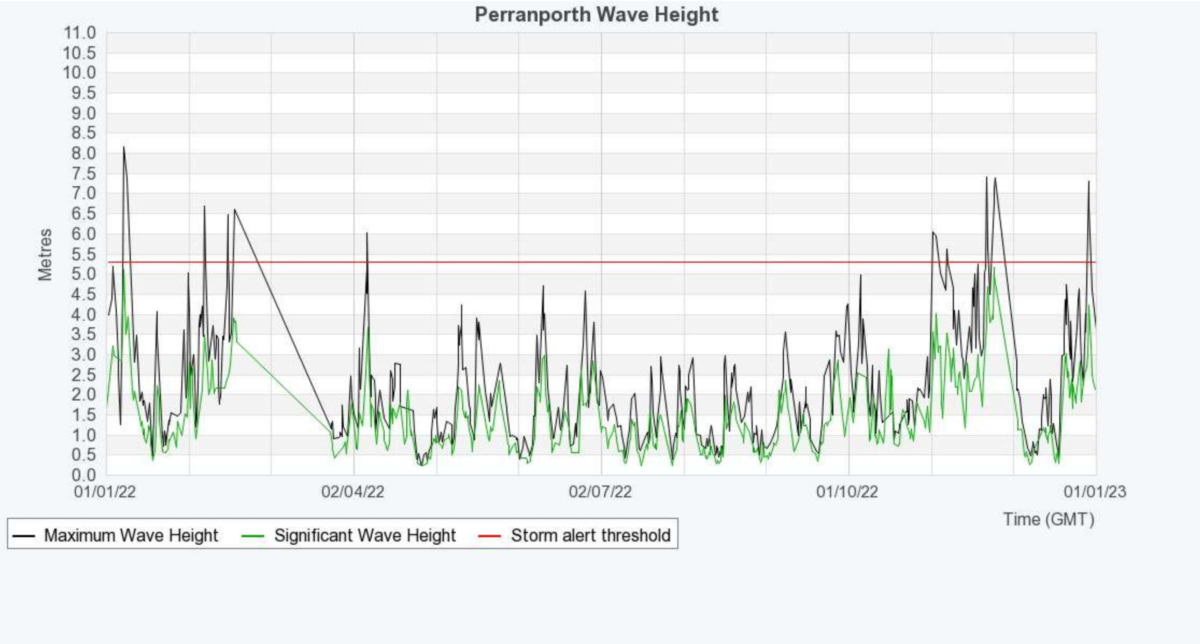

Figure 9. Average monthly wave heights, North Cornwall (2022). NNRCMP

2.3.2 Sea Temperature

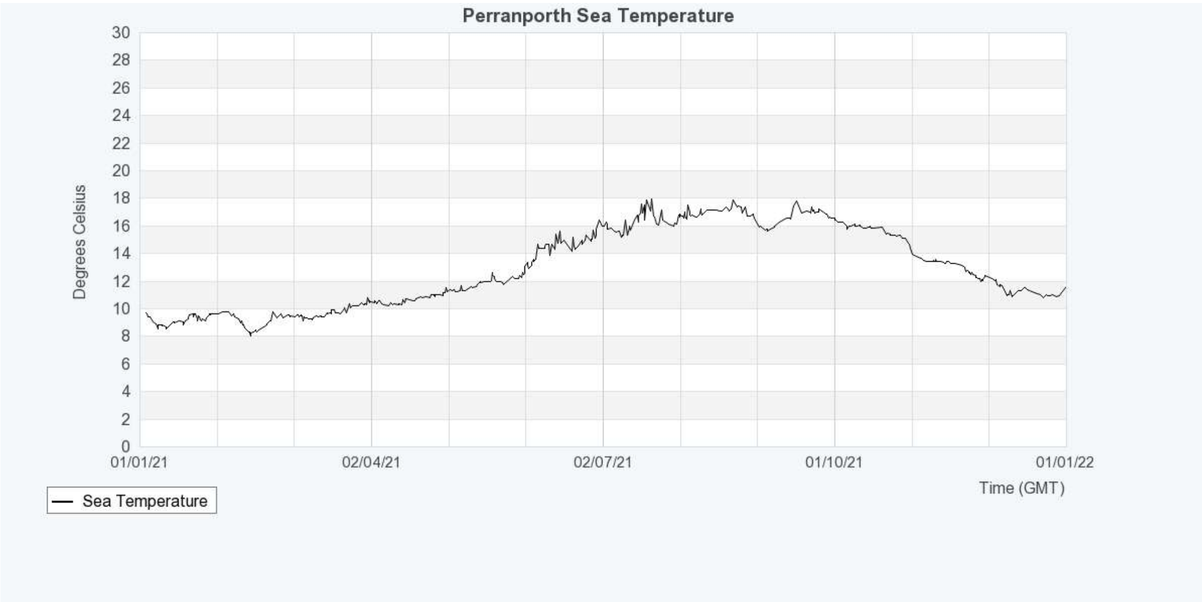

Figure 10. Sea temperature (°C) (2021). NNRCMP

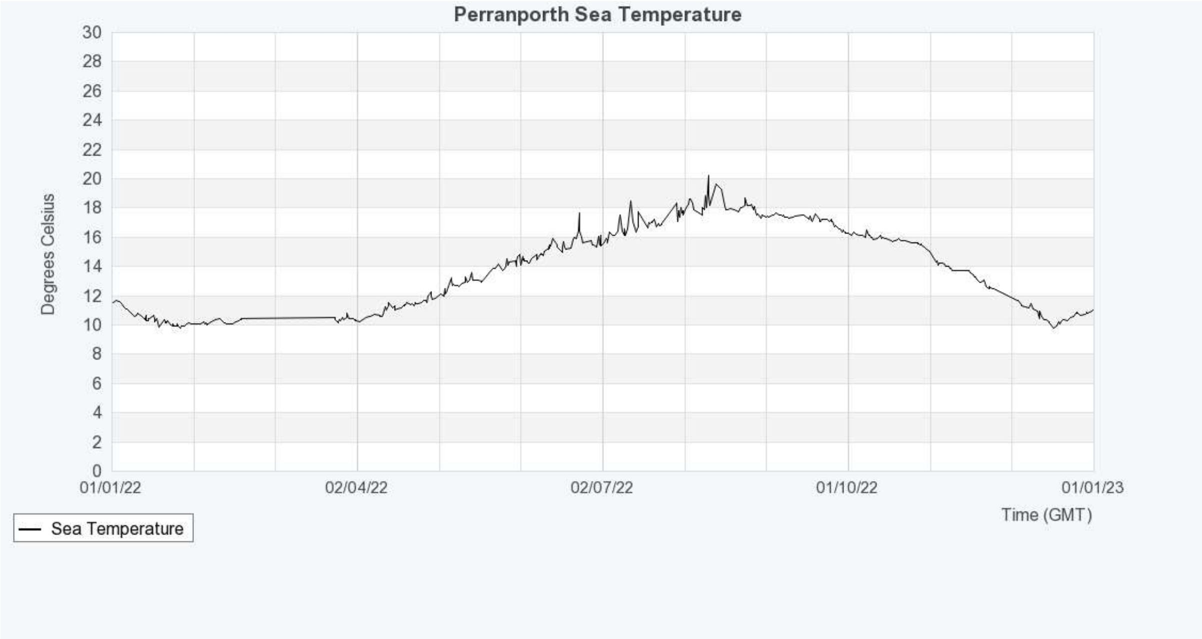

Figure 11. Sea temperature (°C) (2022). NNRCMP

The sea temperatures (Figure 10 and 11) are within the tolerance of the native seaweed species the applicants plan to farm with the peaks in temperature (above the tolerance range) occurring in summer, post-harvest. Site suitability is further indicated within the recent MMO report no. 1184.

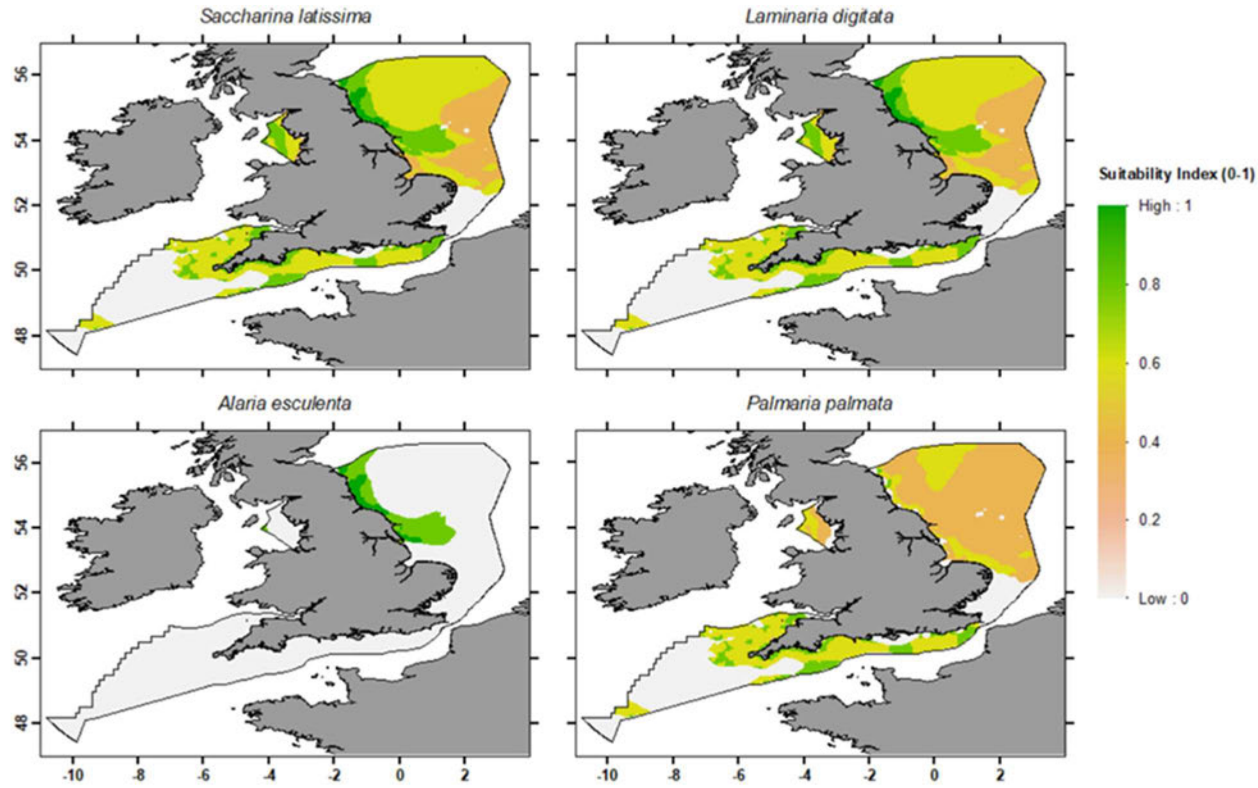

Figure 12. MMO mapping for suitable areas for seaweed species growth off the English Coast. Source: MMO Project No: 1184.

2.4 Deployment Plan

The plan for each licenced site is to deploy (deposit) the main infrastructure – 144 longlines – incrementally over a 2–4 year period in the month of September. The main headline infrastructure remains deposited (and submerged) for the duration of the marine licence and is maintained. Annually, seeded lines (seaweed seeds) are deposited on existing longlines in October/November when the sea temperature is favourable. The seeded lines are removed (harvesting) in April/May annually.

3.0 Farm Impacts

Following the scoping exercise ahead of the WFD assessment (refer to 'WFD Assessment Scoping Assessment'), the applicants identified two reasons why an WFD assessment is required.

They are as follows:

1. The proposed site is within the Bristol Channel SAC
2. The farm infrastructure has the potential to act as a vector for INNS spread.

4.0 Water Framework Directive Screening - RBMP Assessment

4.1 Seaweed Species And Seed Material

The seaweed species to be farmed are all naturally found in the UK and Europe (native). They include native brown, red and green species such as dulse (*Palmaria palmata),* sugar kelp *(Saccharina latissimi),* oarweed *(Laminaria digitata)* and winged kelp *(Alaria esculenta).* Farming a range of seaweed types will enable the farmer to diversify seaweed products, serve existing and emerging markets and offer operational resilience over time. The seaweed will undergo testing to ensure it meets basic standards related to food safety, feed safety and fertiliser safety. Much of this is determined by the water quality and contents in the catchment area. The high-water body status of Cornwall North will ensure a viable product for the business. All species to be farmed are found naturally within the Cornwall North water body and are within their natural biogeographic range.

The seeds for the farm are established from local seaweed populations found within the vicinity of the farm location (South West) using a small amount of fertile material (a few sori). Therefore, the seaweed farmed is from the same populations as from the region it is farmed in and matches local genotype and phenotype. There is no modification. Collection of seed material is described below:

Seed material is sourced from local seaweed populations. The seaweeds to be cultivated are common species found along most of the coastline. No seed material will be collected from within a protected area. Ethically, the fertile material is collected as close to the farm site as possible. Fertile material collected involves the collection of several small patches of fertile material from between 5-10 seaweed 'sori'. This material is then processed by a professional hatchery service and the seeds yielded. This fertile material can be used for several years without recollection.

Methodology: For species already grown, such as sugar kelp, we collect fertile material from seaweed that we have grown from the previous harvest. For new species, collection of fertile material occurs from the coast during low spring tide. The coastline will be selected as close to the farm sites and where the specific seaweed is found. However, this will not be in a protected area. Ideally it is within 2 km of the farm sites. Between 5-10 specimens containing fertile material are collected for each species. Fertile material is removed from the specimens and prepared for transportation according to the specific hatchery's instructions.

Given the low amount of fertile material that is collected and that this material can be used for several years, there will be no significant impact on local seaweed populations.

4.2 Coastal Protection And Flood Risk

The proposed farm sites are not located close to the nearest estuary (The River Camel) which is located outside of Port Quin Bay and to the south. It is more than 2.4 NM from the estuary mouth and associated mudflats. This is important as the species to be farmed do not tolerate reduced levels of salinity and need a standard salinity of 33 parts per million to grow effectively. No significant changes will result from the presence of seaweed farms in Port Quin Bay. Port Quin Bay is not identified as needing coastal protection from storm effects and the bay does not represent a flood risk area. Seaweed farming does not negatively impact flooding.

4.3 Waste And Water Quality

Farming seaweed requires no freshwater water input. It does not require feeding or fertilisers and it produces no waste. In fact, seaweed removes nutrient loads (including N, P and K) through absorption and creation of seaweed biomass. This is called bioremediation, is a valuable ecosystem service and improves water quality within the local water catchment area.

Peer-reviewed, published research articles have established that seaweed farms of 100 Ha and below do not significantly or negatively impact water quality or the natural marine environment (Campbell et al. 2019). Due to the dynamics of the inshore location, any natural material dropping off the farms will be easily dispersed into the wider marine environment, providing food for a range of mobile and benthic species. Deoxygenation or eutrophication effects have not been evidenced around seaweed farms.

This contrasts greatly with fish farming, where excess feed and fish waste can lead to negatively impacted water quality on localised scales. Shellfish also produce waste but do not require feeding.

The applicants are currently working with Exeter and Plymouth Universities and conducting surveys on the existing seaweed farm in Devon. This is a project in collaboration with CEFAS and is monitoring a number of factors including sediment enrichment and biodiversity increase associated with seaweed farms. It is hoped the data will help to fill in knowledge gaps around seaweed farming in Cornwall and Devon.

4.4 Natural Flow And Currents

The location of the seaweed farms (see Figure 1) and the scale of the farms (0.52% of the Cornwall North water body) will result in no significant alteration of natural water flow and currents – especially given the dynamic nature of the water body and surrounds.

In addition, the longline design of the farms reduces impacts to natural flow and currents. The longlines are positioned parallel to each other with a north-south orientation and 20 m gaps in between to enable access by working boats. That distance further avoids impediments to natural flow and currents, expected between 1.4 m/s at its fastest but with an average speed of 0.2 m/s. Final farm orientation reflects the dominant current patterns in the region, orientated along the path of least resistance. In addition, the suspended nature of the farm infrastructure within water depths of 10 - 15 m, in combination with growth being no deeper than 4- 6 m depth range further reduces impact.

The longest seaweed species grown achieves maximum lengths of 1.5 m. Seaweed is adapted to move with currents and flow.

The farm will be using a tried and tested infrastructure design.

4.5 Morphological Effects

The proposed farm site is not located close to sand bars or significant mapped morphological features.

The longlines are held in place by eco-blocks produced by a local company.

- The eco-blocks are 1.8 m^3 with a total of 288 required per site. This provides a highly stable anchoring point for the long-line system but occupies a small area of the seafloor in the region of 518.4 m^3 per site.

The scale of the farms at 0.52% of the Cornwall North water body is very small in comparison to the large-scale morphological shifts that would be observed naturally in the water body (sediments).

The infrastructure system to be used for the seaweed farms, represents a tried and tested system that is being operated successfully in offshore, dynamic sea systems located in the South West – for instance in the Torbay and St Austell areas. In 7+ years, the system has not been dislodged or destabilised significantly on shellfish farms of a similar or larger scale to the proposed seaweed farm. There have been no major losses of equipment or ghost equipment reported along the coast. In addition, the lines have remained in position over the 5+ years despite significant movements of sediment on a seasonal and annual basis. Ongoing maintenance of the lines is essential.

The proposed farm sites are not located close to sand bars or significant mapped morphological features.

4.6 Water Levels

The proposed farms will have no impact on water levels.

4.7 Migratory Mammals, Fish And Mobile Species

Peer-reviewed, published research articles quoted elsewhere in this chapter and ongoing CEFAS supported research at local Universities (Exeter and University of Plymouth) indicates clearly that South West seaweed and shellfish farms protect marine habitats, increase biodiversity, enhancing population levels in fish and benthic species (including those of commercial value). The seaweed canopy provides food, nursery grounds and shelter for a range of species including fish.

Marine mammals have been assessed in the 'Marine Mammal Assessment'. Fish have been assessed in 'Fisheries Assessment'. Birds have been assessed in the 'Bird Assessment'.

The farms infrastructure is submerged 2 m under the water, with only buoys visible at the surface. The applicants selected buoys that are of a shape and colour to minimise disturbance to migratory birds and visual disturbance generally.

Boats working the farm sites operate for the minimum hours required for depositing/removal and monitoring across the year. Usually this requires a single inshore boat. The noise generated by the low-speed boat whilst operating on site is low and much less than that of high-speed recreational boats operating in areas of the sea in multiple numbers. Noise above sea level and below sea level can be monitored. Mitigation of boat noise is discussed under section 1.3.5 'Noise' within this assessment.

The open farm design, described under section 4.4 'Natural Flow and Currents', enables migratory fish to easily navigate through the farm and access the estuary. The scale of the farms would not pose a significant structure within Port Quin Bay or impact and prevent fish migration routes.

Please refer to 'Marine Mammals Assessment', 'Bird Assessment' and 'Fisheries Assessment' for additional in-depth analyses to support this WFD chapter.

4.8 Cumulative Impacts

Port Quin Bay is not considered a highly developed, industrial area and this is reflected in its good WFD status. The following activities are were assessed within the transitional Bay area:

- Aquaculture within Port Quin Bay: No intensive forms of aquaculture.
- Not a Ministry of Defence area.
- No oil or gas licences or pipelines within Port Quin Bay.

- No tidal or wind energy generation.
- No planned significant expansion of port or harbour areas.
- No current aggregate extraction.
- No current marine disposal.
- No dredging.
- Proposed farm is near dive sites/artificial reefs.
- No subsea cables in the vicinity of the farm.
- No major industrial developments along the coast.
- No shipping lane where the seaweed farm is proposed – shipping lanes are predominantly outside of the bay.
- The site is located within the Bristol Channel SAC protecting harbour porpoises.

Please refer to 'Fisheries Impact Assessment' and 'Marine Navigational Safety Assessment and Emergency Response Plan' for a consideration of boat traffic and in-depth analysis of fishing activity within the Port Quin Bay in relation to the proposed seaweed farm sites – including pre-engagement and engagement feedback. It is assessed overall that the proposed farm locations offer the least busy option sat just inside Port Quin Bay, with minimal cumulative impacts and minimal impact on marine traffic, sailing and trawling activity.

4.9 Climate Change

Seaweed farming can contribute to climate change mitigation both directly and indirectly. Directly, seaweed will capture carbon within its biomass (carbon sequestration). The applicants are conducting research with Exeter University to determine exact values for carbon capture in South West seaweeds.

Part of this biomass will enter ocean systems that lock the carbon up for longer terms, as food, which in turn is recycled into the ecosystem. It is also possible to leave seaweed growing on lines (fallow approach) or sink seaweed where more carbon will become locked into long-term sinks. This has a value (additionality case) and requires a carbon code to be developed in order to legitimately trade carbon credits. These could be used to offset industry carbon production, in order to reach 2050 zero emission goals, mitigating climate change. The applicants are working with several groups to formulate an official, government recognised carbon offsetting scheme for UK seaweed farms.

Seaweed can indirectly combat climate change through carbon avoidance along market value chains. For example, seaweed can be used to produce protein without land, fertilisers, feed and freshwater and biomaterials (massive global industry) where carbon production is avoided during production or where the end products are biodegradable and support circular economies.

4.10 Water Usage

The seaweed farms do not require any freshwater input.

4.11 Invasive Non-Native Species

Seaweed farming requires static mooring infrastructure at sea. This can form a structure for the settlement of invasive or non-native species that are already present around our coastline (see MarLIN register and UK INNS register). This potential impact has to be mitigated. The applicants have a biosecurity protocol which applies to all activities at sea, equipment and employees. The biosecurity protocol has been submitted with the licence applications. Furthermore, it can be monitored during farm operations, in collaboration with local Universities.

To date, the following NNS have been recorded in the Bay: the acorn barnacle, *Austrominius modestus* (intertidal) and a seaweed, *Sargassum muticum* (only found in rock pools). Both are reported to be non-invasive and do not have negative impacts on the native ecosystems. The Pacific Oyster, *Magalana gigas* is also present, intertidally. These are not offshore species (rocky reefs/intertidal). Wakame is a seaweed species to be aware of as it can grow on mooring infrastructure. It will be monitored for. Please refer to the 'Biosecurity Plan'. Please also refer to the 'Marine Monitoring Plan'.

4.12 Protected Areas

See assessment above under section 1.3 and refer to the 'Habitat Regulation Assessments'

5.0 Monitoring Program

It is possible to monitor the effects of seaweed farms on the marine environment, biodiversity and habitats, as well as assess the wider economic and social benefits of seaweed farming for local coastal communities.

Such programs need to be done in collaboration with local universities (Exeter University and University of Plymouth) as expertise is important. A range of data can be collected within and outside of the farms. When analysed over time and space, it will indicate or detect significant impacts of the farm on the physical and chemical properties of the marine environment (sediment/water) and on populations/habitats associated with the farms. This can be achieved through the deployment of a range of sensors, seaweed canopy surveys, chemical analyses and ROV surveys for mobile and megafauna.

Such programs are costly in terms of expertise, time, equipment, university overheads and other resources and beyond the affordability of typical seaweed farmers operating a typical seaweed farm business. However, the applicant acknowledges that monitoring is the responsibility of the applicant and a monitoring program will be implemented with Exeter/Plymouth University support: please refer to 'Marine Monitoring Plan'.

It should be noted that recent peer-reviewed publications have reported farms of 100 Ha and less do not have detectable or significant negative impacts on the marine environment or marine life (Campbell *et al.* 2019).

6.0 Assessment Against Natural England Criteria

Natural England identified several potential HIGH and LOW risk impacts of seaweed farming – which may impact water quality, marine life or habitats. This was in the context of placing the farms within MCZ's and not over non-pristine habitat (please refer to 'Fisheries Impact

Assessment'). However, the applicants have considered the factors identified by NE in the context of this licence application – located over coarse sediment (CS).

(Table codes: S – sensitive, IE – insufficient evidence, / – not relevant, SS – subtidal sand, MS – subtidal muddy sand, CR – circalittoral rock, IR – infralittoral rock, X – no impact, ✓- impact. Those potential impacts listed that affect the water body/status specifically are highlighted in blue. The high-risk factors usually form part of any required MCZ assessment screening process (not the case for this application). The low-risk factors are only considered).

Screening assessment: High Risk	CS	Context of seaweed farm	Impact?
Abrasion or disturbance of substrate on the surface of the seabed	S	The eco-blocks used to stabilise the longlines would cause a temporary abrasion/disturbance/scouring of the seabed whilst deployed, albeit small scale given their size. This tried/tested system has been demonstrated not to move significantly once deployed (refer to Biome operated Torbay Seaweed Farm). The weight of the eco-blocks prevents them from moving significantly once deployed. As lines are being deployed incrementally over a 2–3-year period, it is anticipated that 5 days deployment will be required annually. Then the eco-blocks have a lifespan in excess of 20+ years. No more deployment will be required. The infrastructure is located in a SAC area over coarse sediment. However, at full capacity, 100.8 Ha of the coarse sediment will be effectively protected by the licenced farm site, as it can no longer be trawled and the farm infrastructure acts as a *defacto* MPA. MINIMISED and MITIGATED	✓

Genetic modification and translocation of indigenous species	IE	No impact as seaweed to be farmed are UK/European native (natural) species. Seeded from local, natural seaweed populations found within the farm vicinity AVOIDED	X
Introduction and spread of INNS	S	This is a risk as static farm infrastructure is used on site which can act as a raft for settlement of invasive or non-native species. However, the applicants will monitor for INNS during farm operations and employees will follow and adhere to a biosecurity protocol (related to operations at sea, equipment) which will avoid spread of INNS. The protocol is included within the licence application under 'Biosecurity Plan'. NOTE: INNS noted in the Bay have been intertidal species with Wakame being the main species to consider offshore. Dr Angela Mead (CEO/CSO) is an INNS specialist. AVOIDED	X

Penetration of substrate below the surface	S	Eco-blocks do not penetrate the substrate below the surface. AVOIDED	X
Visual disturbance	/	The main farm infrastructure (longlines) is submerged (2 m under the water surface) but are located approx. 10m + off the seabed. Buoys mark the lines on the water surface (camouflaged), with navigational buoys marking the perimeter of the farm, as determined by appropriate regulatory authorities (Trinity House). It does not impact SS. The farms are located within the vision of minimal residential properties however, we have carried out a visual impact assessment to assess the visibility of the farms. MINIMISED AT SEA SURFACE	X

Screening assessment: Low Risk	CS	Context of seaweed farm	Impacts?
Changes in water quality	S	A recent peer-reviewed journal article stated that negative impacts are not detectable or significant for farms containing physical farm structures occupying 10-100 Ha and below (Campbell et al. 2019). The physical farm infrastructure of each proposed site covers 5.04 Ha within their respective 50.4 Ha licenced site. It is recognised generally by scientists that seaweed has a role in bioremediation and the improvement of water quality through nutrient load removal (N/P/K). It is the opinion of Dr Angela Mead, that the presence of seaweed is likely to improve water quality when grown in significant volumes. This is fundamental research that is currently being assessed by several universities around the UK and in Europe. NO IMPACT	X
Deoxygenation	S	Seaweed species farmed are macroalgae. They are not associated with deoxygenation (unlike microalgae and algal blooms). There is no	X

		evidence/studies that identify that farming seaweed leads to deoxygenation. However, following consultation with Dr Angela Mead (27 years; Marine ecologist), she concludes it is unlikely – especially given the spacing between lines, the depth of water below the seaweed (10 -15 m) and the dynamic nature of the sea at the proposed sites (See 'Marine Navigational Safety Assessment and Emergency Response Plan' for conditions). Oxygen levels were monitored by Dr Mead at a similar seaweed farm site in Cornwall with no significant changes in oxygen levels detected. NO IMPACT	
Introduction of light	S	The only introduction of light is from the required navigational marker buoys around the perimeter of the farms. These are standardised buoys for safety and the minimum required will be used. This is a safety measure and unavoidable. See Trinity House requirements within application. Refer to the 'National Landscape Assessment' MINIMISED / OF UNLIKELY SIGNIFICANT IMPACT	✓

Organic enrichment	S	The seaweed species farmed do not require feed or fertiliser. The seaweed species grown absorb nutrients from the water column to build biomass. They therefore remove organic loading that can lead to eutrophication. Peer-reviewed published scientific research indicates that given the size of each of the farm's footprint (5.04 Ha of each of the actual farm's infrastructure) no significant organic enrichment from seaweed farms within sediments below the farms (Campbell et al. 2019) This has been demonstrated for South West based trial farms by Exeter University. This is a CEFAS/Sustainable Futures (Exeter University) study conducted by a PhD student / Dr Carly Daniels and Prof Ross Brown over a period of three years. It involves IFCA helping to complete sediment grabs within and outside of St Austell farms. Initial analyses have not detected organic enrichment. We have permission to present those results broadly but the actual data will be presented as a peer-reviewed report within a journal publication. A PhD student is in the process of completing data collection, analysing data and	X

		assessment of results. EXPECTED: NO IMPACT (Data to fill knowledge gap in near future)	
Physical sediment change	S	Given the small area of the eco-blocks, their spacing and the initial evidence out of Exeter University that the sediment does not receive organic material from the seaweed in amounts that could lead to organic enrichment, no physical sediment change is expected. This is a CEFAS/Sustainable Futures (Exeter University) study conducted by a PhD student / Dr Carly Daniels and Prof Ross Brown over a period of three years. It involves IFCA helping to complete sediment grabs within and outside of Port Quin Bay. Initial analyses have not detected organic enrichment. We have permission to present those results broadly but the actual data will be presented as a peer-reviewed report within a journal publication. A PhD student is in the process of completing data collection, analysing data and assessment of results. Eco-blocks do not penetrate the seabed.	

		Eco-blocks can cause positive physical sediment change in the form of increase of sediment stability, consequently increasing sediment health. EXPECTED: NO IMPACT (Data to fill knowledge gap in near future)	
Smothering/ siltration rate change	S	The seaweed farmed produces significantly less waste than other forms of aquaculture. Given the small area of the eco-blocks, their spacing and the initial evidence out of Exeter University that the sediment does not receive organic material from the seaweed in amounts that could lead to organic enrichment, no physical sediment change is expected. This is a CEFAS/Sustainable Futures (Exeter University) study conducted by a PhD student / Dr Carly Daniels and Prof Ross Brown over a period of three years. It involves IFCA helping to complete sediment grabs within and outside of Port Quin Bay. Initial analyses have not detected organic enrichment. We have permission to present those results broadly but the actual data will be presented as a peer-reviewed report within a journal publication. A PhD student is in the	X

		process of completing data collection, analysing data and assessment of results. EXPECTED: NO IMPACT (Data to fill knowledge gap in near future)	
Introduction of pathogens	S	The seaweed species farmed are UK native and found naturally within the Cornwall North waterbody. They are sourced from natural populations within the region. The seaweeds will be harvested before they start their annual decay. Initial analyses of the seaweed grown in St Austell Bay and Torbay have indicated no negative microflora. NO IMPACT EXPECTED.	X

7.0 Primary References

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Appendix III: Biosecurity Plan

1.0 Farm Details

1.1. Farm Locations

Biome Algae & Camel Fish: Port Quin Bay, North Cornwall. The site locations for the proposed seaweed farms are located inshore, in Port Quin, Cornwall. Port Quin is within the Cornwall North water body GB610807680002. The water body is 19160.18 Ha of water in total. Therefore, the proposed 50.4 Ha farms (100.8 Ha total) would occupy an equivalent of 0.26% (0.52%) of the Cornwall North water body.

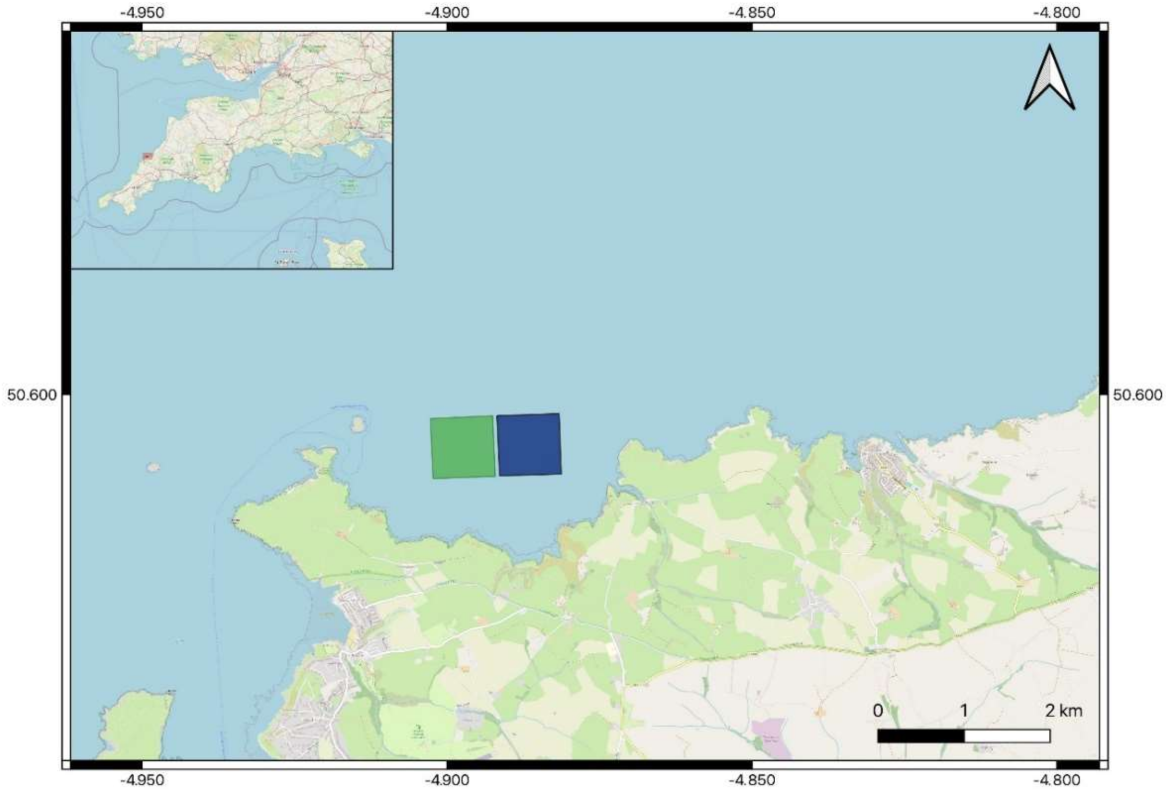

Figure 1. Location of the proposed farms in Port Quin Bay.

1.2. Description Of Farms

Native UK and European species will be farmed on the licenced sites. They will be farmed within the two 50.4 Ha licenced sites (5 Ha total physical farm area at 700 m x 720 m) using longlines. Each site will have a total of 144 long lines (headlines) deployed as permanent infrastructure. Headlines are 160 m in length and positioned in a grid of 36 rows each spaced 20 m apart. This is to allow for adequate spacing between the headlines that will be placed into the site, gradually over 2-3 years (please refer to the proposed farm plan and the 'Marine Navigational Safety Assessment (NSA) and Emergency Response Plan'). There will be 2 eco-blocks on each line and a total of 288 eco-blocks will stabilise the headlines on the seafloor for each site (Figure 2).

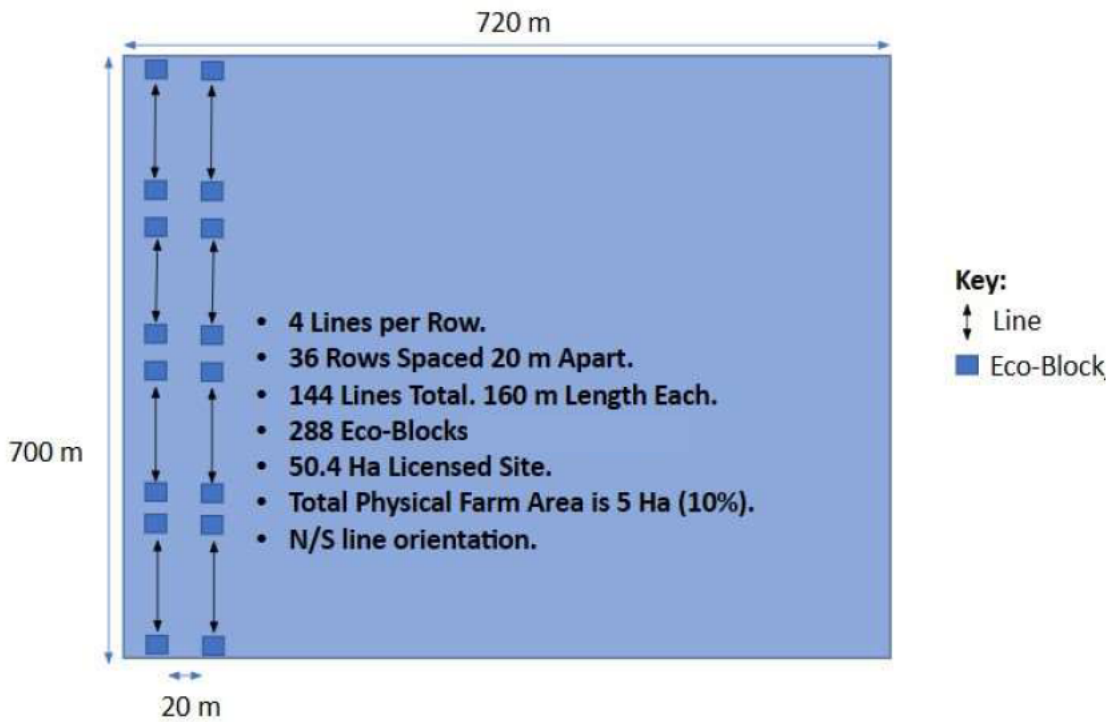

Figure 2. Proposed farm plan (both sites are identical).

Four special mark navigational buoys, as described by Trinity House, (noted within the 'Marine Navigational Safety Assessment (NSA) and Emergency Response Plan') mark the four corners and perimeter of each farm. Standard grey 130 litre buoys are located along the lines. Seeded ropes are attached along the headlines annually (usually October/November). There follows a growth period (November to April) and the seeded lines are then removed (harvesting) in April/May and through to August if required (species dependent).

Figure 3 indicates a typical long-line design. The eco-blocks are 1.8m^3. A line requires 2 eco-blocks. Therefore, a total of 288 eco-blocks will be used per site. The potential area displaced by eco-blocks on the seabed is 518.4 m^3 per site.

This is the same anchoring method currently used by Biome Algae on the seaweed farm site they operate in Torbay, and the seaweed farm site they operated in St Austell. They have been chosen due to their fast deployment using an ROV, minimal impact on sediment, small diameter and the fact they do not move once deployed. They are produced by a marine business located in Torbay and Cornwall. More information can be found within the 'Marine Navigational Safety Assessment and Emergency Response Plan'.

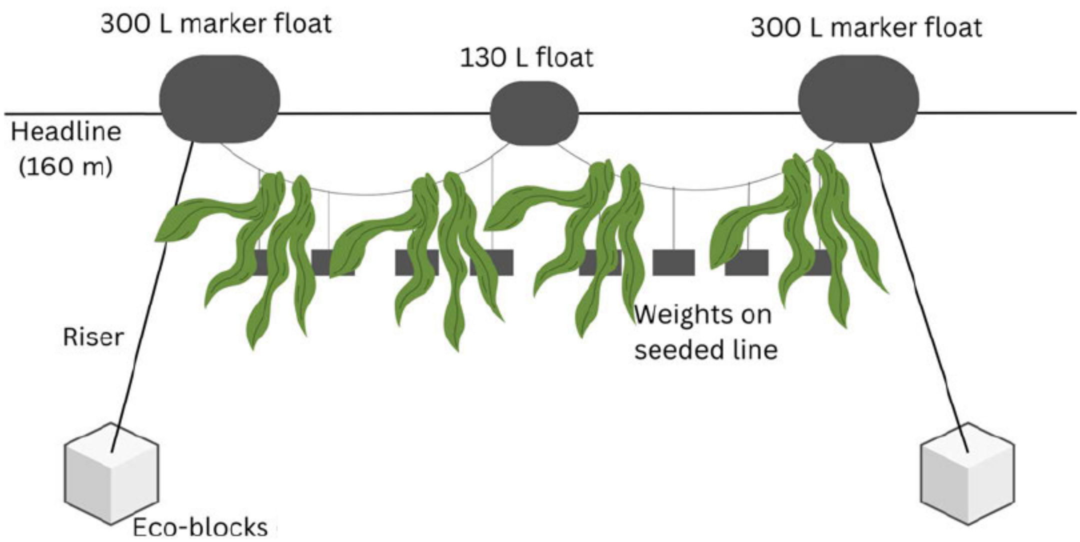

Figure 3. Typical longline (headline) will be 160 m long with eco-blocks designed for sediment type.

The farm system to be implemented is a tried and tested system that is used successfully in offshore shellfish farms located in South West waters. The system is proven to withstand high-energy sea conditions, storms, and sediment shifts over time. There are no recorded incidents of significant infrastructure failure both at St Austell Bay and Torbay sites that Biome has used for seaweed cultivation. The system has been proven to be highly stable throughout the year.

The applicants are currently researching the use of BioGears ropes and hopes to implement them in 2025. These are biodegradable ropes made specifically for Aquaculture with the aim of reducing old ropes going to landfill (*Greene, 2020*). The majority of structures are submerged (sat between 2-6 m) in depths of 10-15 m and therefore not visible from the surface. Furthermore, the applicants select buoys that are of a shape and colour that minimisers disturbance to migratory birds and visual disturbance generally.

1.3 Site Coordinates

The coordinates of the four corner points of the proposed farm in Port Quin Bay are detailed within Table 1.

Proposed Biome Algae corner coordinates:

Farm Corner	Latitude	Longitude
Northwest	50.597784	-4.891862
Northeast	50.59801	-4.881677
Southeast	50.591715	-4.881306
Southwest	50.591518	-4.891385

Proposed Camel Fish corner coordinates:

Farm Corner	Latitude	Longitude
Northwest	50.597496	-4.90274
Northeast	50.597764	-4.892561
Southeast	50.591496	-4.892087
Southwest	50.591242	-4.90231

Table 1. Farm corner coordinates (in WGS84) for the proposed farm locations in Port Quin Bay.

1.4 Plan Period

The biosecurity plan will run in parallel to the licence length and will be undertaken during and as part of farm operations. The plan will be reviewed and updated annually (i.e. detailed in section 9).

1.5 Biosecurity Manager/ Officer

Dr Angela Mead, CEO/CSO: Biome Algae Limited

Paul Blewett: Camel Fish Limited

2.0 Farming Cooperative In The Bay

Biome Algae and Camel Fish will be cooperatively working together. The proposed farm locations are located adjacent to one another however, they are separate applications. Both licence applications will be running independently of each other. (Refer to Figure 1)

3.0 Information Affecting Biosecurity

Salinity	Need a standard salinity of 33 parts per million to grow effectively. No significant changes will result from the presence of a seaweed farm in Port Quin Bay.
Marine Features Present	See 'Water Framework Directive' and 'National Landscape Assessment' for additional detail: the sites are located on gravel sediment which is not protected. The sites are at significant distance from historic sites (shipwrecks), (Marine Conservation Zone (MCZ), coastline and Sites of Special Scientific Interest (SSSI's).
Non-native species known to be present	The majority of non-native species listed/documented for Port Quin Bay are intertidal species only and are not found offshore, at the licenced site location. Invasive non-native species (INNS) noted Wakame being the main species to consider offshore. Dr Angela Mead (CEO/CSO) is an INNS specialist. To date, the following non-native species (NNS) have been recorded in the Bay: the acorn barnacle, *Austrominius modestus* (intertidal) and a seaweed, *Sargassum muticum* (only found in rock pools). Both are reported to be non-invasive and do not have negative impacts on the native ecosystems. The Pacific Oyster, *Magalana gigas* is also present, intertidally. These are not offshore species (rocky reefs/intertidal). Wakame is a seaweed species to be aware of as it can grow on mooring infrastructure. It will be monitored for. Please refer to the 'Marine Monitoring Plan'.

	However, the applicants will monitor for INNS during farm operations and employees will follow and adhere to a biosecurity protocol (related to operations at sea, equipment) which will avoid spread of INNS. There are a few that can attach to mooring equipment. Refer to 'Water Framework Directive'. The precautionary principle will be applied and a biosecurity plan implemented by the farm operators.

4.0 Vessel Types

Until Biome is operating the hybrid kelp farming vessel (purpose designed), in 2024, there will be subcontracted vessels to deploy the headlines, deploy the seeded lines, monitor and maintain their farm, and remove the seeded lines (harvesting). Records of vessels contracted by Biome will be maintained. It will be part of the contractual obligations that the boat crew of hired vessels are aware of and follow the biosecurity protocol developed and implemented by Biome when undertaking operational work on the farm. Any significant changes to vessels used or in the event Biome acquires its own vessels to service the farm, records will be updated. Biosecurity training will be delivered to all Biome staff, vessel operators and crew members by the named Biosecurity Officer. Refresher courses will be delivered annually. Random inspections to check operational procedure is being followed will be undertaken, reported and reviewed internally by Biome with records maintained.

Camel Fish will be operating their own vessels to deploy the headlines, deploy the seeded lines, monitor and maintain their farm, and remove the seeded lines (harvesting). It will be part of the contractual obligations that the boat crew are aware of and follow the biosecurity protocol developed and implemented by Camel Fish when undertaking operational work on the farm. Any significant changes to vessels used will result in records being updated. Biosecurity training will be delivered to all Camel Fish staff, vessel operators and crew members by the named Biosecurity Officer. Refresher courses will be delivered annually. Random inspections to check operational procedure is being followed will be undertaken, reported and reviewed internally by Camel Fish with records maintained.

5.0 Site Activities

The site activities that will take place on the farm are:

- Eco-blocks placed on the seabed
- Ropes, buoys, and other farm infrastructure in the water for extended periods of time

5.1 Activity Risk

Due to the static nature of the farm infrastructure in the water column, there is always some risk that it could become a vector for the spread of invasive species along the coastline.

6.0 Biosecurity Control Measures

Who	What	Where	When
Biosecurity officer, employees and sub-contracted crew/vessel operators	Visual inspection & surveys (infrastructure monitoring & seaweed canopy) INNS records, communication with harbour master, MBA INNS team (Plymouth), Exeter	The seaweed farm – a monitoring program designed by researchers and INNS specialists (see protocol) The seaweed farm / on land	Monthly Monthly

	University and the University of Plymouth. INNS removal from site. Use of specific safety at sea apparatus, wellies & kit: & survey apparatus specific to farm activity Cleaning of specific safety at sea apparatus, wellies & kit, survey apparatus, boat and equipment.	At sea: Equipment to be used ONLY for the purpose of farm operations at sea. At sea: Cleaned on the boat offshore at the end of operations using seawater (deck, equipment and boat) minimising transfer to intertidal zone or docks.	Every time boats are in operation Every time both are in operation

7.0 Site Surveillance Reporting Procedure

A trained team (inclusive of researchers/scientifically qualified staff members) will inspect infrastructure at the farm site using up to three approaches:

1. Visual inspections of ropes whilst servicing the farm (with identification, removal and data recording (noting species, number, and location))
2. ROV inspections of risers and eco-blocks (as for visual inspections)
3. Randomised sampling of the seaweed canopy across lines with quadrats (within quadrats – as above for visual and ROV inspections).

- Training will be undertaken with a recognised INNS institute to understand survey techniques, data collection and identification of invasives.
- Specific protocol for surveys will be laminated and kept on board vessels and in offices for reference. This will include a visual list of common invasive species in the region to be used in the basic training of all survey workers. These will be reviewed regularly and updated under the advisement of research partners/institutes (Biosecurity Officer).
- Monthly survey records and data sets will be maintained internally. Company management will be informed of INNS detection – for actioning.
- There will be strong lines of communication between the Biosecurity Officer, Research institutes listed (including the MBA who are UK lead on INNS records) and locally, the Harbour master and other regulatory bodies/stakeholders if set down as a condition of the marine licence (NE, EA, MMO, AONB).
- Should invasive species be detected, they will be removed from infrastructure (hand-picked off, scrubbing equipment without the use of chemicals, removal and replacement of equipment in extreme infestation cases).

8.0 Biosecurity Records and Data

Biosecurity records and data will be maintained internally with the applicants in line with their data protection and privacy laws. The applicant will produce records for inspection as required under the conditions of the licence.

9.0 Plan Review Date

The plan will be reviewed annually before the start of the seaweed growing season (July-September).

Appendix IV: Marine Monitoring Plan (Original for Reference)

1.0 Introduction & Background

The applicants will conduct a monitoring program during operation of the farm sites in Port Quin Bay. The goal of the monitoring program will be to assess how the seaweed farm interacts with the marine environment. With the aim of:

- Avoiding or mitigating any negative impacts identified through the 'Water Framework Directive Assessment', 'National Landscape Assessment', 'Marine Mammals Assessment', 'Birds Assessment', 'Fisheries Assessment' and the 'Habitat Regulatory Assessments'.
- Invasive and Non-Native Species monitoring (see 'Biosecurity Plan', and 'CIFCA Biosecurity Plan 2019'), to ensure organic enrichment of the sediments is not occurring and measuring of abiotic parameters indicating water quality: (oxygen levels, turbidity, Chl a, temperature).
- Measuring the benefits of the seaweed farm (habitat restoration, biodiversity effects and carbon capture).

Information on the Port Quin Bay area, physical conditions within the bay, water quality, sediment type, other sea-users in the area, navigational safety plans and the planned farm structures to be deployed are described in the following chapters:

- 'Water Framework Directive Assessment'
- 'Marine Navigational Safety Assessment & Emergency Response Plan'

The location of the proposed farms in Port Quin Bay are detailed within Figure 1. The coordinates for the four corner points of the proposed farms are detailed within Table 1 below.

Proposed Biome Algae corner coordinates:

Farm Corner	Latitude	Longitude
Northwest	50.597784	-4.891862
Northeast	50.59801	-4.881677
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Proposed Camel Fish corner coordinates:

Farm Corner	Latitude	Longitude
Northwest	50.597496	-4.90274
Northeast	50.597764	-4.892561
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Table 1. Farm corner coordinates (in WGS84) for the proposed farm locations in Port Quin Bay.

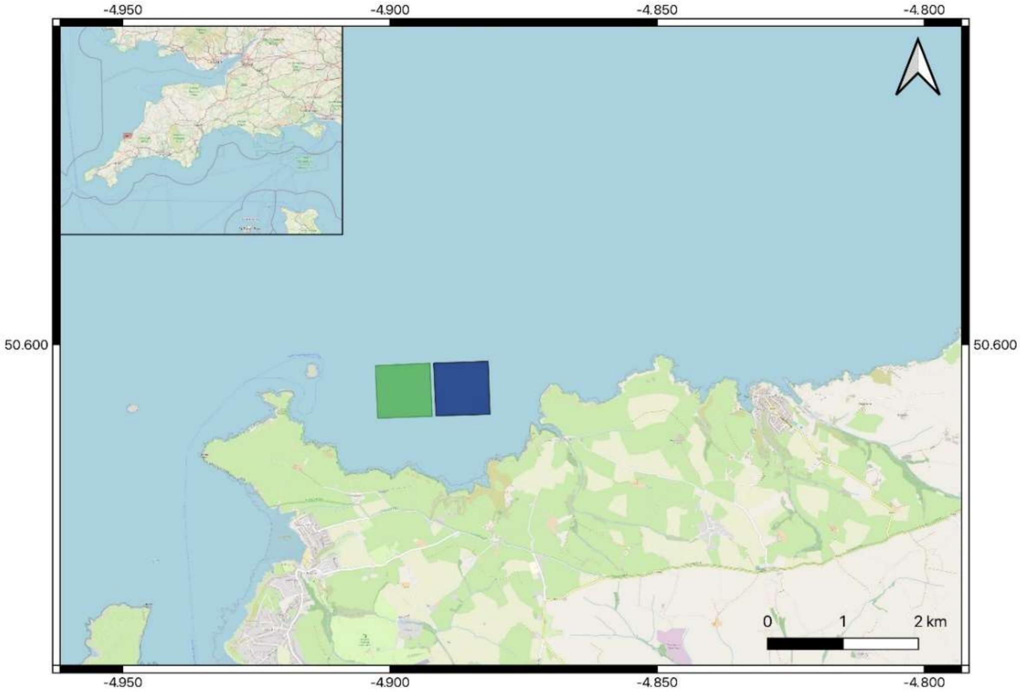


Figure 1. The location of the proposed farms in Port Quin.

Within the Water Framework Directive Assessment, impacts are assessed overall as no impact, impact avoided or impact mitigated.

The monitoring program (described below) will be conducted from the start of each season (deployment of seeded lines) through to removal of seaweed lines (harvesting). The program will build on a monitoring program and collected data on seaweed farms within the South West region (Cornwall and Devon). DEFRA agreed that information collated from a farm within the same region of the UK can act as a baseline proxy for other similar scale farms within the same region. The applicants will partner with Exeter and Plymouth University, who have extensive experience in monitoring seaweed and shellfish farms within the South West region.

2.0 Monitoring To Date

Research institutes (Exeter University, Plymouth University and the Marine Biological

Association) have been conducting vital research on seaweed lines to fill in specific knowledge gaps about the impacts and benefits of farming seaweed on the marine environment, habitats and biodiversity. One such program (Exeter University) has formed the basis to a PhD and was conducted in partnership with Centre for Environment, Fisheries and Aquaculture Science (CEFAS). The institutes have been monitoring and measuring how farming improves/impacts water and sediment quality, increases biodiversity and restores/regenerates habitats in partnership with Biome Algae and West Country Mussels in St Austell Bay, Cornwall and Biome Algae and Aqua Botanika in Torbay, Devon.

Previous monitoring has occurred at licenced sites (L/2015/00333/1 and L/2021/00135/1). To date they have completed sediment studies, canopy surveys, ROV surveys and monitored water quality. On-going data analyses and initial results indicate:

- No significant negative effects have been detected at the current licenced sites. Significant increases in biodiversity associated with seaweed lines have been detected.
- No significant levels of organic enrichment associated with seaweed lines or significant changes in the fauna associated with the sediment on site.

These results are being published as part of a PhD thesis and will be written up as peer-reviewed journal articles.

3.0 Monitoring Concept

The applicants would continue to support research efforts made to assess the impacts of seaweed farming on the marine environment and marine life in the South West. University partners would remain Exeter University and University of Plymouth. This would provide vital data (short and long-term) to fill knowledge gaps around farming seaweed and build on what has already been achieved. Where possible, the applicants will seek out appropriate grants/funding to help complete this research, or fund from within the company.

The applicants will be working with Hortimare (a seaweed breeding and propagation company in the Netherlands) and internally with Dr Angela Mead (27 years research experience in the field), to conduct research around the farming model and seeding/hatchery processes. This will build on the research already conducted in Cornwall by Biome and West Country Mussels and in Devon by Biome and Aqua Botanika.

Access to the site for monitoring purposes can form part of the weekly maintenance survey trips (lines are monitored for integrity/buoys added to lines if required). In addition, the use of sensors deployed at the site will provide continuous data sets around key parameters of interest. Combined field surveys and sample collection will result in the collation of long-term time series data. This can be applied by the regulatory bodies (DEFRA, CEFAS, MMO) when making decisions about aquaculture activities within England in the future.

4.0 Monitoring Plan

4.1 Pre-Monitoring

This will be conducted ahead of deploying seeded lines:

1. With the assistance of CIFCA, collection of sediment samples within and outside of the farm site. To be analysed for organic content and macrofauna. To establish a baseline
2. Collection of water samples within the Bay to establish a baseline.
3. Establish baseline data around macrofauna (benthic and pelagic) in the area – using non-lethal traps (capture/release) and ROVs.

Specifics of the experimental design will be done in consultation with University partners and the applicants.

4.2 Monitoring

4.2.1 Water quality

Water quality data will be collected through sampling and in-situ sensors, with parameters including; temperature, oxygen, Chl a and turbidity. This can be compared to useful satellite data.

4.2.2 Sediments

Infaunal: Grab samples within and outside the farm to compare community assemblages. To be considered alongside data on the sediments related to organic enrichment. Redox experiments will also be conducted to assess the oxidation: reduction relationships in sediments around the farm.

4.2.3 Benthos

Non-lethal catch and release traps to monitor the movement of benthic mobile species through the site.

4.2.4 Pelagic

ROV surveys on-site combined with physical surveys of the farm infrastructure/seaweed canopy to determine farm impacts on biodiversity and movement of species through the farm.

4.2.5 Seaweed

Seaweed samples will be removed throughout the growing season to:

- Profile components of seaweed to include FSA requirements, HABSEC, heavy metal profiles and microbial components of the seaweed produced (soil association and approved independent labs).
- Assessment of carbon content within seaweed.

4.2.6 INNS

Refer to ‘Biosecurity Plan’ and ‘CIFCA Biosecurity Plan 2019’. Protocol to be followed detailed within both.

Specifics of the experimental design will be done in consultation with university partners and the applicants.

Appendix V: Marine Navigational Safety Assessment And Emergency Action Plan

1.0 Introduction: Project Details & Assessment Approach

Biome Algae and Camel Fish are applying for a two individual Marine Management Organisation (MMO) and Crown Estate licences for 2 x 50.4 Ha (100.8 Ha total) seaweed farms in Port Quin Bay, Cornwall (see Figure 1 & Table 1). The site perimeters will be marked according to the standard guidelines usually issued by Trinity House for navigational safety markers (see Annex I) and in accordance with the conditions within the MMO licence. Trinity House are being consulted as Primary Assessors.

The seaweed farms will each consist of 144 x 160 m long-lines, orientated north-south and spaced 20 m apart. The total physical farmed area (based on physical infrastructure alone) is 5.04 Ha (10.08 Ha combined) total. This represents 10% of the proposed licenced site footprints with the remaining 90% as open sea to accommodate sea users and facilitate navigational safety. Clear, open access channels span across the whole sites (wide exit/escape/transitionary channels). The overall structure of the sites is discussed in more detail within this appendix. The sites will be developed incrementally, starting with a low number of lines and increasing to the full 144 lines gradually over 3-4 years working with the Crown Estate. Therefore, the initial footprint of the farms will be maximum 10/100 Ha.

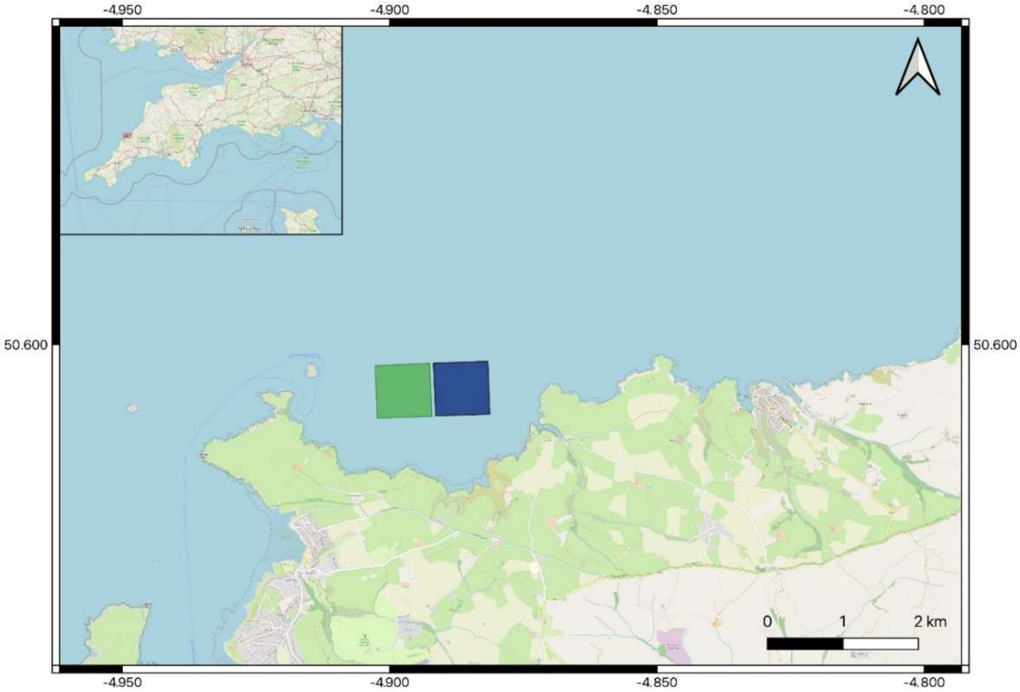


Figure 1. Location of the proposed seaweed farms in Port Quin Bay.

The proposed farms in Port Quin Bay will be situated adjacent to each other with the Biome proposed farm in the East and the proposed by Camel Fish Limited in the West.

Seeded seaweed lines will be deployed onto main headlines in October/November each year. The seeded lines are then removed during harvesting and landed from April onward each year. It is expected that the main harvest will be completed by June end, ahead of the busy summer period for marine traffic.

Proposed Biome Algae corner coordinates:

Farm Corner	Latitude	Longitude
Northwest	50.597784	-4.891862
Northeast	50.59801	-4.881677
Southeast	50.591715	-4.881306
Southwest	50.591518	-4.891385

Proposed Camel Fish corner coordinates:

Farm Corner	Latitude	Longitude
Northwest	50.597496	-4.90274
Northeast	50.597764	-4.892561
Southeast	50.591496	-4.892087
Southwest	50.591242	-4.90231

Table 1. Farm corner coordinates (in WGS84) for the proposed farm locations in Port Quin Bay.

As the proposed sites are not within the jurisdiction of a statutory Harbour Authority, navigational safety associated with the project will fall to the Maritime & Coastguard Agency (MCA) to assess that any identified risks to marine traffic and licenced marine activities in the area have been brought to as low as reasonably possible (ALARP).

The assessment will therefore consider the current levels of marine traffic and cumulative licenced marine activities within the area pre-installation of the proposed project. Risks post-instalment will be assessed and risk levels identified before and after mitigation measures have been put in place, where required.

To assess navigational safety, the applicants have outlined levels of engagement with marine stakeholders related to the project. This is followed by a desktop assessment related to marine traffic using a range of data-based evidence. Consideration is also given to other licenced activities identified within the vicinity of the proposed farm. The outcomes have been used to clearly identify risks associated with the proposed project at this specific marine location. The applicants analysed the risks associated with the project, and where required, have proposed measures to reach ALARP in each case.

In addition, the applicants have included an emergency response plan which clearly outlines actions, responses and responsibilities should any of the identified risks occur within the proposed farm site. This is to accompany the Emergency Response Card outline (provided within the chapter). Currently, this is in draft format until a marine licence is issued, these Emergency Response Cards have been emailed for draft approval to HM Coastguard – OELO@mcga.gov.uk. They are to be submitted formerly once MMO licences are issued.

A clear decommissioning plan for the sites is outlined, to ensure that when activity ceases on sites, they will be returned to original condition, ensuring the sites pose no risks to marine traffic and other marine activities – as per agreements with the Crown Estate.

Although developed for the extensive offshore renewables sector, The applicants referred to the MCA Marine navigational Safety and Emergency Response Risks document/guide. Although the scale and nature of this project is significantly lower than these developments, The applicants have lifted information where it is proportionate and applicable.

2.0 Expert Opinion On Safety

For reference, this chapter has been prepared by Biome Algae. Biome are active seaweed farmers (since 2020) and the consultants used for several granted MMO marine licence applications related to seaweed farms.

The longline farm design is based on existing licenced shellfish farms, operated to a high standard in St Austell Bay and within Torbay, as well as a seaweed farming site within Torbay operated currently by Biome. Biome had been operating in seaweed farms since 2020. Despite seaweed farming being a new entrant as legitimate users of the sea, there are clear similarities between infrastructure found in shellfish and seaweed farms, the former having operated since 2010 and 2015 without significant incident.

The infrastructure has been further assessed, analysed and robustly designed by professional, independent marine engineers to ensure stability through various storm frequencies and specific to Port quin Bay. This is to ensure structural stability which significantly contributes to reducing navigational safety risk to ALARP. Please refer to Chapter 5 and Appendix I.

In order to further ensure the information used to assess the risks was accurate, the applicants consulted a number of experts. Harbour Master Commissioners were consulted. Active fishers were also consulted for their expert opinion on fishing activity within ICES30E5. The applicants consulted a qualified and experienced naval architect for their input. The risks identified, assessments conducted, final farm design and measures in place to achieve ALARP were determined alongside the information provided by these experts.

3.0 Stakeholder Engagement

The applicants have both fully engaging with the MMO's marine licensing process. An initial 28-day public consultation process was undertaken, with the projects individually advertised in a local newspaper, within the Padstow Bay Harbour Masters Office window and on Harbour notice boards (evidence supplied, these Marine Notices were pinned between 16.10.23 to 13.11.23). The applicants also individually published marine notices in Fishing News (evidence supplied).

Following the initial 28-day public consultation period the applicants were asked to reopen their applications by the MMO for another 28-days which both parties complied with. During this 28-day period the applicants did not have to publish marine notices in newspapers. However, they did have to post the marine notices in two car parks; one in Port Quin and one in Port Isaac (evidence supplied). A further 28-day public consultation period will be completed in parallel with further assessment by Primary Assessors before licence decisions are made. This represents a total of 84 days public consultation.

During the second period of public consultation the applicants were involved in a meeting with the public to present and discuss their proposals and to answer questions. This took place in St. Minver Hall, Wadebridge on 27th February 2024. At least 130 + people attended.

In terms of responses from the public, there were both supportive comments and concerns covering a range of topics. The applicants have been working internally and with external and independent support/experts to address all concerns raised by the public and MMO, for further consideration by Primary Assessors and to inform a licence decision (2 x further information requests completed (FIR's) and an FIR completed on 18th December 2023, which included information for Trinity House).

Prior to submitting applications to the MMO, the applicants pre-engaged active stakeholders that operate in the proposed area of works. This included but isn't limited to: fishers (potters and trawlers), charters, boat tours, Harbour Masters, sailing clubs, and divers. When submitting the initial pre-engagement log there were no objections from the listed stakeholders. Since submitting the applications, the applicants have conducted surveys and interviews with active fishers operating in the area of works (specifically for under 12 m vessels). Please refer to Appendix VIII which discusses the fisheries activities in ICES30E5 with vessel operators in this size category and which builds on initial pre-engagement. Stakeholders were aware that there are two proposed seaweed farm sites.

During the licensing process the applicants have had several meetings with the Crown Estate. In part, this was to establish a conflict plan to ensure the farm has no conflicts with any other marine licence applications – there were no conflicts. These were provided by the Crown and have been submitted to the MMO as evidence for both farm sites. Further discussions with the Crown Estate are related to site planning, due diligence and decommissioning arrangements for the sites.

The applicants reached out directly to sailing clubs (evidenced) and received responses: they had no objection to the proposed site. The applicants also contacted the RYA for sailing data from seaTRK and Coast Atlas. Sailing data has been collected for this application through direct communication with the sailing clubs that operate out of Padstow, Camel Fish's experience of marine traffic in the Bay (50+ years' experience) and from Electronic Navigational Charts (ENCs) such as EMODnet. Evidence of our engagement with the sailing clubs and the RYA can be seen in the 'Pre-engagement log' and 'Pre-engagement Evidence'.

Outcomes of all engagement have been combined with outcomes of a desktop study using AIS/Non-AIS data records (within this chapter) and IFCA VMS data sets (see chapter 13).

Overall, the applicants have made significant efforts to engage with a range of key stakeholders during the licence application process. To summarise:

1. We have consulted with the local potting community and they have raised no objections. They have provided us with a letter of support.
2. We have consulted with the local trawlers and they have raised no objections. They have provided us with a letter of support.
3. We have consulted with the local sailing clubs and they have raised no objections.
4. We have pre-consulted with the local Harbour Master's. They initially raised no objections and provided a letter of support. However, since the applications have been ongoing the Harbour Masters have been made an assessor for these licence applications so they can no longer provide the letter of support.
5. We have consulted with local diving clubs and they have raised no objections.
6. We have consulted with local charter companies and boat tour businesses (4) and they have raised no objections. They have provided us with a letter of support.

7. The Crown has indicated that the area is available to lease and have checked the conflict plan, revealing no conflict for either site (included within application).
8. We have consulted with land-based farmers in the Port Quin region and they have raised no objection. They have provided letters of support for the applications.
9. We have consulted with the public who have shown both support and have submitted representations in the form of concerns. We address those concerns within this document.
10. We have ensured that the proposed farm areas are not within main racing areas (sailing).
11. Using the data-driven traffic analyses, we have checked that the final selected locations are positioned within an area of relatively lower marine traffic compared to other areas of the Bay. Infrastructure occupies 10% of the proposed sites, with 90% remaining open sea.
12. We have assessed the location of the farm in relation to the nearest coastline, local harbours, the nearest shipping channels and with regards to re-routing traffic around the farms. Distances indicate that there is sufficient safe space for re-routing transitioning traffic and sufficient distance to avoid navigational safety risks (see below).
13. We assessed the proposed sites and checked that the location would not significantly impact larger vessels (tankers, cargo and cruise ships for example) use the Bay intermittently for anchorage in bad weather (see below).
14. We have checked that re-routing impacts are further reduced by ensuring the farms are orientated to minimise re-routing.
15. The applicants, working with the Crown Estate, will initially install a lower number of headlines – with the site marked for safety. This provides a transitionary period with an initial smaller site whilst marine traffic and sea users become acclimated to the farm's presence.

*NOTE: The distances from the proposed farm to key neighbouring land and tourism features are as follows:

- Nearest Coastline (south of proposed site) – 0.5-0.6 km heading 180^o
- Port Quin Harbour (east of proposed site) – 0.55 km heading 98^o
- Padstow Harbour (southwest of proposed site) – 8.2 km heading 226^o
- Mouls Island cruise pathway (channel between the rumps/mouls) west of the proposed site) – 0.7 km heading 270^o

The applicants have balanced the location and planning of the proposed farms across all stakeholders and agencies whilst mitigating risk to those marine users. We will continue to communicate and engage with all local stakeholders during the farm's operations. Once the licences are granted, all relevant marine users and agencies will be informed of the new location through marine notices, as per the conditions of the licence. Nautical charts will be updated according to MMO conditions.

The assessment reduces risks to ALARP.

4.0 Navigational Risk Assessment

Data sets have been used to assess the risks posed to marine traffic and other licenced marine operations at the proposed farm site.

The applicants have utilised multiple sources of data to capture the overall picture of traffic levels within the Bay but specifically, at the proposed farm locations. To capture vessels with AIS; EMODnet, MarineTraffic and Vesselfinder data were used. These sources capture traffic levels within a 1 km^2 pixel resolution for the farm's vicinity. EMODnet and MarineTraffic present yearly averages for vessels between 2017 and 2021. Vesselfinder data provides vessel density information that can be used to interpret anchorages.

To further the analyses, the applicants use NCI data (vessel counts) that covers the same period and captures different vessel types within or passing the Bay on a monthly basis. Although this data may or may not indicate vessels passing through the exact proposed farm site – the data is a reasonable proxy for maximum traffic levels in the whole Bay area and the counts capture seasonal variability. We have worked on the assumption that all those vessels captured move through the proposed farm site when assessing impact levels.

Fisheries inshore vessel monitoring systems (IVMS) data sourced through the MMO have also been assessed and are detailed within the 'Fisheries Impact Assessment' that accompanies this application. These data provide spatial information on fisheries vessels (>12m) that are fitted with VMS and have been used to investigate the potential impacts of the proposed farm on existing fisheries activities.

The applicants have conducted interviews and surveys with relevant stakeholders (fishers) regarding vessel size, fishing activity, and if they support the application and believe the site locations will have an impact on their fishing activities (Appendix VIII). This document is extremely insightful for fishing activity in the ICES30E5, significantly for those in vessels under 12 m. Through the extensive list of support from fishers in regards to the site locations it can be stated that the proposed sites will not have an impact on ongoing fishing activity with the spatial area mentioned above. The proposed site locations will not have an impact on anchorages for the fishers (Appendix VIII).

4.1 Desktop Study: Vessels With AIS

4.1.1 Annual Vessel Density

Vessel AIS data derived using data sets from EMODnet was used to determine navigational risk of the farm to boats operating AIS (Figure 2-5). The data comprises the yearly average for the number of vessels using AIS technology within a 1 km^2 pixilated area. Data was reviewed from 2017-21 but 2019 was selected as being the most accurate and latest data pre-covid. The location of the farm is indicated within the figures below, using a black arrow to identify the relevant pixel used to assess traffic on the proposed site. Vessel densities (hrs/km^2/yr.) for all sailing, fishing and pleasure craft vessels fitted with AIS at the proposed farm location are detailed within Table 2.

Analysis on EMODnet human activities	2017: hrs/km²/yr. (average)	2018: hrs/km²/yr. (average)	2019: hrs/km²/yr. (average)	2020: hrs/km²/yr. (average)	2021: hrs/km²/yr. (average)	Average for 2017-2021 **including 2020:** hrs/km²/yr.	Average for 2017-2021 **excluding 2020:** hrs/km²/yr.
All vessels	7.39	3.17	4.14	2.13	9.04	5.174	6.226
Sailing vessels	0.71	0.03	0.05	0.04	0.08	0.182	0.316
Fishing vessels	0.45	0.2	0.32	0.01	1.43	0.482	0.57
Pleasure craft vessels	0.63	0.06	0.01	0.02	0.06	0.156	0.278
Others	0.61	0.08	0.01	0.34	0.20	0.248	0.225
Service	0.01	0.11	0.05	0.00	0.09	0.052	0.065
Dredging or Underwater Operations	0.00	0.00	0.00	0.00	0.42	0.084	0.105
High Speed Craft	0.00	0.84	1.71	0.88	4.51	1.588	1.765
Tug and Towing	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Passenger	2.04	1.86	1.94	0.82	1.02	1.536	1.715
Cargo	2.78	0.00	0.00	0.00	0.67	0.69	0.8625
Tanker	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Military and Law Enforcement	0.16	0.00	0.04	0.01	0.55	0.152	0.1875

Table 2. Summary of density of marine vessel traffic at the proposed Port Quin Bay farm for 2017-2021 (1 km² pixel). Spatial Extent: Within ICES30E5, EMODnet reference C-Square 7500:104:459:3.

Analysis by the applicants using EMODnet data indicated vessel traffic levels were variable across the years of available data (Table 2). The average vessel activity for All vessels ranged from 2.13 to 9.04 hrs/km^2/year across the pixel used to assess vessel density. Vessel activity for the three focus categories combined contribute approximately 16 % of the average activity of all vessels between 2017 and 2021.

The three focus vessel categories (sailing, fishing, pleasure) that are typically going to be impacted by the farms remain at low levels (< 1.5 hrs/km^2/yr.) through the period of available data. The broader area of the proposed farm appeared to also be used by passenger vessels and to a lesser extent cargo vessels during this time, the activity for which will have likely contributed to the total values seen in the All-vessel category.

There have been concerns, particularly within the sailing community that in previous applications the influence of the COVID-19 pandemic likely misrepresents the vessel density. Within Port Quin Bay, sailing activity (sailing vessels) was consistently low (ranging from 0.03 - 0.71 hrs/km^2/yr.). The data for 2020 saw 0.04 hrs of activity which is closer to the values of 2018 - 2021. 2017 saw the highest activity of sailing at 0.71 hrs/km^2/yr. Removing the data for 2020 had a small effect on the overall average (reducing the activity by 0.09 hrs/km^2/yr.).

The effect of 2020 on the All-vessels category was more apparent with the lowest amount of activity being recorded that year; 2.13 in a range of up to 9.04 hrs/km^2/yr. As the majority of the All-vessels activity was made up by passenger vessels it is likely that the effect of the pandemic and the associated lockdowns were responsible for this drop-in activity.

The passenger vessel data will likely consist of AIS data for the Puffin Island pleasure cruise that operates in the proximity of the proposed farm. As with most tourism operators in the area, their peak operating periods should fall outside (early summer to mid-late autumn) of the peak farming months (late autumn to late spring). Farm infrastructure and operations will be minimal outside of the peak farming months and the impact the farm imposes on these tourism operators should be minimal. This is supported in Appendix VIII where there is support for the proposed farm locations from local boat charter operators showing that they do not believe the farm locations will affect their tourism operations.

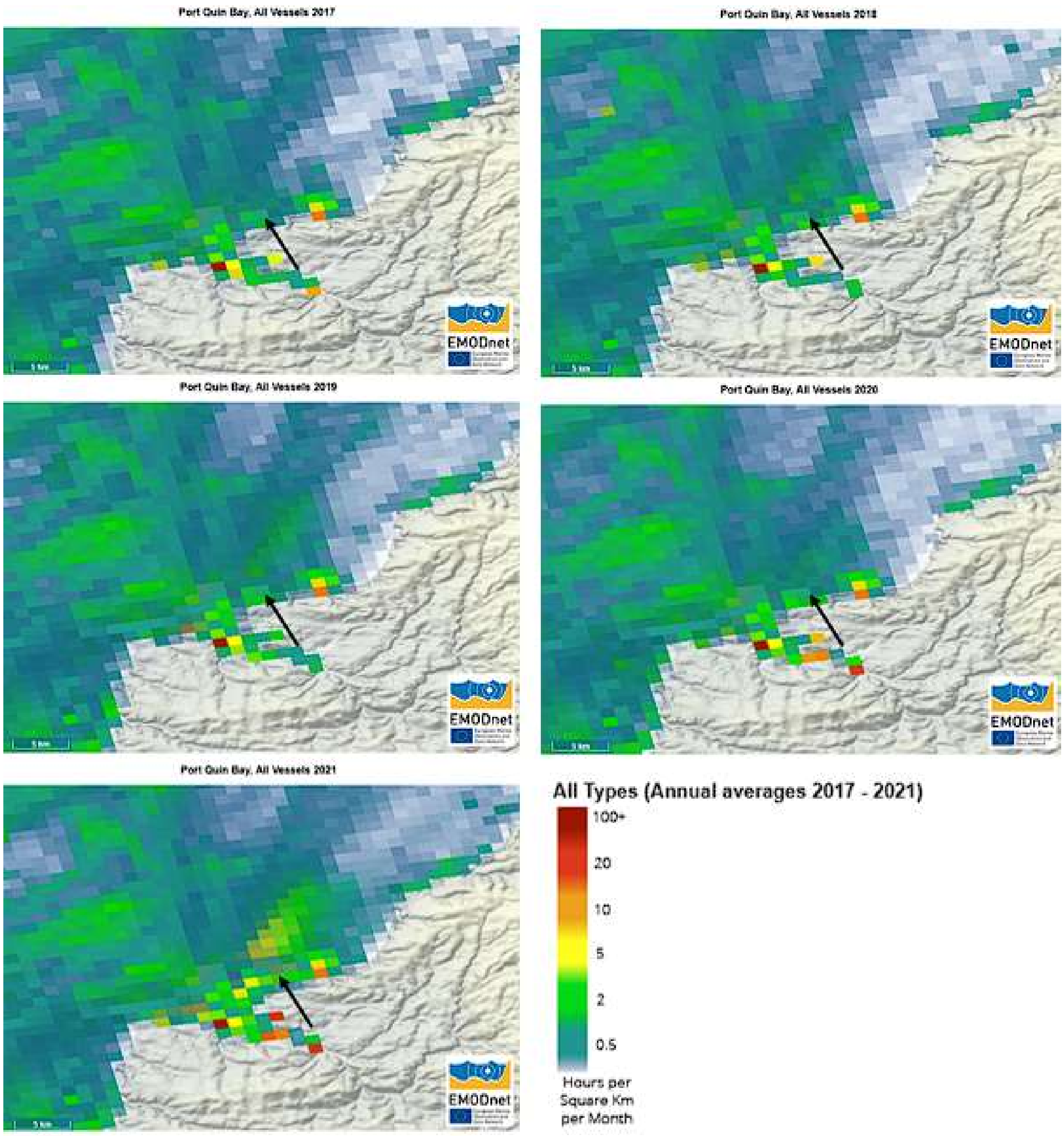


Figure 2. Annual average shipping density (hrs/km^2/Month) in Port Quin Bay for All vessels (from 2017-2021, top left to bottom left respectively). The Proposed farm's location is indicated by black arrow. Source emodnet.ec.europa.eu/geoviewer/. Spatial Extent: Within ICES30E5, EMODnet reference C-Square 7500:104:459:3.

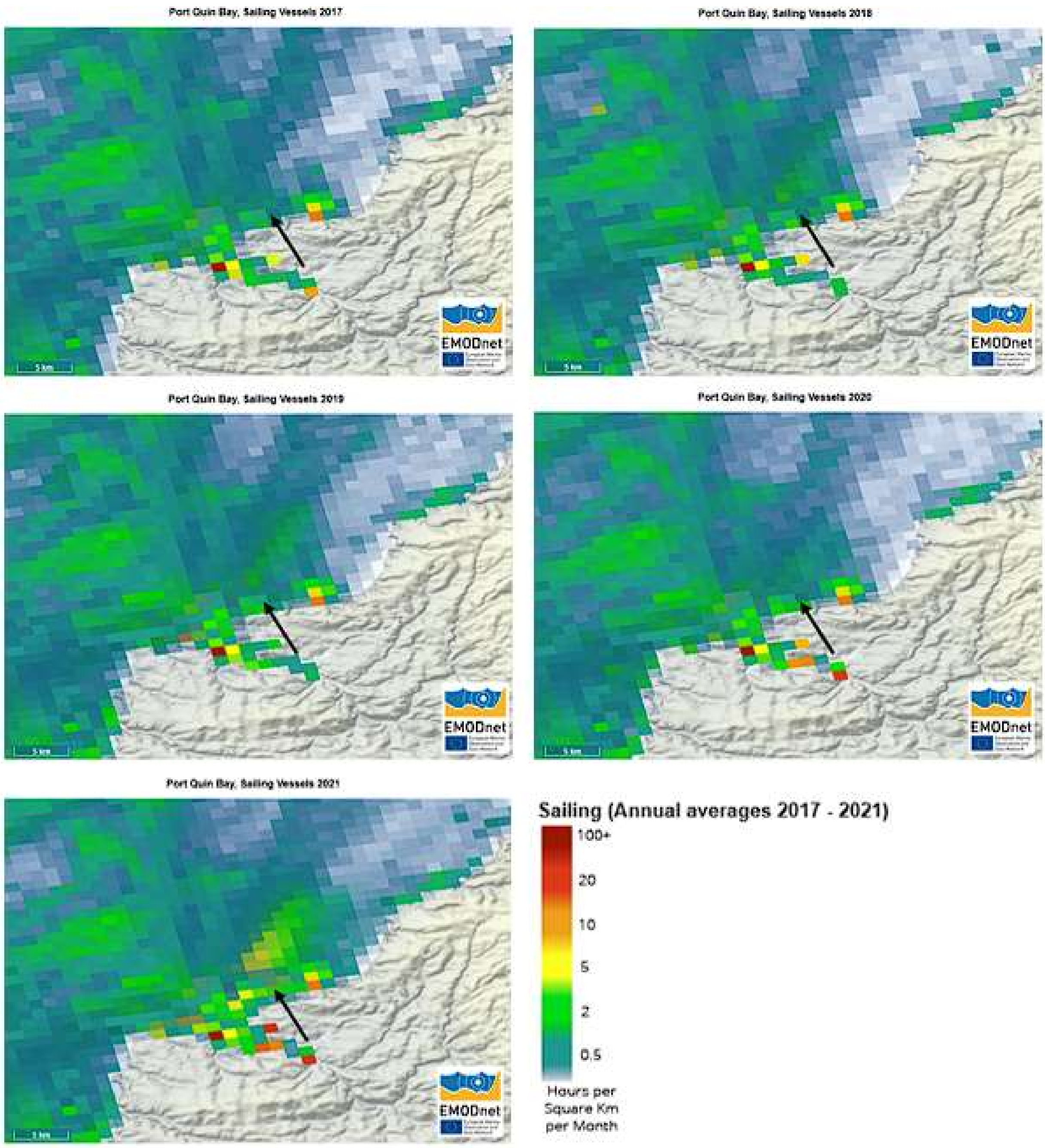


Figure 3. Annual average shipping density (hrs/km^2/Month) in Port Quin Bay for Sailing vessels (from 2017-2021, top left to bottom left respectively). Proposed farm's locations are indicated by black arrow. Source emodnet.ec.europa.eu/geoviewer/. Spatial Extent: Within ICES30E5, EMODnet reference C-Square 7500:104:459:3

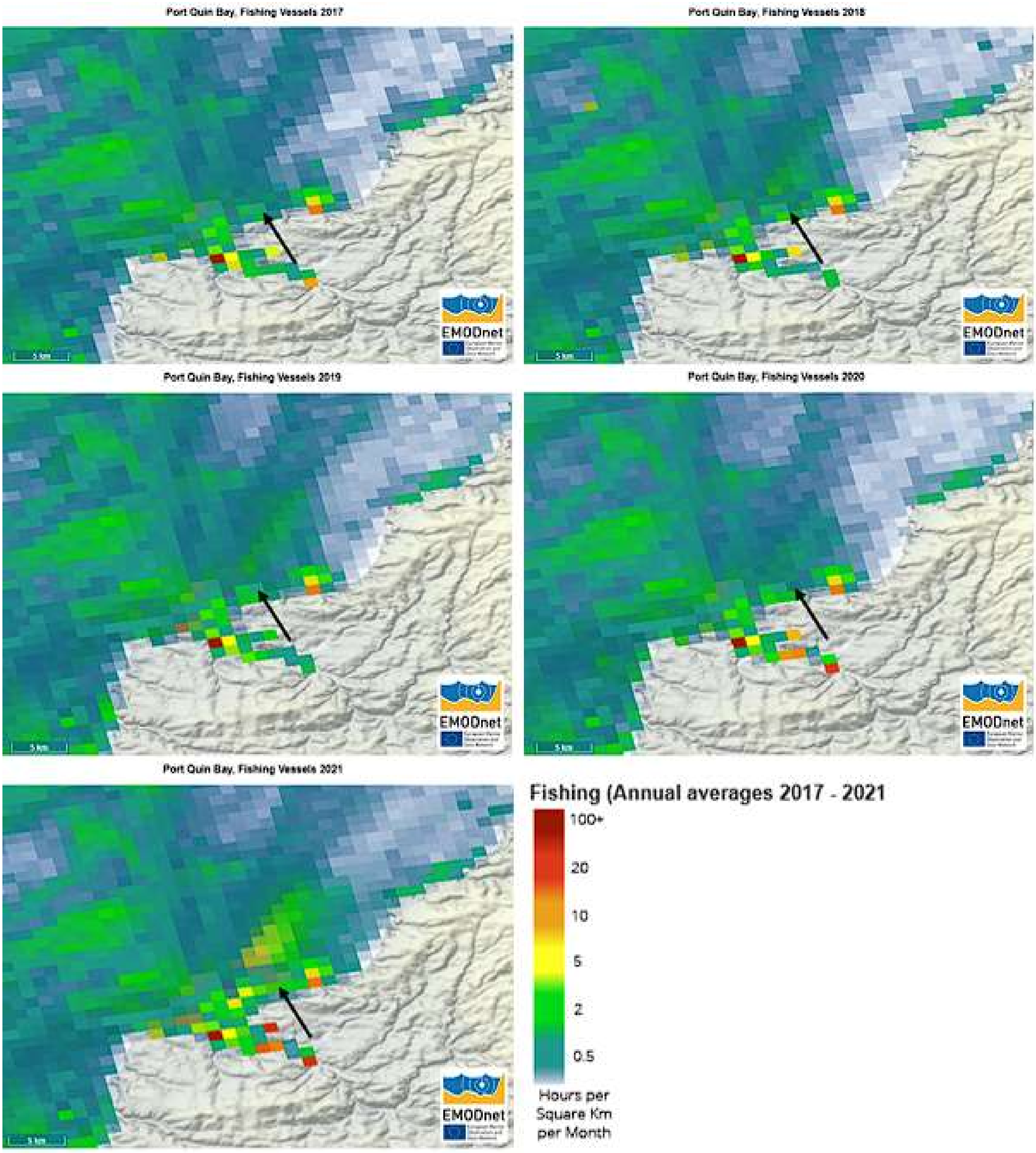


Figure 4. Annual average shipping density (hrs/km^2/Month) in Port Quin Bay for Fishing vessels (from 2017-2021, top left to bottom left respectively). Proposed farm's location is indicated by black arrow. Source emodnet.ec.europa.eu/geoviewer/. Spatial Extent: Within ICES30E5, EMODnet reference C-Square 7500:104:459:3.

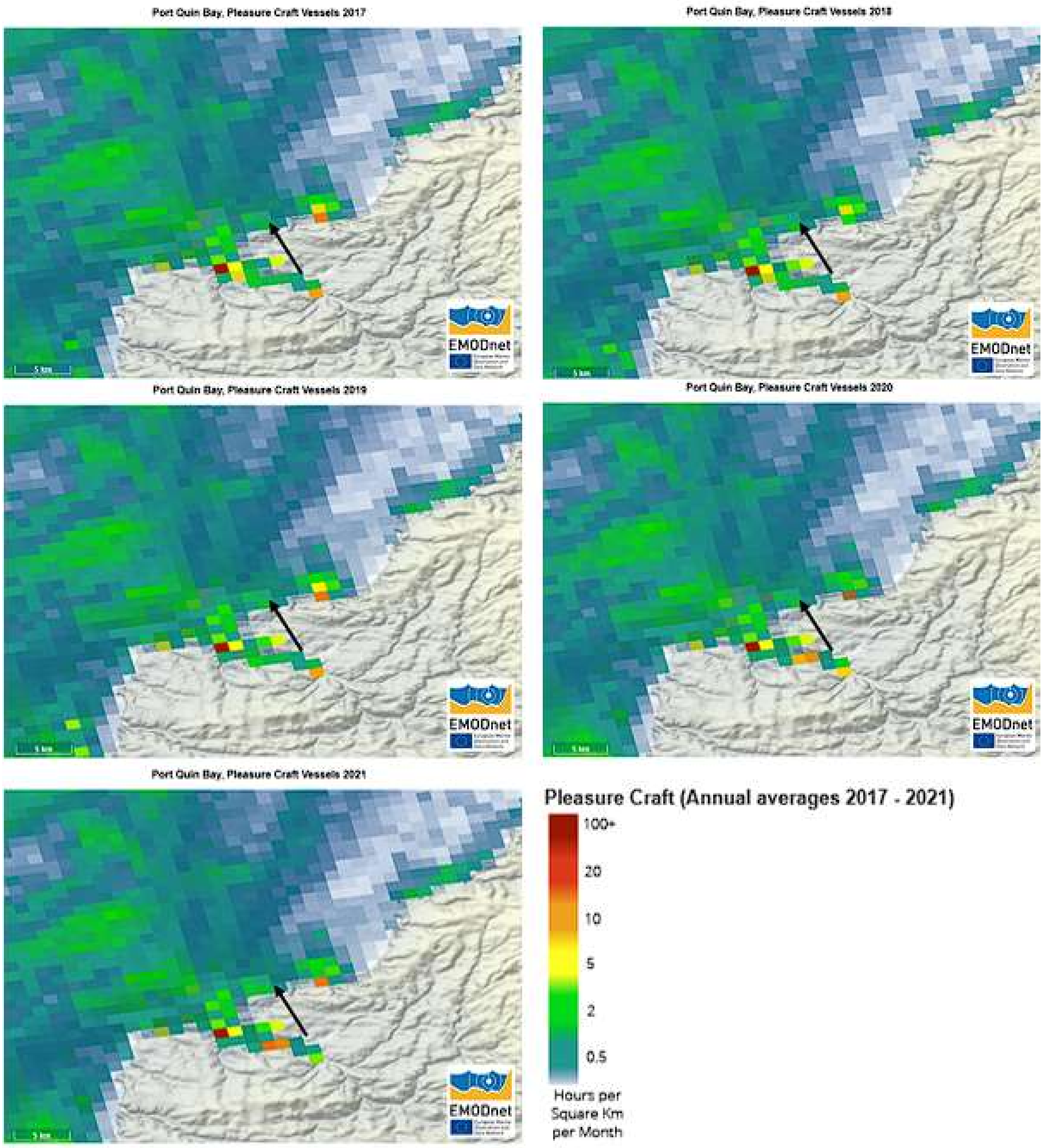


Figure 5. Annual average shipping density (hrs/km^2/Month) in Port Quin Bay for Pleasure Craft vessels (from 2017-2021, top left to bottom left respectively). Proposed farm's location is indicated by black arrow. Source emodnet.ec.europa.eu/geoviewer/. Spatial Extent: Within ICES30E5, EMODnet reference C-Square 7500:104:459:3.

The applicants considered MarineTraffic.com as an additional data source. The Proposed farm within Port Quin Bay lies within pathways of vessels transiting between Padstow Harbour and Port Quin and Port Isaac Harbours (Figure 6). Vessels transiting between these harbours may exhibit some level of interference due to the location of the farm however the number of routes taken between these two harbours is relatively low (between 25-38 routes per 0.08 km^2 per year).

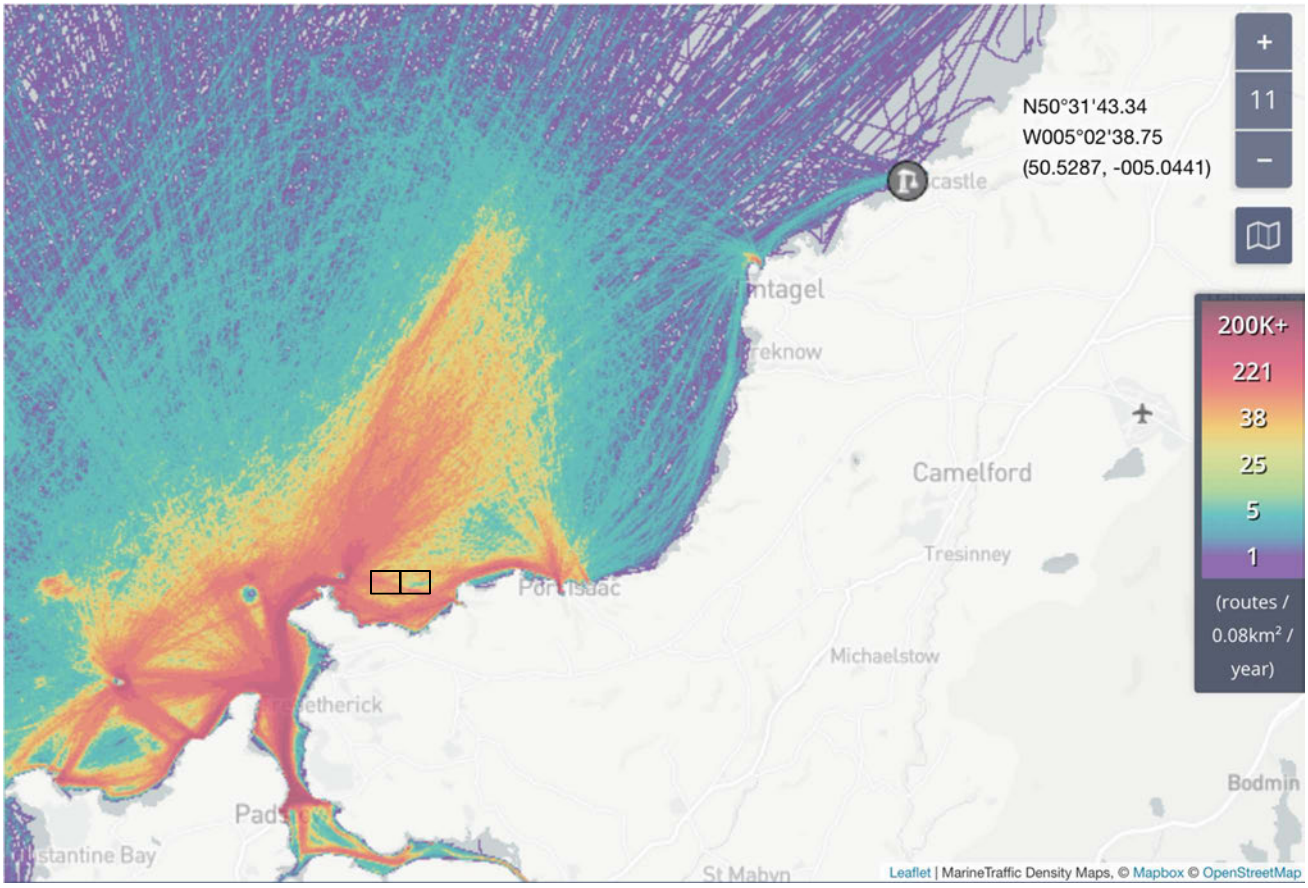


Figure 6. Routes of marine vessels transitioning in/out Port Quin Bay in 2021 (routes/km^2/year). Proposed farm is indicated by black rectangle. Source MarineTraffic.com. Spatial Extent: Within ICES30E5.

4.1.2 Monthly Vessel Density

Average vessel density (hrs/km^2/month) between 2017-2021 at the proposed farm in Port Quin Bay during the two busiest months of seaweed farming; April (harvesting) and November (deployment and seeding) and for a peak recreational month as comparison (in this instance, June) is detailed within Table 3. Out of these months selected, and with the exception of June 2020, the vessel activity for All vessels was shown to peak in June each year (Table 3). Within the Fishing sector, activity was more variable with activity appearing to peak in the shoulder seasons. No fishing vessel activity was recorded during the key months in 2020 and for all vessels the average across the three months in 2020 was 0.03 hrs/km^2/month, and this is likely associated with the Covid-19 Pandemic. One anomalous peak in fishing vessels activity was recorded in November 2021 where activity was recorded at 15.77 hrs/km^2/month and contributed to 98% of all vessel activity recorded that month. This peak likely drives the increased average in November Table 3. Excluding this peak, the fishing activity ranged from 0 to 3.06 hrs/km^2/month across all years. With the exception of this peak in fishing activity, the general activity within the area of the proposed farm suggests that farm operations undertaken by the applicants will be occurring outside of periods of the year that are typically busy with other operators. The proposed farm will therefore likely have minimal impact on other sectors within the Bay. Generally, each of the three focus categories remained low in activity within the Bay (Refer to Figure 2). Peaks in activity were mainly attributable to passenger and cargo vessels.

Activity across all sectors was lowest in 2020 compared to the remaining years and this is likely a result of lockdowns and other restrictions associated with the COVID-19 pandemic

All Vessels Key Month Averages 2017-2021 (hrs/km²/month).					
Month / Year	2017	2018	2019	2020	2021
April	2.75	0.69	3.33	0.00	4.49
June	12.84	6.64	4.71	0.05	24.80
November	0.04	0.08	0.02	0.05	16.13

Sailing Vessels Key Month Averages 2017-2021 (hrs/km²/month).					
Month / Year	2017	2018	2019	2020	2021
April	0.00	0.00	0.00	0.00	0.00
June	0.00	0.23	0.03	0.00	0.30
November	0.00	0.00	0.00	0.00	0.00

Fishing Vessels Key Month Averages 2017-2021 (hrs/km²/month).					
Month / Year	2017	2018	2019	2020	2021
April	0.10	0.00	0.98	0.00	0.43
June	3.06	0.63	0.00	0.00	0.00
November	0.04	0.00	0.00	0.00	15.77

Averages 2017-2021 (exc. 2020).				
Month / vessel category	All vessels (hrs/km²/month)	Sailing vessels (hrs/km²/month)	Fishing vessels (hrs/km²/month)	Pleasure craft vessels (hrs/km²/month)
April	2.815	0	0.3775	0.015
June	10.7475	0.14	0.9225	1.87
November	4.0675	0	3.9525	0

Averages 2017-2021 (inc. 2020).				
Month / vessel category	All vessels (hrs/km^2/month)	Sailing vessels (hrs/km^2/month)	Fishing vessels (hrs/km^2/month)	Pleasure craft vessels (hrs/km^2/month)
April	2.252	0	0.302	0.012
June	8.608	0.112	0.738	1.496
November	3.264	0	3.162	0

Table 3. Monthly vessel density data (hrs/km^2/month) averaged from the available 2017-2021 EMODnet data for the key months of April (harvesting) and November (seeding & deployment) and using June as representative for increased recreational activity (summer month). Spatial Extent: Within ICES30E5, EMODnet reference C-Square 7500:104:459:3.

Overall, the annual and monthly data indicates that the area of the proposed farm site does experience some marine traffic. However, relative to other areas within and outside the Bay, the marine traffic is generally lower throughout the year and the impact of the farm on other operators using the Bay should be low. This can be supported by Appendix VIII where from the two interviews conducted there are 24 individual fisher/businesses that support the proposed licenced sites and have agreed that the proposed farms will **not** affect their activities. This is crucial as these individuals are active stakeholders in the proposed area of works as well as the majority use vessels under 12m's which covers the data gaps of EMODnet, AIS, and VMS. In addition, the document evidences that there has been a decline in the fishing activity within the area of Port Quin Bay as a whole with a fraction of the fishers there had been in previous years. As a result of this, we have been able to garner such extensive support from fishers stating the proposed site locations will not affect their operations. Both the EMODnet data and the data from active fisheries operators show the same thing; that the proposed site locations will not affect fishing activity as there are low levels of fishing activity.

4.2 Desktop Study: Vessels Without AIS

Smaller vessels without AIS have also been considered within the NSA. We contacted the Station Managers at the National Coastwatch Institution (NCI) Boscastle and Stepper Point stations. In previous applications the NCI has been able to provide supplementary data for vessels without AIS which have then been used to assess the usage of the proposed area by these types of vessels. The proposed farm in Port Quin Bay however lies within the blind spots of the two nearest stations. NCI Boscastle and Stepper Point were able to provide some anecdotal evidence. They informed Biome that:

- There are six fishing vessels that have AIS and are associated with the neighbouring bay at Port Isaac. Two of which are UK registered vessels and have been observed fishing in the waters around the Bay. The remaining four are UK registered vessels that have Port Isaac as their home port however have not been documented in the waters around the Bay. The two that fish the waters have AIS and moor in Padstow over winter. This coincides with the EMODnet data detailed above.
- The wildlife charter boat operating from Padstow visits both Port Quin Bay and Port Isaac Bay and may contribute towards some of the Passenger vessel data listed above.
- Vessels from within the Leisure sector rarely travel far enough out to sea to fall within the field of view of stations.
- Vessels from within the military and law enforcement sector are documented as always being further out to sea than the waters associated with the Bay.

The data on other vessels typically provided by the NCI in previous applications is not available.

Cross-referencing, from the data available in section 4.1.2, vessel activity within the Bay was low and shows slight variation between years. There was some seasonality in the data with activity generally peaking in the summer months. However, there were years when vessel activity peaked outside of the summer months and this was likely caused by increased fishing activity. It appears that this Bay typically experiences little activity from larger pleasure craft vessels and the majority of the activity that occurs in the Bay is from passenger vessels. The applicants acknowledge that individuals will utilize the Bay using personal kayaks or paddleboards for example, in the area of the farms which are not captured within the data assessed. However, these vessels will be able to transition through the safety channels of the farms with ease, given their size.

Peaks in vessel activity outside of the key farming operation windows of April and from October to November likely suggest that the impact of the farm on other vessel activities within the Bay will be minimal. These trends are highly relevant for the proposed activities on the farm and further support the statements made previously around vessel activity.

The seeded lines will be deposited in October and November each year when sea temperature drops. This is at a time where vessel activity within the vicinity of the proposed farm is typically lower. Biome recognises that this may coincide with other fishing activity in the Bay. However, from the data accessible, fishing activity infrequent at this time of year and believe the impact the farm imposes would be low. The seeded ropes will be removed in spring ahead of the busy summer period each year. This is important as it will further reduce risk of entanglement for other vessels during busy periods, should they accidentally enter the charted and navigationally marked farm, as there will be fewer vessels operating. This contributes toward achieving ALARP.

We calculated those vessels over the size of a large cabin rib (16+ m long, 0.96+ max draft and 4.1 m+ width) risk entanglement (see 'under-keel clearance'). Therefore, vessels whose keels would not clear the main headlines should primarily avoid entering the farm to avoid entanglement risk. Avoidance is assisted by the applicants ensuring all navigational maps/charts are updated with the marine farm's location, mariners' notices are issued, ensuring navigational safety markers are in place and maintained, solas taped buoys and noting that vessel crews are warned of marine farms in the general vicinity (see risk matrices in Annex II).

5.0 Farm Construction And Layout

The proposed farms will cover a total area of 100.8 Ha (approximately 1440 m x 700 m) as detailed in Figure 1. The main infrastructure of the farm is a series of long-lines (288 x 160 m spaced 20 m apart) that are anchored to the sea floor with eco-blocks (Figure 7, Chapter 5 and Appendix I). The majority of the farm infrastructure is submerged. Only navigational safety buoys and marker/floating buoys are physically on the surface of the water. The eco-blocks anchoring the farm are sitting at depths of between 10-17 m max. The lines lie 1 m below the surface of the sea. The eco-blocks are made out of an environmentally sound, non-toxic and recycled concrete mixture (Marine Crete or similar alternative).

Access channels (20 m) have been built into the farm plan to enable Biome, Camel Fish, and other vessels to navigate through the farm, as well as providing access to emergency response vehicles (RNLI) if a search and rescue/recovery situation arises. Each access channel is marked by buoys to guide navigation within the farm. The buoys are standard grey 300/200 ltr. Navigational safety buoys are described in detail below.

Work to deploy long lines will be undertaken with fully trained and qualified crew, registered appropriate CAT vessels, professional service providers and during daylight hours with safe weather conditions. These precautions will reduce navigational safety risks to the applicants' boats and crew and in accordance with ALARP

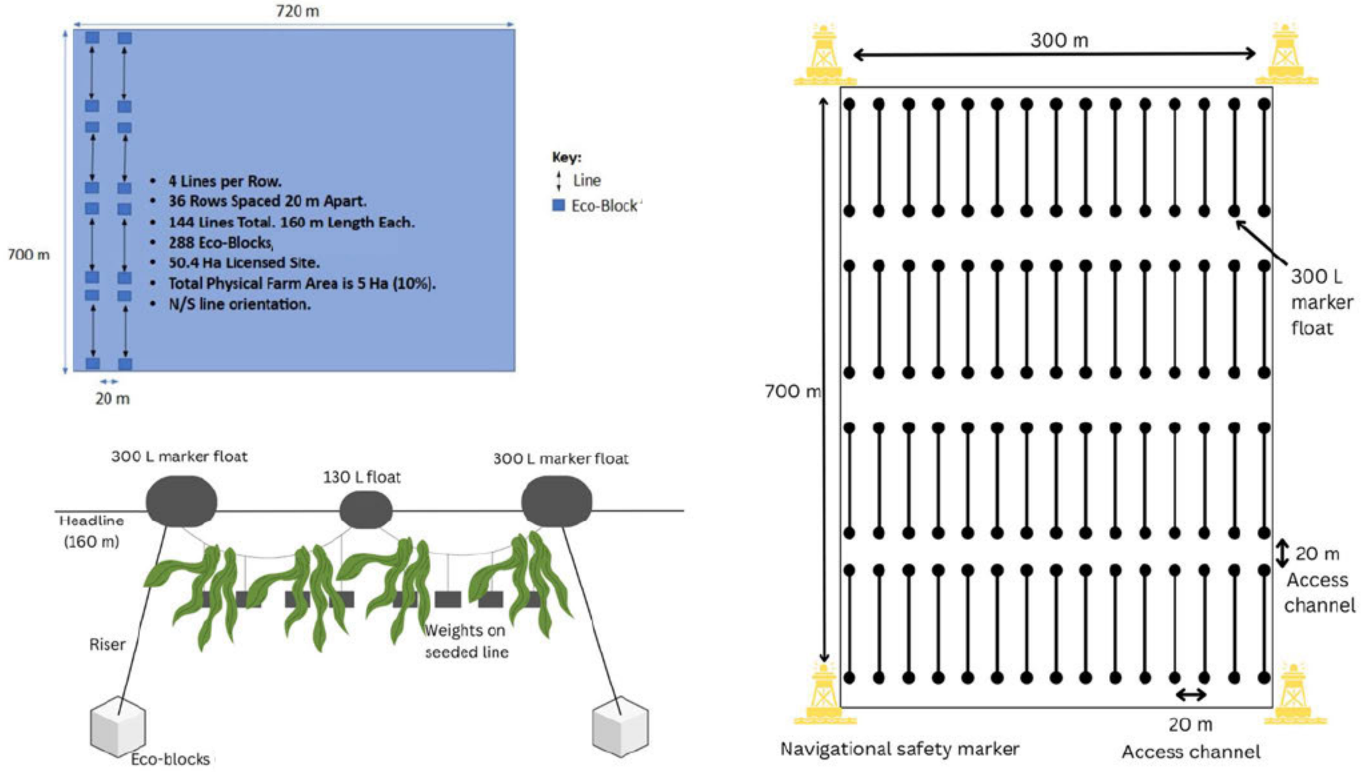


Figure 7. Farm plan (Top left), cross section of farm infrastructure (bottom left) and aerial layout (right) of an individual proposed farm in Port Quin Bay.

The site will be marked in accordance with expected, standard Trinity House guidelines (Annex I). In Figure 7, the top image shows how the lines will be structured and orientated. The middle image of Figure 7 illustrates a typical cross-section of the submerged lines (see Chapter 5 and Appendix I). The bottom image illustrates an aerial representation of how the lines will be deployed including access channels.

6.0 Safe Activity Within & Around The Farm

Post-instalment of the site, the applicants have considered what risks are posed to marine users within and within the vicinity of the farm. The distances of the proposed site from marine anchorage indicate that the farm is significantly distant enough from those activities to minimise risks to ALARP. In addition, the distances also indicate that re-routing of vessels around the proposed farm site as they transition in and out the Bay reduces the risk to ALARP (see above).

In terms of regularly transitioning vessels in and out of Port Quin Bay, the outstanding risks that are unavoidable and unpredictable post-instalment are identified as follows:

1. During storms, larger vessels could find themselves transitioning through the farm accidentally.
2. For other reasons, on the part of vessel skippers of larger vessels, they could find themselves transitioning through the farm accidentally or other.
3. The final risk to be assessed is the potential break-away of farm infrastructure from the farm.

If vessels were to enter the farm for whatever reason, it should be stated that as per Crown Estate lease law, the farm will have appropriate insurances in place. These insurances include cover for vessels and other licenced users if infrastructure breaks away from the farm and causes damage which is assessed as low/unlikely (Chapter 5, Appendix I). Vessels are covered by legally-required insurance policies.

In order to assess these risks, the applicants have conducted an under-keel clearance assessment (UKC). The applicants consulted a naval architect (Rockabill Marine Design) in this respect. The applicants consulted with active fisheries operators to identify keel lengths within the vicinity of the farm. These were indicated at 1-2 m and 3 m or above. Although they stated this was an indication only. Larger cargo vessels were considered.

Based on this Biome, decided to assess UKC for a range of vessels within this indicated size range.

6.1 Under Keel Clearance Assessment

Assessment number: RMD-EQ-169-00-002

6.1.1 Introduction

Rockabill Marine Design (RMD) has been contracted by the applicants to compare a kelp farm design, against the guidance set out by the Maritime and Coastguard Agency (MCA), MGN 654, Annex 3. RMD are a Naval Architecture consultancy base in Hampshire who specialise in the design of aquaculture and offshore wind support vessels. The annex was originally written for assessing minimum water depth over tidal devices. The kelp farm structures are submerged at 1 m.

6.1.2 Farm Location, Water Depth And Navigation

A map indicating the location of the farms has been supplied to RMD by the applicants. The kelp farms are to be located 550 m northwest of Port Quin Bay Harbour as shown on the map in figure 11. The shallowest water depth at the locations or nearest to the farm locations map is 10 m.

On the updated maps once, the licence is accepted there should be a notice for marine farms that advises caution when operating in the vicinity of a marine farms (Caption 1).

MARINE FARMS

Marine farms exist within the areas indicated. They may not all be shown individually and their positions may change frequently. Marine farms may be marked by lit or unlit buoys or beacons. Mariners are advised to avoid these structures and their associated moorings.

Caption 1. Marine Farms Notice that should be present on updated Port Quin Bay Maps.

In line with this notice, the 4 corners of each farm will be marked with lit buoys (standard).

The specialist marker buoys between the four lit buoys are unlit. All buoys will conform to Trinity House and MMO requirements as per licence conditions (Figure 8). The lines on which the kelp is grown will be suspended below the water surface by 1 m. This would give a CVD value of 1 m between the buoys. If a larger vessel was to drift into the farm it would become entangled in it. Based on the usage of the Bay as previously discussed, the potential of a significantly larger vessel interacting negatively with the farm is low with maps and markers in place.

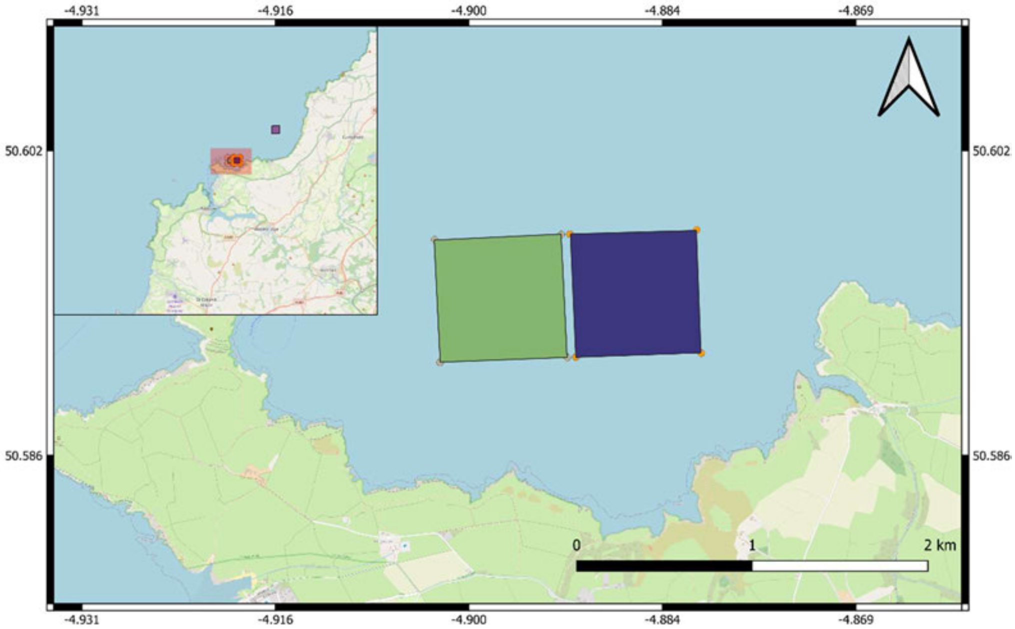


Figure 8. Map of the special mark buoys used to indicate the proposed farm in accordance with Trinity House and MMO. The Yellow circles represent the lit Navigational Safety Marker positions on the Biome site (blue) as well as the proposed Camel Fish site (green) as reference for their positions within the same bay area.

6.1.3 Typical Craft In Area

Local fishing operators have been consulted on the draft of typical vessels going in and out of Port Quin Bay. They have indicated that they are typically 1-2 m but could be up to 3 m or beyond. A UKC calculation has been carried out for typical designs of vessels with a canoe body draft of this depth (ignoring yacht keels as they get shallower as they heel).

6.1.4 UKC Calculation

Within RMD, we have designed several vessels to similar drafts. For this study, we are referencing:

Vessel Description	Length (m)	Max Draft (m)	Width at Waterline (m)
Large Cabin RIB	15	0.95	4.0
Wind farm CTV	32	1.75	10.5
Police Patrol Vessel	49	3.1	16.1

Assuming a maximum heel of 15 degrees when turning at full speed and an increase of vessel draft due to movement squat, the following calculation has been carried out.

Vessel Description	Ds (Still Water Draft) (m)	Dd (Dynamic Draft) (m)	Dc (Safe Clearance Depth) (m)
Large Cabin RIB	0.95	1.482	1.927
Wind farm CTV	1.75	3.134	4.074
Police Patrol Vessel	3.1	5.228	6.796

Within the area of the kelp farm, but not directly over the lines, the vessels will have the following UKC.

Vessel Description	UKC (Clearance Under Keel) (m)
Large Cabin RIB	8.043 – 13.043
Wind farm CTV	5.926 – 10.926
Police Patrol Vessel	3.204 – 8.204

The Dd (Dynamic Draft) assumes the vessels would be going full speed, conducting high speed maneuvers in an area known to have marine farms.

As shown above, the Large Cabin RIB is technically above the kelp farm, but realistically it is highly likely that it could get caught up in the lines.

The chapter indicates that vessels with a draft of 0.95 m or lower may be able to enter the farm without becoming entangled within the permanent farm infrastructure located 2 m below the surface. Vessels exceeding 0.95 m draft will become entangled within farm infrastructure. Therefore, this is a risk posed to marine vessels.

6.2 Risk Mitigation Measures

The applicants propose that the following measures will mitigate the risk to ALARP:

1. Navigational marker buoys will be in place and maintained during licenced operations at sites.
2. The presence of marine farms is marked on all navigational charts, which captures this new proposed farm.
3. As per licence conditions, the applicants will ensure the proposed farms are plotted on all appropriate/required marine ENCs before activities commence. And notice to mariners will be issued as per the conditions of the MMO licence, to inform stakeholders and marine users accordingly.
4. The removal of seeded ropes from the farm from June to October (covering the higher vessel activity periods associated with summer) should help mitigate entanglement further.
5. The staged approach by the applicants in terms of filling the site with headlines to capacity should help mitigate entanglement and raise awareness of the new instalment in a safer way.

6. Should a vessel find themselves within the farm and entangled, the applicants will follow the Emergency Response Plan detailed below.
7. Access channels built into the farm will further reduce the risk of entanglement to ALARP.
8. Access channels will allow access to the site for coastguard, RNLI and other rescue and recovery vessels.

Generally, rules for notifications of farm activity are as follows:

- Local mariners and FO to be made aware 5 days or more before activity commencement.
- MMO/Coastguard and UKHO notified within 24 hours of these notices issued. But in the case of a break-away, this will happen within 3 hours.
- When activities cease, the same parties are notified within 10 days of activity ceasing and the MMO must be notified within 1 week of issuing notices.

In terms of the stability of the infrastructure and potential breakaway, the risks are mitigated to ALARP as follows (Chapter 5 and Appendix I):

1. Long-lines and anchorage are planned, assessed and designed by professional marine engineers for stability across local sea, weather and storm conditions.
2. The long lines will be tensioned appropriately to ensure infrastructure stays in place.
3. Regular site maintenance (weekly where weather allows, post storm when weather allows and regularly during deployment of seeded line and harvest) will ensure that long lines will be maintained, potential faults or faults identified and repaired in a timely manner.
4. Infrastructure will be regularly replaced ahead of the end of its lifespan.
5. Buoys will be marked accordingly and regularly assessed with lashes replaced as required.

6. Regular research/monitoring activities executed within the farms involve the use of drop-down cameras. Eco-block integrity will be monitored.

The Hazard matrices forming the annexes at the end of this chapter detail the potential risks in more detail, the consequences, the risk level before mitigation and then the risk level with mitigation measures in place. In each case, mitigation has reduced the risks to ALARP.

6.3 Use Of Navigational Safety (Special Mark) Buoys

The presence of navigational safety buoys is essential to mark the perimeter of the farm clearly. Clear, conforming markings will reduce navigational safety risk to other vessels. As the proposed site lies <2 NM from the shore at MHWS, marking is required in accordance with the local lighthouse authority (LLH) and General lighthouse authority (GLA) regulations. The following guidance had been used in the creation of this document:

- IALA Guideline G1162, The Marking of Man-Made Offshore Structures, Edition 1.1, December 2021
- IALA Guidance 1077, Maintenance of Aids to Navigation, Edition 1, December 2009
- DfT Port Marine Safety Code (DfT 2016).
- DfT A Guide to Good Practice on Port Marine Operations, February 2018

Trinity House has been consulted with respect to lighting and marking of the proposed farm as primary assessors (8 total). Their standard advice for projects of this type is presented in Annex 1. Additional non-lit navigational marker buoys will be added (8 total). Performance and effectiveness of the marking system will be under inspection regularly as per the requirements of the regulatory bodies and licence requirements (servicing/record keeping) (Table 5).

* = RECOMMENDED + = TO BE CONSIDERED	Lights (yellow)	Radar Beacon	AIS Ato N	Floatin g Ato N
Aquaculture	*	+	+	*

Table 5. IALA recommended marking and considerations of offshore structures.

The site will likely be marked in accordance with Trinity House standard guidelines for these project types (Annex 1): to be confirmed. This involves the use of yellow spherical shaped lighted buoys exhibiting FLY.5/3s light character and surmounted with a yellow 'X' shaped top-mark. Unlit yellow marker buoys will also be present (See Annex 1). Numbers and locations required are decided by Trinity House. They will be present seaward of MHWS for the whole licenced period from commencement of activities to decommissioning. Positions of these markers will be reported to all relevant authorities including Trinity House, alongside contact details. This will be within 10 days of deployment so that nautical charts can be amended. An emergency contact will be on record for 24-hour contact purposes.

Update: Following consultation with the MMO, they note that Trinity House requires the mid points of the sides of the site to be marked with unlit, yellow pillar-shaped special marks with yellow St Andrew's Cross topmarks. In addition, the corners of site are to be marked with lighted, pillar-shaped special mark buoys with yellow St Andrews cross topmark, and a characteristic of Fl Y 5/3s. The MMO would likely condition these on any determination they are minded to make).

7.0 Decommissioning Statement

This section will cover the following:

1. Recovery arrangements in the unlikely event that infrastructure breaks away from the farm

2. The full decommissioning of the site in the event of the licence ending and non-renewal by the applicants OR the applicants go into receivership/liquidation and operations on site cease indefinitely.

The applicants emphasise that the farm will be front and foremost monitored regularly and maintained to a high standard of integrity. This covers the main infrastructure, seeded lines and associated buoys. This is further supported by chapter 5 and Appendix I. Therefore, the loss of equipment is assessed as a low risk.

In the event that equipment should break away from the farm, all equipment will be marked so that it is traceable (including contact details for notification). In the event of a significant structure failure, the applicants will report this to regulatory bodies, local Harbour Masters and local mariners (including MMO, MCA, Trinity House and UKHO). The priority will then be to contain the situation with immediate effect – to prevent further loss, to retrieve lost equipment and remediate the situation. Fast response times will reduce risk to other vessels, from floating debris. A crew can be onsite to repair or retrieve within 3 hours (tide permitting), and inside the 24-hour MMO licence requirement but within 3 hours of discovery for coastguard, UKHO and MMO.

The applicants explored the potential use of GPS sensors installation, which would be linked to an APP via 4 or 5G and transmit live data to farm operators. The applicants consulted a project partner with expertise in this field. Our intention is to install these sensors on the navigational marker buoys, if feasible. When feasible, from a technology perspective, camera technologies can be installed on the farms for additional monitoring (longer-term future-proofing).

Decommissioning of the site is the actionable and financial responsibility of the applicants, whatever the circumstances that require the licenced site to be returned to its original status prior to the installation of the farm (infrastructure) or as in agreement with the Crown Estate. This will be undertaken as a legal priority of the applicants, in line with licence conditions. The

Crown Estate complete due diligence in this respect as part of the Crown licence and tenancy agreement and applicants work with them to complete these works if/when required.

Decommissioning will involve the following:

1. Removal of seeded lines and/or headline and risers using an appropriate vessel.
2. Removal of eco-blocks using an appropriate vessel, divers and ROVs if required.

It is important to consult with the Crown Estate, Natural England, the Environmental Agency and any other appropriate regulatory bodies in advance of full decommissioning, to discuss the eco-blocks prior to removal. They will have provided bio-genic reef habitat on site. It should be decided under advisement and in line with the advice of those Bodies as to whether they are to be removed. Removal of the eco-blocks will be considered a mandatory part of decommissioning by the applicants unless otherwise advised by such Bodies with the authority to determine another course of action.

In decommissioning the site, all equipment will be removed:

- Buoys will be removed, cleaned and stored on land;
- Lines and ropes will be removed, cleaned and stored on land;
- All additional structures (if present) are dismounted, cleaned and stored on land; and
- Eco-blocks will be lifted out with the appropriate workboat crane, transported to the quayside for unloading, cleaning and storage on land (subject to the decision of them being left in-situ for maintaining artificial habitat).

- Crew will wear safety gear throughout decommissioning operations.

Update: Following consultation with the MMO, they note concerns from Trinity House over any liability if the project goes into administration, or is not decommissioned fully, as it could fall on Trinity House, as the General Lighthouse Authority for England, Wales and the Channel Islands, to ensure the area is safely marked until made safe for other marine users with associated costs having to be covered by Trinity House and the general lighthouse fund. The MMO is minded to *address this on any determination they make to ensure any future owner, or receiver, is liable to make the area safe and not abandoned.*

The applicants have had discussions with the Crown regarding decommissioning and they have their own internal due diligence that they conduct to make sure that there are adequate funds available by the applicants for decommissioning.

8.0 Site Operations & Emergency Response Plan

8.1 Deployment And Harvest

During deployment of the eco-blocks, risers and main long lines, a qualified, experienced boat crew will assist using appropriately designed vessels and ROVs if required. It is anticipated deployment of main infrastructure will take place in September/October and the removal of main infrastructure will take place during the following harvest in April/May/June. It will be weather dependent with boats and crew operating in calm, daylight conditions to reduce risk. Deployment of seeded seaweed lines will take place in October to early December. This is to ensure deployment of seeded material is in favourable conditions for both crew and seeds (weather, daylight, sea temperature, calm conditions). Notices of activities (commencement and completion) will be given to authorities, UKHO, local Harbour Masters and others as required, to ensure local mariners are aware of activities in advance, as per conditions of the marine licence. Informed mariners are more likely to avoid a working site, reducing navigational safety risk.

8.2 Monitoring And Site Maintenance

Regular monitoring of main infrastructure and seeded lines will occur post-deployment.

1. The main infrastructure will be monitored regularly for integrity using the applicants' vessels, crew (visual/physical inspections) or third party service providers. Additional monitoring will take place post storm activity, when it is safe to return to sea. Maintenance work will occur where necessary to ensure the eco-blocks, risers and headlines are secure. This will reduce navigational safety risk. Maintenance work will involve mending equipment and/or replacing equipment where necessary.
2. Each individual headline will be regularly checked to reduce the risk of drifting or lost equipment that could pose a navigational safety risk.
3. Seeded lines will be monitored regularly for integrity. Maintenance work will occur where necessary to ensure the lines are secure. This would usually involve raising the headline, checking the lengths of seeded line and securing with new knots and ties where/if required.
4. Risers and headlines will be replaced with new ones at the reasonable end of their lifecycle (5-10 years).
5. Monitoring will continue up to harvesting periods annually, where seeded lines are removed and general site maintenance of marker buoys will continue across the year.
6. Ecological monitoring will be conducted alongside monitoring using an in-house scientific team and other recognized Universities, organisations and regulatory bodies.
7. Biosecurity surveys will be undertaken regularly in line with the 'Biosecurity Plan' submitted with this application.

It is expected that a working harbour in Padstow will be used to land the harvested seaweed material. The working harbour will also moor applicant vessels (currently the situation). Service providers (coded workboat vessels) have designated mooring in Cornwall. Applicant and service provision vessels can respond to an incident within 45 minutes to an hour. In addition, if there is a report of lost gear or other incident, crew can be on site within the licence condition times.

Trips to site will be kept at a minimum to achieve all of the above adequately. Safety at sea will be at the forefront of all monitoring decisions made. Staff will be fully qualified and experienced, with qualifications updated accordingly and regular training exercises/drills undertaken pertaining to operations at sea and sea safety (such as STCW, medicals). This will reduce the applicant's risk to navigational safety and inform the emergency response plan. All crew members (direct or third party) will be required to wear appropriate clothing, life jackets and PPE.

8.2.3 RNLI And Rescues

Both applicants have consulted with the RNLI on a local and wider basis. This is in reference to rescue missions where the RNLI may need to navigate through the farms directly, as response time and human health must be at the forefront of considerations and actions. It was also in reference to the potential rescue of crew or a vessel accidentally entangled in the farm, should extreme or uncontrollable circumstances lead to this situation.

The RNLI vessel at Port Isaac is a D-class (LB1) lifeboat which is 5m long and 2m wide. The main RNLI vessel at Padstow is a Tamar-class lifeboat (Spirit of Padstow) and is 16.3 m long and 5.3 m wide.

In terms of scenario 1 – both vessels will be able to directly access through the proposed farms given vessel sizes and the regularly spaced, fully open sea channels between longlines (20 m spacing minimum). In terms of scenario 2 – a vessel that has become entangled in lines and requires rescue – human life is always at the forefront of considerations. Lines can be cut to access and/or free the vessel. Protocol will be followed to alert all relevant stakeholders and marine users at the earliest opportunity – particularly if lines are outside of the site navigational markers. Repairs will be made as soon as physically and safely possible to do so and within the licence parameters set. Communication with all stakeholders and marine users will be maintained until the issue is resolved (marine notices and direct communication from the applicants).

Applicants have discussed in principle, with the RNLI, that training exercises and drills will be made possible to practice rescue scenarios, which can be implemented when activity commences on sites.

8.3 Standard Operational Procedures

1. The Farm and marine operations shall be operated to the relevant maritime safety regulations from STCW, ISO, SOLAS, IMO, COLREGs).
2. There will usually only be 1 vessel (~20 m workboat) operating at the farm at any time. It will NOT be present at all times. Applicants can also have access to a faster rib-type vessel which can be deployed to the farm to assist in emergencies, for crew transfers and in case of mechanical issues. The faster, smaller vessel provides the ability for self-rescue.
3. All vessels used within farm operations will only be operated by crew who are fully qualified and have current medicals to operate within 12 Nm of a safe haven. These will be updated accordingly, and insurances will be in place as per legal requirements. Training and medicals will be undertaken at accredited clinics and training centres only.
4. All crew will wear appropriate safety gear and PPE as per maritime safety guidelines and this will include the use of appropriate personal floatation devices (PFDs)/life jackets.
5. All vessels will have clear postings for muster stations. Crew will be inducted to each vessel and briefed on muster procedures with crew allocated responsibilities on board.
6. All vessels will carry the appropriate emergency equipment in line with the number of insured crew aboard the vessel (such as life rafts).
7. All vessels will undertake regular emergency drills to ensure crew are aware of procedures and protocols during emergencies.

8. Vessels will be inspected annually (MCA) to ensure they meet all requirements legally to comply with safety requirements as per the legal requirements.
9. All incidents will be reported to appropriate Bodies immediately and procedures followed as per maritime safety guidelines.
10. The farm operates a rigorous system of risk assessments and method statements in conducting all operations. Following the ALARP principle (Figure 9). See attached Risk and Hazard Logs (appendices).
11. All vessel trips will be logged within a vessel log by the master. These logs will detail trip dates, crew, duration and purpose, fuel used, weather and general conditions, state of the vessel and if any issues/incidents occurred.

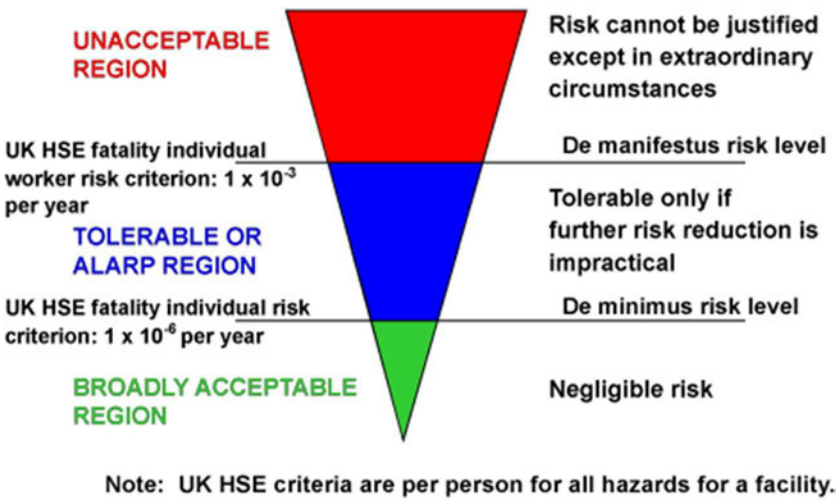


Figure 9. The ALARP principle. Source Primatech.

8.4 Procedures During Emergency Scenarios (Immediate Actions)

For emergency scenarios at sea during all farm operations the first point of contact is the coastguard (Call 999) and through channel 16 or 13 on the VHF radio (using either MAYDAY or PAN-PAN signals) to liaise with the local coastguard.

For any emergencies involving third party vessels, the Coastguard should liaise with the farm DPA so that the farm operations team can provide assistance.

8.4.1 Emergency Scenarios

8.4.1.1. Vessel Stranded In The Farm

8.4.1.1.1 Initial Actions

- Determine nature of problem – i.e. strayed into farm, entanglement etc.
- In the case of an emergency contact the coastguard.
- Obtain as much information as possible - Location, vessel name, names and number of people on board, state of vessel.
- Inform CEO, DPA, Operations Manager and Skipper.

8.4.1.1.2 Farm Vessels

- If farm vessels are on location, they may be required to act as on scene assistance under the guidance of the coastguard/RNLI/Harbour Masters.
- Initially assist the vessel via radio instruction to exit the farm by the safest route.
- If a vessel is entangled in the farm the farm vessel team may provide manual assistance to free a vessel and guide the vessel out of the farm.
- Liaise with coastguard via radio if necessary to provide and relay additional information.
- When appropriate, exchange contact information for insurance purposes.

8.4.1.1.3 Farm Operations/Designated Person Ashore

- Liaise with coastguard and farm vessels and if requested by coastguard liaise with the vessel in difficulty.

8.4.1.1.4 Communications

- Vessel in difficulty to contact coastguard, provide location, status, nature of problem, no. of pax onboard, nature of assistance required.
- Coastguard to inform Farm staff there is a vessel stranded in the farm and provide information as above to enable optimal response from the farm operations team.

8.4.1.2 Vessel Grounding

8.4.1.2.1 Initial Actions

- Inform skipper
- Stop engines
- Sound emergency alarm
- Close watertight and fire doors
- Display shapes and turn on navigational lights
- Turn on deck lights
- Turn on fire pumps
- Prepare life raft, epirb, flares and grab bags in case of abandonment

8.4.1.2.2 Communications

- Contact designated person ashore
- GMDSS messages as appropriate
- Inform MAIB

8.4.1.2.3 Bridge Team/Person's Tasks

- Check and record position on chart
- Check and record tidal information
- Check and record weather forecasts
- Consult contingency plan
- Consult SOPEP manual
- Consider refloating if possible – adjust ballast as necessary
- Consider assistance available – tugs or large vessels in vicinity
- Maintain a log of events

8.4.1.2.4 Emergency Team/Person's Tasks

- Sound around the vessel
- Deploy pollution prevention boom if necessary
- Sound all tanks and cargo holds
- Record all damage and report to skipper

- Maintain watch for pollution
- Assess internal damage – particularly tanks and collision bulkheads

8.4.1.2.5 Engine Team/Person's Tasks

- Sound all tanks
- Switch to high level suction pumps
- Record all damage and report to skipper
- Inspect fuel lines and pipes for fractures

8.4.1.3 Vessel Collision

8.4.1.3.1 Initial Actions

- Inform skipper
- Stop engines
- Sound general emergency alarm
- Manoeuvre vessel to minimise effects of collision (damage on leeward side)
- Close watertight and fire doors
- Switch on deck lighting
- Switch on fire pumps
- Muster crew
- Prepare life raft, epirb, flares and grab bags in case of abandonment

8.4.1.3.2 Communications

- VHF to Channel 16 and 13 if appropriate
- Updated GMDSS with vessel's position
- Broadcast Distress Alert and Message
- Inform designated person ashore
- Inform MAIB

8.4.1.3.3 Bridge Team/Person's Tasks

- Stop main engines
- Start fire pumps
- Check and record vessel position

- Check and record nearest port options
- Consider additional risks from fire/explosion
- Initialise SOPEP if required
- Stability assessment
- Consult contingency plan
- Offer assistance to other vessel – exchange details when appropriate
- Display correct shapes and turn on lights
- Check and record weather forecasts

8.4.1.3.4 Emergency Team/Person's Tasks

- Check for fire/damage/pollution
- Sound bilges and tanks
- Estimate size of damaged area and location above or below waterline
- Check for casualties or missing persons
- Assess whether repairs can be carried out

8.4.1.4 Vessel Taking On Water/Flooding

8.4.1.4.1 Initial Actions

- Inform skipper
- Stop engines
- Sound general emergency alarm
- Manoeuvre vessel to minimise the effects of conditions
- Close watertight and fire doors
- Switch on deck lighting
- Switch on fire pumps
- Muster crew
- Consider causes
    - Collision with another vessel or object at sea
    - Collision with shore or jetty
    - Collision with submerged object

- Following explosion onboard
  - Following fire onboard
- Consider dangers
  - Loss of watertight integrity consequent loss of buoyancy
  - Loss of buoyancy will ultimately lead to vessel sinking
- Prepare life raft, epirb, flares and grab bags in case of abandonment

8.4.1.4.2 Emergency Team/Person's Tasks

- Assess whether vessel is holed above or below waterline
- Estimate the rate of ingress
- Attempt temporary repairs if possible
- Sound all tanks and spaces
- Look for signs of pollution

8.4.1.4.3 Bridge Team/Person's tasks

- Close all watertight and fire doors
- Start bilge/ballast pumps in affected areas
- Record times and sequence of events in log book
- Assess stability
- Inform designated person ashore and emergency services if necessary
- Send urgency/distress messages as appropriate
- Consider refloating if possible
- Consider abandoning ship
- Initiate SOPEP if applicable.

8.4.1.5 Man Overboard (MOB)

8.4.1.5.1 Initial Action

- Inform skipper
- Raise alarm and inform skipper
- Maintain visual contact with MOB
- Relay position of MOB in relation to vessel

- If possible, release lifebuoy with light and smoke signal
- Steer wheel over to side of casualty
- If possible, push MOB button on vessel GPS
- Sound 3 prolonged blasts: Morse “O”

8.4.1.5.2 Emergency Team/Person’s Tasks

- Muster crew
- Radio Coastguard and ask for assistance
- Rig pilot ladder/floatation devices for assistance in recovery

8.4.1.5.3 Bridge Team/Person’s Tasks

- Maintain lookout, pointing at target
- Hoist signal flag “O”
- Note vessel position, wind and tide speed and direction at time
- Commence recovery manoeuvre
- Engines on stand-by

8.4.1.5.4 Communications

- Broadcast emergency message
- Update GMDSS information log
- Distribute VHF for internal communication

8.4.1.6 Fire Onboard Vessel

8.4.1.6.1 Initial Action

- Inform skipper
- Sound general emergency alarm
- Manoeuvre vessel to minimise effects of wind and consider anchoring
- Stop engines
- Muster crew
- Close watertight and fire doors
- Switch on fire pumps

- Determine the location and extent of fire
- Consider sending distress signal
- Contain fire if possible (fans, vents, watertight doors)
- Ready other available firefighting equipment (PPE and extinguishers)
- Record location and weather conditions (tide and wind direction)
- Prepare life raft, epirb, flares and grab bags in case of abandonment

8.4.1.6.2 Emergency Actions

- Investigate a search if muster list isn't completed
- Ensure fire doors are closed
- Isolate electrical supplies
- Exhibit NUC signals/shapes
- Confirm and record position

8.4.1.6.3 Communications

- Send distress signal
- Inform of vessel position, nature and size of fire, number of passengers and crew onboard, measures being taken, and nature of assistance required

8.4.1.6.4 Out Of Control Fires

- Consider using fixed-firefighting system to tackle and boundary cool
- Anchor vessel if possible
- Regularly update coastguard and fire brigade
- Consider protocol of abandoning ship

8.4.1.6.5 Manageable Fires

- Consider temperatures and risk of reignition - maintain boundary cooling
- Check fire has not spread - if possible, check internal walls and behind bulkheads
- Consider restoring ventilation to clear smoke
- Update fire brigade and coastguard

8.5 Vessels, Equipment, And Personnel For Response

A detailed risk assessment will be conducted with the vessel operator (skipper) before leaving shore for all farm operations. This will ensure that the vessel and equipment on board are suitable and adhere to maritime safety guidelines. The MCA are the main points of contact should an emergency arise while working on the site. All other relevant bodies will be notified within 24 hours of an incident occurring, except for in the case of a break away where the coastguard, UKHO and MMO will be notified within maximum 3 hours of discovery.

8.6 Emergency Contact Details

- **Biome Algae: To be provided**
- **Vessel Operator: To be confirmed and regularly reviewed/on record**

- **Camel Fish: To be provided**
- **Vessel Operator: To be confirmed and regularly reviewed/on record**

NOTE: See Marine Emergency Action Card (MEAC) drafts, produced in consultation with HM Coastguard. This will be updated to a final version before marine operations commence.

In conclusion, the applicants have ensured, through this assessment, the following:

- The project plan is clearly described.
- Stakeholder concerns have been integrated into the project plan.
- Adjustments have been made as a result of stakeholder engagement to reduce concerns and risks.
- Additional assessments made have enabled all further risks to be identified.
- All risks have been brought to ALARP through the body of this assessment due to mitigation or actions to be taken.
- A clear decommissioning statement is in place.
- An emergency response plan is in place.

8.7 Emergency Equipment And Disaster Recovery Plan

The primary objective of this disaster recovery plan is to ensure the safety of personnel, minimise damage to infrastructure, and facilitate the swift recovery of seaweed farm equipment in the event of a disaster. The applicants conform to the 'polluter pays' principle, which is the commonly accepted practice that those who produce pollution should bear the costs of managing it to prevent damage to human health or the environment.

The applicants would therefore contribute to charities returning our equipment. All equipment will be marked, a GPS on each Navigational Safety Marker, cameras will be installed on site when feasible, continuous monitoring and maintenance of all equipment and use of ROV's.

8.7.1. Emergency Response

a. Emergency Contacts: - List emergency contacts, including local authorities, medical services, and relevant government agencies.
b. Emergency Procedures: - Clearly outline emergency procedures for establishing communication. A chain for internal updates and alerts among farm personnel as well as external communication with local authorities, media, and relevant stakeholders.

8.7.2. Infrastructure And Equipment

a. Equipment Inspection: - Establish a routine inspection schedule for equipment and infrastructure to identify and address potential issues before they become critical.
b. Equipment Redundancy: - Consider having redundant systems for critical equipment to ensure continuous operation.

8.7.3. Recovery Procedures

a. Assessment and Documentation: - After a disaster, conduct a thorough assessment of damage and document all findings.

b. Prioritise Recovery Efforts: - Prioritise recovery efforts based on the criticality of operations, with a focus on restoring essential functions first.

c. Resource Allocation: - Allocate resources efficiently, considering manpower, equipment, and financial resources.

8.7.4. Training And Drills

a. Regular Training: - Conduct regular training sessions for farm personnel on emergency response and recovery procedures.

b. Simulation Drills: - Schedule simulation drills to ensure personnel are familiar with their roles and responsibilities during a disaster.

8.7.5. Continuous Improvement

a. Post-Event Evaluation: - After a disaster, conduct a thorough evaluation of the effectiveness of the response and recovery efforts.

b. Update the Plan: - Based on post-event evaluations and lessons learned, update the disaster recovery plan to enhance future response capabilities.

8.7.6. Contact Information

a. Key Contacts: - Compile a list of key contacts, including personnel, emergency services, and relevant stakeholders.

b. Plan Distribution: - Ensure that all personnel have access to the updated disaster recovery plan.

9.0 MMO Potential Advisories And Conditions On Marine Licence's Determined From The Applications

A. An advisory to state that "During the period from the commencement of construction of the authorised project, to the completion of decommissioning seaward of Mean High-Water Springs, exhibit such lights, marks, sounds, signals and other aids to navigation, and take such steps for the prevention of danger to navigation as Trinity House may from time to time direct."

B. In case of damage to, or destruction, or decay of the authorised project or any part thereof, the MMO, MCA, Trinity House and the UKHO should be notified as soon as reasonably practicable and no later than 24 hours following the awareness of any such damage, destruction or decay.

C. All buoys should be maintained to IALA Category 3 Availability of 97%

D. An advisory to state that "Reports must be provided to Trinity House on the availability of aids to navigation using the reporting system provided by Trinity House."

E. A notification must be sent to The Source Data Receipt team, UK Hydrographic Office, Taunton, Somerset, TA1 2DN (Email: sdr@ukho.gov.uk) of completion of the licenced activities, no later than 10 days after their completion. A copy of the notification must be sent to the MMO within one week of the notification being sent.

F. Trinity House and UKHO are to be provided with accurate positions of buoys in Latitude/Longitude WGS84 within 24 hours of buoys being established.

Annex I: Trinity House

Trinity House have been engaged regarding the proposed licenced sites and have requested a cumulative navigational impact assessment of the projects and other within the wider area.

10.1 Cumulative Navigational Impacts

The proposed farms co-ordinates are:

Farm Corner	Latitude	Longitude
Northwest	50.597784	-4.891862
Northeast	50.59801	-4.881677
Southeast	50.591715	-4.881306
Southwest	50.591518	-4.891385

Table 6. Farm corner coordinates (in WGS84) for the Biome proposed farm location in Port Quin Bay. MLA/2023/00308

Farm Corner	Latitude	Longitude
Northwest	50.597496	-4.90274
Northeast	50.597764	-4.892561
Southeast	50.591496	-4.892087
Southwest	50.591242	-4.90231

Table 7. Farm corner coordinates (in WGS84) for the Camel Fish proposed farm location in Port Quin Bay. MLA/2023/00307

Both proposed farms are adjacent and form a single footprint of 100.8 Ha.

The Crown Estate Conflict Plan/Report: No indications of any conflicting activities within the vicinity of the proposed farm sites – only the SAC is flagged which does not impact navigational safety.

10.2 Activities Assessed Cumulatively In Relation To Traffic In The Area

Within ICES30E5 there will be 3 seaweed farms operated individually. Two of these sites will be located in Port Quin Bay and they are: MLA/2023/00307 and MLA/2023/00308, each site is 50.4 Ha. The third site has been granted a licence (L/2023/00169/1) and is located 3.1 miles NE of the two proposed farms which are adjacent to each other. This site is 100 Ha. This results in a foot print of 100.8 Ha in Port Quin and 100 Ha in the Port Isaac region. Please refer to Figure 10 and Table 8 for the Port Isaac farm location and co-ordinates.

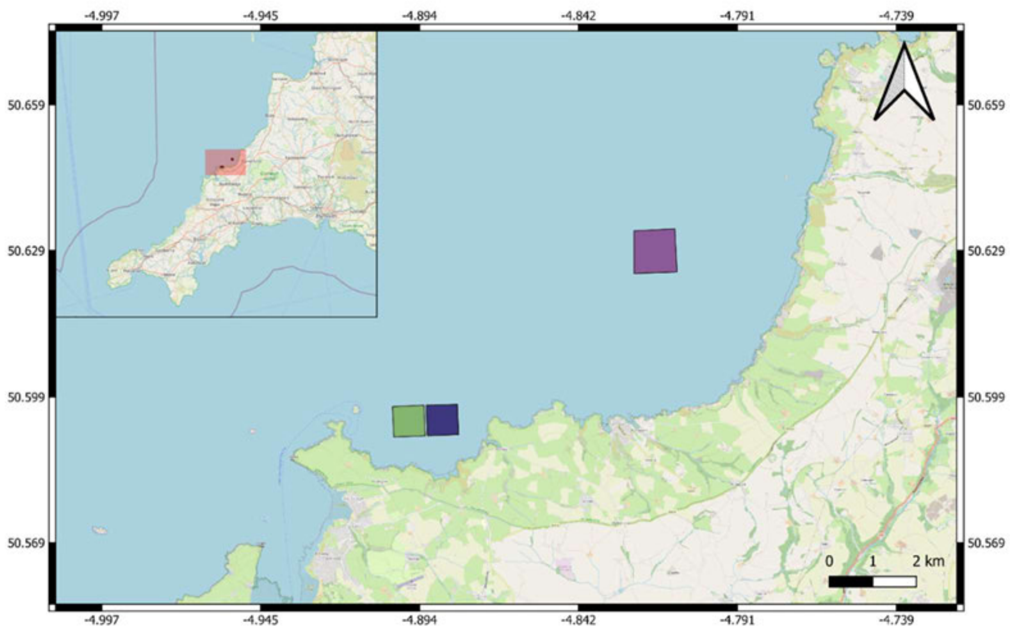


Figure 10. Location of the three farm sites in the area of Port Quin Bay and Port Isaac.

Farm Corner	Latitude	Longitude
Northeast	50.63397	-4.81122
Northwest	50.63359	-4.8244
Southeast	50.62505	-4.81054
Southwest	50.62479	-4.82444

Table 8. Farm corner coordinates (in WGS84) for the licenced farm location in Port Isaac Bay. L/2023/00619/1

10.3 Traffic Level Assessment

Using EMODNET and MarineTraffic data (AIS), which are summarized in Table 2 and Figures 3-6, MarineTraffic gives the highest traffic level (in the Southern area of the sites) as 221 routes/0.08km^2/year (medium). For the remainder area of the sites, it is less than this value. The EMODNET data presents traffic levels of between 0.27 to 0.57 hrs./km^2/year for fishing, sailing and pleasure vessels (low range). All vessels range from 5.174 – 6.226 hrs./km^2/yr. which is low to medium. Overall traffic is assessed at low to medium for within the area of the proposed site locations which is lower than the rest of the Bay (Refer to Figure 2,3,4, and 5).

The main traffic transitioning in the area moves outside of both proposed farms to the South and North.

In addition, the most Southern part of each proposed farm site is located 550 m + from land/headland (see Figure 11 and 12). Waters in this southern region are 10 m deep or less. Therefore, traffic passing between the land and proposed farms is likely to be small leisure vessels – allowing for ample space for transitioning. Larger vessels will continue to transition north of the proposed farms, where water is deeper for safe keel/draft clearance (15-16 m).

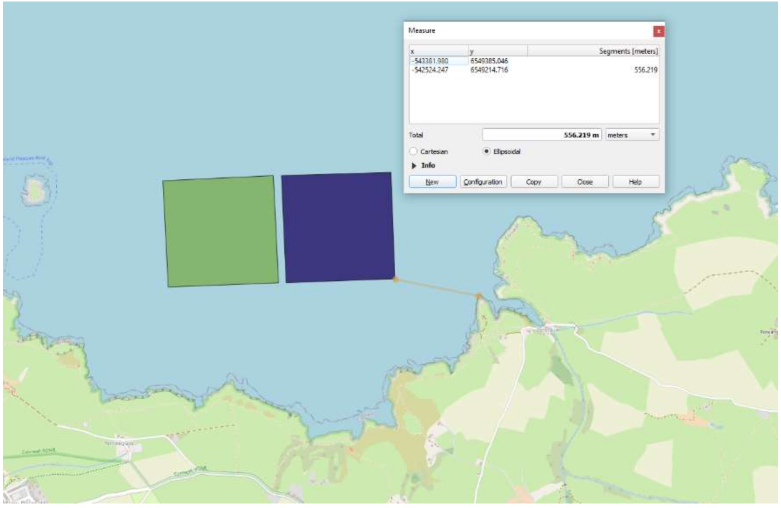


Figure 11. Closest distance from the proposed sites to the land (Port Quin Harbour mouth).

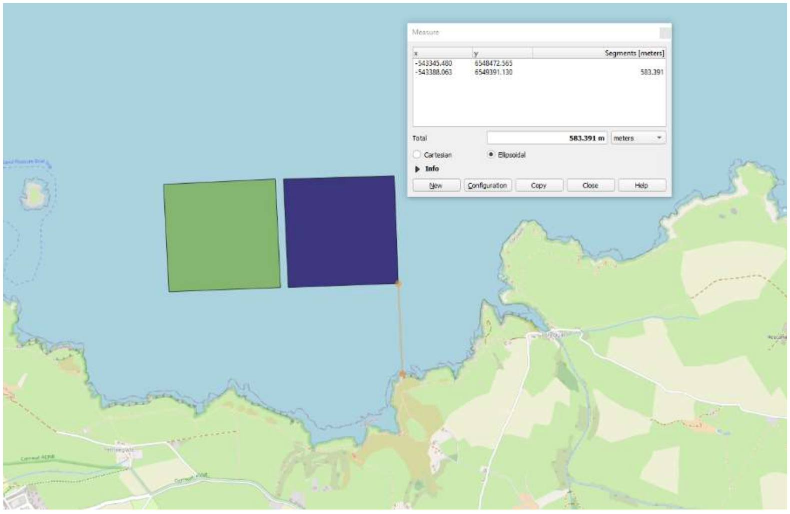


Figure 12. Second closest distance from the proposed sites to the land.

Within the Fisheries Impact Assessment no ping data was detected (VMS) for large trawling vessels – with smaller fishing vessels using the bay infrequently (direct communication with fishers: see Appendix VIII) and observations of Camel Fish Ltd – fishers operating within the region for 50+ years).

Using Figure 6, it is possible to see that traffic levels around L/2023/00169/1 are very low. And not within any major transition routes. At a distance of 3.1 miles (5 km) from the proposed farm sites, there is no significant cumulative impact of the licenced and proposed developments relative to each other.

Please refer to Annex III: Supplementary Assessment: Anchorage.

Evidence supplied in support of response:

- An updated **cumulative** Navigational Safety Assessment highlighting the information which assesses traffic levels in the region.
- The Crown estate Conflict Plan

Annex II: Safety Assessment And Risk Matrices

- Formal safety assessment I – Summary table: Hazard Log
- Risk control matrices x 2 (should be considered collectively)
- Marine Emergency Action Card (Draft) for reference

11.1 Formal Safety Assessment I – Summary Table: Hazard Log

Brief description of the work or Method Statement Title	Navigational Risks and Hazards in proximity of Seaweed Farm	Project No/ Location:	MLA/2023/00307 & MLA/2023/00308	Method Statement Ref No	Marine procedures		
		Assessed d By:	Dr Angela Mead	Assessed On Site By:	Dr Angela Mead	Expected Duration of	
		Date of Assessment:	15/05/2024	Date of on-site assessment:	15/05/2024	Review Cycle:	1
Persons & Vessels at Risk:	EMP - Employee	CON - Contractor	PUB - Public	CV - Company Vessels	OV - Other Vessels		

+ Formal safety assessment I – Summary table: Note: green – 1-7 (LOW RISK), yellow – 8-12 (MODERATE RISK) and red – 13+ (HIGH RISK)

Hazard Ref No	Risk	Hazard Identification & Foreseeable Risks	Without Controls			Control Measures	Method of Monitoring Control Measures	With Controls		
			C	L	RR			C	L	RR
1	Vessel Collisions with company Vessels	• Inattention from fatigue, from excessive driving or arduous work resulting in exhaustion. • Unaware of the correct destination. • Poor visibility • Too many vessels in a constrained area (the farm) • Distraction • Inclement weather conditions	5	3	15	Leave plenty of time for the intended journey including a rest period before starting work. Take regular rest breaks. Adhere to working hours. Ensure skippers and crews are properly inducted and familiarised with farm location and entry and exit points, escape channels and marker buoys Understand exact destination and passage objectives prior to departing to familiarise yourself as much as possible. Make use of radar and AIS There will usually only be one vessel operating within the farm Only necessary personnel in the wheelhouse during navigation and no mobile Ensure the crew complete regular safety drills and have all the required licences/medicals up to date (STCW, ISO, SOLAS, IMO). Ensure all the crew has access to a copy of the NRA and ERP and are familiar	Company management to ensure all masters and crew are properly qualified and current. Vessel log to be recorded after each use - collisions or near misses to be recorded Near miss log to be recorded Toolbox talks / safety briefings issued daily with awareness raised of other company boats in operation Farm maintenance log to be recorded Responsibility of vessel masters to ensure all maritime laws and company guidelines are	2	1	2

						With the document and procedures within. Operate in safe sea conditions, in daylight hours where possible. Ensure all crew know what their responsibilities are on the boat in an emergency and who to immediately alert about any collision (muster stations). Ensure the correct safety equipment is on board and that crew wear life vests at all times (e.g. life rafts and vest) Ensure the skipper uses the correct methods to alert other boats to their presence in low visibility Make sure the navigational safety markers are in sound working order to alert other sea users to the farm perimeters Ensure lines are maintained at the correct distances and that channel sizes are correct. Use eco-blocks ensure the lines remain in place. Regularly maintain the lines in excellent condition. . Ensure That if multiple crews are operating in the area, they are briefed and aware of where each other are operating. Ensure there is an adequate rescue vessel on standby. With a 10-minute response time	adhered to and regular refresher training and drills carried out. Current operated farms have experienced 0 entanglement or collisions			

						Ensure there is an employee on land who is the designated person to send out the appropriate alerts if required MEAC card maintained up to date Keep lines within navigational markers Regularly review data sources recording annual traffic in the area (AIS and non-AIS) Break-aways will be reported to the coastguard/UKHO/MMO within 3 hours of discovery. Ensure all local mariners are made aware of activities 5 days ahead of commencement AND within 10 days after activities cease (marine notices). Ensure the navigational safety markers are well maintained, to include the yellow spherical shaped lighted buoys (Fly.5s light character, surmounted with a yellow shaped cross topmark and the unlighted yellow markers (as per trinity House guidelines. Ensure nautical charts are updated. Ensure vessels are of a CAT level appropriate. Maintain the lines below the surface (2 m).				

						Monitor lines weekly. Operate within 12 NM of a safe haven Ensure appropriate insurances are in place Ensure boats will pass annual inspections (safety). Equipment will be marked and traceable/retrievable Site will be fully decommissioned at the end of life of the farm. Call the coast guard and RNLI. Assist and guide vessels to safety in the event of a collision. Follow all STCW action protocols. Sailing crew should aim to avoid entering the marine farm area due to clear warning signs within the Bay area, updated charts, solas tape markings on all buoys and appropriately maintained navigational safety aids.				

2	Vessel Collisions with Other Vessels	• Lack of situational awareness. • Failure to set priorities – lack of positive action. • Preoccupation with administrative tasks. • Failure to communicate intentions (officer/master/pilot). • Lack of assertiveness – failure to challenge incorrect decisions • (officer/master/pilot). • Failure to comply with standard procedures and international • regulations. • Failure to utilise available data and resources. • Lack of training • "Human-technology"	5	3	15	Leave plenty of time for the intended journey including a rest period before starting work. Take regular rest breaks. Adhere to working hours. Ensure skippers and crews are properly trained and familiarised with all onboard equipment - especially bridge navigation equipment and are aware of their look out duties. Ensure clear watch protocols are adhered too so that the skipper / helm is not distracted. Make use of radar and AIS •. Only necessary personnel in the wheelhouse during navigation and no mobile phones in the bridge • Ensure the crew complete regular safety drills and have all the required licences/medicals up to date (STCW, ISO, SOLAS, IMO). • Ensure all the crew has access to a copy of the NRA and ERP and are familiar with the document and procedures within. • Operate in safe sea conditions, in daylight hours where possible. • Ensure all crew know what their responsibilities are on the boat in an emergency and who to immediately alert about any collision (muster stations). • Ensure the correct safety equipment is on board and that crew wear life vests at all times (e.g. life rafts and vest) • Ensure the skipper uses the correct methods to alert other boats to their presence in low visibility • Make sure the navigational safety markers are in sound working order to alert other sea users to the farm perimeters • Ensure lines are maintained at the correct distances and that channel sizes are correct. • Use eco-blocks to ensure the lines remain in place. • Regularly maintain the lines in excellent condition. • Ensure That if multiple crews are operating in the area, they are briefed and aware of where each other are operating.	Responsibility of vessel masters to ensure all maritime laws and company guidelines are adhered to and regular refresher training and drills carried out. Vessel log to be recorded after each use - collisions or near misses to be recorded Company management to ensure all masters and crew are properly qualified and current. Near miss log to be recorded Toolbox talks / safety briefings issued daily with awareness raised of other company boats in operation Farm maintenance log to be recorded	2	1	2

						• Ensure there is an adequate rescue vessel on standby. With a 10-minute response time • Ensure there is an employee on land who is the designated person to send out the appropriate alerts if required • MEAC card maintained up to date • Keep lines within navigational markers • Regularly review data sources recording annual traffic in the area (AIS and non-AIS) • Break-aways will be reported to the coastguard/UKHO/MMO within 3 hours of discovery. • Ensure all local mariners are made aware of activities 5 days ahead of commencement AND within 10 days after activities cease (marine notices). • Ensure the navigational safety markers are well maintained, to include the yellow spherical shaped lighted buoys (Fly.5s light character, surmounted with a yellow shaped cross topmark and the unlighted yellow markers (as per trinity House guidelines. • Ensure nautical charts are updated. • Ensure vessels are of a CAT level appropriate. • Maintain the lines below the surface (1-2 m). • Monitor lines weekly. • Operate within 12 NM of a safe haven • Ensure appropriate insurances are in place • Ensure boats will pass annual inspections (safety). • Equipment will be marked and traceable/retrievable • Site will be fully decommissioned at the end of life of the farm. • Call the coast guard and RNLI. Assist and guide vessels to safety in the event of a collision. • Follow all STCW action protocols. • Sailing crew should aim to avoid entering the marine farm area due to clear warning signs within the Bay area, updated charts, solas tape markings on all buoys and appropriately maintained navigational safety aids.				

3	Propeller Fouling: snagging on ropes and buoys	Fouled propeller disabling propulsion of vessel With sailing vessels most likely to accidentally enter a farm, traffic levels were assessed as moderate		4	1 2	•. Seed lines on the farm will be kept at a depth of 2m and deeper (ref 1,2) Seeded lines to be removed during July/August (busier sailing months) •. company vessels to be equipped with anti-propeller fouling guards • Vessel will be equipped with multiple knives that can be used to free the vessel from snags/entanglement if necessary •. company vessel crews to be well drilled in releasing fouled propellers by safe methods and carry appropriate equipment and PPE to do so (ref 1,2) • Should Other vessels get fouled company vessels will assist as above (ref 1,2) • The farm location will be clearly marked on marine charts (ref 1.2) • Farm will be clearly marked by lit special marks (ref 1,2) • Sailing crew should aim to avoid entering the marine farm area due to clear warning signs within the Bay area, updated charts, solas tape markings on all buoys and appropriately maintained navigational safety aids.	Crew and Master to regularly drill for freeing of propellers (Plus, ref 1,2) and seeded line removal.	2	1	2
4	Rudder / Skeg fouling or snagging ropes or buoys	Ropes or buoys getting entangled in a vessels hull or elements of the structure e.g. rudder or skeg and getting disabled	3	4	12	•. Seed lines on the farm will be kept at a depth of 1m and deeper (ref 1,2) •. company vessels to be equipped with anti-propeller fouling guards (ref 3) • Vessel will be equipped with multiple knives that can be used to free the vessel from snags/entanglement if necessary (ref 3) •. company vessel crews to be well drilled in releasing fouled lines by safe methods and carry appropriate equipment and PPE to do so (ref 1,2) • Should Other vessels get fouled or entangled company vessels will deploy to assist (ref 1,2) •. The farm location will be clearly marked on marine charts (ref 1,2) •. Farm will be clearly marked by lit special marks (ref 1,2) Sailing crew should aim to avoid entering the marine farm area due to clear warning signs within the Bay area, updated charts, solas tape markings on all buoys and appropriately maintained navigational safety aids.	Crew and Master to regularly drill for freeing of entangled lines (ref 1,2) Crews to regularly monitor navigation aids around the site to ensure they are in correct working (ref 1,2)	2	1	2

5	Grounding	Uncharted wrecks, shallow areas, rocks	3	4	12	•. The farm is in an area of 15 of water at LAT. So, grounding on the seabed is highly unlikely. •. Farm is located away from any charted wrecks, foul ground or rocks •. It is highly unlikely there will be any uncharted wrecks in the area after considerable discussion with the local trawler and potting fleets and after undertaking an English Heritage archaeology assessment. Ref 1,2 above	Master and crews to be familiar with the local area and charting and knowledgeable about hazardous areas both near the farm and on the passage out and back (ref 1,2). Any changes to the seabed topography to be logged and reported Ref 1,2 above	2	1	2
6	Fishing vessels Snagging Underwater moorings	Anglers, trawlers or pots snagging fishing gear on mooring blocks	5	3	15	The eco-blocks will be located inside the clearly marked perimeter of the farm so vessels should not encounter them Company Vessel will be equipped with suitable equipment and trained in safe methods to cut away any snagged gear Vessel will be equipped with multiple knives that can be used to free the vessel from snags/entanglement if necessary (ref 3)	Ensure farm location is well known and understood by proper engagement with key local stakeholders - fishers, yacht clubs especially during early operations	2	1	2
7	Impact with Structure	vessel collision with farm infrastructure	3	4	12	•. There are no 'fixed' structures on the farm - only floating ones. [farm buoyage and navigation marks] •. As such any contact with these is unlikely to be significant except to high-speed vessels. •. The farm is well marked by marine charts and by special marks •. . Recreational traffic was originally assessed as low using a range of data sets. Additional data sets have altered the assessment to moderate. Biome has increased the risk level before mitigation from 8 to 12. However, mitigation reduces it to 2 (ALARP). However, refer to 1,2, 3 and 4 above	Farm staff to monitor traffic around farm Refer to 1,2, 3 and 4 above	2	1	2

11.2 Risk Control Matrix 1

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/981718/MGN_654_Annex_1_NRA_Method p.102

Description			Risk Control Type				Risk Control Effect		
			Asset	Rule	Good Practice	Option	Prevention	Mitigation	Emergency Response
1		**Vessel Assets**							
	1	Emergency Response - Requisitioned Vessels	✓						✓
	2	Search and Rescue - Inshore	✓						✓
	3	Search and Rescue - Lifeboats	✓						✓
	4	Search and Rescue Requisitioned Vessels	✓						✓
	5	Tugs				✓			✓
2		**Aviation Assets**							
	1	Search and Rescue - Helicopter	✓						✓
	2	Oil Spill Dispersant - Aircraft	✓						✓
3		**Offshore Seaweed Farm Installation Assets**							
	1	Marks and Lights	✓				✓	✓	
	2	Design specifications e.g., to aid SAR	✓					✓	✓
5		**Shore Based Assets**							
	1	Marine Radar, Navigation and Communications Systems	✓				✓		
	2	Marine Rescue Coordination Centres	✓						✓
6		**Other Assets**							
	1	Pilot Services	✓				✓		
	2	Charts	✓				✓		
8		**Configuration & Design**							
	1	Optimise location, alignment, size and layout			✓		✓		
	2	Minimum safe (sea) clearances		✓			✓		

9		**Site Designation**							
	1	Safety zones of appropriate configuration and extent during construction, operation and decommissioning phases.				✓	✓		
10		**Routeing and Routeing Management**							
	1	Implementation of IMO routeing measures within or near the development e.g., Traffic Separation Scheme, Recommended Route, Area to be Avoided etc.				✓	✓		
	2	Manage traffic through VTS from MCA Control Centre				✓	✓		
	3	Continuous watch by multi-channel VHF, including Digital Selective Calling (DSC) from farm workboats			✓		✓		
	4	Monitoring by radar, AIS and/or closed-circuit television (CCTV) from farm workboats				✓	✓		
	5	Speed limits to control wash			✓		✓		
11		**Navigational Marking**							
	1	External Marking of farm to Trinity House requirements based on IALA recommendations		✓			✓		
	4	Aids to Navigation to Trinity House requirements		✓			✓		
12		**Communication & Training**							
	1	Promulgation of information and warnings through notices to mariners and other appropriate media		✓	✓		✓		
	2	Marking on Navigation Charts		✓			✓		

13		**Safety Management**							
	1	Operator's Safety Management System			✓			✓	
	2	Operators Safety and Operations Plan			✓			✓	
	3	Operators Emergency Plan			✓			✓	
	4	Contingency plan if GPS switched off/failed			✓				
	5	Emergency Response Plan	✓				✓	✓	✓
14		**Regulatory**							
	1	MMO				✓			
15		**Search & Rescue**							
	1	SAR response planning			✓				✓
	2	SAR asset provision planning			✓				✓
	3	Emergency Response Cooperation Plan		✓					✓
16		**Emergency Planning**							
	1	Salvage response planning			✓			✓	
	2	Salvage asset provision planning			✓			✓	
	3	Oil Spill response planning			✓			✓	
	4	Oil Spill asset provision planning			✓			✓	

11.3 Risk Control Matrix 2

NOTE: red indicates level 3 or 4 hazards, yellow indicates level 2 hazards and green indicates level 1 hazards. NOTE: Marine collision frequency has been raised from level 2 to 3, in line with re-assessment of recreational traffic levels from low to moderate. This does not materially change tolerability with monitoring levels.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/981718/MGN_654_Annex_1_NRA_Method p.102

			Severity				Frequency				Tolerability					
			Minor	Significant	Severe	Catastrophic	Extremely Remote	Remote	Reasonably Probable	Frequent	Broadly Acceptable	Broadly Acceptable	Tolerable with Monitoring	Tolerable with Additional Controls	Tolerable with Modifications	Unacceptable
1		**Physical Hazards**	1	2	3	4	1	3	5	7	1	2	3	4	5	6
	1	Operational Injuries	1						5				3			
	2	Mechanical Injuries		2				3							5	
	3	Chemical Hazards		2			1						3			
	4	Biological Hazards (Pathogens & Parasites)		2				1					3			
2		**Environmental Hazards**														
	1	Biological Pollution (non-endemic species introduction)		2				2						4		
	2	Organic Pollution		2			1					2				
	3	Chemical Pollution		2			1					2				
	4	Habitat Modification		2			1						3			
3		**Climate Hazards**														
	1	Storm Activity	1					2				2				
	2	Flooding		2				2					3			

KEY

	Severity Index (IMO)			Frequency Matrix (IMO)			Tolerability Index (HSE)	
1	Minor	Single or Minor Injuries	1	Extremely Remote	Once in 20 years in a 5000 ship fleet	1	Broadly Acceptable	Technical review is required to confirm the risk assessment is reasonable. No further action is required
2	Significant	Multiple or Severe Injuries	3	Remote	Once a year in a 1000 ship fleet	2	Tolerable with Monitoring	Risk must be mitigated with engineering and/or administrative controls. Must verify that procedures and controls cited are in place and periodically checked
3	Severe	Single Fatality or Multiple Severe Injuries	5	Reasonably Probable	Once a year in a 10 ship fleet	3	Tolerable with Additional Controls	Risk should be mitigated with design modification, engineering and/or administrative control to a Risk Class 3 or below before operation
4	Catastrophic	Multiple Fatalities	7	Frequent	Once per month on 1 ship	4	Tolerable with Modifications	Risk should be mitigated with design modification, engineering and/or administrative control to a Risk Class of 4 or below before construction
						5	Unacceptable	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent

11.4 Draft Marine Emergency Action Cards

DRAFT MARINE EMERGENCY ACTION CARD

For *Port Quin Bay Seaweed Farm*

Development Summary

Marine License Reference: MLA/2023/00308

The Seaweed farm, located within Port Quin Bay, will cover an area of 50.4 Ha of approximately 720 m x 700 m. The main infrastructure of the farm is a series of submerged long-lines anchored with eco-blocks. This will comprise 144 x 160 m lines arranged in a N/S orientation. The perimeter of the farm is marked by navigational safety buoys as indicated by Trinity House; yellow with special marks, lit at night and with radar reflectors fitted.

Emergency Contact One of the following or a combination of both, must be 24/7	
Duty Holder name	Biome Algae Limited
Primary number	07955 019341
Secondary number	07933 556312
Media relations (if applicable)	N/A
Coastguard	Emergency: 999 Routine: 02392 552100
Police	Emergency: 999 Routine: 101

Development location	
Range & Bearing from land	0.6km heading 180°
Dimensions of the area	720m x 700m
Number of devices	144 x 120m lines

Device Specific information *(adapt to suit the device)*			
Heights/depths (m and ft)		Lights / Markings	
Height above sea level	0.5m	Lights	6 lights, 2 Second Yellow Flashing marking corners and middles of outside edges.
Depth below surface	1.5-7m	Marks	6 Yellow Hazard Markers and lights marking corners as above

Electronic monitoring

Visual only from shore.

Details of regular maintenance activities:

Weather permitting the seaweed farm is checked at least weekly by one of the company's work boats.

During seeding and harvesting operations the site is attended more regularly.

Summary of number of personnel working offshore and emergency response capabilities:

Likely to be a maximum of 10 pax offshore.

There will usually only be 1 vessel working at the site, occasionally there will be 2, with six crew members. The vessel with have emergency response capabilities with a 8.5m Humber rib.

There will be one 10m fast open workboat and a larger 15m catamaran workboat. Both vessels should be MCA Cat2 and equipped with crane, basic FFA and liferafts and VHF radio.

Details of vessels operating to/from the development – include name, callsign, description, communications (e.g., channels used), number of crew, operating limits, etc.

This is a DRAFT MEAC that will be completed post-license issue once Biome has identified the vessels and crews that will be used to help operate the farm. The MEAC will be submitted to the MCA ahead of any at sea operations for final approval.

This DRAFT MEAC is being submitted to the MCA for approval in principle.

Personal SAR Locating Device Make & Model				
Functions: yes/no	COSPAS-SARSAT	AIS	DSC	121.5MHz
	N/A	N/A	N/A	N/A

Additional information pertinent to the development

This farm is in the licensing phase and has not yet been deployed as such this MEAC is at the DRAFT stage.

Detailed information must be included to describe the development, the devices and how the operation will work. This should include diagrams and pictures as appropriate:

The proposed seaweed farm consists of 144 x 160 m lines, all running north to south. The corner coordinates of the farm are detailed within (Table 9).

Farm Corner	Latitude	Longitude
Northwest	50.597784	-4.891862
Northeast	50.59801	-4.881677
Southeast	50.591715	-4.881306
Southwest	50.591518	-4.891385

Table 9. Corner coordinates (in WGS84) for the Biome proposed farm location in Port Quin Bay.

The outline and layout of the farm is detailed in Figure 1. The farm consists of 144 x 160 m lines. Each line consists of a double headline set up that extends the 160 m length. The lines are secured to the seabed using an eco-block at each end of the line. A 30 m riser is attached to the anchors at either end and extends vertically through the water column and is attached to the headline. The ends and the centre points of the line are marked using a total of four 300 litre grey buoys (one at either end and two 20 m apart in the centre of the line that mark a centre channel). Between each end and centre buoys, smaller 130 litre grey buoys are used to keep the line suspended and taught. These smaller buoys are positioned approximately every 20 m. Attached to both of the headline ropes that form the line, a series of 4 m dropper ropes seeded with seaweed hang suspended in the water using weights.

DRAFT MARINE EMERGENCY ACTION CARD

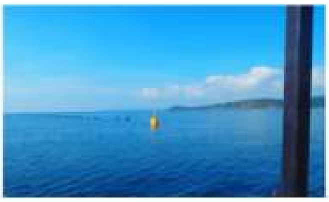
For *Port Quin Bay Seaweed Farm*

Development Summary

Marine License Reference: MLA/2023/00307

The Seaweed farm, located within Port Quin Bay, will cover an area of 50.4 Ha of approximately 720 m x 700 m. The main infrastructure of the farm is a series of submerged long-lines anchored with eco-block. This will comprise 144 x 160 m lines arranged in a N/S orientation. The perimeter of the farm is marked by navigational safety buoys as indicated by Trinity House; yellow with special marks, lit at night and with radar reflectors fitted.

Emergency Contact One of the following or a combination of both, must be 24/7	
Duty Holder name	Camel Fish Limited
Primary number	07837194105
Secondary number	N/A
Media relations (if applicable)	N/A
Coastguard	Emergency: 999 Routine: 02392 552100
Police	Emergency: 999 Routine: 101



Development location	
Range & Bearing from land	0.6km heading 180°
Dimensions of the area	720m x 700m
Number of devices	144 x 120m lines

Device Specific information *(adapt to suit the device)*			
Heights/depths (m and ft)		**Lights / Markings**	
Height above sea level	0.5m	Lights	6 lights, 2 Second Yellow Flashing marking corners and middles of outside edges.
Depth below surface	1.5-7m	Marks	6 Yellow Hazard Markers and lights marking corners as above

Electronic monitoring

Visual only from shore.

Details of regular maintenance activities:

Weather permitting the seaweed farm is checked at least weekly by one of the company's work boats.

During seeding and harvesting operations the site is attended more regularly.

Summary of number of personnel working offshore and emergency response capabilities:

Likely to be a maximum of 10 pax offshore.

There will usually only be 1 vessel working at the site, occasionally there will be 2, with six crew members. The vessel with have emergency response capabilities with a 8.5m Humber rib.

There will be one 10m fast open workboat and a larger 15m catamaran workboat. Both vessels should be MCA Cat2 and equipped with crane, basic FFA and liferafts and VHF radio.

Details of vessels operating to/from the development – include name, callsign, description, communications (e.g., channels used), number of crew, operating limits, etc.

This is a DRAFT MEAC that will be completed post-license issue once Camel Fish has identified the vessels and crews that will be used to help operate the farm. The MEAC will be submitted to the MCA ahead of any at sea operations for final approval.

This DRAFT MEAC is being submitted to the MCA for approval in principle.

Personal SAR Locating Device Make & Model				
Functions: yes/no	COSPAS-SARSAT	AIS	DSC	121.5MHz
	N/A	N/A	N/A	N/A

Additional information pertinent to the development

This farm is in the licensing phase and has not yet been deployed as such this MEAC is at the DRAFT stage.

Detailed information must be included to describe the development, the devices and how the operation will work. This should include diagrams and pictures as appropriate:

The proposed seaweed farm consists of 144 x 160 m lines, all running north to south. The corner coordinates of the farm are detailed within (Table 9).

Farm Corner	Latitude	Longitude
Northwest	50.597496	-4.90274
Northeast	50.597764	-4.892561
Southeast	50.591496	-4.892087
Southwest	50.591242	-4.90231

Table 9. Corner coordinates (in WGS84) for the Camel Fish proposed farm location in Port Quin Bay.

The outline and layout of the farm is detailed in Figure 1. The farm consists of 144 x 160 m lines. Each line consists of a double headline set up that extends the 160 m length. The lines are secured to the seabed using an eco-block at each end of the line. A 30 m riser is attached to the anchors at either end and extends vertically through the water column and is attached to the headline. The ends and the centre points of the line are marked using a total of four 300 litre grey buoys (one at either end and two 20 m apart in the centre of the line that mark a centre channel). Between each end and centre buoys, smaller 130 litre grey buoys are used to keep the line suspended and taught. These smaller buoys are positioned approximately every 20 m. Attached to both of the headline ropes that form the line, a series of 4 m dropper ropes seeded with seaweed hang suspended in the water using weights.

Annex III: Supplementary Assessment: Anchorages

The applicants have considered the designated safe anchorage area within the vicinity of the proposed farms. This is with respect to whether the proposed farms will result in the loss of access to a viable anchorage area (designated for safe anchorage for larger vessels) in the case of extreme weather events or vessel issues. This anchorage has been designated under EU Directive 2002/59 which states that *"Member States shall draw up plans for the accommodation of ships in order to respond to threats presented by ships in need of assistance in the waters under their jurisdiction, including, where applicable, threats to human life and the environment. The authority or authorities referred to in Article 20(1) shall participate in drawing up and carrying out those plans."*

Within Port Quin Bay the designated safe anchorage area is situated in the south-west of the Bay (Figure 13.0a: anchor symbol/co-ordinates provided). This is located 1 km from the closest farm site point. To the west of the proposed farms, there is an open ocean access channel from the closest farm point to Mouls Island and the main coastline that is between 700 m (former) and 1 km (latter) in terms of distance. Figure 13.0b illustrates the channel available for access between Mouls Island and the farm locations (700 m distance). The vessel, the Jubilee Queen, is a 25 m long, 8 m wide vessel for context.

The next closest designated safe anchorage is **2 miles** away at Steppers Point.

It has been reported that larger vessels (cargo ships) using the Bay over the past 10 years (2014-2024 inclusive) were, *inter-alia*:

Arslan I: 91m x 14m
Fokko Ukena: 88.63m x 12.4m
Hav Zander: 88.28m x 12.5m
Hendrik S: 82.51m x 12.4m

Hendrika Margaretha: 81.05m x 12.29m
Prins 2: 62.02m x 10.95m
Kingdom of Fife: 61.2m x 13.8m

Figure 14.0 and Table 9.0 indicates marine traffic levels within the Bay for such larger vessels (2017-2023). Refer to source Table 2.0 (section 4.1.1). Data is sourced from EMODNET. Vessels considered were cargo ships and naval/military vessels as an indicator of larger vessels utilizing the Bay. Tankers were not present in the Bay (Table 2.0 (section 4.1.1). The larger vessels captured within the data (likely including the cargo vessels listed above) are not specifically utilizing the safe anchorage point each time but are either transitioning through or temporarily anchored within the wider bay area.

The data is presented on an annual basis, rather than cumulative years basis. As this reflects the number of larger vessels accessing the Bay per year (and therefore, per individual farming season).

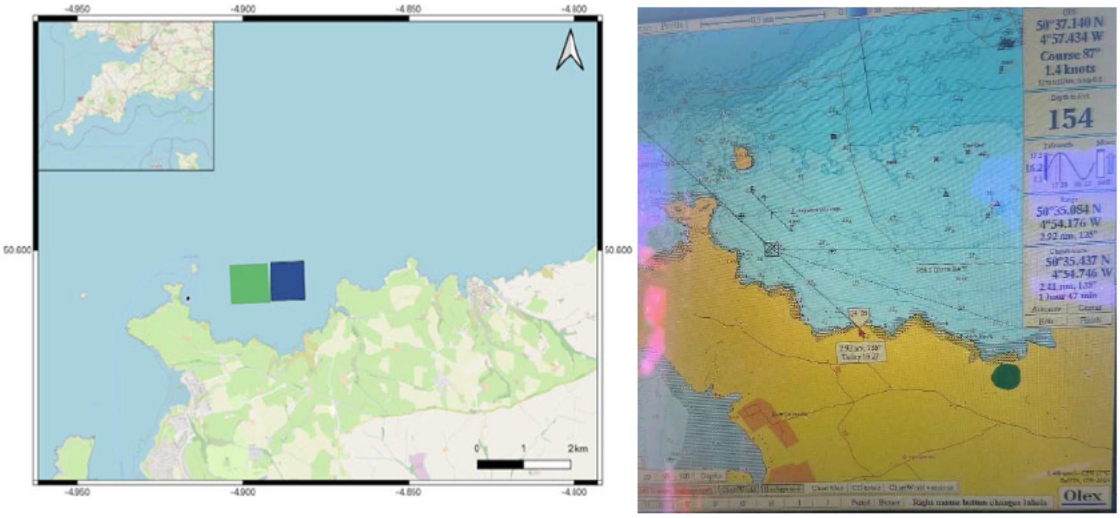


Figure 13.0a: The proposed farms in Port Quin Bay (blue rectangle and green rectangle) in relation to the Port Quin safe anchorage situated 1km to the south-west (black circle). Anchorage marked with co-ordinates on chart plotter (anchor symbol).

Figure 13.0b: Illustration of west channel distance between farms and Mouls Islan (approx. 700 m). Vessel is the Jubilee Queen (passenger vessel) 25 m long x 8 m wide, for context.

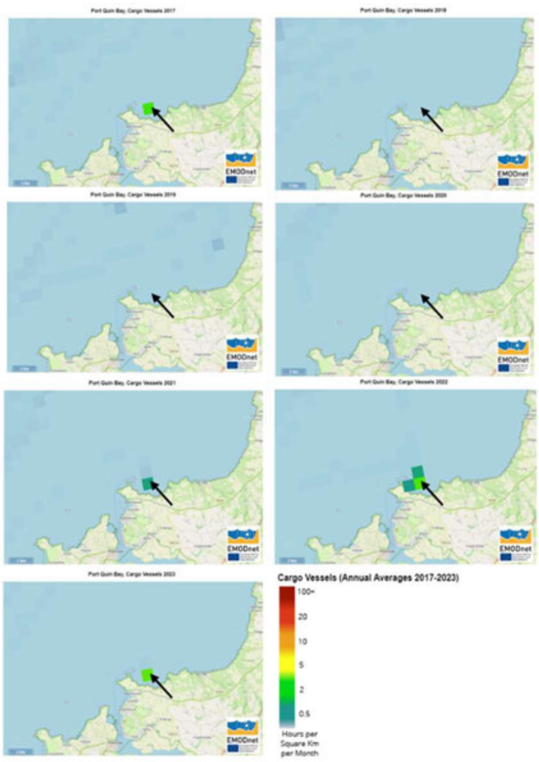


Figure 14.0: EMODNET data (2017 to 2023) for larger cargo vessels in Port Quin Bay.

hr/yr/km^2 / Year	2017	2018	2019	2021	2022	2023
Cargo	2.78	0.00	0.00	0.00	2.94	3.31
Military/Navy	0.16	0.00	0.04	0.55	0.00	0.02
Total	**2.94**	**0.00**	**0.04**	**0.55**	**2.94**	**3.33**

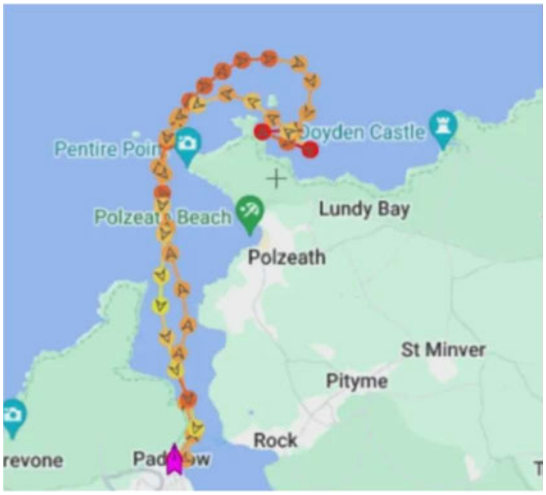
Table 9.0: Number of cargo and military vessel hours (hr) spent within a 1km^2 area of Port Quin Bay (proposed farm locations) each year from 2017-2023 (adapted from Table 2.0 (section 4.1.1).

Figure 14.0 and Table 9.0 assess larger vessel traffic transitioning through the Bay or temporarily/generally anchoring within the wider Bay. In Figure 14.0, the 1km^2 pixel indicated by the arrow is the location and footprint of the proposed seaweed farms. This indicates traffic levels for cargo vessels within that 1 km^2. The pixel colour is indicative of the scale in terms of traffic density within a 1km^2 area – as vessel hours spent within that km^2, each year (a monthly average per year is presented as the values in Table 9.0). Dark green to light green represents low traffic density on the scale (a minimum of 0.00 vessel hrs/km^2/yr in 2018 and a maximum of 3.33 vessel hrs/km^2/yr in 2023 as a monthly average).

In 2022, the data indicates that mobile cargo vessels accessing the Bay were able to anchor and transition through the Bay within the 1km^2 pixels above and adjacent to the proposed farms – and did. Alternative locations around the farm perimeter are usable for general anchorage and access and would accommodate displacement at traffic levels indicated. Therefore, the impact of the proposed farms on larger vessels in terms of temporary, general anchorage outside of the safe anchorage point is assessed as low (not significant).

If we assume (unlikely worst case scenario) all the larger vessels accessing the Bay across a full year need to use the safe anchorage (multiple extreme weather events or vessel issues) to safeguard human life: at the traffic levels indicated, vessel sizes indicated, relative size of the open access channel between the farms and Mouls/coastline for access and the fact vessels can and do anchor in the 1km^2 west adjacent to the farms, the proposed farms will not prevent them from accessing the Bay for shelter or the safe anchorage point. There is no significant impact or significant risk to human health. In addition, the stability of the farm infrastructure (Chapter 5 and Appendix I) will not pose a risk to the wider marine environment or vessels within the Bay in adverse weather conditions. EU Directive 2002/59 within the Bay is still achieved.

We report on an incident in July 2024. The GB Row Endurance vessel 'SeaChange' deliberately sought the safe anchorage in the south-west of Port Quin Bay. They began to drift south-east (anchor slipping) and therefore requested an emergency rescue. Two RNLI vessels and the Coastguard attended. The size of the vessel and vessel trackers do indicate that, if the proposed farms were in place, the rowing vessel would have been able to access the safe anchorage point within the 700m to 1 km channel to the west if approaching from the west. They could have also accessed from a similar channel size to the east farm perimeters and along the southern farm perimeters (550 m width) if approaching from the opposite direction. The vessel trackers indicate the rescue vessels could access from the 700m – 1 km west channel from Padstow and rescue if the farms were present (direct route, slightly altered trajectory or through the regularly spaced open 20 m wide open sea channels between longlines: see assessment under 'Emergency Response Plan'). In addition, if the farms had been installed, the surface buoys, securely attached to the appropriately, stable anchored headlines could have potentially provided an emergency option for tying/anchoring the rowing vessel whilst awaiting rescue if absolutely necessary.



The applicants consulted with a Naval Architect and conducted some research on typical sizes of significantly larger cargo vessels traversing the seas and oceans. We collated the following indications of size displayed in Table 10 and Figure 15.

Dimensions	Length (m)	Beam (m)	Draft (m)
ULCV	380-400	57-59	14-16
Panama Canal	294.1	32.3	12
Panama Canal expansion	366	49	15
Suez Canal	No-limitation	77	20

Table 10. Indication of size of Ultra Large Container Vessels (ULCV) with respect to panamax, post-panamax and the Suez Canal (Source: Andres & Piniella, 2017).

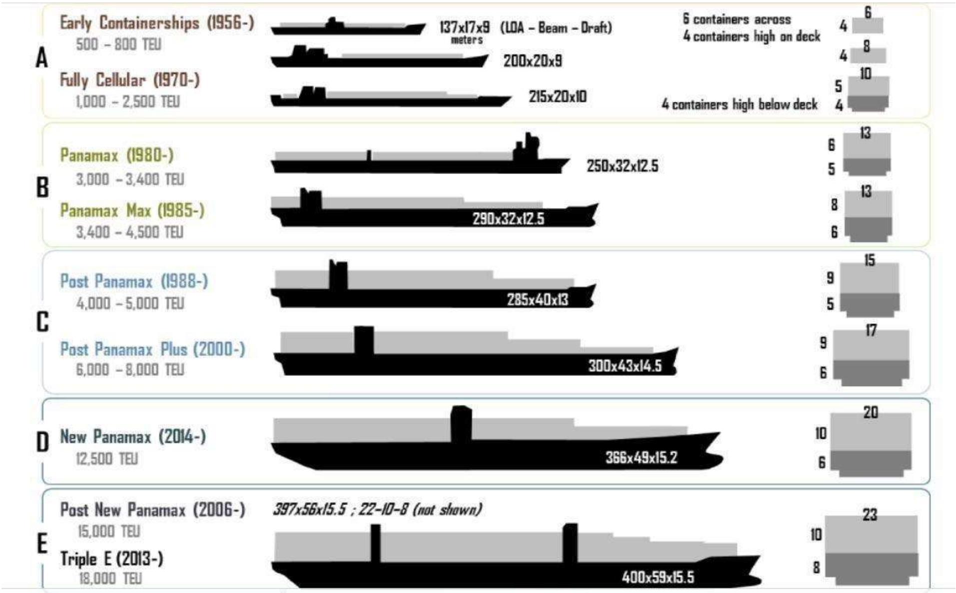


Figure 15. Summary table for sizes for different categories of cargo ship.

Given the draft sizes indicated for ULCV's in Table 10 and Figure 15, the majority of cargo ships anchoring within Port Quin Bay, in depths of 10-17 m max (depths at farm locations) are more likely to be from category A and B or smaller (as per the recorded list above).

In addition, observations of fishers operating within Port Quin Bay (ICES30E5) stated that significantly larger vessels relatively rarely enter and anchor around in the Bay. In terms of the safe anchorage location in depths of 8-9 m, significantly larger vessels would be unlikely to use the designated safe anchor point but can still access shelter within the perimeters of the proposed farms.

Appendix VI: MDMS Archaeological Report

Preface

The following report has been rewritten in response to a FIR from the MMO. The assessment refers to both Biome Algae and Camel Fish's licence application, as referenced above. Please refer to 'Appendix IX: MDMS Port Quin Seaweed Farm Marine Archaeological Assessment'.

The FIR questions that have been responded to are the following:

1.1 The MMO note this Archaeological Desk Based Assessment (DBA) has been produced by MSDS Marine on behalf of Camel Fish and Biome Algae Limited to support the marine licence applications for two adjacent seaweed farms in Port Quin Bay, north Cornwall. In doing so, we feel this presents a measured and considered approach to begin addressing the potential impacts generated by the proposed developments. The MMO found the DBA to be of a good standard, utilising a range of sources, considering the development related impacts, and providing recommendations.

1.2 There are, however, some areas of the document that would benefit from checking and further clarification. The MMO request that positions of the two geophysical anomalies (W_004 and W_005) within 'Table 7 Gazetteer of archaeological sites within the study area' be checked for accuracy, with a clearer, additional annotated figure showing the locations of these features in relation to the proposed seaweed farm.

This has been updated and provided in the archaeological report provided by MSDS.

1.3 Following this, additional consideration needs to be included as to the mitigation strategy necessary for these features, either as a phased approach to understanding their nature and associated significance, or as a more standardised approach of precautionary avoidance.

Furthermore, the MMO need to see from the assessment how the limitations of the geophysical survey data may affect what approach may be most suitable – given the proposed developments design parameters. For instance, would a survey utilising a combination of geophysical and hydrographical techniques, or an archaeologically targeted evaluation be required, prior to any archaeological exclusion zones being proposed?

This has been updated and provided in the archaeological report provided by MSDS.

1.4 With regard to the three proposed development options (in summary: 1. Screw anchors; 2. Eco-blocks; 3. Oil rig anchors and chains) the MMO note that the latter is the preferred choice. As such, to understand this option in more detail, additional consideration should be provided as to what impact all associated chainage may have on the seabed during not only daily tidal changes, but extreme weather events. This is in part due to the possibility that direct impacts from the introduction of such chains may in fact extend way beyond the footprint of the placed anchors, whilst also creating impacts at depth within the seabed.

The applicants have decided to use eco-blocks at the form of infrastructure for the licence applications. This change can be seen across all new and updated chapters. There will be no penetration of the seabed. This has been updated and provided in the archaeological report provided by MSDS.

1.5 Should the 'option 1 Screw anchors' be taken forward, there is a similar need for the DBA to explain how an archaeological written scheme of investigation (WSI) can incorporate appropriate means of mitigation to sub-surface deposits of potential archaeological and geoarchaeological interest – prior to construction. This is due to the limited direct information currently attained for these locations, and on reflection of the research aims in the South West England Research Framework Action Plan's. Such as Theme C: Environment and Dating – landscape change and methodologies. Therefore, the MMO require to have these points be *clarified in the DBA, such that it can inform any post-consent WSI, and thereby commit to the procedures that need to be included.*

Screw anchors will no longer be taken forward. This has been updated and provided in the archaeological report provided by MSDS.

1.6 The DBA must incorporate clearer recommendations for mitigation (perhaps through future archaeological work) to enable a greater understanding of potential heritage assets and associated deposits of interest residing on/within the seabed at the proposed location. With specific consideration provided of where existing marine geophysical survey data is currently unsuitable or insufficient to inform appropriate measures of mitigation.

This has been updated and provided in the archaeological report provided by MSDS.

1.7 The MMO also note that there is no need to reference the National Planning Policy Framework (2012) in section 2 'Legislation, policy and guidance'.

This report was prepared and written by an independent company. This report been provided separately alongside this report and is titled *'MDMS Port Quin Seaweed Farms Marine Archaeology Assessment'*.

Appendix VII: UXO Report

Preface

The following report has been written in response to a FIR from the MMO. The assessment refers to both Biome Algae and Camel Fish's licence application, as referenced above. Please refer to 'Appendix XI: Port Quin UXO Desk Based Assessment'.

The FIR questions that have been responded to are the following:

7.5 Unexploded Ordinance
The MMO has been made aware that historical use of the site for the farms was as a Naval aerial bombing practice and air to air/sea and ground firing range (see image below). Therefore, there is the potential for unexploded ordinance within the development area. The MMO therefore requests that further assessment of the risks associated with this and any mitigation or surveys required be considered within the application documents

We have had an independent assessment of the UXO and have provided this risk assessment with the other updates and new chapters. As with all new and updated chapters this has been done cumulatively for both proposed seaweed farm sites. It should be noted that there will be no penetration of the seabed with these two licenced sites as we have opted for using Eco-blocks are the form of infrastructure. This is reflected in our updates.

This report was prepared and written by an independent company. This Assessment has been provided alongside this report.

Appendix VIII: Fisher Survey and Interview Data

Preface

The following supporting document has been provided is in response to a FIR from the MMO. The document refers to both Biome Algae and Camel Fish's licence application, as referenced above.

The survey and interviews have been conducted with input from local fishers, local potters, local trawlers, local charters, and local boat tourers. This represents a wide range of fisheries operators and stakeholders that operate within ICES30E5.

This document contains sensitive information and the applicants will submit a redacted version of the appendix which may be shared with the wider public. This is to protect our collaborators, interviewees, partners and advisors, from a data protection perspective – at their request. The unredacted appendix may be shared confidentially with primary assessors.

1.0 Survey And Interview Data

An initial survey and interview of 17 fishers that work out of Padstow, Port Isaac, and Port Quin was conducted on the 15th of December 2024. This survey was conducted to provide information and data from active Stakeholders that actively work along the coastline of Padstow, Port Isaac, and Port Quin Bay (within ICES30E5). However, this is not limited to coastline fisheries operators and included those that operate within ICES30E5 but further offshore than the proposed farm locations. Furthermore, the majority of operators surveyed and interviewed operate vessels that are under 12 m however, this was not limited to under 12 m operators. The survey was conducted to collect data regarding the form of fishing/activity the operator conducts and their vessel size. This data was collected to fill the gaps of data used in the applications taken from EMODnet, MMO data, Marine Traffic, AIS, VMS, and CIFCA. All operators in this initial survey that were engaged supported the licence application farm locations and did not believe the proposed area of works would affect their current fisheries activities.

Fisheries Operator	Category	Vessel Size
John Murt	Static Fishing	Under 10 meters
Peter Ward	Static Fishing	Under 10 meters
Martin Biddle	Static Fishing	Under 10 meters
Ivan Bate	Static Fishing	Under 10 meters
James Dunn	Trawling	Over 12 meters
Berlewen Fishing Industries	Netting/Boating Tours	Under 10 meters
Padstow Sealife Safari's	Boat Tours	Under 10 meters
Padstow Charter	Charter	Under 10 meters
Les Burt	Static Fishing	Over 12 meters
Callum Greenhalgh	Static Fishing	Under 10 meters
Jim May	Static Fishing	Over 12 meters
Kevin Lance	Static Fishing	Under 10 meters
Tom Brown	Static Fishing/Netting	Under 10 meters
Daniel Sproull	Static Fishing	Under 10 meters
Camel Fish/Pentire Fishing	Trawling/Static Fishing	Under 12 & Over 12 meters
Emma Kate Padstow Fishing Trips	Boat Tours	Under 10 meters
Jason Nicholas	Static Fishing	Under 10 meters

Table 1. A table identifying the fisheries operator, their work activity/fishing type, and their vessel size. Source: Survey and Interviews with Local Fishers from Padstow, Port Quin, Port Isaac that work out of these locations and within the surrounding waters.

A second survey and interview of 15 fishers that work out of Padstow and Port Quin was conducted on the 14th of May 2024. This survey was conducted for multiple purposes;

- To provide data and information from active fishers who actively work with ICES30E5, the area in which the proposed seaweed farms are located.
- To share information in regards to shellfish, fish species, and fishing activity in Port Quin Bay and its surrounds specifically.
- To clearly state if the proposed farms will affect their fishing activities.

Fisheries Operator	**Vessel**	**Landing Port**	**Do the proposed farms affect fisheries activity**
Martin Biddle	Avocet	Padstow	No
Ivan Bate	Autumn Rose	Padstow	No
Les Burt	Sanderling	Padstow	No
James Dunn	Lucy too	Padstow	No
Jim May	Orcades III	Padstow	No
Tom Murt	Forget me not	Port Isaac	No
John O'Connor	Patrice	Padstow	No
David Evans	Shamrock	Port Isaac	No
Nick Chapman	Kerry Marie	Padstow	No
Jason Nicholas	Lisa Marie	Padstow	No
Dugald Sproull	Razorbill	Padstow	No
Kevin Lance	Pieces	Padstow	No
Tom Brown	Maverick	Padstow	No
Peter Ward	Janice Mary	Port Isaac	No
Martin Murt	Brenellis	Padstow	No

Table 2. A table identifying the fisheries operator, their vessel name, their landing port, and if they believe the proposed farms will affect their fishing activity. Source: Survey and Interviews with Local Fishers from Padstow, Port Quin, Port Isaac that work out of these locations and within the surrounding waters.

2.0 Proposed Farm Locations Not Affecting Fisheries Operators

From the two interviews conducted there are 23 individual fisher/businesses that support the proposed licenced sites and have agreed that the proposed farms will **not** affect their activities. This is crucial as these individuals are active stakeholders in the proposed area of works as well as the majority use vessels under 12m's which covers the data gaps of EMODnet, AIS, and VMS.

3.0 Fishing Activity

All individuals in Table 2 agree that the fishing effort would not be affected by the proposal as they do not fish in that area and the species that they fish are not found in the proposed sites area. We have been told that Plaice used to be caught in Port Quin Bay but this was around 15 – 20 years ago when it was last worth fishing. During the interviews we were also told that over the last few years when the two trawlers left in Padstow tried to fish within the area of Port Quin Bay it has been a waste of time for fishing as they hardly caught anything. Vessel Shamrock last fished the area 2 years ago and in a 2-hour trawl they caught 2 plaice and 1 sole. This data conducted from surveys and interview supports the data provided in the Fisheries Assessment and the Fisheries Impact Assessment, and data provided with the applications sourced from EMODnet, AIS, VMS, the MMO, and data collected from CIFCA. When looking at all of this data it is apparent that there is minimal fishing activity in Port Quin Bay and specially within the proposed area of works.

From the second survey it was agreed that the main species fished in Port Quin Bay were shellfish; Crab and Lobster. It was also mentioned that these species are caught close to the coast and further offshore, **not within the vicinity of the proposed area of works**. This is supported by the data provided in the Fisheries Assessment and the Fisheries Impact Assessment, and data provided with the applications sourced from EMODnet, AIS, VMS, the MMO, and data collected from CIFCA. This is also supported by the initial survey that showed that out of the 17 fishers/businesses, 12 of these are static fishers. These static fishers do not oppose the proposed area of works as they would not affect their fisheries activities.

4.0 Vessel Size

From both sets of surveys and interviews we have found that vessel size varies from 6m-15m. With 23 individuals/businesses. This data holds significance as it covers the data gap of EMODnet, AIS, VMS, and CIFCA data that may not capture vessels under 12 meters. As this data is not captured through resources and sources online the only way to capture it is through surveys and interviews of active fisheries operators which have been conducted by the applicants. This is crucial as active fisheries operators that have been surveyed and interviewed have unanimously supported the farm locations and have provided data that evidences that they do not conduct activities within the proposed area of works and that the farms will **not** affect their activities.

Port Quin Seaweed Farms

Marine Archaeology Assessment

MSDS Marine

2023/MSDS23265/1

Port Quin Seaweed Farms

Marine Archaeology Assessment

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Client	Biomealgae
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1.0 Introduction

1.0.1 MSDS Marine were contracted by Biomealgae to provide a desk-based assessment for an offshore site proposed for the construction of two new, adjacent seaweed farms. The proposed development site is situated in Port Quin Bay, off the north coast of Cornwall (Figure 1). For the purposes of this assessment, the two proposed seaweed farms will be jointly referred to as "the Site".

1.0.2 This report contains information on the policy, legislation, guidance and methodology undertaken for the assessment. The report also characterises the baseline for offshore archaeology and maritime heritage within, and immediately surrounding, the site. Finally, the report assesses impacts on offshore archaeology and maritime heritage and recommends further work and appropriate mitigation.

1.0.3 The components of the baseline environment described in this desk-based assessment (DBA) are the prehistoric, maritime and aviation sites of archaeological potential, in addition to the Historic Seascape Character (HSC). The baseline is defined as the present nature of the archaeological environment within the site.

2.0 Legislation, policy and guidance

2.0.1 Relevant policy and legislation to offshore archaeology and cultural heritage include the following:

- The World Heritage Convention (1972);
- United Nations Convention on the Law of the Sea (1982);
- International Council of Monuments and Sites Charter on the Protection and Management of Underwater Cultural Heritage (1996) (the Sofia Charter);
- UNESCO Convention on the Protection of the Underwater Cultural Heritage (2001);
- Protection of Wrecks Act (1973);
- Ancient Monuments and Archaeological Areas Act (1979);
- Protection of Military Remains Act (1986);
- Merchant Shipping Act (1995);
- National Heritage Act (2002);
- Marine and Coastal Access Act (2009);
- UK Marine Policy Statement (2011); and
- National Planning Policy Framework (2012).

2.0.2 The Site is located within the South West Inshore Marine Plan area. The South West Inshore and South West Offshore Marine Plan[1] includes objectives and policies of relevance to heritage, the key policy being SW-HER-1:

"Proposals that demonstrate they will conserve and enhance the significance of heritage assets will be supported.
Where proposals may cause harm to the significance of heritage assets, proponents must demonstrate that they will, in order of preference:
a) avoid
b) minimise
c) mitigate
any harm to the significance of heritage assets.
If it is not possible to mitigate, then public benefits for proceeding with the proposal must outweigh the harm to the significance of heritage assets."

2.1 Guidance

2.1.1 The following industry guidance has been identified and consulted to ensure this assessment meets its requirements:

- Standard and Guidance for Historic Environment Desk Based Assessment (DBA) (Chartered Institute for Archaeologists, 2020);
- Code of Practice for Seabed Development (Joint Nautical Archaeology Policy Committee, 2006);
- Military Aircraft Crash Sites (English Heritage, 2002);
- Aircraft Crash Sites at Sea (Wessex Archaeology, 2008a); and
- Identifying and Protecting Palaeolithic Remains (English Heritage, 1998).

[1] HM Government. 2021. South West Inshore and South West Offshore Marine Plan. https://www.gov.uk/government/publications/the-south-west-marine-plans-documents

3.0 Methodology

3.0.1 This section provides an overview of methods used to inform the assessment. The Site and Study Area are described first, followed by data sources and detailed methods for the review of these data sources then follows.

3.0.2 The baseline assessment is primarily focused on known and potential remains relating to:

- Palaeolandscape and submerged prehistory;
- Maritime and aviation remains; and
- Historic Seascape Character.

3.1 Study Area

3.1.1 The areas examined for the purpose of this report include the Site and a 2 km Study Area (see Figure 1). The terrestrial part of the Study Area was limited to 200 m measured from Mean High Water Springs. This area was selected to best characterise the potential for maritime archaeological remains.

3.2 Data sources

3.2.1 The baseline survey involved consultation of readily available archaeological and historical information from documentary and cartographic sources and repositories including:

- List of wrecks designated under the Protection of Military Remains Act, 1986 (digitised and available online via the government Marine Map portal[2]);
- Historic England (designated heritage assets and Historic Seascape Characterisation);
- The United Kingdom Hydrographic Office (UKHO) Wrecks, Obstructions and Fouls records;
- National Record of the Historic Environment (NRHE) data;
- Cornwall Historic Environment Record (HER) data;
- Existing geological, geophysical, and geotechnical information accessed via the BGS GeoIndex (Offshore) http://mapapps2.bgs.ac.uk/geoindex_offshore/home.html#;
- Single beam data available from the Admiralty Seabed Mapping service (specifically, survey: 2011 HI 1157 Hartland Point to Lands End Blk2 2m SB);
- British Geological Survey data and reports (principally Evans, C.D.R. 1990. *United Kingdom offshore regional report: the geology of the western English Channel and its western approaches*);
- Rapid Coastal Zone Assessment Survey for South-West England[3] (RCZAS); and
- Other secondary sources consulted include relevant literature from journals, publications and unpublished archaeological reports.

3.2.2 These sources were assessed, and information compiled into a gazetteer for the Site and Study area (see Section 13.0).

3.2.3 All sources have been used to develop an understanding of the heritage baseline within the Study Area throughout the Quaternary period. This data is assessed and presented

[2] https://explore-marine-plans.marineservices.org.uk/
[3] Grant, M., Westley, K. & Sturt, F. 2019. *Rapid Coastal Zone Assessment Survey for South-West England: North Coast of Devon (excluding Exmoor) and North Coast of Cornwall. Phase One Desk-Based Assessment.* Historic England Project 6047.

chronologically within the report, beginning with the potential for submerged prehistoric landscapes.

Assessment and limitations of geophysical data

3.2.4 In addition to the existing databases, the Admiralty Marine Data Portal[4] was accessed for existing bathymetry data covering the Study Area. Survey *2011 HI 1157 Hartland Point to Lands End Blk2 2m SB* covers the Site and was assessed by MSDS Marine for evidence of maritime and aviation remains. The data were supplied gridded to 2 m and although labelled as single beam data, the data is actually multibeam data. The data were collected as part of the Maritime Coastguard Agency (MCA) Civil Hydrography Programme (CHP) and, whilst the data were collected in 2011, the specification for CHP data is generally high and the data are of good quality. Additionally, there was no evidence of highly dynamic features such as sandwaves within the vicinity of the Site, which may mask archaeological remains.

3.2.5 It is noted that a 2 m grid is suitable for the identification of larger features (>2 m) such as wrecks or larger structures. Two anomalies were observed within the Site and are clearly visible within the data. It is feasible that activities noted as taking place within the Site, such as bottom trawling, may have altered these anomalies between the collection of the data and production of this report.

3.2.6 Despite the limitations, the data allows for the identification of larger features of potential archaeological interest, including the remains of wrecked vessels and submerged structures. The results of the assessment of this data have been fed into the main report. In terms of positional accuracy, whilst there are no accompanying details, it can be confidently assumed (due to the nature of bathymetry data, the data collection process, and the purpose for which the was collected) that it will be sub meter.

3.3 Chronology

Archaeological Chronology

3.3.1 Three chronology systems are used when discussing archaeological remains or periods. These are as follows:

- Absolute dates: These are fixed dates that correspond with calendar years and are suffixed with BC (Before Christ) or AD (Anno Domini). For example, a date of 643 BC occurred 2,666 years ago, and a date of 1066 AD occurred 957 years ago (correct as of 2023);
- Calibrated radiocarbon dates: these can either be presented as calendar dates, or as the number of years before 1st January 1950 (before practical radiocarbon dating technology was available, and before large scale nuclear testing altered the global ratio of ^{14}C to ^{12}C making dating subsequent to this date unreliable). For example, a date of 11,700 Before Present (BP) occurred 11,773 years ago (correct as of 2023) and could also be presented as 9,749 BC, noting that there is no 'year zero' so 1 is subtracted from each date; and
- Uncalibrated radiocarbon dates: these are dates that are based on the radiocarbon dating that do not take fluctuations in ^{14}C levels into account. These dates can be calibrated using a calibration curve to convert them into calendar dates.

3.3.2 Dating in this report uses BP or BC dates. For events or sites that predate the Mesolithic (10,000 BP/8,000 BC) dates are usually given in BP*. From the Mesolithic onwards, dates are generally

[4] https://data.admiralty.co.uk/portal/apps/sites/#/marine-data-portal

given in BC. In some cases, dates after the Mesolithic are provided in BP where environmental features and events are discussed e.g., the development of the current coastlines of the UK in approximately 5,000 BP.

3.3.3 The main archaeological periods discussed in this report are listed in Table 1.

Broad period	Sub-period	Date
Palaeolithic	Lower	c.970,000 – 150,000 BP
	Middle	150,000 – 40,000 BP
	Upper	40,000 – 10,000 BP*
Mesolithic	Early	8,000 BC* – 7,000 BC
	Late	7,000 – 4,000 BC
Neolithic	Early	4,000 – 3,300 BC
	Middle	3,300 – 2,900 BC
	Late	2,900 – 2,200 BC
Bronze Age		2,600 – 700 BC
Iron Age		800 BC – 43 AD
Roman		43 – 410 AD
Early Medieval		410 – 1066 AD
Medieval		1066 – 1540 AD
Post Medieval		1540 – 1901 AD
Modern		1901 AD – Present

Table 1 Archaeological periods and dates in England.

3.4 Quaternary chronology

3.4.1 The Quaternary chronology of the UK is outlined in Table 2. Marine Isotope Stages (MIS) are alternating warm and cold periods derived from oxygen isotope data taken from deep sea core samples.

Stage		Age		Climate	Marine Isotope Stage		Epochs and Periods		
Main	Sub.	Start	End		Stages	Record			
Beestonian		970,000	936,000	Interglacial	25		Pleistocene	Early Pleisto.	Lower Palaeolithic
		936,000	917,000		24				
		917,000	900,000	Interglacial	23				
		900,000	866,000	Stadial	22				
Cromerian Complex		866,000	814,000	Sequence poorly understood but evidence for a series of small expansions of the British Ice Sheet marking at least 4 interstadials and 5 warm episodes.	21				
		814,000	790,000		20				
Bruhnes-Matuyama reversal (c. 780kBP)		790,000	761,000		19			Middle Pleistocene	
		761,000	712,000		18				
		712,000	676,000		17				
		676,000	621,000		16				
		621,000	563,000		15				
		563,000	524,000		14				
		524,000	478,000		13				
Anglian		478,000	424,000	Stadial	12				
Hoxnian		424,000	374,000	Interglacial	11				
Wolstonian/ Saalian complex	Unnamed	374,000	337,000	Stadial?	10				
	Purfleet	337,000	300,000	Interglacial	9				Middle Palaeolithic
	Early	300,000	243,000	Stadial?	8				
	Aveley	243,000	191,000	Interglacial	7				
	Late	191,000	123,000	Stadial	6				
Ipswichian		123,000	109,000	Interglacial	5e			Late Pleistocene	
Devensian – Early		109,000	96,000	Stadial	5d				
Devensian – Early	Chelford	96,000	87,000	Interstadial	5c				
Devensian – Early		87,000	82,000	Stadial	5b				
Devensian – Early	Brimpton	82,000	71,000	Interstadial	5a				
Devensian – Early		71,000	57,000	Stadial	4				
Devensian – Mid	Upton Warren	57,000	29,000	Interstadial	3				Upper Pal
Devensian – Late	Dimlington	29,000	14,700	Stadial	2				
Devensian – Late	Windermere	14,700	12,900	Interstadial					
Devensian – Late	Loch Lomond	12,900	11,700	Stadial					
Holocene		11,700	Present	Interglacial	1		Holocene		Meso.

Table 2 Quaternary chronology (based on Marshall et al. 2020[5], with dates from Lisiecki and Raymo[6])

[5] Marshall, P., Bayliss, A., Grant, M., Bridgland, D.R., Duller, G., Housley, R., Matthews, I., Outram, Z., Penkman, K.E.H., Pike, A., Schreve, D. & Xuan, C. 2020. *6390 Scientific dating of Pleistocene sites: guidelines for best practice. Consultation Draft*. Swindon: Historic England.

[6] Lisiecki, L. E. & Raymo, M. E. 'A Pliocene-Pleistocene stack of 57 globally distributed benthic 18O records'. *Palaeoceanography*. **20**.

3.5 Palaeolandscapes and Submerged Prehistory

3.5.1 The report investigates the potential for submerged prehistoric remains to be present within the site. Existing geological data, findspots of prehistoric material (including archaeological evidence and faunal remains, for example) and key studies are important sources to establishing this potential.

3.5.2 The assessment of submerged prehistoric remains seeks to identify periods in which the Site was inhabitable dry land and periods in which the area lay under ice sheets or water masses, rendering the Site uninhabitable by humans. Different geological formations are also associated with differing environmental conditions and thus different archaeological potential. The report therefore investigates the full Quaternary sequence within the Site. The assessment also seeks to identify the previous environmental characteristics of the Site and Study Area (e.g., marine, terrestrial, lacustrine, fluvial, marsh, riverine, etc.) at different times during the Quaternary period, as this is key to understanding palaeolandscape and paleoenvironmental potential and also to how past human populations may have interacted with these environments.

3.5.3 Determining the potential for remains to survive is equally important. This involves consideration of the current geological makeup of the area, along with the effects of erosion and other geological forces, following the succession of glaciations and marine transgressions which have shaped the area.

3.6 Maritime and Aviation Records

3.6.1 To provide an assessment of the known and potential maritime and aviation archaeological resources within the application area, records of known wrecks, recorded losses and casualty records, Named Locations, isolated finds and seabed features were collated. Searches of records held in the UKHO wrecks database, the NRHE and HER were undertaken and all details for the area recorded. UKHO data includes detail on wrecks and seabed obstructions that have been collated to ensure the safety of navigation at sea. As such, information on the size, position and nature of features on the seabed to ensure safety of navigation is the primary focus of the data, although in a number of cases specific historical detail is provided to establish the identity and nature of loss of a wreck or obstruction.

3.6.2 Data from the NRHE and Cornwall HER have been collected to provide information on the terrestrial and marine historic environment and archaeological interest of sites and features on land and at sea. Within the marine zone, NRHE data constitute records of 'Known Wrecks' (where a specific wreck location is known), 'Recorded Losses' (linked to casualty records of ships or aircraft seen in distress or lost at sea, rather than specific sites on the seabed) and isolated find spots and Named Locations (NL - records where only approximate or no location data exist). Many of these records are broadly indicative of areas of maritime archaeological potential, rather than specific records of wrecks on the seabed. HER data constitutes findspots, monuments, investigative events and designated assets (Scheduled Monuments & Listed Buildings, specifically for the Study Area), which contributes to the archaeological understanding of the area.

3.6.3 Intertidal and coastal remains are also considered where they fall within the Study Area and where they may illustrate the potential of the Site through demonstration of previous patterns of activity within the wider adjacent landscape and coast.

3.7 Historic Seascape Characterisation

3.7.1 Assessment of Historic Seascape Character (HSC) within the application area involved reviewing the HSC data in ArcGIS to identify any historical or archaeological character, or elements thereof. The existing character types were then summarised (see section 8.0).

3.8 Assessment of Significance

3.8.1 The UK Marine Policy Statement indicates that authorities should take account of the particular nature of the interest in the (heritage) assets and the value they hold for this and future generations. Therefore, this report contains an assessment of significance for remains which are identified within the Site.

3.8.2 Both designated and non-designated heritage assets can hold heritage value. Value considers whether, for example, the receptor is rare, has protected status or has importance at a local, regional, national, or international scale. Designated heritage assets, such as Protected Wrecks, have high value.

3.8.3 For non-designated assets, significance (value) is best defined by Historic England's 'Conservation Principles'[7], which describes value as a combination of evidential, historical, aesthetic and communal values:

- Evidential value derives from the physical fabric of an asset and its ability to provide evidence relating to how the asset was made and used and how this changed through time;
- Historical value can derive from particular aspects of past ways of life or association with notable families, persons, events or movements. It is the connection between past events and society with the present;
- Aesthetic value relates to the design, construction and craftsmanship of an asset. It can include setting and views to and from the asset, which may have changed through time; and
- Communal value derives from the meanings that an historic asset has for the people who relate to it or for whom it figures in their collective experience or memory. It may be commemorative, spiritual or symbolic, such as meaning for identity or collective memory.

3.8.4 The assessment of significance also considers the potential for archaeological remains to contribute towards questions identified in relevant research frameworks, namely:

- *People and the Sea: A Maritime Archaeological Research Agenda for England*[8];
- *South West England Research Framework*[9]; and
- *Research and Conservation Framework for the British Palaeolithic*[10].

[7] Historic England (English Heritage). 2008. Conservation Principles. English Heritage: Swindon
[8] Ransley, J., Sturt, F., Dix, J. and Blue, L. 2013. *People and the Sea: A Maritime Archaeological Research Agenda for England*. Council for British Archaeology.
[9] Research Frameworks Network. 2023. *South West England Research Framework* https://researchframeworks.org/swarf/ Accessed 12 September 2023.
[10] The Prehistoric Society & English Heritage. 2008. *Research and Conservation Framework for the British Palaeolithic.*

4.0 Baseline Assessment

4.1 Site location

4.1.1 The Site lies between c. 1.0 to 2.7 km to the northwest of Port Quin, off the north coast of Cornwall. The Mouls (a small, rocky island) lies c. 780 m to the west and the nearest land-point is at the mouth of Port Quin inlet, c. 560 m to the southeast (Figure 1).

4.1.2 The RCZAS[11] places the Site within section PDZ15 (Pentire Point to Wanson Mouth), characterised by north or northwest facing "...rugged cliffs, stormy seas, stunted and windblown trees, and isolated settlements which have grown up clustered in the shelter of river valleys". It is also noted that this part of the coastline is one of the most sparsely populated in the region.

4.2 Designated heritage assets

4.2.1 No designated heritage assets lie within the Site. Two Scheduled Monuments and ten Grade II Listed Buildings lie within the Study Area, the latter principally situated within the small settlement of Port Quin:

- Scheduled Monuments:
  - The Rumps (Figure 9; TI_006);
  - Round barrow SE of Scarnor Point (TI_002);
- Listed Buildings (TI_012):
  - Varley Cottage;
  - Carolina Cellar and wall adjoining to north west;
  - North west wall to fish cellars;
  - Quay Cottage;
  - Garages/boatsheds and adjoining walls 3 metres to south west of Carolina Cellars;
  - Lacombe Cottage;
  - Slip and retaining wall on south and east side of beach;
  - Wall to beach on north east side of Port Quin;
  - Doyden Castle; and
  - Guys Cottage and Quin Cottage.

4.2.2 These are referred to where relevant within this report where they relate to the archaeological potential of the Site and included in the gazetteer with further details (see Section 13.0). The proposed development would not lead to direct physical impacts to any of these terrestrial designated assets.

4.3 Non-designated heritage assets

4.3.1 One record for a non-designated heritage asset has been identified within the Site, representing the former location of a 20th century aerial bombing or naval gunnery target. No correlating UKHO record exists, and it is not known if any physical remains are present. The HER

[11] Grant *et al*. 2019.

also places the broad location of ten documented losses within the Site, which have not been correlated with seabed remains.

4.3.2 Two geophysical anomalies have been identified within the Site which may represent wrecks or parts thereof. These anomalies do not correlate with any UKHO, NRHE or HER records.

4.3.3 There are a small number of wrecks and documented losses of vessels recorded within the Study Area. They are discussed further below and are listed within the gazetteer (Section 13.0). Their distributions are shown on figures within the baseline maritime archaeology section of the report (Section 6.0).

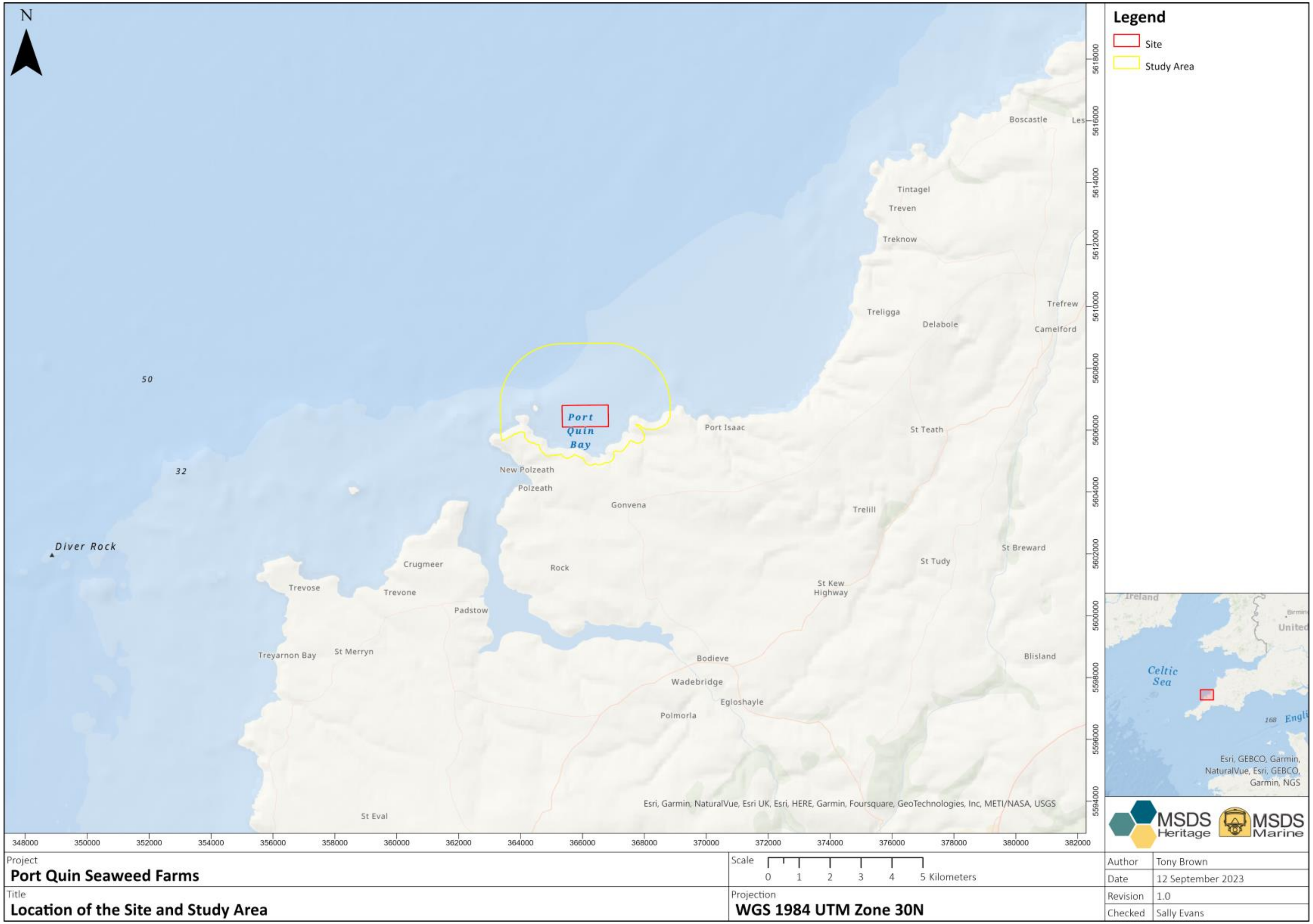

Figure 1 Location of the Site and Study Area.

5.0 Submerged prehistory

5.0.1 The prehistoric archaeological record of Britain covers the period from the earliest hominin occupation, potentially as far back as 970,000 BP, to the end of the Iron Age and the Roman invasion of Britain in AD 43. The coastline changed drastically during prehistory and large tracts of the seabed surrounding the British Isles were once sub-aerially exposed. The British Isles have been affected by several glacial events over the last million years, including the Anglian (478,000 to 424,000 BP), the Wolstonian (380,000 to 132,000 BP) and the Devensian (115,000 to 11,700 BP) and intervening marine transgressions, all of which have influenced archaeological potential. The archaeological potential is inferred from the presence (or absence) of prehistoric landscapes off the coast of north Cornwall, discussed in a variety of published reports and grey literature. Palaeolandscape and palaeoenvironmental remains associated with the Site are further investigated in this Section.

5.0.2 Prehistoric archaeological potential is gauged with reference to evidence for human activity in the UK during each period and the contemporary environment within the Site. Depositional environment and post-depositional factors are also key to understanding potential and geological deposits form an important consideration in understanding archaeological, palaeoenvironmental and palaeolandscape potential. Deposits with potential for prehistoric archaeological remains, or palaeoenvironmental information are generally those laid during periods of sub-aerial exposure or by fluvial process, rather than sub-glacial or marine deposits (though these may include remains capable of providing dates for different environmental conditions and constraining time periods of potential suitability for habitation). However, there is also potential for archaeological material to be redeposited or reworked within secondary contexts because of fluvial erosion or glacial processes[12].

5.1 Previous geotechnical investigations

5.1.1 Few geotechnical investigations have been undertaken in Port Quin Bay by the BGS. The work undertaken comprises the collection of a small number of grab samples of superficial surface sediments only. Seismic data have been collected within the wider area further offshore, but no survey lines enter the Site or Study Area[13].

5.1.2 A wider study of the sub-seabed geology of the Celtic Sea, Western Approaches and the western English Channel included the examination of a range of geotechnical investigations[14]. The results of the study have been incorporated into this assessment; however, the original geotechnical reports have not been reviewed.

[12] Hosfield, R. and Chambers, J. 2004. *The Archaeological Potential of Secondary Contexts*. ALSF Project 3361.
[13] British Geological Survey (BGS). GeoIndex Offshore. https://mapapps2.bgs.ac.uk/geoindex_offshore/home.html Accessed 05 September 2023.
[14] Evans, C.D.R. 1990. *The geology of the western English Channel and its western approaches United Kingdom Offshore Regional Report*. London: HMSO. https://webapps.bgs.ac.uk/Memoirs/docs/B01850.html

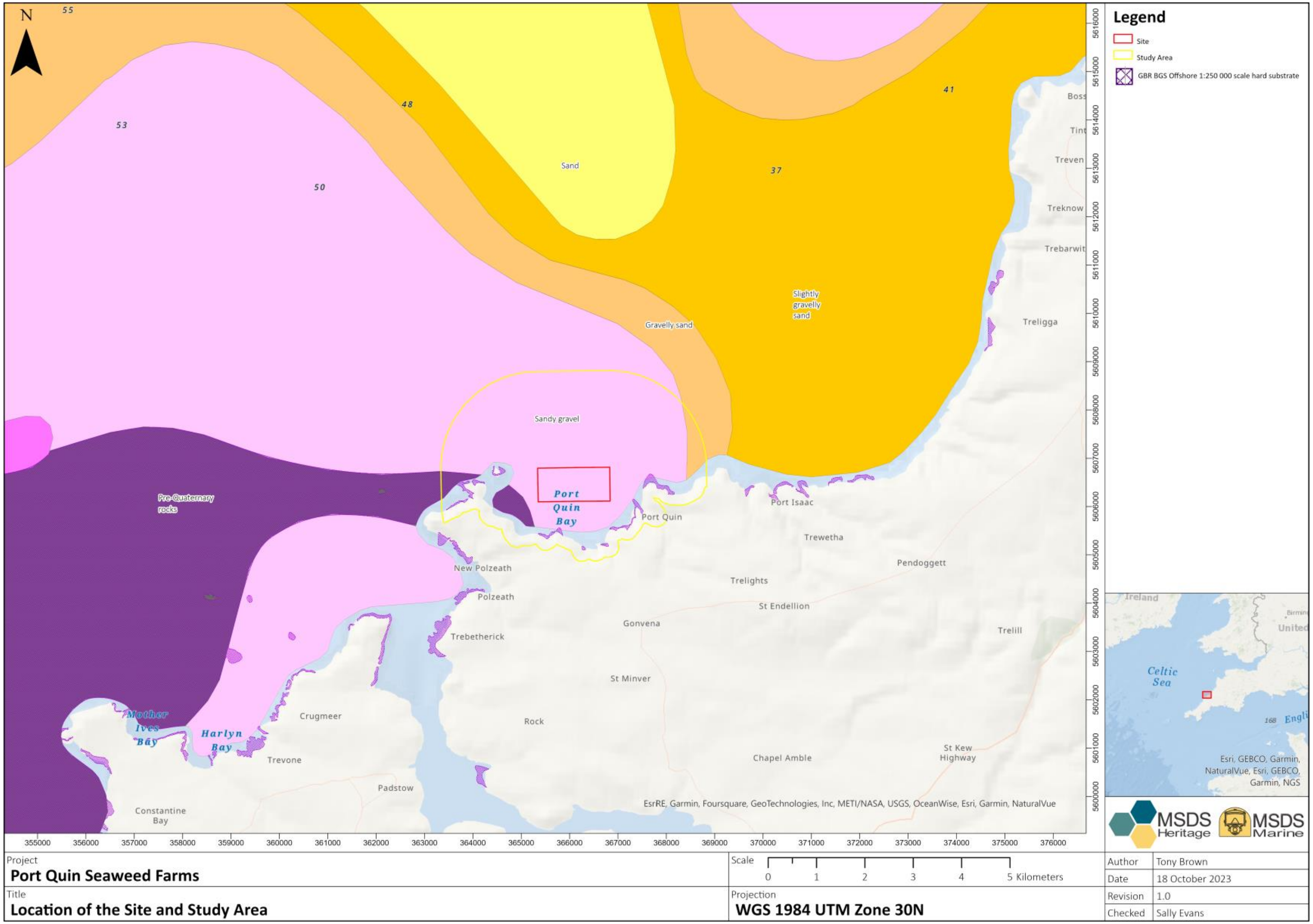

Figure 2 Seabed sediments (from BGS).

5.2 Geology: pre-Quaternary bedrock

5.2.1 The wider region, including the Site and Study Area, is underlain by undifferentiated Devonian and Carboniferous rocks, comprising mudstone and sandstone (undifferentiated) and limestone[15]. This bedrock dominates the surrounding offshore bedrock geology, with little variation within c. 40 km of the shore.

5.2.2 The bedrock outcrops in several locations at the base of the cliffs forming the south of Port Quin Bay, with more substantial outcrops within the western part of the bay and further west, beyond The Rumps (see Figure 2).

5.3 Geology: Quaternary sediments

5.3.1 It is noted that Quaternary deposits are limited in distribution and difficult to date across the continental shelf beneath the Celtic Sea and Western Approaches, including the Site. Three Quaternary geological units have been identified by Evans (1990) within this wider area of study. No site-specific geotechnical investigations have been undertaken and the presence or absence of the geological units described below is provisional at present.

5.3.2 The earliest Quaternary deposit of the Celtic Sea, the Melville Formation, generally comprises sand with small amounts of gravel and is arranged in tidal ridges up to 60 m thick, far to the west and southwest of the Isles of Scilly. The Melville Formation is thought to be contemporaneous with sediments above the youngest glacial till but has itself produced glaciogenic till and glaciomarine sediments, the latter being attributed to the Dimlington stadial (29,000 to 14,700 BP). The Melville Formation principally occurs far to the west and southwest of the Site and is very unlikely to be present within the Site itself.

5.3.3 'Layer B', above and partly contemporaneous with the Melville Formation, comprises poorly sorted sandy/shelly gravel and coarse sand, representing a lag deposit left during the Late Devensian and Early Holocene marine transgression and measuring a few tens of centimetres in thickness.

5.3.4 'Layer A' generally comprises sand of varying grain size, up to one metre in thickness and representing sediment deposited by hydrodynamic processes.

5.3.5 The BGS records sandy gravel seabed sediments across the Site and Study Area (see Figure 2), which likely correlate with Layer A and/or Layer B deposits. A single grab sample recorded within the Site and several from within the Study Area record sand as the seabed sediment[16].

Thickness of Quaternary sediments

5.3.6 The Quaternary deposits within the Site and Study Area are recorded as up to 5 m in thickness[17]. The western nearshore part of Port Quin Bay (beyond the Site) is characterised by exposed, pre-Quaternary bedrock, demonstrating the thin sediment cover in the wider area[18] (see Figure 2). This figure, coupled with that given by Evans (1990; see Section 5.3.4), suggests that Layer A deposits may in truth range in thickness from 1 to 5 m.

[15] BGS. GeoIndex Offshore.
[16] BGS. Sample ID: +50-005/653/GV/1.
[17] BGS. GeoIndex Offshore.
[18] BGS. Land's End Sheet 50° N – 06°W 1:250,000 Series. Sea Bed Sediments and Quaternary Geology.

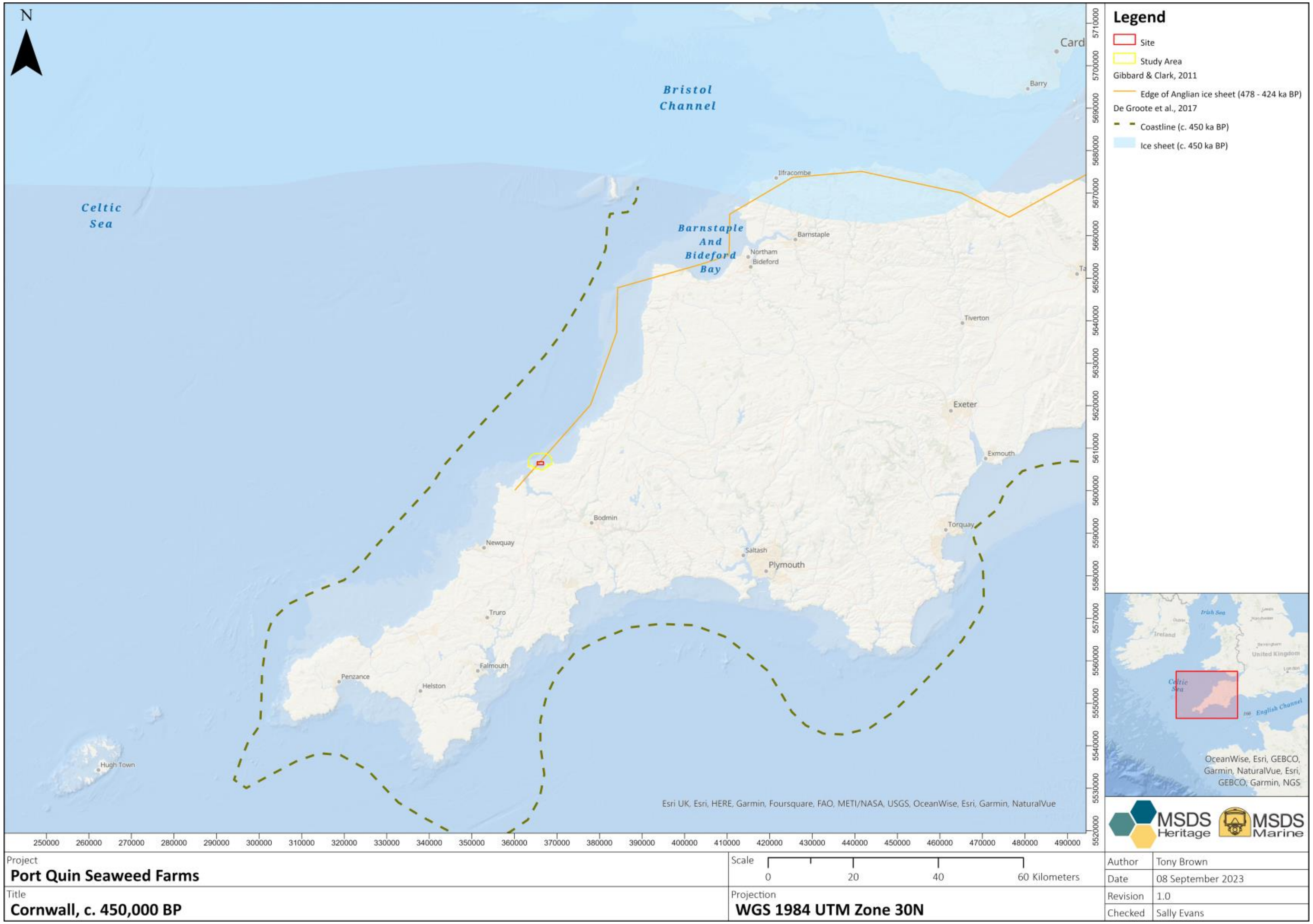

Figure 3 Cornwall, c. 450,000 BP.

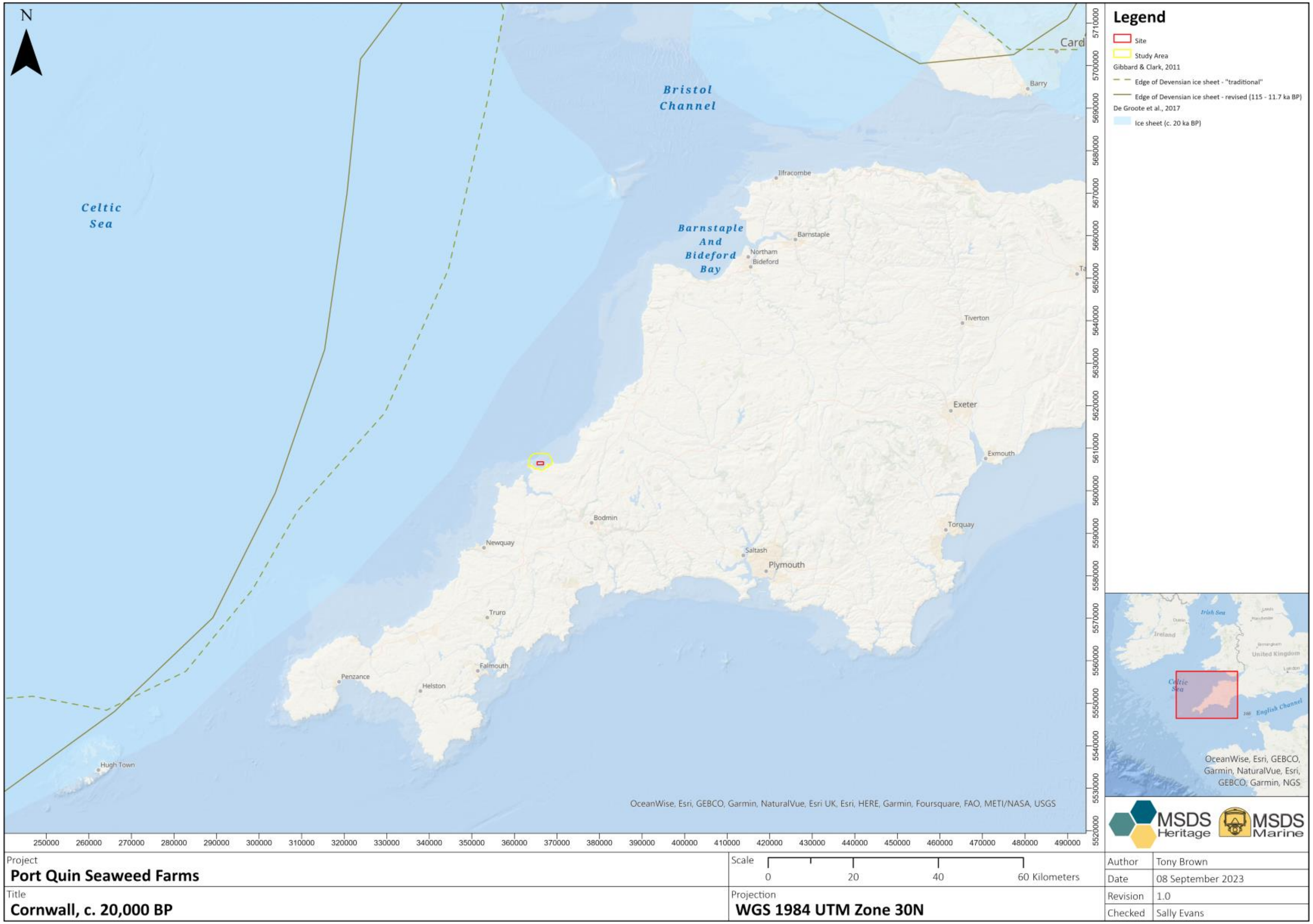

Figure 4 Cornwall, c. 20,000 BP.

Quaternary geomorphology and processes

5.3.7 The study of Pleistocene glacial extents remains an evolving academic focus and the southwest of England is often re-examined in this context. During the Anglian glaciation, Britain experienced the most extensive glacial coverage currently documented. According to Gibbard & Clark[19], the southern boundary of the Anglian ice sheet reached the north coast of Cornwall, seeming stopping closely along this line, however, De Groote *et al*. [20] suggest that this ice sheet slightly overran part of the north Devon coast, halting broadly at this latitude (see Figure 3).

5.3.8 Gibbard & Clark (2004, 2011) suggest that the ice sheet of the later Wolstonian glaciation (c. 380,000 to 132,000 BP) terminated within the Celtic Sea, to the west of the Site, whilst Mitchell & Orme[21] suggest that this glaciation reached as far south as the Isles of Scilly, c. 125 km to the southwest of the Site, and Kellaway *et al*. [22] have suggested that the Wolstonian glaciers covered much of the western English Channel. Mitchell & Orme (1967) also suggest that the resilient, Devonian and Carboniferous cliffs, forming much of the north Cornish coastline, resisted the push of the glaciers and represent a hard boundary to the Wolstonian advance. This rationale further gives weight to Gibbard & Clark's (2004) hypothesis on the limit of the Anglian ice sheet (see Section 5.3.7).

5.3.9 The extent of glaciation during the Last Glacial Maximum (LGM), the Devensian glaciation (c. 115,000 to 11,700 BP), was suggested by Scourse[23] to have extended into the Western Approaches and western English Channel. This, along with other 'traditional' views, was revised by Gibbard & Clark (2004) to suggest that the ice sheet reached further to the southwest, covering more of the Celtic Sea and less of the Bristol Channel, but not extending into the English Channel. The scholarship agrees that the Devensian ice sheet did not reach the north coast of Cornwall, although De Groote *et al*. (2017) suggest a southern limit closer to the Site than Gibbard & Clark (see Figure 4).

5.3.10 Though the Cornish peninsula may have avoided the impacts of the British-Irish ice sheet, Harrison *et al*. [24] have suggested that the cold climate facilitated the formation of niche (or cirque) glaciers and perennial snowbanks at the coastal site of Rosemergy, c. 67 km to the southwest of the Site. This study concluded that a north-facing, shallow hollow was likely occupied by a niche glacier during the LGM, and it is feasible that similar features within the Study Area were similarly occupied during this phase.

5.3.11 Much of the preserved Quaternary sequence on the continental shelf of the Celtic Sea was deposited during the last glaciation, the Dimlington stadial (c. 29,000 to 14,700 BP), as a series of outwash plain sediments (Layer B). During the subsequent climatic amelioration and marine

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[19] Gibbard, P.L. & Clark, C.D. 2004. 'Pleistocene glacial limits in England, Scotland and Wales'. *Developments in Quaternary Science.* **2**, pp. 47-82; Gibbard, P.L. & Clark, C.D. 2011. 'Pleistocene Glaciation Limits in Great Britain'. *Developments in Quaternary Science*. **15**, pp. 75-93.

[20] De Groote, I., Lewis, M. & Stringer, C.B. 2017. 'Prehistory of the British Isles: A tale of coming and going'. *Bulletins et Mémoires de la Société d'anthropologie de Paris.* **30**(1).

[21] Mitchell, G.F. & Orme, A.R. 1967. 'The Pleistocene deposits of the Isles of Scilly'. *Quarterly Journal of the Geological Society of London.* **123**, pp. 59-92.

[22] Kellaway, G.A., Redding, J.H., Shephard-Thorn, E.R. & Destombes, J.P. 1975. 'The Quaternary history of the English Channel'. *Philosophical Transactions of the Royal Society of London.* **279A**, pp. 189-218.

[23] Scourse, J.D. 1990. 'The Isles of Scilly', in Ehlers, J., Gibbard, P.L. & Rose, J. (eds.) *Glacial deposits in Britain and Ireland.* Rotterdam: AA. Balkema.

[24] Harrison, S., Knight, J. & Rowan, A.V. 2015. 'The southernmost Quaternary niche glacier system in Great Britain'. *Journal of Quaternary Science.* **30**(4), pp. 325-334.

transgression, the high-energy littoral zone moved over these earlier sediments, eroding and reworking them whilst forming a new layer of mobile marine sediments (Layer A)[25].

5.3.12 The bedform type is categorised by Johnson *et al*.[26] as 'rough rock', whereas sand patches and rippled sand sheets are recorded further offshore.

Pre-Devensian deposits

5.3.13 No pre-Devensian Quaternary deposits have been tentatively identified within the Study Area and no site-specific geotechnical data was available at the time of writing to suggest otherwise. Although such deposits were likely present, a combination of glacial impacts and high energy hydrodynamic processes may have combined to remove these or erode them to such an extent as to be currently undetected in the geotechnical and geophysical data.

Late Devensian and Holocene deposits

5.3.14 The Quaternary sequence within the wider Celtic Sea region generally begins with the Melville Formation (MIS 2), although this unit is unlikely to be present within the Site itself or nearby (see Section 5.3.2). This deposit formed during the Dimlington stadial under glacial and glaciomarine conditions.

5.3.15 Layer B deposits formed atop and partly contemporaneously with the Melville Formation, as a lag deposit under intertidal conditions during marine transgressions of the Windermere interstadial (Late Devensian) and Early Holocene. Layer B may be represented within the Site, however, in the absence of site-specific geotechnical data, this could not be confirmed at the time of writing. Any Layer B deposits that may be present are anticipated to have been eroded and reworked to a significant extent.

5.3.16 Layer A represents sediment transported and deposited atop Layer B and is actively reworked by modern currents up to depths of c. 0.5m. Layer A sediments are not derived from the nearby mudstone, siltstone and sandstone cliffs, but rather from glacial and glaciomarine deposits within the wider marine environment[27]. Layer A forms the present seabed, characterised more locally by the BGS (see Figure 2).

5.3.17 Other coastal deposits are recorded along this stretch of the coastline, beyond the Study Area. Of note are the estuarine deposits recorded at the mouth of the River Camel, c. 4 km to the southwest of the Site[28]. Although no such deposits are currently recorded within the Site and their presence cannot be wholly excluded in the absence of site-specific geotechnical data, the sheltered conditions and presence of an outwash environment of a sizeable watercourse (necessary for the formation of significant silty/clayey deposits) are not replicated in Port Quin Bay, suggesting a low overall likelihood. At Trewornan, c. 7.2 km south from the Site, estuarine deposits are recorded up to 14.4 m thick[29].

5.3.18 The general Quaternary sequence for the southern Celtic Sea is laid out in Table 3.

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[25] Evans. 1990.
[26] Johnson, M.A., Kenyon, N.H., Belderson, R.H. & Stride, A.H. 1982. 'Sand transport', in Stride, A.H. (ed.) *Offshore tidal sands – processes and deposits*. London: Chapman and Hall. Pp. 58-94.
[27] Evans. 1990.
[28] Grant *et al*. 2019.
[29] Grant *et al*. 2019.

Name	Description	Depositional Environment	Period	MIS	Thickness (m)
Layer A	Sands of varying grain size.	Marine	Holocene	1	<1
Unnamed estuarine deposits	Alluvial silts and clays, occasionally interbedded with peat layers and submerged forest remains.	Freshwater environments in wider scrub and woodland	Holocene	1	Recorded locally up to 14.4 m
Layer B	Sandy/shelly gravel and coarse sand.	Intertidal/marine	Devensian to Holocene	2 to 1	Generally, a few tens of centimetres
Melville Formation	Generally, sand with few gravel inclusions. More widely, includes glacial debris, boulders and silty clays.	Glaciomarine	Devensian	2	Up to 60 m (on tidal sand ridges further offshore)

Table 3 General Quaternary sequence within the southern Celtic Sea.

Sea levels

5.3.19 The scholarship examining the extent of exposed land around the British Isles is broadly in agreement that the landscape north of Cornwall's north coast was terrestrial for most of the past 900,000 years. The principal studies examined for this assessment do not entirely correlate with their depictions of prehistoric coastlines (see Figure 5), however, this may be attributed to the wider scale of some of these studies. This Section endeavours to examine the key sources relating to this topic within the context of the South West of England and, more specifically, the north Cornish coast, with the aim of determining phases when the environment of the Site may have been conducive to human occupation.

5.3.20 A broad study of prehistoric coastlines by Brooks *et al.*[30] models the fluctuation of Britain's coastlines from 18,000 to 6,000 BP, based on topographic, bathymetric and relative sea level (RSL) data and Glacial Isostatic Adjustment (GIA) modelling. The marine lowstand of the LGM illustrates the coastline far to the northwest in c. 18,000 BP, with a substantial phase of marine transgression occurring by c. 13,000 BP, at the height of the Windermere interstadial. The model produced by Brooks *et al*. (2011) suggest that continued temperature increase resulted in the further encroachment of the sea, submerging the Site, or placing it within the intertidal zone, by c. 8,000 BP and achieving the current coastline by 6,000 BP (see Figure 5 to Figure 7). The large scale of this study is considered to account in large part for the minor crossover of the 6,000 BP coastline over that of the present, rather than suggesting this took place.

[30] Brooks, A.J., Bradley, S.L., Edwards, R.J. & Goodwyn, N. 2011. 'The palaeogeography of Northwest Europe during the last 20,000 years'. *Journal of Maps*. **7:1**, pp. 573-587.

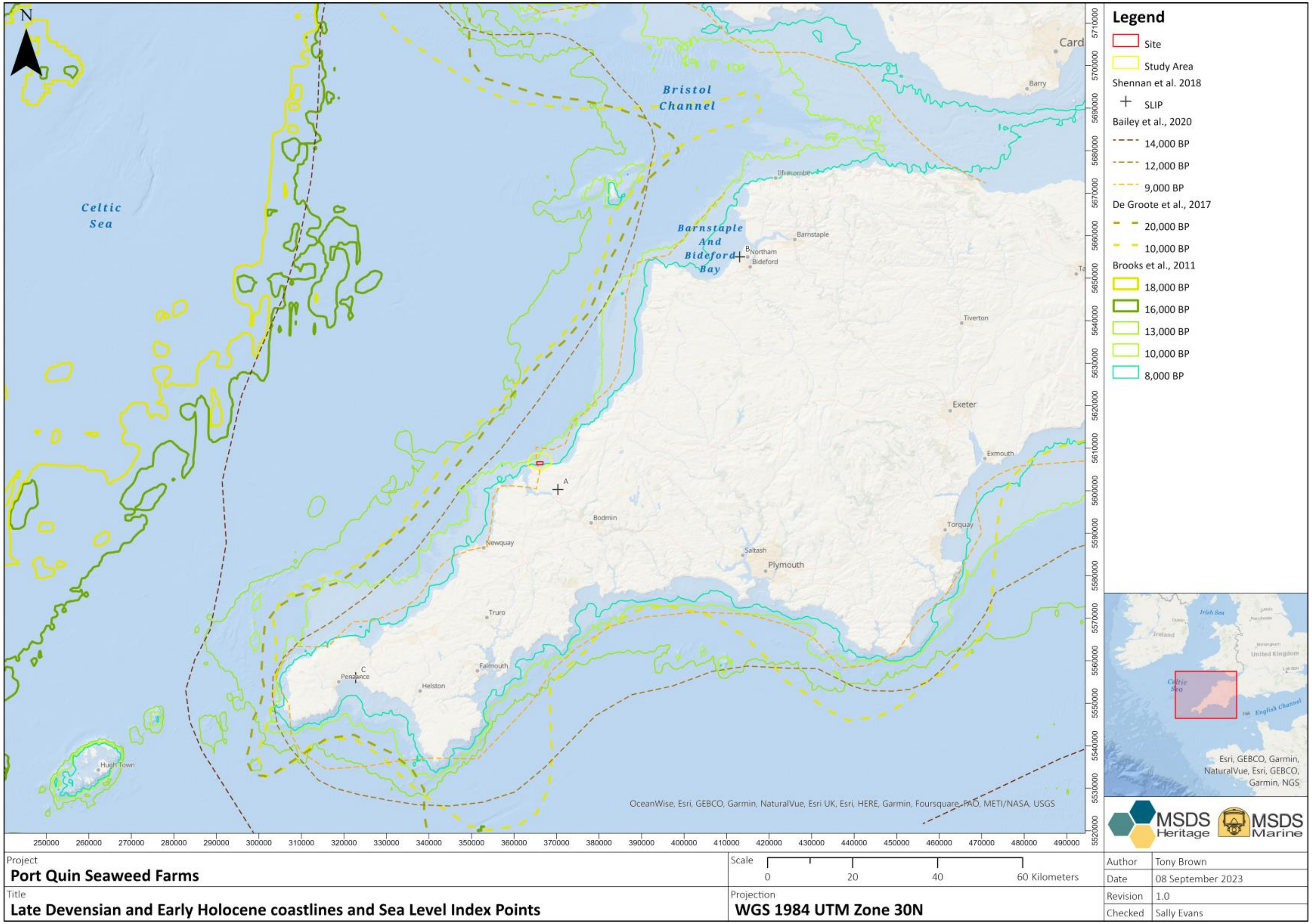


Figure 5 Late Devensian and Early Holocene coastlines and Sea Level Index Points.

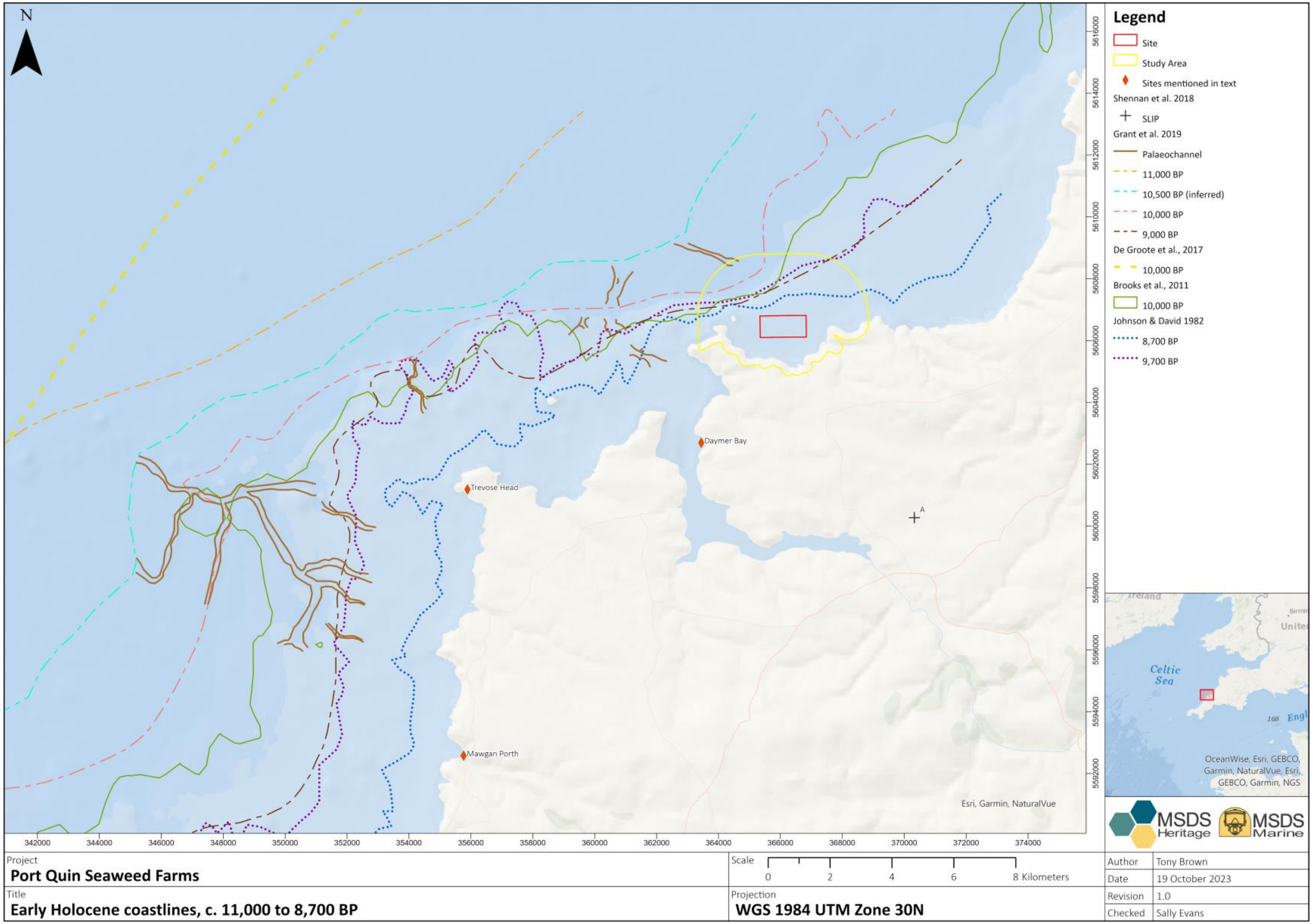
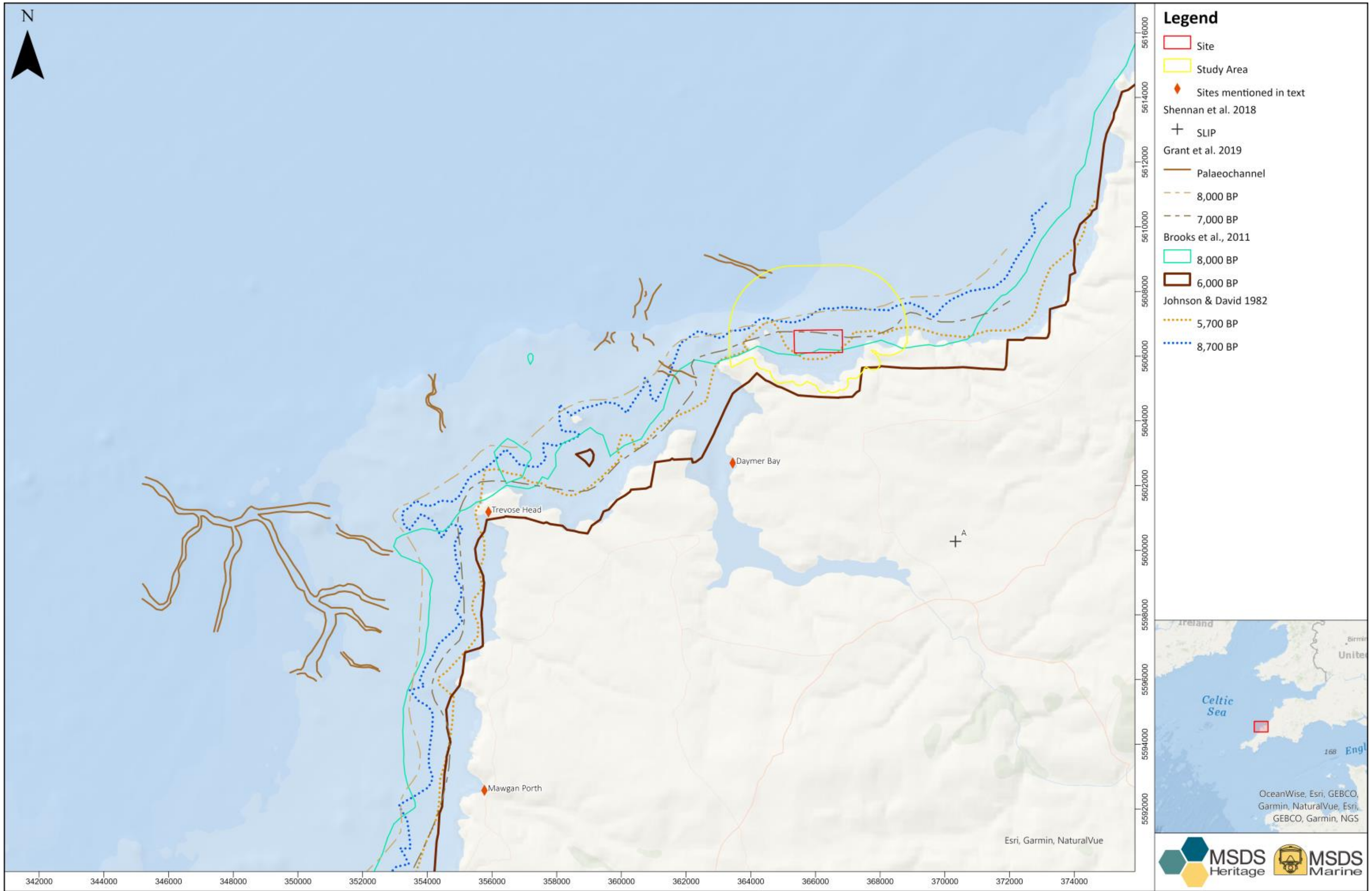


Figure 6 Early Holocene coastlines, c. 11,000 to 8,700 BP.



Project	Scale	Author	Tony Brown
Port Quin Seaweed Farms	0 2 4 6 8 Kilometers	Date	19 October 2023
Title	Projection	Revision	1.0
Early Holocene coastlines, c. 8,700 to 5,700 BP	**WGS 1984 UTM Zone 30N**	Checked	Sally Evans

Figure 7 Early Holocene coastlines, c. 8,700 to 5,700 BP.

5.3.21 De Groote *et al*. (2017) conducted a review of evidence for hominin occupation of Britain, using periodic visualisations of the sub-aerial landmass from Stringer's *Homo britannicus*[31], illustrating a largely similar pattern of coastline for the Cornish peninsula from c. 900,000 BP to c. 10,000 BP. The exception is the time slice at c. 20,000 BP, which illustrates the sub-aerial exposure of much of the English Channel as a land bridge to the European continent, correlating with the LGM (area not reproduced in this document). Stringer's work drew on a wide body of source material to illustrate the exposed landmass, including Palaeolithic and Mesolithic site dating, palaeoenvironmental and palaeo-faunal remains and geotechnical data. Late Devensian and Early Holocene coastline extents from De Groote *et al*. (2017) have been reproduced by Figure 5 and Figure 6. Although the depiction of the coastline at c. 10,000 BP varies considerably from that of Brooks *et al*. (2011), both concur that the Site was sub-aerially exposed at this time (see Figure 6).

5.3.22 More recent studies have examined the marine transgressions of the Late Pleistocene and Early Holocene. Grant *et al*. (2019) used bathymetric data to identify submerged cliff lines and palaeochannels, illustrating potential prehistoric shorelines from 11,000 to 7,000 BP (see Figure 6 and Figure 7). One such palaeochannel is mapped within the northern part of the Study Area and it is feasible that smaller, unmapped palaeochannels may be present within the Site. This study was also influenced by the local (Padstow-Newquay) palaeolandscape maps produced by Johnson & David[32], which were themselves based on sea level curves produced by Kidson & Heyworth[33] and bathymetric data.

5.3.23 Bailey *et al*.[34] traced marine transgression from c. 14,000 to c. 9,000 BP, based principally on dating of prehistoric sites, findspots and palaeo-shorelines. It is noted in the study that the illustrated model predictions of shorelines (see Figure 5) are only loosely constrained by dated palaeo-shoreline features. These loose parameters, along with the large scale of this study account for the minor crossover of the 9,000 BP coastline over that of the present, rather than suggesting this took place.

5.3.24 Both Grant *et al*. (2019) and Bailey *et al*. (2020) concur with Brooks *et al*. (2011) that a significant phase of marine transgression occurred between 14,000 to 11,000 BP, however, the former suggests a coastline further to the west around 11,000 BP. The series of palaeochannels identified by Grant *et al*. (2019) terminate at a common depth not identified by the study but possibly representing a former shoreline dating between 11,000 to 10,000 BP, c. 3.6 km to the northwest of the Site (see Figure 6). This period falls within the Early Holocene, during climatic amelioration after the Loch Lomond stadial (12,900 to 11,700 BP) and may be associated with a phase of rapid melting of niche glaciers and perennial snowbanks, as recorded elsewhere on the Cornish peninsula[35].

5.3.25 The same three studies, plus that of Johnson & David (1982), generally concur with the encroachment of the sea to within the Study Area by 10,000 BP, with slight variations (see Figure 6). Johnson & David (1982), Brooks *et al*. (2011) and Grant *et al*. (2019) illustrate

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[31] Stringer, C. 2006. *Homo brittanicus*. London: Allen Lane.
[32] Johnson, N. & David, A. 1982. 'A Mesolithic Site on Trevose Head and Contemporary Geography'. *Cornish Archaeology*. **21**, pp. 67-103.
[33] Kidson, C. & Heyworth, A. 1973. 'The Flandrian sea-level rise in the Bristol Channel'. *Proceedings of the Ussher Society.* **2**(6), pp. 565-584.
[34] Bailey, G., Momber, G., Bell, M., Tizzard, L., Hardy, K., Bicket, A., Tidbury, L., Benjamin, J. & Hale, A. 2020. 'Great Britain: The Intertidal and Underwater Archaeology of Britain's Submerged Landscapes'. *The Archaeology of Europe's Drowned Landscapes*. Cham: Springer. Pp. 189-219.
[35] Harrison *et al*. 2015.

continued encroachment of the sea after 10,000 BP, however, their assertions of final inundation of the Site differ in date. Brooks *et al*. (2011) suggest that the Site was submerged by c. 8,000 BP, perhaps with the southern boundary situated within the intertidal zone. Johnson & David (1982) place the coastline at 8,700 BP c. 250m north from the Site and suggest the Site was submerged as late as 5,700 BP. Grant *et al*. (2019), although using Johnson & David's data as one source, suggest a slightly different phasing of the transgression, placing the 9,000 BP shoreline c. 640 m to the north and northwest of the Site, the 8,000 BP shoreline c. 430 m in the same direction and the 7,000 BP shoreline slightly within the Site's northern boundary. The studies produced by Brooks *et al*. (2011) and Bailey *et al*. (2020) have a much greater scope, modelling coastlines over a much larger period and landscape. The studies by Johnson & David (1982) and Grant *et al*. (2019) focus specifically on the north coasts of Devon and Cornwall and, in the latter case, the local coastline modelling was informed by high resolution bathymetric data[36], Sea Level Index Points (SLIP – see below) and other recent data. These factors therefore lend greater weight to the reliability of the conclusions of Johnson & David (182) and Grant *et al*. (2019), however, the date of ultimate submergence of the Site could only be determined with greater confidence upon detailed examination and analysis of site-specific geotechnical data (not available at the time of writing).

5.3.26 In the southwest of England, a substantial part of the sub-aerial environment was submerged by c. 7,000 BP and the current form of the coastline was achieved by c. 6,000 BP, when the RSL measured -4 to -6 m[37]. This is a broad, regional overview and conclusion; on a local level, specifically to the Site, the present coastal form was achieved much later in specific circumstances. Johnson & David (1982) suggest that the Site was inundated as late as 5,700 BP, with the RSL at c. -6 m CD (see Figure 7). The 8,700 BP coastline illustrated by this study lay c. 260 to 660 m north from the Site, suggesting a protracted period of marine transgression during which the Site lay within the intertidal zone. Furthermore, the *terminus post quem* of 3,900±30 BP for the submerged forest bed below a midden at Daymer Bay, c. 4 km to the southwest of the Site (see Figure 7), suggests that the ultimate submergence of some local areas did not occur until much later in the Holocene[38]. Sea level curves reproduced by Grant et al. (2019) suggest that the RSL at 4,000 BP stood at c. -2.5 m CD.

5.3.27 The changes in RSL following the Devensian glaciation have been studied in detail and recent works by Shennan *et al*.[39] have consolidated recent available SLIPs for the whole of the UK. Only two SLIPs are available for the north coast of Cornwall and Devon and one for Cornwall's southern coast (Figure 5; Table 4). The closest, situated c. 6.8 km southeast from the Site, suggests that in c. 7,371 BP the sea level stood at -12.7 m CD (Figure 5 to Figure 7; A). This correlates with Brooks *et al*. (2011), who suggest that the final stage of marine transgression occurred between 8,000 and 6,000 BP, and Grant *et al*. (2019), who suggest this took place after 7,000 BP. The current depth of the Site (at seabed) is -11.1 to -15 m CD, exhibiting a declination to the north. Similar patterns are shown at Barnstaple and Bideford Bay, c. 67 km

[36] EMODnet Digital Bathymetry (DTM 2016) (ifremer.fr)
[37] Hosfield, R., Straker, V. & Gardiner, P. *South West Research Framework: Palaeolithic and Mesolithic.* https://researchframeworks.org/swarf/palaeolithic-and-mesolithic/#section-1 Accessed 05 September 2023; Brooks *et al*. 2011.
[38] Grant *et al*. 2019.
[39] Shennan, I., Bradley, S.L. & Edwards, R. 2018. 'Relative sea-level changes and crustal movements in Britain and Ireland since the Last Glacial Maximum.' *Quaternary Science Reviews*. **188**, pp. 143-159.

to the northeast of the Site (Figure 5; **B**), and at Mount's Bay, c. 66 km to the southwest on Cornwall's southern coast (**C**).

MSDS ID	Age (cal BP)	Corrected RSL (m)	Unique sample ID
A	7371	-12.7	Q2781
B	7480	-6.42	Q672
C	6222	-7.88	Q2779
	5826	-6.81	Q2776
	5796	-8.06	Q2777
	4986	-7.63	Q2774
	4959	-7.06	Q2780
	1490	-1.67	Q2778
	1137	-1.75	Q2775

Table 4 Extract from Shennan et al. *(2018) showing relative sea level data from Cornwall and north Devon.*

5.3.28 There is some disparity between Johnson & David's (1982) coastline models and the results of more recent assessments, for example the 5,700 BP RSL of c. -6 m CD given by Johnson & David compared to the 5,796 BP RSL of -8.06 m CD given by Shennan *et al*. (2018). These discrepancies may be attributed to the greater quantity and/or quality of data available to more recent studies or may reflect local variation, as previously mentioned in Section 5.3.26 (Johnson & David relating to the landscape around Trevose Head and the SLIP data sourced from Mount's Bay, Figure 5; **C**). The available data suggests that the Site was submerged between 7,000 and 5,700 BP, likely being situated within the intertidal zone for much of this period.

5.4 Prehistoric archaeological potential

Lower and Middle Palaeolithic (c. 970,000 to 45,000 BP)

5.4.1 The available data suggests that parts of the Site may have been sub-aerially exposed up to c. 3,750 BC (5,700 BP), although little detail is available for pre-Devensian stages (Lower and Middle Palaeolithic). Where present, the earliest Quaternary unit possibly within the Site (Layer B) is understood to lie atop the bedrock, suggesting that no substantial units of pre-Devensian Quaternary geology are present. Section 5.3 demonstrated that the Site, Study Area and a much larger part of what is now the Celtic Sea were sub-aerially exposed for large parts of the known chronology of hominin occupation of Britain and it is likely that these environments periodically supported ecosystems and habitats conducive to hominin occupation.

5.4.2 No Lower or Middle Palaeolithic remains have been recorded within the Study Area by the HER or RCZAS[40]. Wider archaeological evidence demonstrates that hominins did occupy the Cornish peninsula, although Wymer[41] illustrates a general post-Anglian date and southern Cornwall

[40] Grant *et al.* 2019.
[41] Wymer, J.J. 1999.*The Palaeolithic Occupation of Britain.* Salisbury: Trust for Wessex Archaeology Ltd. Pp. 116.

distribution. At Watchet, north Somerset, c. 127 km north-east from the Site, eroded Head gravels (Doniford Gravel) in the sea cliff have deposited flint handaxes, cores and debitage onto the beach below. This assemblage has generally been attributed to MIS 11 to 8 (Hoxnian & Wolstonian; late Lower Palaeolithic & early Middle Palaeolithic), although some artefacts may pre-date this. Further afield, at Abbots Pill, Avon, a large assemblage of flint tools and debitage derived from Head gravels has been attributed to MIS 11 to 8 and at Rhossili, Gower peninsula, a hand axe found on the beach was presumed to have derived from the low cliff of Head gravels. Although these assemblages are recorded significant distances from the Site, the general pattern for Palaeolithic findspots in the Bristol Channel and Celtic Sea coastlines correlates directly with artefact-bearing Head deposits.

5.4.3 Head deposits are recorded by the BGS to a limited extent within the wider locality, principally associated with small watercourses cutting through the rough coastal ground to feed into the sea. One such watercourse runs through Port Quin[42], however, no Head deposits or similar geology is known to occur within the Site nor along the cliffs forming Port Quin Bay.

5.4.4 The Site lies on an exposed part of the north Cornwall coast, known for its rough seas compared to the south coast and further east in the Bristol Channel. It is feasible that pre-Devensian deposits laid down over the bedrock during periods of sub-aerial exposure were removed by high energy hydrodynamic processes and any archaeological remains with them eroded. This theory is supported by the relative youth of identified Quaternary sediments likely present within the Site (see Table 3).

5.4.5 It is feasible, if unlikely, that small pockets of pre-Devensian deposits may exist within the Site and Study Area, perhaps within fissures and depressions in the underlying bedrock, which may contain Lower or Middle Palaeolithic and/or palaeoenvironmental remains. In the absence of site-specific seismic data, it is not possible to determine if such features are present. Furthermore, it is noted that the seabed sediment unit (Layer A) is derived from glacial deposits not local to the Site[43], raising the potential for redeposited artefacts.

5.4.6 A potential for Lower or Middle Palaeolithic remains therefore exists where:

- Pockets of pre-Devensian deposits survive;
- Remains have been eroded from local pre-Devensian deposits and redeposited locally; or
- Remains have been eroded and translocated from non-local pre-Devensian deposits, to be redeposited locally.

5.4.7 In consideration of the data available at the time of writing, each of these possibilities is considered very unlikely and, coupled with the overall rarity of Lower and Middle Palaeolithic remains, a very low potential is considered for remains dating to these periods.

5.4.8 Palaeoenvironmental evidence would only be identifiable if derived from a contiguous, undisturbed deposit. In consideration of the likelihood of such deposits relating to the Lower and Middle Palaeolithic periods within the Site, a very low potential for palaeoenvironmental remains from these periods is likely.

[42] BGS. https://geologyviewer.bgs.ac.uk/ Accessed 07 September 2023.
[43] Evans. 1990.

Upper Palaeolithic (c. 45,000 to 10, 000 BP)

5.4.9 The Devensian (109,000 to 11,700 BP) was the last glaciation to affect the UK and flint artefacts and skeletal remains indicate a human presence during middle and later parts of the stage, following the absence of hominins from the UK archaeological record between 180,000 to 60,000 BP (a further period of absence is noted between 25,000 to 18,000 BP, during the Dimlington stadial).

5.4.10 The earliest evidence for Upper Palaeolithic activity in the South West is represented by a human maxilla (jawbone) and lithic material, discovered at Kent's Cavern in Devon in 1927 (c. 100 km to the southeast of the Site)[44], although there remains some academic debate over the exact age of this find[45]. The provenance of this material from a cave site is typical of the early Upper Palaeolithic record of the South West. Britain appears to have been abandoned during the LGM and recolonisation is thought to have occurred during the Windermere interstadial (14,700 to 12,900 BP). While open air sites dating to this period are known within the UK, the focus remains on cave sites, particularly in the South West.

5.4.11 A hiatus in human activity coincides with the Loch Lomond stadial (or Younger Dryas; 12,900 to 11,700 BP), during which conditions of extreme cold were re-established in the UK. Regional studies show that Cornwall was not exempt from the colder climate[46], which may have prevented contemporary human occupation. During the subsequent climate amelioration of the later Loch Lomond stadial and human recolonisation of Britain, cave sites continue to dominate the regional archaeological record, with evidence known from several sites in the region, including Kent's Cavern.

5.4.12 Sea level studies indicate that the Study Area would have been exposed during the Upper Palaeolithic and that the Devensian ice sheet did not extend over the Site. Head deposits and later alluvial deposits associated with small watercourses may date from the late glacial or Holocene periods, however, no such deposits are mapped within the Site. The Melville Formation has been found to include glaciogenic lithological material, recovered from beneath modern seabed sands and likely relating to glacial till. Furthermore, several core samples recorded a glaciomarine deposit atop the till, interpreted as forming beneath an ice shelf during the Dimlington stadial. As a glaciogenic/glaciomarine deposit, the archaeological potential for the Melville Formation is very low. In addition, this formation has not been recorded within or near to the Site, however, and is only mapped in the middle and outer parts of the continental shelf far to the west and southwest of Cornwall[47].

5.4.13 The sea level assessment undertaken in Section 5.3 demonstrates that the Site lay sub-aerially exposed throughout the Upper Palaeolithic and the local palaeochannel system mapped by Grant *et al*. (2019) suggest that, at the end of the Upper Palaeolithic, this landscape was traversed by numerous freshwater channels (Figure 6). Such a landscape, close to marine resources, sources of freshwater and associated resources, may have been conducive to faunal and human occupation.

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[44] Higham, T., Compton, T., Stringer, C.B., Jacobi, R., Shapiro, B., Trinkaus, E., Chandler, B., Groning, F., Collins, C., Hillson, S., O'Higgins, P., Fitzgerald, C. & Fagan, M. 2011. 'The Earliest Evidence for Anatomically Modern Humans in Northwestern Europe'. *Nature*. **479**, pp. 521 -24.

[45] Proctor, C., Douka, K., Proctor, J., & Higham, T. 2017. 'The Age and Context of the KC4 Maxilla, Kent's Cavern, UK'. *European Journal of Archaeology*. **20**(1), pp. 74-97. doi:10.1017/eaa.2016.1

[46] Harrison *et al*. 2015.

[47] Evans. 1990.

5.4.14 Despite the inferred potential, no Upper Palaeolithic remains have been recorded within the Study Area and few have been dated to this period with confidence in Cornwall. Furthermore, no cave sites, which form the principal environment for Upper Palaeolithic remains in the South West, are situated within the Study Area nor on the north Cornwall coast. It is feasible that the exposed coastlines of this landscape, colder due to their proximity to the ice sheet and shrinking due to the encroaching sea, were not favourable for human occupation until rather late in the Upper Palaeolithic. Furthermore, deposits containing artefactual and palaeoenvironmental remains may have been eroded by hydrodynamic process. These factors, combined with the overall rarity of Upper Palaeolithic material in the national archaeological record, suggest a very low potential for such within the Site.

Mesolithic (c. 10,000 to 6,000 BP)

5.4.15 As climatic conditions ameliorated further during the onset of the Holocene, the wider landscape experienced a series of marine transgressions, submerging much of the proglacial environments north of the Site (see Figure 5 to Figure 7). Sea level studies indicate that parts of the Site may have remained sub-aerially exposed up to c. 3,750 BC (5,700 BP), suggesting that Mesolithic groups were able to access the Site throughout the Mesolithic period. Furthermore, the coastline study by Johnson & David (1982) suggests that the Site may have lain within an intertidal zone for a prolonged period between c. 8,700 to 5,700 BP. As an intertidal deposit, Layer B, if present within the Site, may have been laid down during this period, coinciding with the window of potential for human activity. Any artefacts or other evidence which may be held within Layer B deposits, however, have likely experienced erosion and some degree of translocation, as suggested by the nature of the deposit and the local marine environment, reducing the overall potential for archaeological and palaeoenvironmental remains and their inherent value. Layer A deposits may also contain Mesolithic artefacts, derived from local Layer B deposits or elsewhere within the wider marine landscape.

5.4.16 The coastlines of north Devon and Cornwall exhibit several submerged forest sites, indicative of aerial exposure during the Early Holocene. Closest to the Site, c. 4 km to the southwest at Daymer Bay and Doom Bar (see Figure 7), a spread of shellfish remains, and possible charcoal fragments suggest a midden site. Radiocarbon dating from the forest bed (not the midden deposit itself, which was unable to be dated) provided a date of 3,900±30 BP, suggesting a rather late marine inundation of the River Camel estuary. Analysis indicates that a well-drained, scrub/woodland developed here with little or no connection to the marine environment, perhaps protected from the sea by sand bars or other natural defences[48]. Other submerged forest sites along this coastline also share the character of a sheltered location, such as Mawgan Porth, c. 16.6 km to the southwest, and Westward Ho!, c. 68 km to the northeast. The three sites also share a common location within a river estuary (relating to the rivers Camel, Menalhyl and Torridge, respectively). Such characteristics are not suggested within Port Quin Bay, which is more exposed to the north and erosive hydrodynamic processes. Furthermore, estuarine silt and clay deposits, commonly recorded at submerged forest sites, are not known to be present within the Site itself, however, without site-specific geotechnical data these cannot be excluded as a possibility. It is feasible that a similar scrub/woodland environment occupied Port Quin Bay and the Site (or parts thereof) during the Mesolithic period, fed by small watercourses and

[48] Grant *et al*. 2019.

palaeochannels (as suggested by larger such features by Grant *et al*. (2019) – see Figure 7) and partially sheltered by the cliffs to the south. It may also be possible to recover key palaeoenvironmental evidence pertaining to such an environment, if held within undisturbed Layer B deposits within the Site, however, these deposits, if present, are likely to have experienced erosion.

5.4.17 The Waterlands project[49] produced a high-level assessment model for predicting the likelihood of prehistoric landscape features (palaeochannels, tunnel valleys, submerged forests, etc.) within English waters, based on a wide range of evidence including sea level modelling and geotechnical data. The project places the Site within an area of known potential, based on knowledge of sub-aerial exposure of a landscape plus known nearby palaeolandscape features. It also, however, identifies any such features within this area to have a high sensitivity and high vulnerability to impacts. The interpretation of the Site within these parameters is that where palaeolandscape features may be present, these are likely to have been altered or removed by natural processes, such as the high energy hydrodynamic processes. The broad results of the Waterlands project fed into the Historic Seascape Characterisation project (see Section 8.0), which highlights the Site and Study Area as falling under the previous sub-type 'Palaeolandscape component (probable) – 10,000 to 4,000 BC'.

5.4.18 Numerous Mesolithic artefacts and lithic scatters have been recorded throughout Cornwall, indicating widespread occupation of the peninsula. A single find of flint debitage of likely Mesolithic or Neolithic date forms the known evidence of these periods within the Study Area (Figure 9; TI_001). Slightly further afield, an isolated flint artefact at Polzeath (c. 2.4 km south from the Site; HER ID: MCO1198) and a lithic scatter at Pentire Head (c. 2.3 km west from the Site; HER ID: MCO6734) add a little more data to the local Mesolithic character, however, conclusions regarding local past occupation and potential are extremely problematic using such a limited evidence base.

5.4.19 Slightly further afield, a significant assemblage of Mesolithic flint artefacts is recorded at Trevose Head, c. 10.5km to the southwest of the Site (see Figure 6 and Figure 7). Johnson & David (1982) plotted this and other Mesolithic flint scatters along the elevated present coastline between Trevose Head and Port Quin Bay, hypothesizing potential access points to the (now submerged) marine lowlands. Although no flint scatters or access points are suggested within Port Quin Bay and its surrounding cliffs, the clifftops and marine lowlands, certainly to the west of the Site, were occupied by Mesolithic groups.

5.4.20 Mesolithic groups likely exploited the intertidal environment, foraging for shellfish and crafting materials. Evidence for such is provided by the record of a Mesolithic to Late Neolithic shell midden, with flint artefacts and faunal remains, at Westward Ho! Beach, Devon, c. 66.5 km to the northeast of the Site[50]. It is therefore feasible that such activity may have taken place within the Site and Study Area, prior to ultimate inundation.

5.4.21 The nature of the anticipated Quaternary deposits within the Site is not suggestive of a good potential for *in situ* Mesolithic remains. The uppermost unit (Layer A) is actively reworked at present by hydrodynamic processes and the earlier Layer B deposits were subjected to high

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[49] Goodwyn, N., Brooks, A.J. & Tillin, H. 2010. *Waterlands: Developing Management Indicators for Submerged Palae-environmental Landscapes.* Report for the Marine Aggregate Levy Sustainability Fund.

[50] https://www.heritagegateway.org.uk/gateway/Results_Single.aspx?uid=MDV14854&resourceID=104 Accessed 07 September 2023.

energy intertidal processes during marine transgression. Whilst Mesolithic evidence may have feasibly been deposited during sub-aerial exposure of the Site, it is likely that any such remains have been heavily disturbed by later processes. Mesolithic peoples may have occupied and exploited the Site, however, the likelihood of encountering *in situ* remains is very limited. Redeposited remains within the seabed sediment may occur, though the overall potential is low.

5.4.22 Furthermore, there is a potential for palaeoenvironmental evidence within the Site, however, this would be dependent on the preservation of contiguous, undisturbed Layer B deposits. Such conditions may occur within palaeolandscape features, such as palaeochannels, however, no such features have been identified within the Site. Site-specific geotechnical investigation may be able to refine our understanding of the sub-sea floor layout within the Site and determine if any palaeolandscape features are present.

Neolithic & Bronze Age (4,000 to 700 BC)

5.4.23 The sea level and coastline data demonstrate that marine transgression continued at a steady pace throughout later prehistory. This process may have slowed during the Neolithic, however, the reviewed regional sea level data for this period is limited (see Table 4). The local coastline model produced by Johnson & David (1982) suggest that the Site may have only been ultimately inundated by c. 3,750 BC (5,700 BP), suggesting that parts of it lay within an intertidal zone during the Early Neolithic (4,000 to 3,300 BC). Although there is evidence more widely within Cornwall of Neolithic occupation, no evidence within the Study Area or surrounding locality has been dated with confidence to this period. There is a slight potential for archaeological and/or palaeoenvironmental remains to be present within the Site, in association with the potential for Layer B deposits, however, the anticipated post-depositional erosive processes have likely disturbed these contexts. Although there is this limited potential for *in situ* or redeposited artefacts, the overall potential for such is very low.

5.4.24 Johnson & David's (1982) study further suggests that part of the Site and the southernmost marine lowlands of Port Quin Bay may have remained sub-aerially exposed or within the intertidal zone into the Middle or Late Neolithic and possibly the Early Bronze Age. Slightly further afield, the undated midden recorded at Daymer Bay, c. 4 km to the southwest of the Site (see Figure 7), lay above the forest bed which was radiocarbon dated to 3,900±30 BP (1,950 BC), illustrating Bronze Age occupation of the now-submerged forest, part of the last remaining marine lowlands. Other evidence of nearby Bronze Age occupation is provided by several barrows, of varying certainty, occupying the clifftop heights within the Study Area, also summarised by Grant *et al*. (2019). These include a group of three, or possibly four, at Scarnor Point, c. 1.9 km east from the Site (Figure 9; TI_002), and a pair of possible barrows at Downhedge Cove/Pentire Glaze, c. 845 m south from the Site (TI_003). Further possibilities are situated c. 1.2 to 1.4 km west from the Site, at The Rumps and on the plateau to the south (TI_004, TI_005, TI_007, TI_009), at Lundy Hole (TI_008) and Carnweather (TI_010), although one or more of these may be natural features or upcast heaps from mines or quarries.

5.4.25 No submerged forest remains have been identified within Port Quin Bay and the evidence suggests a very low potential for such (see Section 5.4.16). Bronze Age archaeological and/or palaeoenvironmental remains may be present within Layer B deposits, if these survive within the Site, however, these have likely been disturbed by subsequent hydrodynamic processes.

Although there is this limited potential for *in situ* or redeposited Bronze Age artefacts, the overall potential for such is very low.

5.5 Summary

5.5.1 Identification of geological units and assessment of potential for contemporary human presence alongside their formation is a key method for determining the potential for submerged prehistoric remains. In the absence of site-specific geotechnical data, the conclusions made in this Section are provisional at present, based on the results of wider and nearby geological and archaeological studies. Furthermore, there is a very limited quantity of other geotechnical data for the Site and surrounding area and the broader, high-level studies may not necessarily reflect the true geology of the Site itself.

5.5.2 There is a very low overall potential for submerged prehistoric archaeological remains and palaeoenvironmental remains within the Site. No submerged pre-Devensian (Lower and Middle Palaeolithic) deposits are anticipated within the Site, Study Area and wider environs, as these are thought to have been removed by subsequent marine and glacial processes. There is seabed sediment cover over the entirety of the Site, however, which increases the potential for preserved deposits beneath.

5.5.3 The Site was likely sub-aerially exposed throughout the Upper Palaeolithic and possibly also throughout the Mesolithic (or at least periodically, within the intertidal zone). Evidence also suggests exposure of parts of the Site during the Early Neolithic and other parts of the surrounding environment into the Early Bronze Age. A potential for contemporary deposits (Layer B) has been identified, although high-energy intertidal and marine processes suggest that such deposits (Layer B), if present, have been extensively reworked.

5.5.4 The expectation, therefore, is that any sub-aerial deposits which are (or may have been) present within the Site and have (or had) archaeological remains contained therein have been eroded to such an extent that the potential for *in situ* remains is very low. There is potential for redeposited remains, either from eroded local deposits or translocated from elsewhere, however, the rarity of such finds generally coupled with the active reworking of marine sediments suggests a very low overall potential for these. A slightly greater potential may be considered for Mesolithic remains, in consideration of the sub-aerial exposure of the Site, anticipated environmental characteristics and nearby evidence of contemporary human activity, notably at Trevose Head.

5.5.5 Furthermore, by the nature of their character, palaeoenvironmental remains are either very difficult or impossible to identify when removed from their original contexts in an uncontrolled manner. In consideration of the extensive past and present erosion and reworking of deposits within the Site, there is a very low potential for palaeoenvironmental remains. In the absence of site-specific geotechnical data, the potential for depressions in the bedrock and palaeochannels (as identified within the northern boundary of the Study Area and further west; see Figure 7), which have the potential to preserve palaeoenvironmental remains, cannot be ruled out.

5.5.6 The confidence of the assessment of potential for submerged prehistoric remains would be improved by the results of site-specific geotechnical investigation.

6.0 Maritime archaeology

6.0.1 This section considers the potential for remains relating to coastal and maritime cultural landscapes to be present within the Site, defined as evidence of 'human utilization… of maritime space by boat, settlement, fishing, hunting, shipping and its attendant subcultures, such as pilotage, lighthouse and seamark maintenance'[51]. Remains considered therefore range from shipwrecks or other durable evidence, such as cargos and ballast, to features including navigational aids, sailing marks, ports, harbours and jetties. Navigational hazards, such as shallow reefs or sand banks, influence archaeological potential (particularly for wrecks), as does the preservation environment of a site (see Section 6.1). All can inform our understanding of the potential of the Site.

6.0.2 Other coastal remains which do not necessarily relate to boat use are also considered, including fish traps and other evidence of human interaction with the sea. In addition, other coastal features are also reported on where they inform the potential of the Site. This may include potential for eroded remains from nearby coastal features or settlements or other evidence of coastal use which informs the potential of the Site.

6.1 Navigational Hazards and Preservation Environment

Navigational hazards

6.1.1 The key navigational hazards within the Study Area are the rocky cliff faces forming the coastline around Port Quin Bay, with promontories at The Rumps, Doyden Point and Kellan Head. The Mouls is a small, rocky island to the northeast of The Rumps, c. 780 m west from the Site, forming another navigational hazard. Two rocky outcrops, known as the Cow & Calf, are situated slightly north of the mouth of Port Quin harbour. The BGS maps areas of exposed bedrock around The Mouls, at inlets around the bay and a larger area within the west of Port Quin Bay (see Figure 2). No exposed bedrock is mapped within the Site; however, this may be represented by the two identified geophysical anomalies (see Section 6.2.31).

Preservation Environment

6.1.2 The physical characteristics of an area can determine the rate of preservation of materials and thus can affect archaeological potential. The *Areas of Maritime Archaeological Potential 2 – Characterising the Potential for Wrecks* (AMAP2) project assessed the environmental factors affecting the preservation of maritime archaeological remains on the seabed[52]. These factors included sediment type, sediment thickness, water depth and sediment transport, concluding that the best preservation environment was burial in fine-grained sediments. However, it was also identified that this environment can cause instability in archaeological materials, as even low-energy sediment transport can cause the repeated covering and uncovering of remains by shifting sediment.

[51] Westerdahl, C. 1992. The maritime cultural landscape. IJNA. **21**(1), pp. 5-14.
[52] SeaZone (2012) AMAP2 – Characterising the potential for Wrecks.

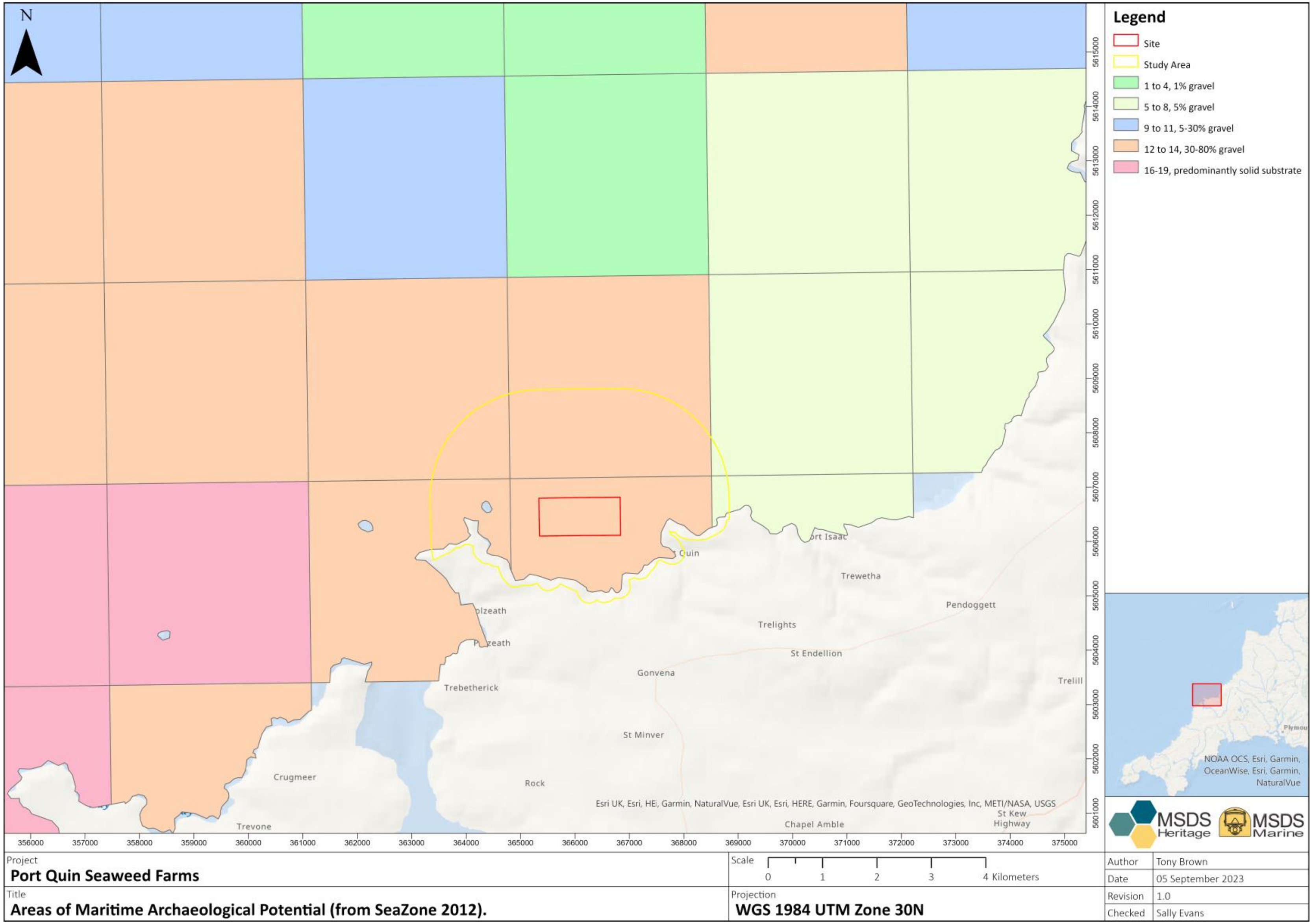

Figure 8 Areas of Maritime Archaeological Potential (SeaZone 2012).

6.1.3 The Site is characterised by sandy gravel, with an attributed preservation level of 12 to 14, on a scale of 1 to 19 where 1 represents the best preservation environment. The Site therefore represents a poor preservation environment. This level of preservation has been attributed to much of the Study Area, except for a small part at the eastern boundary where a level of 5 to 8 has been attributed (see Figure 8).

6.2 Maritime Archaeological Potential

6.2.1 The following sections consider archaeological potential from each period. Few maritime archaeological remains pre-dating the post-medieval period are present within the Study Area and the terrestrial records have been examined alongside local, regional and national scholarship to determine the likely archaeological potential of the maritime environment.

Prehistoric to Romano-British (10,000 BC to 410 AD)

6.2.2 As discussed in Section 5.0, parts of the Site may have been terrestrial up to c. 3,750 BC, with a protracted intertidal character throughout the Late Mesolithic and into the Early Neolithic. Therefore, most Mesolithic or Neolithic remains, if present, would likely be of a terrestrial or intertidal nature. The potential for terrestrial and intertidal remains for this period has been discussed in the previous section and only maritime remains will be considered here.

6.2.3 The Late Mesolithic (c. 7,000 to 4,000 BC) may have seen vessels such as logboats and hide boats using the marine areas of the Site and Study Area. The earliest known western European logboat evidence dates to c. 7,900 to 6,500 BC (Pesse, Netherlands[53]) and hide boats likely have a much longer tradition pre-dating the classical sources mentioning them[54]. The high energy marine environment may have prevented the use of simple hide craft and logboats, though adapted designs using features such as an outrigger or twin hulls, may have been employed for greater stability. Although no evidence of such vessel designs has been identified in Britain, the speculation is derived from similar technological cultures in East Asia and Polynesia.

6.2.4 With tin and copper being essential components to the Bronze Age, Cornwall's natural abundance of these metals, along with smaller quantities of silver and gold, facilitated the region's key role in the later prehistoric trade routes of the European Atlantic seaboard and the Mediterranean[55]. The southernmost part of the Study Area may have lain within the intertidal zone during the Early Bronze Age, as suggested by the *terminus post quem* of 3,900±30 BP (1,950±30 BC) for the submerged forest bed below a midden at Daymer Bay, c. 4 km to the southwest of the Site (Figure 7).

6.2.5 Cornish trade continued into the Iron Age, as attested to by classical sources describing the journeys of Tartessian and Carthaginian sailors in the sixth and fourth centuries BC[56]. The Rumps is a Scheduled, Iron Age promontory fort, situated between 1.2 and 1.6 km west from the Site (Figure 9; TI_006). Excavations during the 1960s place the earliest phase of occupation in the 2nd century BC and the final phase in the mid-1st century AD. Two fragments of amphora suggest continental trade, although it is noted in the corresponding HER record that these sherds were too small to be diagnostic and cannot confirm the stratigraphic dating.

[53] Cunliffe. 2001a. *Facing the Ocean*. Oxford: Oxford University Press. Pp. 65.
[54] *Ibid.* Pp. 66.
[55] Cunliffe. 2001b. *The Oxford Illustrated History of Prehistoric Europe*. Oxford: Oxford University Press. Pp. 354.
[56] *Ibid*.

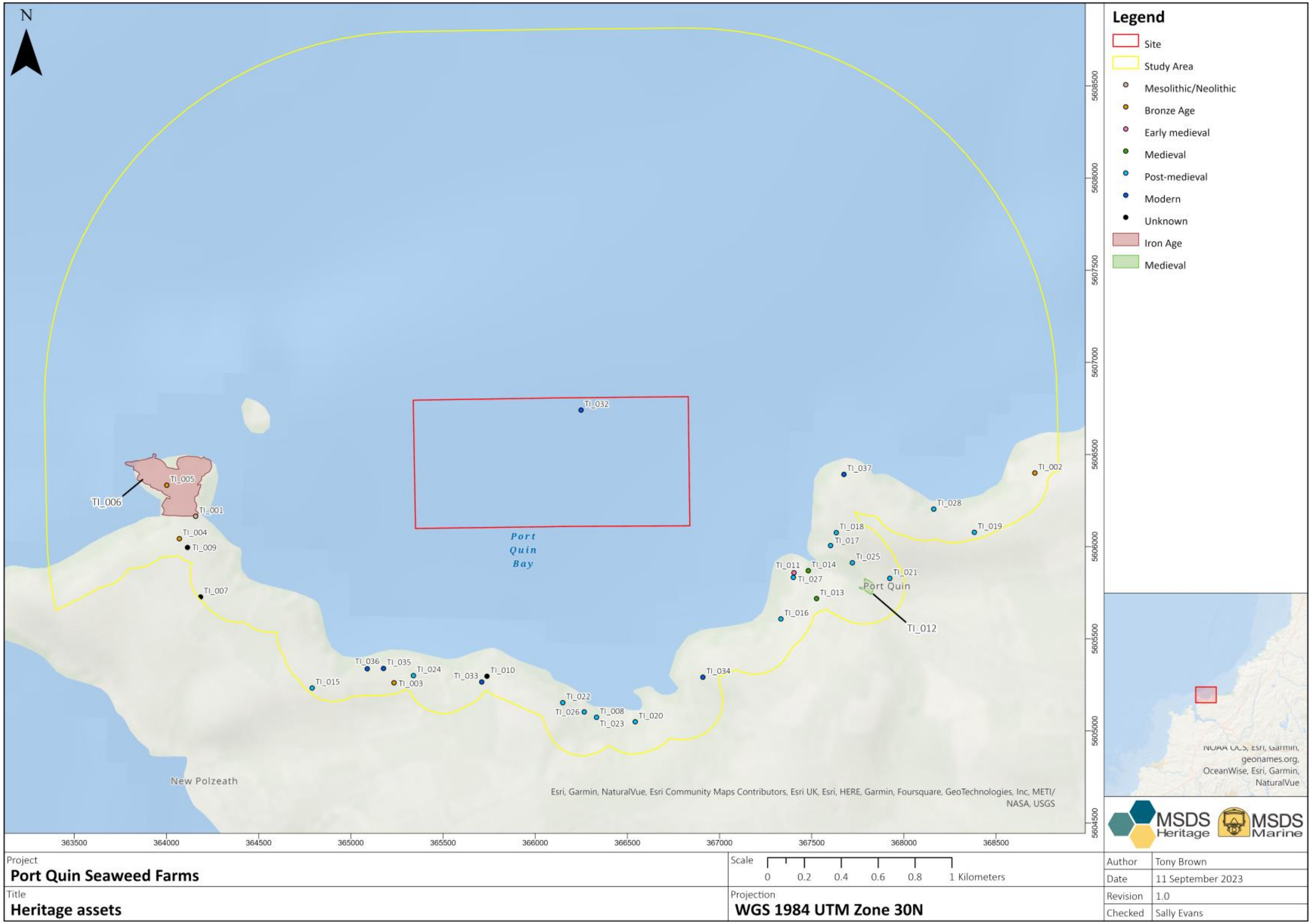

Figure 9 Heritage assets.

6.2.6 Furthermore, recovery of mussel and limpet shells from the deposits at The Rumps indicate that the nearby marine environment was exploited during the Late Iron Age.

6.2.7 Occupation of the terrestrial parts of the Study Area took place during the Bronze Age and Iron Age, which involved foraging for marine resources and possibly also seafaring. Evidence of prehistoric and Romano-British maritime activity is, however, very rare both within the UK and internationally and the overall likelihood of encountering such within the Site is very low.

Early medieval to medieval (410 to 1536 AD)

6.2.8 Maritime technology and activity continued to develop in the early medieval and medieval periods. Raiders, invaders and settlers from Ireland, Scandinavia and northern Europe brought new boat building technologies and opportunities for trade which led to the growth of several major ports on the east coast of the UK[57].

6.2.9 As a peripheral part of Britain characterised by moors, heath, rocky shores and inclement weather, many parts of Cornwall had a very different experience of incoming peoples and changes of government and administration typical of other parts of Britain in the early medieval period. Indeed, the traditional Cornish culture held stronger links with Ireland and other Brythonic peoples in Wales and Brittany, whereas most of England looked to northern Germany, the Low Countries and Scandinavia.

6.2.10 The only notable early medieval site highlighted by the RCZAS in the locality is Tintagel, which emerged as a royal stronghold in the 5th and 6th centuries AD, c. 11.5 km to the north-east of the Site[58]. The early medieval evidence within the Study Area is scant and inconclusive. The aforementioned fragments of amphora recovered at The Rumps (see Section 6.2.4) have been postulated to be post-Roman in date, however, their condition prevents accurate diagnosis. An Ogham-inscribed stone was recorded within the grounds of the 19th century Doyden Castle by the 1880 1st Edition Ordnance Survey[59] (c. 620 m southeast from the Site), however, it has since been returned to its original location at a crossroads outside of Port Quin (Figure 9; TI_011).

6.2.11 Port Quin, c. 1 km to the southeast from the Site, is first recorded in 1201, although no archaeological records are available for the medieval period (Figure 9; TI_012). It is likely that the post-medieval evidence is a palimpsest record accurately representing a continuation of the local activities of the medieval period. Doyden is first recorded in 1316 and marked by the HER as a possible settlement, c. 790 m southeast from the Site (TI_013), though the name has no known meaning in Cornish and may be a personal name, rather than a settlement. The National Trust guesthouse currently occupying this location was constructed in the early 20th century. The only other recorded medieval evidence within the Study Area is a metal detector find of a 1351-2 Edward III silver groat on the beach below Doyden Castle (TI_014).

6.2.12 A small part of an HE polygon Named Location (NL) is situated within the Study Area, terminating c. 1.9 km west from the Site (Figure 10; DL_004). The NL concerns the record of an unnamed vessel stranded at Pentire (possibly Pentire Point) in 1350. The NLs for two further 14th century cargo vessels are situated slightly beyond the Study Area, in Padstow Bay.

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[57] Hutchinson, G. 1997. *Medieval Ships and Shipping.* Leicester: Leicester University Press; Friel, I. 2003. *Maritime History of Britain and Ireland.* London: British Museum Press.
[58] Grant *et al*. 2019.
[59] Ordnance Survey. Cornwall XIII.SW & XIX.NW, surveyed 1880, published 1888.

6.2.13 Early medieval and medieval maritime remains are very rare in the archaeological record and the steep cliffs and seabed conditions suggest a poor preservation environment (see Section 6.1.3). The evidence suggests that the Study Area was occupied during the medieval period, and it is very likely that maritime activities were undertaken in association with this occupation, however, the overall likelihood for encountering early medieval or medieval remains within the Site is very low.

Post medieval to modern (1540 to present)

6.2.14 The development of Cornwall's mineral extraction industry expanded during the post-medieval period, with an increased demand for tradeable goods, precious metals and resources to facilitate other industries nationally. Within the Study Area, mines are recorded at Pentire (Figure 9; TI_015) and Gilsons Cove (TI_016), the former first mentioned in 1580. No fewer than eight post-medieval quarries and potential quarries are recorded within the Study Area (TI_017 to TI_024) and a sand pit within Port Quin (TI_012). The BGS records four slate formations as the bedrock geology around Port Quin Bay, indicating the likely quarried material.

6.2.15 A post-medieval slipway is recorded at Port Quin (Figure 9; TI_012) and a quay further into the harbour, c. 900 m southeast from the Site (TI_025). A branch from the main coastal footpath towards a narrow cove is marked as Markham's Quay on the 1880 1st Edition Ordnance Survey[60] suggests a further landing point (TI_026). There is no firm evidence to suggest that quarried slate and other resources were transited by sea from the locality, however, the presence of several landing or mooring sites and the difficulty associated with overland transport of heavy materials suggests that transport by sea would have been preferable. Further post-medieval maritime activity within the Study Area is suggest by the number of fish cellars incorporated into the buildings of Port Quin.

6.2.16 The recording of maritime history became common practice by the post-medieval period and our knowledge of contemporary and later maritime activity is therefore much more robust than for earlier periods. Documentary evidence of vessels lost during these periods provides evidence of maritime activity in the waters surrounding, and within, the Study Area.

6.2.17 A total of 14 HE records within the Study Area relate to positions describing lost vessels (documented losses; Figure 10). One represents part of the NL describing the loss of a medieval vessel at Pentire (DL_004; see Section 6.2.12) and also the loss of a modern fishing trawler, one relates to an early 19th century vessel lost slightly north of The Mouls (DL_003), one represents an early 20th century loss and is incorrectly placed on the clifftop west of Port Quin (DL_002) and the remaining ten are attributed a general location within the Site (DL_001).

[60] Ordnance Survey. Cornwall XIX.1, surveyed 1880, published 1881.

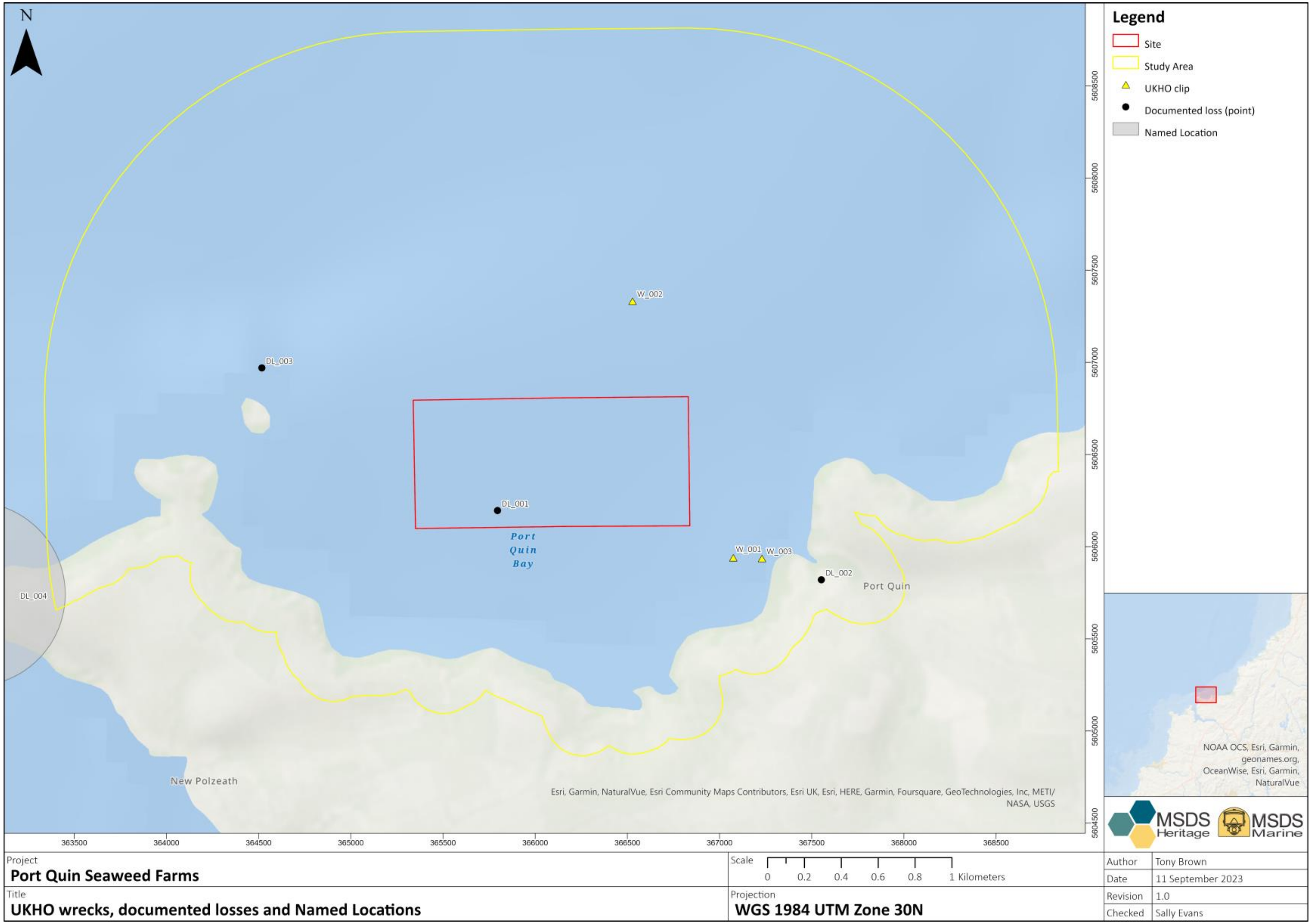

Figure 10 UKHO wrecks, documented losses and Named Locations.

Date lost	Vessels reported lost
14th century	1
18th century	1
19th century	5
20th century	7
Total	14

Table 5 Documented losses by period.

Vessel type	14th century	18th century	19th century	20th century	Totals
Barque			2		2
Cargo vessel	1		1		2
East Indiaman		1			1
Fishing vessel/trawler				3	3
Galliot			1		1
Ketch				1	1
Lugger				1	1
Schooner			1	2	3
Total	1	1	5	7	14

Table 6 Vessel types indicated by the documented losses.

6.2.18 In addition to demonstrating the increase in loss records and implied increase in vessel activity from the 19th century (see Table 5), the documented losses also give an insight into the type of maritime activity carried out in nearby waters, through assessment of vessel types (Table 6).

6.2.19 The documented losses indicate maritime activity in and around the Study Area from the 14th and 18th to 20th centuries and can be understood within the wider context of activity on land. Historic maps and terrestrial archaeological records give an indication of landward activity, which provides further information on the archaeological potential of the Offshore Development. The available Ordnance Survey maps for the Study Area range in date from 1881 to 1963 and illustrate little variation of the landscape and land use[61]. Port Quin forms the only settlement in the Study area with direct access to the sea. Other small settlements or farmsteads are illustrated slightly beyond the Study Area at Pentire Farm, Pentire Glaze, Porteath, Trevigo and Roscarrock. Further afield lay the coastal settlements of Polzeath, Pentireglaze and Port Isaac. The maps mark numerous quarries and shafts, with much of the terrestrial landscape enclosed as pasture or farmland. It is likely that arable farming or pastoralism formed the main activities within the Study Area during the post-medieval period.

[61] National Library of Scotland. https://maps.nls.uk/ Accessed 11 September 2023.

6.2.20 Local fishing and trade likely took place from Port Quin, including transportation of quarried slate. Only small vessels, however, are able to access Port Quin, because of the narrow inlet, rocky seabed and frequent rough sailing conditions. The RCZAS notes that, despite the relatively high number of strandings and losses for this section of coastline, there is little evidence of physical wreckage, presumably due to high-energy hydrodynamic processes and salvage[62]. The latter represents a frequently documented activity of coastal communities of the post-medieval period.

6.2.21 In addition to the documented losses, two further 20th century losses within the Study Area are associated with known seabed remains and have live UKHO records. The probable wreck of the *Sphene* is recorded c. 523 m north from the Site (Figure 10; **W_002**) and the *Skopelos Sky* is recorded c. 429 m to the southeast of the Site (**W_003**). Both operated as cargo carrying vessels. A third UKHO record relates to an area of foul ground, c. 291 m to the southeast of the Site, and may represent an additional wreck, possibly concealed by seabed sediments (**W_001**). No UKHO records suggest the presence of seabed remains within the Site.

MSDS ID	Period	Description	WGS84		UKHO ID	NRHE ID
			Easting	Northing		
W_001	Unknown	Foul round. Possible wreck.	367074.7	5605942.2	78683	-
W_002	20th century	Probable wreck of the *Sphene*. Foundered in 1946 after striking The Mouls. Upright on seabed with centre collapsed. Live UKHO record.	366528.1	5607333.8	17907 (dangerous wreck)	1518506
W_003	20th century	Wreck of the *Skopelos Sky*. Abandoned west of Doyden Point after engine failure in 1979. Partly broke up, suggested that only the engine remains at the position of the live UKHO record.	367230.4	5605938.3	17737 (dangerous wreck)	1519039
W_004	Unknown	Geophysical anomaly: possible wreck and debris.	366404	560227.7	-	-
W_005	Unknown	Geophysical anomaly: possible wreck or debris.	366551.4	5606364.2	-	-

Table 7 Gazetteer of archaeological sites within the study area.

[62] Grant *et al*. 2019.

W_001: Foul ground

6.2.22 **W_001** relates to an area of foul ground recorded by the UKHO in a scour hole. It was detected by acoustic sensor in 2010 at 5.52 m deep, in general water depth of 6.2 m. The scour is measured as 0.7 m deep at contact and the contact itself as 3.2 m long, 2.2 m wide and 1.38 m high.

W_002: Probable wreck of the *Sphene*

6.2.23 **W_002** relates to the probable wreck of the *Sphene*, a 1920 British registered, steel-built steam ship, formerly named *River Tawe*. It had a triple expansion, single shaft engine of 79 hp, weighing 815 tonnes. The remains at this location were first detected in 1985 and last detected in 2010, with sonar measurements of 61 m long, 14.9 m wide and 5 m high. The remains are upright with a collapsed centre and bows facing west-northwest, exhibiting heavy marine growth and laying in waters 29 m deep.

6.2.24 The *Sphene* was transporting coal from Barry to London on the night of 5th February 1946 in heavy seas and poor visibility, striking The Mouls at 4am, however, the HE record for the event of the loss is given as an NL, the whole polygon situated southwest of the Study Area in Padstow Bay (between 2.6 to 3.6 km southwest from the Site). The Shipwreck Index records that the vessel drifted away to sink off Boscastle (c. 16 km northeast from the Site; cited by HE event record). The HE record for the remains of the Sphene is situated c. 180 m west-southwest of the UKHO record location (see Figure 10).

6.2.25 Diver accounts from 1989 to 2010 suggest continued deterioration of the vessel and collapse of its superstructures, exposing the engine, boiler and pipework. There has also been noted evidence of salvage.

W_003: Wreck of the *Skopelos Sky*

6.2.26 **W_003** relates to part of the wreck of the *Skopelos Sky*, a Greek registered, steel cargo ship of 1,652 tonnes. The remains were first detected in 1979 and last detected in 2011, with sonar measurements of 8.8 m long, 8.8 m wide and 3.7 m high.

6.2.27 The *Skopelos Sky* experienced engine failure during a storm on the night of 18th December 1979, whilst transporting drums of lubricating oil from Garston to Algiers. Stranded c. 300 m west of Doyden Point, the vessel quickly broke up with parts of the superstructure and cargo driven ashore and against the surrounding cliffs. The HE location for the remains is c. 190 m south of the UKHO location (see Figure 10). The UKHO record notes that the remains at this location comprise a single item, possibly an engine.

Other possible wreck remains

6.2.28 Publicly available bathymetric data for the Site were reviewed[63]. The data available were collected in 2011, and whilst labelled as singlebeam data is likely to be multibeam data. Two anomalies were identified within the southeast part of the Site, having dimensions and forms suggestive of possible wrecks or parts thereof. These anomalies do not correlate with any other UKHO, HE or HER locations.

[63] 2011 HI 1157 Hartland Point to Lands End Blk 2 2m SB https://seabed.admiralty.co.uk/selected-items?x=-537752.41&y=6539927.74&z=10.83 Accessed 4th September 2023.

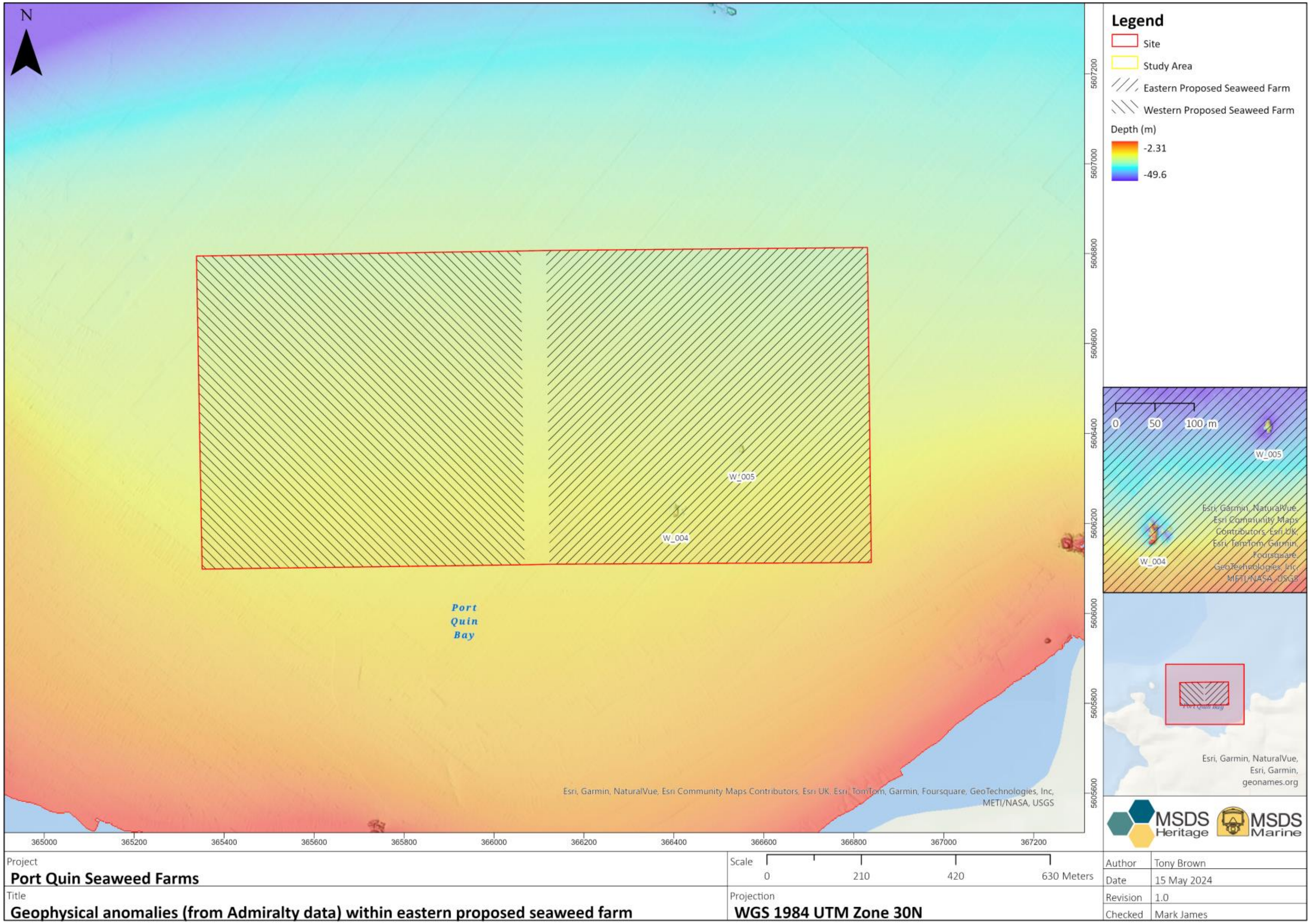

Figure 11 Geophysical anomalies.

6.2.29 The larger anomaly (Figure 11; W_004) is situated c. 200 m to the southwest of the smaller and measures c. 28 m long and c. 10.4 m wide, orientated north/south. A distribution of smaller anomalies to the immediate east may represent associated debris.

6.2.30 The smaller anomaly (W_005) measures c. 16 m long and c. 3 to 9.5 m wide, exhibiting an 'arrowhead' form in plan, orientated north/south.

6.2.31 It is feasible that these two anomalies may represent outcropping bedrock geology, however, such features are only mapped close to the cliffs and no other similar forms are present within the Site or much of the Study Area. In the absence of further data, W_004 and W_005 would be provisionally attributed high and medium archaeological potential, respectively. It may be possible to further our understanding of these anomalies through diver and/or ROV inspection.

First and Second World War remains

6.2.32 Like much of the UK coastline, the First and Second World Wars have left traces in the archaeological record of the Study Area. The location of a bombing or gunnery target is recorded within the Site (TI_032). The corresponding HER record describes six anchored targets, presumably associated with the First World War Crugmeer (Padstow) airfield, c. 6.6 km to the southwest of the Site, and/or the Second World War St Merryn airfield, c. 11 km to the southwest. The arrangement and construction of the targets is not mentioned. An aerial photograph of Port Quin Bay, dating to 29th June 1948, does not illustrate any features possibly relating to the target array[64]. Similarly, Admiralty bathymetry and Google Earth aerial photographs do not illustrate any features at this location.

6.2.33 Associated sites within the Study Area comprise Second World War bombing target indicators at Carnweather Point (TI_033) and Trevan Point (TI_034) and Second World War or unspecified observation posts at Treberick (TI_035 & 036 and Kellan Head (TI_037).

6.2.34 Although no floating or seabed remains associated with the target array have been identified, it is possible that anchors, cables and other associated remains may be present, either on or beneath the present seabed. Furthermore, the target indicates potential for quantities of unexploded ordnance (UXO) to be present within the Site which may require separate assessment by a UXO specialist.

Summary

6.2.35 The archaeology of the Study Area suggests that the coastal high ground south of Port Quin Bay experienced Mesolithic, Bronze Age, Iron Age and possibly Neolithic occupation. Port Quin and Doyden are recorded as medieval settlements and post-medieval occupation is attested by the former and other small, nearby settlements and farmsteads, along with records of maritime losses.

6.2.36 In consideration of the rarity of maritime remains of these periods, the poor preservation environment and the high-energy hydrodynamic processes active in the vicinity, a very low overall potential is anticipated for prehistoric and medieval remains. Similarly, although post-medieval losses are documented within the Site and Study Area, the poor preservation

[64] Cambridge air photos, catalogue No: AX46 https://www.cambridgeairphotos.com/location/ax46/ Accessed 11th September 2023.

environment and processes suggest a very low overall potential for remains of this period within the Site.

6.2.37 Physical remains within the Site are suggested by two geophysical anomalies (W_004 & W_005). The nature and character of these is not known, although they may present wrecks or parts thereof, relating to documented losses or unidentified vessels. Considering the poor preservation environment and hydrodynamic processes, if these anomalies do represent wrecks, they are likely to be steel-built and date to the modern period. Alternatively, these may represent outcropping bedrock geology. Higher resolution geophysical data and/or the results of diver/ROV survey would be required to further determine the characteristics of these anomalies.

6.2.38 Furthermore, the location of a target array within the Site presents a moderate potential for seabed remains of this wartime feature.

7.0 Aviation

7.0.1 Aviation technology has been available since the early 20th century, though air travel became more prevalent after World War I. During the inter-war years, commercial air travel boomed, and during World War II the skies were dominated by military aircraft. After the war, commercial aviation steadily increased and improved; in 1950, UK airports ran 195,000 flights and in 2018 they ran 2,215,000[65]. The remains of thousands of aircraft casualties, both civil and military, are present in UK waters[66].

7.1 Aviation archaeological potential

7.1.1 There are no known aviation remains within the Site or Study Area. The nearest recorded crash site is an HE NL recorded c. 2.6 to 3.6 km to the southwest of the Site, relating to the loss of a British Hampden Mk I bomber in 1942.

7.1.2 Records within the Study Area and further afield suggest that the Site and Study Area may have been used by military aircraft during both World Wars. The target array situated within the Site (Figure 9; TI_032) may have been used for both aerial bombing and naval gunnery practice and the corresponding HER record suggests associations with First World War Crugmeer (Padstow) airfield and/or the Second World War St Merryn airfield. Although no further detail to support a First World War association was available, nearby target indicators (TI_033 & 034) and observer posts (TI_035-037) largely date to the Second World War.

7.1.3 Aircraft casualties rarely result in articulated aircraft remains on the seabed. Due to the traumatic nature of an aircraft crashing into the sea, the remains of an aircraft are usually scattered on the seabed[66]. Aircraft, particularly military aircraft, are typically small and built of light materials; crashed remains may travel on the sea surface before sinking and settling on the seabed. Therefore, it is rare for remains to be identified articulated and *in situ*.

7.1.4 While wartime and later aviation activity is known within the area, there are no known aviation remains within the Site. Additionally, the nature of aircraft crash sites leads to the majority representing disarticulated remains. Thus, while the aviation activity and losses reported in the area indicate a general level of potential for aircraft remains to occur within the Site, any such remains are likely to be disarticulated. Potential is therefore limited, though chance finds may occur.

[65] UK Government. 2018. Aviation statistics: data tables- Air traffic at UK airports. Available at: https://www.gov.uk/government/statistical-data-sets/aviation-statistics-data-tables-avi#air-traffic-at-uk-airports-avi01
[66] Wessex Archaeology 2008. Aircraft Crash Sites at Sea: A Scoping Study. Archaeological Desk-based Assessment. Unpublished Report.

8.0 Historic Seascape Characterisation

8.0.1 The Historic Seascape Character (HSC) of the Site and Study Area was assessed using the Historic Seascape Characterisation data, provided by HE. The current and past sub-character types within the Site are summarised in Table 8. Section 12.0 (Appendix I) includes figures displaying the distribution of character types within the Study Area.

Character Area	Character type within Site	Date
Coastal and Conflated	Recreation; Leisure sailing	AD 1900 – Present
Sea Surface	Recreation; Leisure sailing	AD 1900 – Present
Water Column	Fishing; bottom trawling Navigation hazard: hazardous water	AD 1900 – Present
Sea Floor	Fishing; bottom trawling	AD 1900 – Present
Sub-Sea Floor	Cultural topography; coarse sediment plains	Unknown
Previous (Sub types)	Port Quin Bay: Seine netting (certain)	AD 1750 - 1900
	Port Quin Bay: Fishing ground (probable/possible)	AD 1066 – 1750
	Port Quin Bay: Palaeolandscape component (probable)	10,000 – 4,000 BC
	Celtic Sea: Seine netting (certain)	AD 1750 - 1900
	Celtic Sea: Fishing ground (probable/possible)	AD 1066 – 1750
	Celtic Sea: Palaeolandscape component (probable)	10,000 – 4,000 BC

Table 8 Historic Seascape Characterisation character types within the Site.

8.0.2 The current character types include fishing and leisure sailing. The previous sub-types were also reviewed and include palaeolandscape components discussed in detail in Section 5.0, and fishing, which is discussed within Section 6.0 in relation to the maritime history of the area.

8.0.3 These current and previous character types summarise the known archaeological features in the area and contribute to the understanding of archaeological potential of the Study Area.

9.0 Assessment of significance

9.0.1 This section provides an assessment of the significance of remains identified within the Site, with reference to Conservation Principles and relevant research frameworks (see Section 3.8).

9.0.2 A very limited potential for palaeolandscape, palaeoenvironmental and submerged prehistoric remains has been identified within the Site. Of the two Quaternary units possibly present, that of the greatest archaeological potential (Layer B) is expected to have been extensively eroded and reworked by post-depositional, high energy hydrodynamic processes. Layer B deposits are not known to exist within the Site but a greater potential for their survival is identified if occurring within fissures, palaeochannels or other similar sub-seabed features. In the absence of site-specific geotechnical data, it is not possible at present to determine with confidence the presence of Layer B deposits and/or palaeolandscape features within the Site.

9.0.3 A very low potential for submerged prehistoric remains of Palaeolithic, Neolithic and bronze Age date has been identified. A low potential for Mesolithic remains has been identified, elevated slightly by the recorded evidence of Mesolithic occupation of the surrounding landscape and sub-aerial exposure of the Site for much of this period. Where Layer B deposits are identified within the Site, these have the potential to contain *in situ* prehistoric remains and palaeoenvironmental evidence. Redeposited artefacts may be present within Layer B or Layer A (modern seabed sediments) deposits. As potential deposits may be able to inform our understanding of the post-LGM landscape and processes (evidential value), the significance of any remains present is likely to be low to moderate.

9.0.4 The two geophysical anomalies within the Site may relate to wrecks and there is potential for finds of maritime and aviation material which may survive as smaller items (not identified within the Admiralty bathymetric data) or buried remains. Both maritime and aviation remains have the potential to be of high significance and the latter in particular may fall under the automatic designation of the Protection of Military Remains Act, in some cases. Recognition of any remains within the Site is therefore of importance to ensure impacts can be avoided, minimised, or mitigated.

9.0.5 Possible further remains of archaeological interest may relate to the former 20th century bombing/gunnery target. Anchors, cables and other elements associated with the target array may be present. Such artefacts and features may hold some historical and evidential value through their association with wartime activities. Further understanding may therefore make a limited contribution to regional research themes related to defence and warfare[67].

[67] https://researchframeworks.org/swarf/post-medieval-industrial-and-modern/#section-147

10.0 Assessment of Impacts and Mitigation

10.1 Overview of Construction Impacts

10.1.1 The proposed development would involve the construction of a seaweed farm, comprising two adjacent blocks, separated by a 50 m gap. The expected design life for the seaweed farm is 50 years.

10.1.2 Each block will comprise 144 no. 160 m long-lines, orientated north-south and spaced 20 m apart. The long-lines will be arranged in columns of four (4), amounting to 72 no. columns in total across the whole farm. The total physical farmed area (based on infrastructure alone) is 10.08 ha.

10.1.3 Gravity-based anchors have been selected as the most suitable option for the Site, namely the RC2000 reef cube®. Individual anchor weight for optimum stability will be 29.5 tonnes, equating to 5 no. cubes. The typical seabed footprint of one anchor point (five cubes) is c. 20 m^2. A total of 576 no. anchor points are required across the 288no. long-lines, resulting in the use of 2,880 no. cubes, with a seabed footprint of 11,520 m^2.

10.1.4 The primary interaction with the seabed will be the installation of the cube anchors. Calculations used to reach the optimum anchor point weight have considered zero tolerance for lateral movement (drag) of the anchor points. Therefore, once in place, no further direct physical impacts to the seabed are considered likely from the in-place anchor cubes.

10.1.5 Additional direct physical impacts to the seabed may result from construction and survey vessel anchoring. The number of construction/survey vessels and frequency of anchoring were not known at the time of writing.

10.1.6 Indirect physical impacts may be experienced through hydrodynamic processes resulting in scouring around infrastructure or vessel anchors/blocks. Any scour would be experienced more towards the perimeter of the farms, exponentially decreasing in magnitude towards the centre due to the protective effect of more peripheral anchors.

10.1.7 Indirect impacts arising from the development would also include the potential removal of this area of seabed from research opportunities, through the installation of the seaweed farm. The potential for this impact to occur has been raised by Historic England in relation to other, similar project proposals. Further research has therefore been conducted to better understand this impact and its potential to occur. Techniques for undertaking marine archaeological research primarily include geophysical, geotechnical, ROV and diver investigations. Discussions with Biomealgae demonstrate that all have the potential to be carried out within the Site following the construction of the seaweed farm. The proposed 20 m headline spacing will allow access for smaller vessels and a range of other vessels on which research equipment can be mounted. Geophysical equipment, including MBES and sub-bottom profiler (either towed or hull mounted), can be deployed using small vessels, Unmanned Survey Vessel (USV), Autonomous Underwater Vessel (AUV) or Remotely Operated Vehicles (ROVs). Geotechnical coring can be undertaken from small vessels or by divers (the potentially shallow depth of burial of deposits of interest (Layer B – if present) further supports the use of smaller scale geotechnical equipment, including diver-led coring), though deep boring from larger vessels is unlikely to be possible due to the seaweed infrastructure. However, both ROVs and divers will be used in the existing monitoring which is planned for the seaweed farm and further investigation of the area could be undertaken following construction. With tailoring of suitable methodologies, the effects of this impact would be minimal and archaeological remains within the boundary of the seaweed farm would be accessible to most forms of investigation.

10.1.8 The construction of the seaweed farm may also have positive effects. The Site and Study Area are currently used for bottom trawling (see Section 8.0, Figure 14 and Figure 15), which would cease within the Site following the construction of the seaweed farm. At present, nets and gear may snag on seabed remains, such as those suggested by the geophysical anomalies, and the proposed development would offer improved protection for these remains and any other as-yet undetected remains.

10.2 Palaeolandscape: impacts and mitigation

10.2.1 The anchor designs anticipate a maximum footprint of 11,520m^2 within the 10.08 ha (100,800 m^2) area of the seaweed farm. Anchor cubes will sit upon the uppermost seabed sediments, preserving any subcropping sediments.

10.2.2 Section 5.0 has demonstrated an overall very low potential for features or remains of palaeolandscapes of archaeological interest within the Site, however, this potential would increase if Layer B deposits were identified. In the absence of site-specific geotechnical data, the presence or absence of Layer B deposits cannot be determined with confidence. Palaeoenvironmental remains may also be contained within Layer B deposits, although the overall likelihood of such is very low even if the deposits are identified within the Site, in consideration of the anticipated erosive processes experienced by Layer B deposits. The potential for preserved palaeoenvironmental remains would increase should palaeolandscape features be identified within the Site, which may also be achieved through site-specific geotechnical investigation.

10.2.3 In assessing marine licence applications, the MMO refer to the Marine Policy Statement and relevant marine plans[68], which, in this case, is the South West Marine Plan. Both documents are referred to below.

10.2.4 The Marine Policy Statement[69] sets out that "…heritage assets should be enjoyed for the quality of life they bring to this and future generations, and that they should be conserved through marine planning in a manner appropriate and proportionate to their significance" (para 2.6.6.3) and goes on to state that "The more significant the asset, the greater should be the presumption in favour of its conservation", identifying that the loss of a designated heritage assets should be wholly exceptional (para 2.6.6.8).

10.2.5 The South West Marine Plan further states that there is a need for public authorities to "…consider both designated assets and non-designated assets in regard to their value, and risk of harm. Similarly, elements contributing to the significance of the asset should not be compromised or harmed" (para. 458). The South West Marine Plan emphasises the importance of significance in these decisions recognising that management should involve the protection of the marine historic environment according to its level of significance (Section 3.2), and the

[68] https://www.gov.uk/guidance/make-a-marine-licence-application
[69] https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf

overall objective (Objective 8) relevant to the marine historic environment is to "Identify and conserve heritage assets that are significant to the historic environment of the south marine plan areas".

10.2.6 The palaeolandscape remains within the area are not considered to be of high significance but do have potential to hold a low to moderate level of significance, in consideration of their potential to inform our understanding of the development and human occupation of the submerged landscape (see Section 9.0).

10.2.7 The South West Marine Plan, in policy SW-HER-1, indicates that proposals should demonstrate that they will, in order of preference, **(a) avoid, (b) minimise or (c) mitigate** harm upon all heritage assets, including those newly identified or discovered, or non-designated assets that are yet to be assessed for designation. If mitigation is not possible, the public benefits of the development should outweigh the harm to the significance of heritage assets (pp. 37).

10.2.8 Avoidance, as the preferred method of preservation, may be achieved through the selected anchor design, featuring non-penetrative installation. Whilst there is the feasibility of outcropping Layer B deposits within the Site, the overall likelihood is very low, and any such deposits would be expected to have experienced a significant degree of erosion which would compromise the integrity of any palaeoenvironmental evidence contained within the uppermost sediments.

10.2.9 Minimisation of impacts is the second preferred method for preservation. While potential palaeolandscape remains cannot be avoided entirely, the extent of potential impacts has been minimised by the anchor design and would result in a very limited area of potential impact from hydrodynamic processes around the anchor blocks, such as scour. The resultant impact would not represent the loss of the whole asset or a material part of the asset or its significance. Impacts to the palaeolandscape have therefore been minimised through anchor design.

10.2.10 As an additional mechanism for allowing mitigation, it is proposed that a Protocol for Archaeological Discoveries (PAD) be put in place and training provided to site staff, with a particular emphasis on the identification of palaeolandscape remains which may occur within the Site (e.g. Layer B deposits). This will include training on how to identify sediments of interest should they be encountered during the construction, operation (including monitoring) or decommissioning of the seaweed farm. Should any such remains be identified, mechanisms will be put in place allowing for either protection or mitigation, including research or further investigation of these remains (using AUVs, ROVs or divers as discussed above)[70]. The PAD is discussed in further detail below (Section 10.4) and its use here is considered appropriate and proportionate, given the level of significance (moderate) and anticipated level of impact (very limited) to potential palaeolandscape remains. The full details of these mechanisms will be included within a Written Scheme of Investigation (WSI) for the development, to be produced in line with relevant guidance[71].

10.2.11 In summary, impacts to the palaeolandscape have been minimised through anchor design, resulting in a comparatively small area of impact and removal of the area from other activities

[70] Biomealgae are currently supporting a variety of other research projects in association with the development, including working with partners at The Crown Estate, Cefas, the Marine Biological Association and Plymouth and Exeter Universities, and are actively open to developing other research work.
[71] The Crown Estate, 2021. *Archaeological Written Schemes of Investigation for Offshore Wind Farm Projects*. The Crown Estate.

which may cause impacts (e.g. bottom trawling). The full extent of potential impacts, however, has not been identified. Specific detail concerning the presence (or absence) of deposits of archaeological interest would be required to assess the likely full extent of impacts, however, the anchor design has sufficiently minimised the risk to this resource so that targeted investigation is not considered a proportionate response.

10.2.12 Additionally, mitigation in the form of the PAD, with potential for protection or mitigation through further work if necessary, is recommended. While the development cannot entirely avoid impacts, it has minimised them and recommended proportionate mitigation actions, in accordance with Policy SW-HER-1.

10.3 Known archaeological remains and anomalies of archaeological potential: impacts and mitigation

10.3.1 The assessment has not identified any remains of known archaeological interest within the Site. A single HER entry within the Site relates to a Second World War target array, however, no further detail is available and no physical remains are suggested at this location by the Admiralty bathymetry. This may indicate prior partial or wholesale removal of the array, sinking and burial of elements or incorrect coordinates in the HER entry.

10.3.2 It is therefore feasible that parts of the array, such as anchors, may be present at this location buried beneath seabed sediments.

10.3.3 Furthermore, analysis of the Admiralty bathymetric data has identified two anomalies of potential anthropomorphic origin within the southeast corner of the Site, sitting atop or partially buried by seabed sediments (Figure 11). These features do not correlate with records or data from other sources and no further detail was available at the time of writing.

10.3.4 The proposals have the potential to impact archaeological remains upon or below the seabed, however, the extent of any impacts would be determined by factors including burial depth and characteristics of the remains.

10.3.5 Without additional survey data (geophysical and/or diver/ROV), appropriate mitigation for the two geophysical anomalies would be afforded by the application of Archaeological Exclusion Zones (AEZs). These should measure 50 m from the extents of the anomalies and any associated peripheral features, establishing a protective buffer where not intrusive or potentially destructive activities may take place. Should these anomalies represent wrecks, a 50 m AEZ would provide adequate protection to any contiguous structures and debris spreads that may be present. The size of the AEZs takes into consideration the limitations of the bathymetry data, in particular the minimum object detection size of 2 m.

10.3.6 AEZs may be altered or removed following discussion with the Archaeological Curator(s), supported by new evidence. Such new evidence may be obtained from geophysical, diver or ROV survey and inform understanding of the archaeological significance, character and distribution of the features. Improved understanding of the extent of any remains may enable AEZs to be reduced or removed if proven to be of no archaeological interest.

10.3.7 As no physical remains are known to be present at the HER-given location of the target array, establishment of an AEZ here may not be considered a proportionate mitigation. A 25 m Temporary Archaeological Exclusion Zone (TAEZ) may be suitable, to protect any potential remains until further information can be obtained. Diver survey at this location may be able to confirm if remains are present here upon the seabed and geophysical survey may be able to detect any remains buried beneath shallow sediments.

10.4 Previously unknown archaeological remains: impacts and mitigation

10.4.1 In the course of works, previously unknown archaeological remains may come to light, for example during installation of anchors or lines or during post-construction monitoring, both of which have the potential to encounter seabed remains.

10.4.2 This assessment has discussed the potential for such remains, including potential maritime and aviation remains. Two geophysical anomalies have been identified which do not correlate with any other available records. It is also feasible that other remains may be present. Identification of such remains is crucial to identifying and mitigating any currently unforeseen impacts. As such, it is recommended that a PAD should be implemented during construction works. This should be in line with the Crown Estate (2014) guidance *Protocol for Archaeological Discoveries: Offshore Renewables Projects*.

10.4.3 The WSI will include the PAD and will set out a chain of communication for reporting any potential archaeological remains identified on site. This will involve site staff reporting finds to the 'Site Champion' (an elected member of on-site staff) who will in turn record the find and implement Temporary Exclusion Zones. The Site Champion will then notify the 'Nominated Contact' (who can be the Retained Archaeologist). The Nominated Contact will identify the find and its archaeological potential and make recommendations for any further mitigation actions which will be dependent on the potential significance of the find and any other associated material. Examples of potential mitigation include implementation of Archaeological Exclusion Zones (AEZs) where necessary. AEZs may be recommended if, for example, remains of a shipwreck, aircraft or prehistoric archaeological site, or other 'high potential' remains are identified. Other options for mitigation such as geophysical survey using an AUV or coring may be recommended if sediments with palaeoenvironmental potential (e.g. fine grained or organic) are encountered. The Nominated Contact will also notify others, including the project manager, and will notify and agree mitigation with the archaeological curator. Other actions and further detail will be set out within the proposed WSI.

10.4.4 The WSI will review activities to be undertaken during construction and operation in detail and will identify key activities where interactions with the seabed may occur, which may result in encounters with archaeological remains. These activities include installation of anchors (whereby archaeological material on the seabed may be recovered accidentally through entanglement with drill equipment or excavation of seabed material) and use of diver and ROV surveys for monitoring (which may lead to direct visualisation of material on the seabed). Groups undertaking these activities will be briefed on the PAD, ensuring all relevant staff have a clear awareness of their obligations, the protocol for reporting and chain of communication.

10.5 Historic Seascape Character: impacts and mitigation

10.5.1 The HSC data indicates the Site lies within areas characterised by leisure sailing, fishing (bottom trawling and Seine netting) and sediment plains, with previous activity in the area noted as fishing and palaeolandscape components. Palaeolandscape impacts have been discussed above.

10.5.2 The proposed development would result in the insertion/placing of anchors and associated seaweed farm installations (see Section 10.1). These features would alter fishing practices within the area, however, research indicates that structures in the marine environment can form artificial reefs around which marine species may aggregate[72]. As such, the insertion of the development may support fishing by supporting larger stocks and providing nursery environments.

10.5.3 In addition, leisure sailing takes place within the area. While the seaweed farm may alter marine navigation within the Site boundaries, it would not alter or inhibit marine leisure activities across the broader area in which they are recorded. Furthermore, while the development would involve the insertion/placing of anchors and associated seaweed farm installations, it would not alter the wider character of the reported sediment plains.

10.5.4 Therefore, no negative effects to the HSC of the area are anticipated from the development and no mitigation is proposed.

10.6 Recommended further work

10.6.1 The assessment has identified within the Site:

- Two geophysical anomalies or potential archaeological significance;
- One HER entry possibly relating to the physical remains of a Second World War bombing/gunnery target array;
- Very low potential for prehistoric/palaeoenvironmental remains should Layer B deposits be present; and
- Very low potential for remains associated with post-medieval or earlier maritime losses and/or aviation losses.

10.6.2 Recommendations made at this stage are based on the results of this assessment and would have one or more of the following aims:

- To characterise the archaeological significance of remains/features of archaeological potential;
- To identify the extent of any remains; and/or
- To investigate the potential for sub-seabed deposits of archaeological/palaeoenvironmental interest.

10.6.3 The anchor design option (Section 10.1) has a low overall potential to impact archaeological remains, based on information at the time of writing:

- Palaeoenvironmental or palaeolandscape remains are unlikely to be affected by the proposals;
- Any remains relating to the former gunnery/bombing array are likely of solid construction and are therefore unlikely to be affected by the proposals; and
- Unknown maritime and/or aviation remains on the seabed or shallowly buried therein may be impacted during the installation of the anchor cubes.

[72] Degraer, S., Carey, D.A., Coolen, J.W P., Hutchinson, Z.L., Kerckhif, F., Rumes, B., & Vanaverbeke, J. 2020. 'Offshore Wind Farm Artificial Reefs Affect Ecosystem Structure and Functioning: A Synthesis'. *Oceanography* **33**(4), pp. 48-57.

Diver survey

10.6.4 Implementation of a diver survey would allow the targeted collection of key data to further inform the archaeological character and potential of the Site.

10.6.5 Investigation of the two geophysical anomalies would likely be able to ascertain if these are of anthropomorphic origin and if of archaeological interest. If proven to be geological, modern or otherwise of no archaeological interest, any associated AEZ may be reviewed, through agreement with the Archaeological Curator(s). Similarly, diver survey of the seabed at the location of the target array may be able to confirm if any remains are present here.

10.6.6 Should areas of significant scour depth be identified, divers may be deployed with hand-operated boring equipment, allowing sample cores of the sub-seabed to be assessed by a geoarchaeologist. Such assessment would allow any deposits relating to Layer B to be identified.

10.6.7 Any further work would be agreed with the Archaeological Curator(s) and be preceded by an agreed Written Scheme of Investigation, providing sufficient detail for undertaking the works. The results of any works may require further investigation, assessment and/or alternative works, to be discussed and agreed between relevant parties at an appropriate stage.

11.0 Conclusion

11.0.1 This assessment has considered the known and potential marine archaeological remains within an area proposed for the construction of a seaweed farm in Port Quin Bay, Cornwall. The assessment has considered submerged prehistory, maritime and aviation remains and HSC. The assessment is primarily based on desk-based sources, though a review of pre-existing Admiralty bathymetric data was also undertaken.

11.0.2 In the absence of site-specific geotechnical data, the potential for submerged prehistoric remains is provisional at this stage. The assessment identified a potential for prehistoric and palaeoenvironmental remains to be present, particularly if contiguous Layer B deposits are identified. The presence of such deposits is uncertain and, although these are likely to have experienced impacts from hydrodynamic processes, survival may occur if encountered in conjunction with palaeolandscape features such as palaeochannels. At the time of writing, the presence or absence of such features is uncertain, and the identified broad potential would need to be assessed alongside future site-specific geotechnical data to determine. Archaeological and palaeoenvironmental remains are likely to have no greater than moderate significance.

11.0.3 The assessment identified two geophysical anomalies within the Site, potentially representing wreck remains of uncertain date, and a high potential for other wreck remains, most likely dating to the modern period. A very low potential has been identified for maritime remains of all other periods and for aviation remains. Remains of a 20th century bombing/gunnery target may be present on the seabed, along with a potentially high quantity of UXO.

11.0.1 Proposals comprise the construction of a seaweed farm, involving the installation of 576 no. anchor points (each comprising 5 no. reef cubes) and the potential to impact upon seabed and sub-surface remains. The foundation design and removal of the area from potentially destructive bottom trawling, will ensure that impacts to potential submerged prehistoric landscapes and unidentified archaeological remains will be minimised, in line with the South West Marine Plan, however.

11.0.2 As an additional mechanism for allowing mitigation, it is proposed that a PAD be put in place and training provided to site staff, with a particular emphasis on the identification of palaeolandscape remains. Should any such remains be identified, mechanisms will be put in place allowing for either protection, research or further investigation of these remains (e.g. using AUVs, ROVs or divers). The full details of these mechanisms will be included within a WSI for the development, to be produced in line with relevant guidance.

12.0 Appendix I: Historic Seascape Character

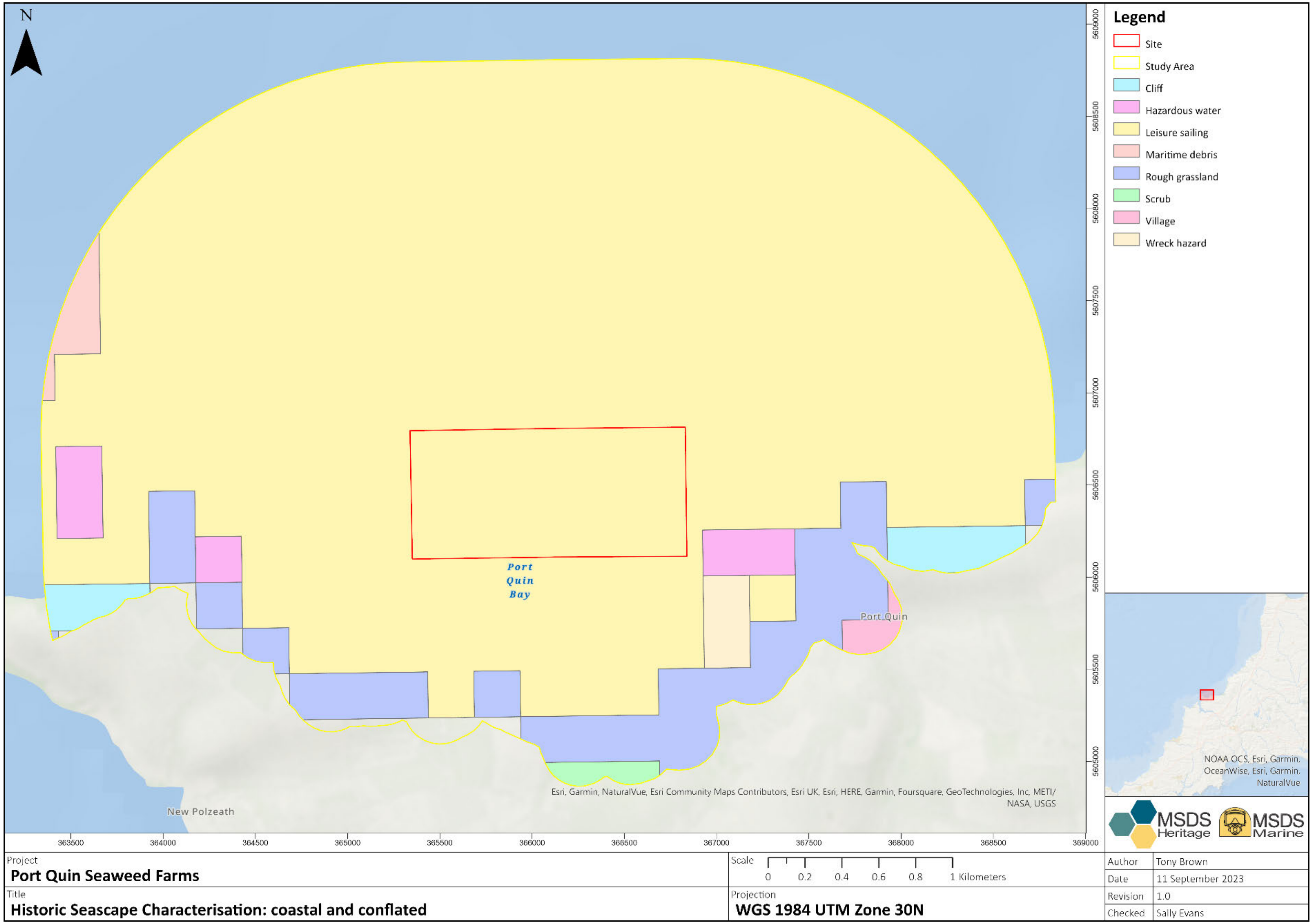

Figure 12 Historic Seascape Character: coastal and conflated.

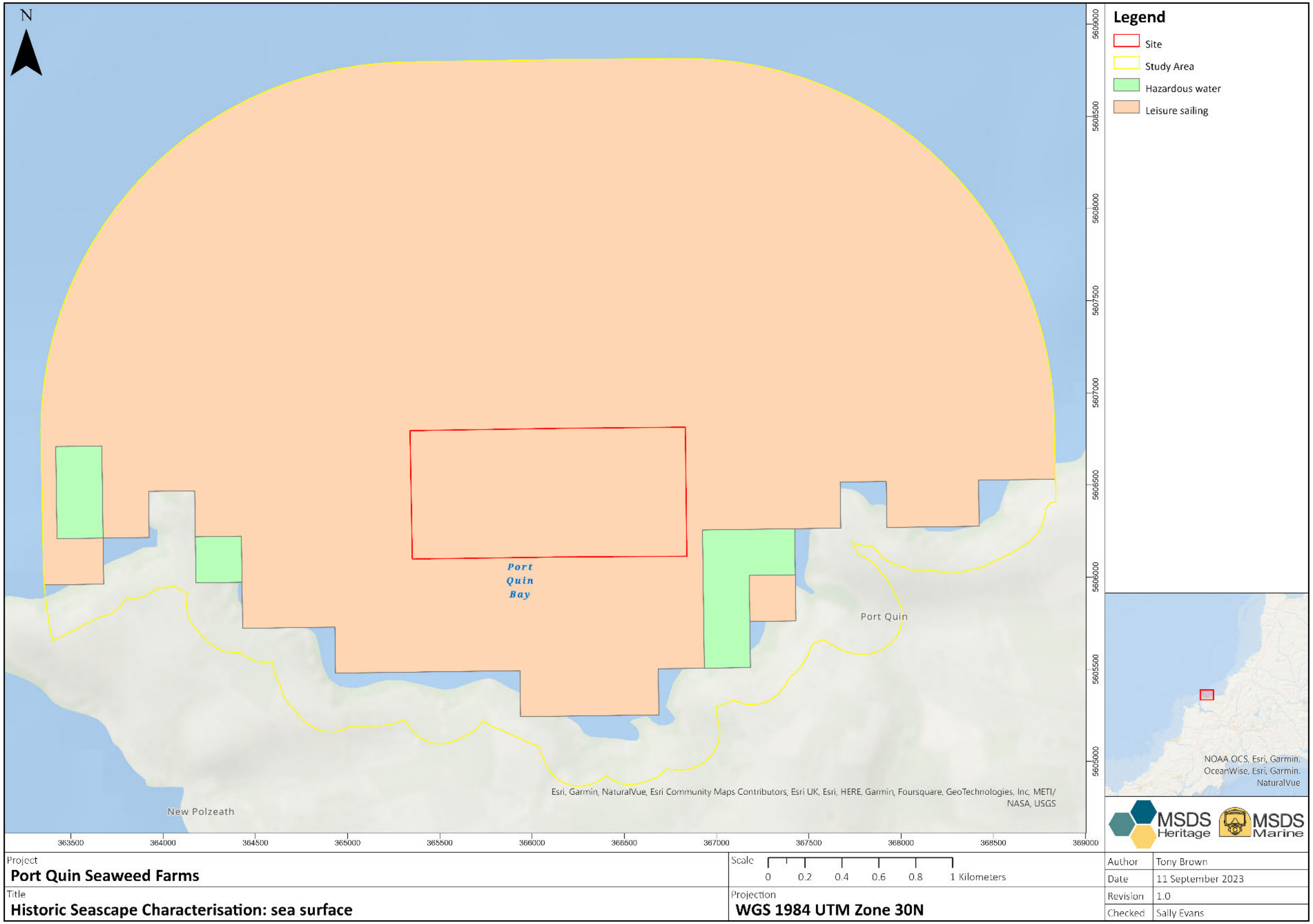

Figure 13 Historic Seascape Character: sea surface.

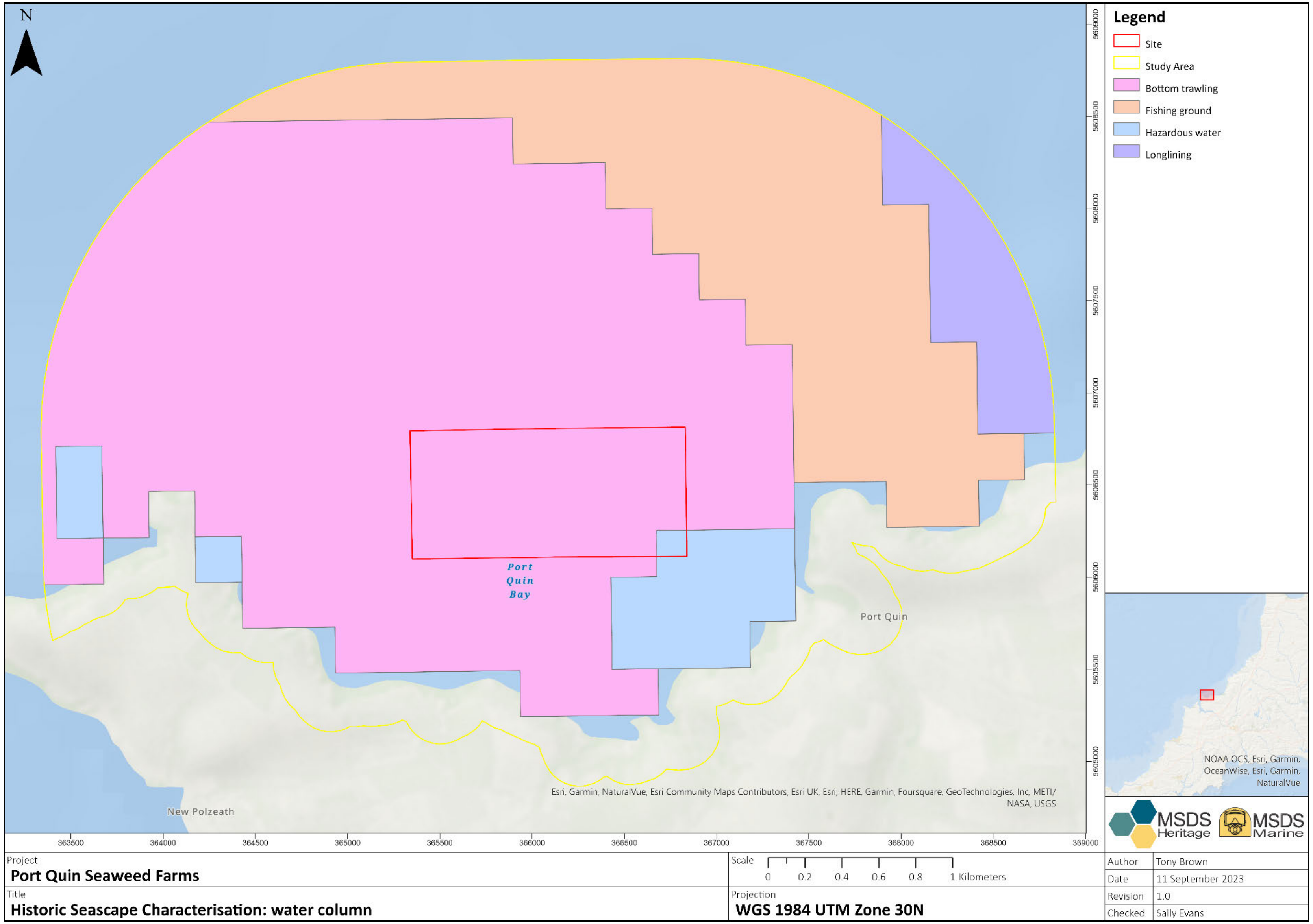

Figure 14 Historic Seascape Character: water column.

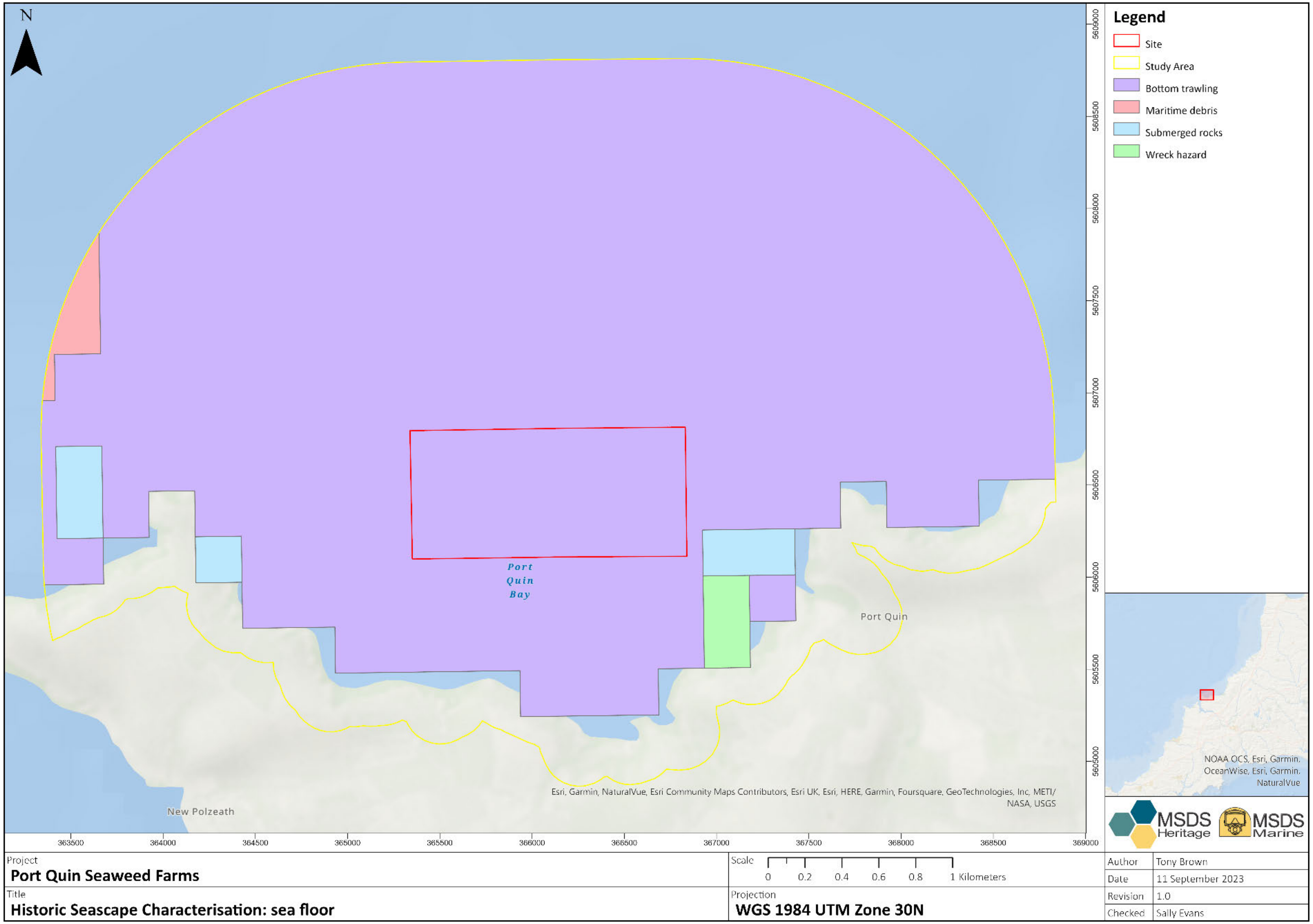

Figure 15 Historic Seascape Character: sea floor.

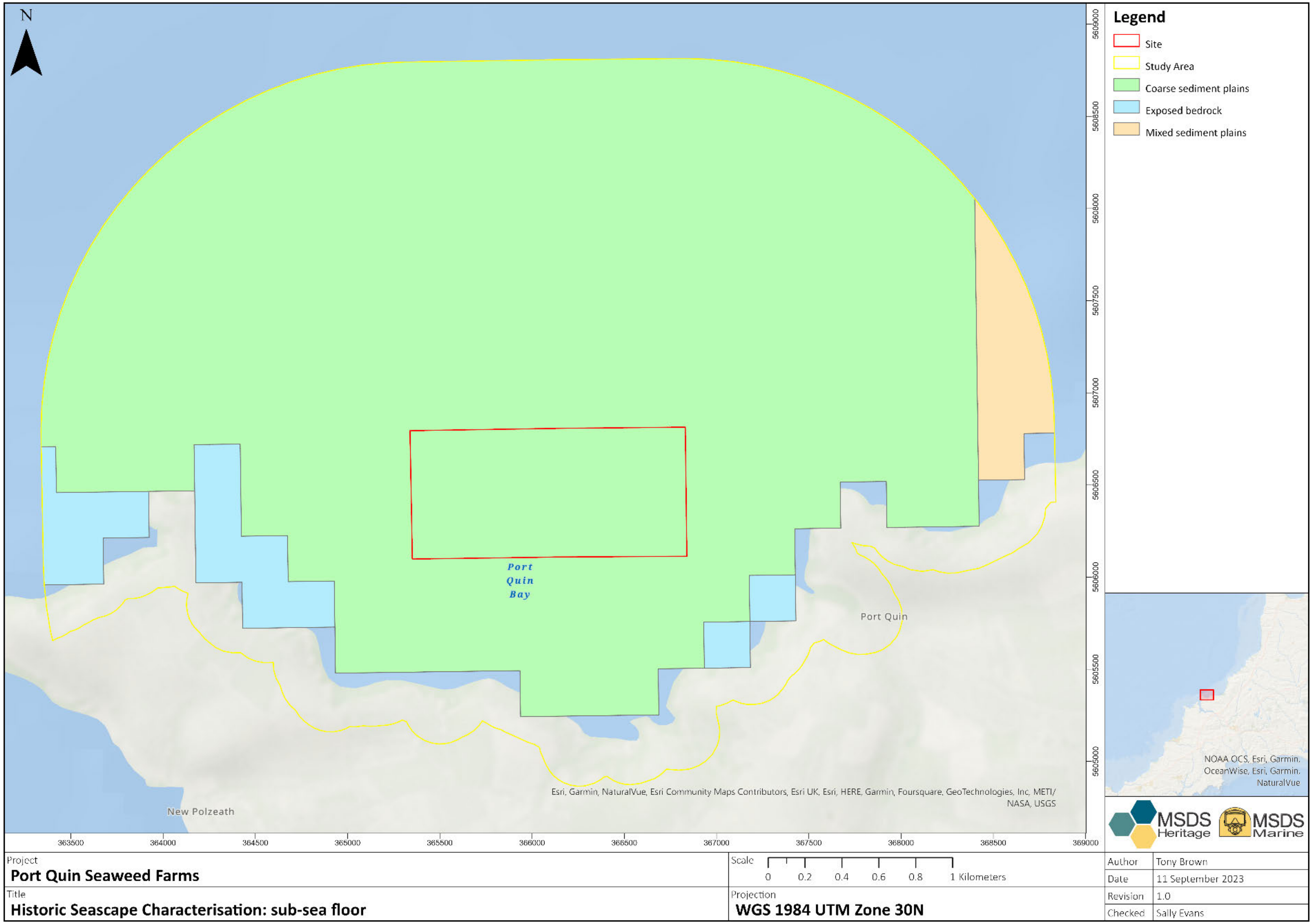

Figure 16 Historic Seascape Character: sub-sea floor.

13.0 Appendix II: Gazetteer

MSDS ID	Description	Period	Vessel Type	Eastings	Northings	HE ID	HER/PAS ID	UKHO ID	Position taken from	Site/Study Area
Wrecks and geophysical anomalies				**WGS84**						
W_001	Possible wreck: foul ground with firm acoustic contact from scour hole. 3.2 (L) x 2.2 (W) x 1.38 m (H). Located in 2011 at 5.52m (general water depth: 6.2m. Scour 0.7m deep at contact.	Unknown	Unknown	367074.7	5605942.2	-	-	78683	UKHO	Study Area
W_002	Wreck: British steam ship SPHENE (probably). Upright, centred collapsed, bows WNW. Built 1920, foundered after striking The Moules in 1946 whilst carrying coal from Barry to London. First identified in 1985. Sonar: 61 (L) x 14.9 (W) x 5 m (H). C. 50 m in length, at depths of 24 to 29 m.	20th Century	Steam ship (carrier)	366528.1	5607333.8	1527827	-	17907	UKHO	Study Area
W_003	Wreck: after part of the Greek carrier SKOPELOS SKY. Single item, possibly engine. Engine failed whilst transporting lubricating oil from Garston to Algiers, later running aground and breaking into pieces. Cargo washed ashore. Sonar: 8.8 (L) x 8.8 (W) x 3.7 m (height). First detected in 1979, last in 2011.	20th Century	Carrier	367230.4	5605938.3	1519039	-	17737	UKHO	Study Area
W_004	Geophysical anomaly: detected on Admiralty SBES data. Possible wreck and debris. 28 (L) x 10.4 m (W).	Unknown	Unknown	366404	560227.7	-	-	-	Admiralty bathymetry	Site
W_005	Geophysical anomaly: detected on Admiralty SBES data. Possible wreck or debris. 16 (L) x <9.5 m (W).	Unknown	Unknown	366551.4	5606364.2	-	-	-	Admiralty bathymetry	Site
Terrestrial and Intertidal Remains				**OSGB36**						
TI_001	Small piece of flint debitage, probable Mesolithic/Neolithic date.	Mesolithic/ Neolithic	-	193480	80940	-	1084766	-	HER	Study Area
TI_002	Bronze Age barrow at Scarnor Point: oval-shaped cropmark of ring ditch.	Bronze Age	-	198060	81130	-	MCO2552	-	HER	Study Area
	Bronze Age round barrow at Scarnor Point: 21 m diameter, 2 m high.	Bronze Age	-	198056	81108	-	MCO3446	-	HER	Study Area
	Probable Bronze Age bowl barrow at Scarnor Point: 12 m diameter, 1.6 m high. HE & HER entries likely for same site ≤5 m separation.	Bronze Age	-	198007	81099	431044	MCO3445	-	HER	Study Area
TI_003	Possible Bronze Age barrow at Downhedge Cove: visible on aerial photographs.	Bronze Age	-	194569	80039	-	MCO2554	-	HER	Study Area
	Possible Bronze Age barrow at Pentire Glaze: visible on aerial photographs as a low mound.	Bronze Age	-	194520	80000	-	MCO2553	-	HER	Study Area
TI_004	Possible Bronze Age barrow at The Rumps: visible on aerial photographs as a low earth and stone mound.	Bronze Age	-	193390	80819	-	MCO3550	-	HER	Study Area
TI_005	Possible Bronze Age barrow at The Rumps: visible on aerial photographs taken in 2006.	Bronze Age	-	193326	81110	-	MCO52798	-	HER	Study Area
TI_006	Early medieval findspot at The Rumps: rim and handle fragment of an amphora.	Early medieval	-	193400	81080	-	MCO1309	-	HER	Study Area

MSDS ID	Description	Period	Vessel Type	Eastings	Northings	HE ID	HER/PAS ID	UKHO ID	Position taken from	Site/Study Area
	Iron Age building platform at The Rumps: alleged building platform excavated on the eastern flank of western Rump.	Iron Age	-	193400	81080	-	MCO26580	-	HER	Study Area
	Iron Age building platform at The Rumps: alleged hut platform on the eastern flank of the western Rump.	Iron Age	-	193400	81080	-	MCO26582	-	HER	Study Area
	Iron Age building platform at The Rumps: possible hut platform with grass markings situated on the southern side of the eastern Rump.	Iron Age	-	193400	81080	-	MCO26583	-	HER	Study Area
	Iron Age findspot at The Rumps: bone objects.	Iron Age	-	193400	81080	-	MCO1307	-	HER	Study Area
	Iron Age findspot at The Rumps: fired clay finds.	Iron Age	-	193400	81080	-	MCO1308	-	HER	Study Area
	Iron Age findspot at The Rumps: single, blue, glass bead.	Iron Age	-	193400	81080	-	MCO1306	-	HER	Study Area
	Iron Age findspot at The Rumps: metal objects.	Iron Age	-	193400	81080	-	MCO1304	-	HER	Study Area
	Iron Age findspot at The Rumps: shell and grain finds.	Iron Age	-	193400	81080	-	MCO26584	-	HER	Study Area
	Iron Age findspot at The Rumps: stone objects.	Iron Age	-	193400	81080	-	MCO1303	-	HER	Study Area
	Iron Age findspot at The Rumps: wood finds.	Iron Age	-	193400	81080	-	MCO1305	-	HER	Study Area
	Iron Age hut circle at The Rumps: large circular structure with postholes cut into underlying slate.	Iron Age	-	193400	81080	-	MCO20167	-	HER	Study Area
	Iron Age hut circle at The Rumps: parts of two huts excavated between middle and innermost ramparts.	Iron Age	-	193400	81080	-	MCO20166	-	HER	Study Area
	Iron Age hut circle at The Rumps: west of inner entrance.	Iron Age	-	193400	81080	-	MCO20165	-	HER	Study Area
	Iron Age occupation site at The Rumps: possible hut platform on the eastern flank of the western Rump.	Iron Age	-	193400	81080	-	MCO26581	-	HER	Study Area
	Iron Age or Romano-British findspot at The Rumps: pottery sherds.	Iron Age	-	193400	81080	-	MCO1302	-	HER	Study Area
	Prehistoric findspot at The Rumps: flint core of uncertain date.	Prehistoric	-	193400	81080	-	MCO1301	-	HER	Study Area
	The Rumps: Scheduled Monument of Late Iron Age multivallate promontory fort. Outermost rampart undated. Excavations show occupation between 2nd century BC and mid 1st century AD. HER location given, as more central to site than HE.	Iron Age	-	193400	81080	1004625	MCO6575-7	-	HER	Study Area
TI_007	Two mounds, either remains of barrows or natural features.	Prehistoric	-	193000	80000	431056	-	-	HE	Study Area
TI_008	Mound, possibly a barrow or quarry spoil. Same location as HER entry for Lundy Hole quarry (MCO26571).	Unknown	-	195639	79820	430768	?MCO26571	-	HE	Study Area
TI_009	Pentire: possible ploughed down barrow or mine/quarry spoil.	Unknown	-	193433	80771	-	MCO65420	-	HER	Study Area
TI_010	Carnweather possible ploughed down barrow or mine/quarry spoil.	Unknown	-	195049	80050	-	MCO65421	-	HER	Study Area
TI_011	The Long Cross: site of early medieval Ogham-inscribed stone first shown on 1st edition OS. Since moved to junction of road from St Endellion to Port Quin.	Early medieval	-	196722	80590	-	MCO52965	-	HER	Study Area
TI_012	Medieval settlement of Port Quin, first recorded in 1201 as 'Porquin'.	Medieval	-	197108	80502	-	MCO16488	-	HER	Study Area

MSDS ID	Description	Period	Vessel Type	Eastings	Northings	HE ID	HER/PAS ID	UKHO ID	Position taken from	Site/Study Area
	Port Quin: (possibly) 18th century wall to beach.	18th Century	-	197114	80536	1320628	MCO57121	-	HER	Study Area
	Port Quin: (probable) mid-19th century fish cellars. Now store with holiday accommodation above.	19th Century	-	197132	80531	-	MCO57122	-	HER	Study Area
	Port Quin: 18th century slate retaining wall on south and east side of beach.	18th Century	-	197103	80506	1332583	MCO57115	-	HER	Study Area
	Port Quin: 18th century stone rubble slip.	18th Century	-	197122	80510	1332583	MCO57114	-	HER	Study Area
	Lacombe Cottage, Port Quin: late 18th century house.	18th Century	-	197140	80538	1220126	MCO57117	-	HER	Study Area
	Port Quin: late 18th century NW wall to fish cellars.	18th Century	-	197138	80500	1124699	MCO57113	-	HER	Study Area
	Varley Cottage, Port Quin: pair of (probably) late 18th century cottages merged into one.	18th Century	-	197313	80522	1220133	MCO57112	-	HER	Study Area
	Guys Cottage & Quin Cottage, Port Quin: pair of 19th century cottages merged into one.	19th Century	-	197146	80526	1129880	MCO57116	-	HER	Study Area
	Quay Cottage, Port Quin: pair of 19th century cottages merged into one.	19th Century	-	197111	80554	1220116	MCO57120	-	HER	Study Area
	Port Quin: possible post-medieval boatsheds or fish cellars now used as garages.	Post-medieval	-	197130	80523	1220119	MCO57118	-	HER	Study Area
	Port Quin: post-medieval corn mill recorded on 1840 tithe map.	19th Century	-	197249	80491	-	MCO29341	-	HER	Study Area
	Port Quin: post-medieval sand pit.	19th Century	-	197129	80480	-	MCO29340	-	HER	Study Area
	Port Quin: stone rubble wall adjoining 19th century fish cellars.	19th Century	-	197120	80542	1129879	MCO57123	-	HER	Study Area
	Port Quin: walls adjoining boatsheds or fish cellars, 3 m to SW of Carolina Cellars.	Post-medieval	-	197130	80525	-	MCO57119	-	HER	Study Area
	Post-medieval fish cellars at Port Quin. Uncertain survival.	Post-medieval	-	197144	80480	-	MCO18615	-	HER	Study Area
TI_013	Medieval settlement of Doyden, first recorded in 1316 as 'Doden'.	Medieval	-	196842	80447	-	MCO14304	-	HER	Study Area
TI_014	English silver groat of 1351-2, Edward III, minted in London. Found through metal detecting.	Medieval	-	196800	80600	-	74436	-	HER	Study Area
	Pewter spoon, 17th century, with fossilized marine organisms and corrosion on surface, found near harbour mouth through metal detecting, probably from a wreck.	17th Century	-	196800	80600	-	81704	-	HER	Study Area
TI_015	Pentire: post-medieval mine first named in 1580, producing lead and silver in 1850.	16th Century	-	194099	80000	-	MCO12403	-	HER	Study Area
TI_016	Gilsons Cove: post-medieval mine.	19th Century	-	196647	80339	-	MCO12105	-	HER	Study Area
TI_017	Carnweather Point: post-medieval quarry pit.	Post-medieval	-	195155	80054	-	MCO65417	-	HER	Study Area

MSDS ID	Description	Period	Vessel Type	Eastings	Northings	HE ID	HER/PAS ID	UKHO ID	Position taken from	Site/Study Area
TI_017	Port Quin: post-medieval quarry pit.	Post-medieval	-	196922	80734	-	MCO65406	-	HER	Study Area
TI_018	Port Quin: post-medieval quarry.	Post-medieval	-	196954	80804	-	MCO65407	-	HER	Study Area
TI_019	Reedy Cliff: post-medieval quarry.	Post-medieval	-	197703	80795	-	MCO65405	-	HER	Study Area
TI_020	Lundy Hole: post-medieval quarry pit.	Post-medieval	-	195850	79792	-	MCO65416	-	HER	Study Area
TI_021	Port Quin: post-medieval quarry pit.	Post-medieval	-	197241	80552	-	MCO65408	-	HER	Study Area
TI_022	Markhams Quay: possible quarry site.	Unknown	-	195458	79901	-	MCO65422	-	HER	Study Area
TI_023	Lundy Hole: post-medieval quarry pit.	Post-medieval	-	195639	79820	?430768	MCO26571	-	HER	Study Area
TI_024	Downhedge Cove: post-medieval quarry on coastal rough ground.	Post-medieval	-	194650	80059	-	MCO29334	-	HER	Study Area
TI_025	Port Quin: post-medieval quay.	Post-medieval	-	197039	80639	-	MCO4888	-	HER	Study Area
TI_026	Markhams Quay: landing site, implied by place names.	Unknown	-	195574	79849	-	MCO65415	-	HER	Study Area
TI_027	Doyden Castle: post-medieval, castellated folly. Previous interpreted as an Iron Age cliff castle. HER location more accurate than HE.	19th Century	-	196718	80564	431041	MCO26579	-	HER	Study Area
TI_028	Port Quin: post-medieval building platform of unknown function adjacent to inscribed stone (possibly Victorian graffiti).	Post-medieval	-	197485	80925	-	MCO56782	-	HER	Study Area
TI_029	Possible medieval field boundary on Reedy Cliff. Slightly curving linear bank/break in slope cut by a known post-medieval boundary.	Medieval	-	198039	81198	-	MCO65114	-	HER	Study Area
TI_030	Possible post-medieval field boundary at Pentire. A 260 m long WNW-ESE aligned linear bank/shallow break in slope.	Post-medieval	-	192836	80429	-	MCO65117	-	HER	Study Area
TI_031	Post-medieval field boundary at Markhams Quay. Footpath branching off from main clifftop path to shore.	Post-medieval	-	195702	79817	-	MCO65278	-	HER	Study Area
TI_032	Port Quin Bay: six 20th Century anchored bombing or gunnery targets.	20th Century	-	195579	81488	-	MCO46155	-	HER	Site
TI_033	Carnweather Point: bombing range target indicator.	20th Century	-	195020	80020	-	MCO29901	-	HER	Study Area
TI_034	Trevan Point: site of WWII bombing range target indicator.	20th Century	-	196220	80030	-	MCO29898	-	HER	Study Area
TI_035	Treberick: WWII bombing range observation posts. Possibly same as nearby HE record 1411316.	20th Century	-	194488	80101	-	MCO42714	-	HER	Study Area
TI_036	Royal Observer Corps monitoring post, built August 1960. Possibly same site as nearby HER record MCO42714.	20th Century	-			1411316		-	HE	Study Area
TI_037	WWII bombing observation post on Kellan Head. Since destroyed.	20th Century	-	197000	81119	1416011	MCO43364	-	HER	Study Area

MSDS ID	Description	Period	Vessel Type	Eastings	Northings	HE ID	HER/PAS ID	UKHO ID	Position taken from	Site/Study Area
Documented losses										
DL_001	Thornton: English East Indiaman, stranded at Port Quin and subsequently wrecked on 10 or 11 February 1700, whilst homeward bound from Madras to London, carrying spices and 'redwood' or dyewood. Loss of 'most' of 100-strong crew. Wooden sailing vessel of 34 guns constructed in London in 1696.	18th Century	East Indiaman	195120	80950	904949	-	-	HE	Site
	Atlas: English, wooden, rigged cargo vessel, driven ashore above entrance to Port Quin harbour and broken up on 10 September 1829, carrying coal from Newport to Fowey. No loss of life.	19th Century	Cargo	195118	80948	905297	-	-	HE	Site
	Elodie: Austro-Hungarian, wooden, rigged barque, stranded at Tresarrick Cliffs carrying coal from Cardiff to Barcelona and abandoned whilst sinking c. 6 miles NE of Trevose Head on 22 March 1876. Vessel drifted ashore near Port Quin at the foot of the Tresarrick Cliffs, subsequently breaking up with loss of all cargo. No loss of life.	19th Century	Barque	195120	80950	905831	-	-	HE	Site
	Athanassia Vaglianos: Greek, wooden, rigged, barque, sprung a leak off the Isles of Scilly carrying coal from Swansea to Agrigento and run ashore 2 miles east of Port Isaac on 15 May 1884. No loss of life and wreck sold at public auction.	19th Century	Barque	195120	80950	1100763	-	-	HE	Site
	Elizabeth: English, wooden, rigged, cargo schooner (alternatively recorded as a ketch), foundered whilst carrying coal from Newport to Padstow on 19 December 1890. Loss of all 3 crew.	19th Century	Schooner	195120	80950	906080	-	-	HE	Site
	Bat: wooden, rigged, fishing lugger, stranded on 12 November 1907 and lost with all hands (crew of 3).	20th Century	Lugger	195120	80950	906222	-	-	HE	Site
	Madeleine: French, wooden, rigged, schooner wrecked in Port Quin Bay on 12 January 1911, carrying pit wood from Brest to Newport. No loss of life and vessel broke up after salvage of cargo.	20th Century	Schooner	195120	80950	906246	-	-	HE	Site
	Reine D Arvor: wooden, rigged, French schooner, stranded and abandoned on 27 January 1919 c. 15 miles NW of Trevose Head. Subsequently wrecked under the cliffs.	20th Century	Schooner	195120	80950	907680	-	-	HE	Site
	Navator: screw driven ketch wrecked on shore rocks on 26 July 1920, carrying coal from Port Talbot to Hayle. No loss of crew.	20th Century	Ketch	195120	80950	907693	-	-	HE	Site
	A L B: English, wooden, screw driven, auxiliary oil engine, fishing vessel stranded and wrecked carrying ballast from Port Isaac on 12 January 1933.	20th Century	Fishing	195120	80950	907738	-	-	HE	Site
DL_002	Our Girlie: English, screw driven, oil engine fishing vessel wrecked in a gale near Port Quin on 27 November 1928. No loss of life.	20th Century	Fishing	196870	80550	907722	-	-	HE	Study Area
DL_003	De Jacob: Dutch galliot carrying wine and wool wrecked near Padstow on 12 December 1815, with loss of all hands (unknown number).	19th Century	Galliot	193850	81740	905182	-	-	HE	Study Area

MSDS ID	Description	Period	Vessel Type	Eastings	Northings	HE ID	HER/PAS ID	UKHO ID	Position taken from	Site/Study Area
DL_004	Wreck of unnamed, wooden, rigged cargo vessel carrying wine. Stranded at Pentire (possibly Pentire Point) on 4 October 1350. Exact location of loss and any loss of life unknown.	Medieval	Cargo	192270	80540	1620767	-	-	HE	Study Area
	Kael Coz: English, steel, screw driven, oil engine trawler, stranded on Rumps Point in dense fog out from Padstow on 10 July 1991. No loss of life.	20th Century	Trawler	192270	80540	1519327	-	-	HE	Study Area

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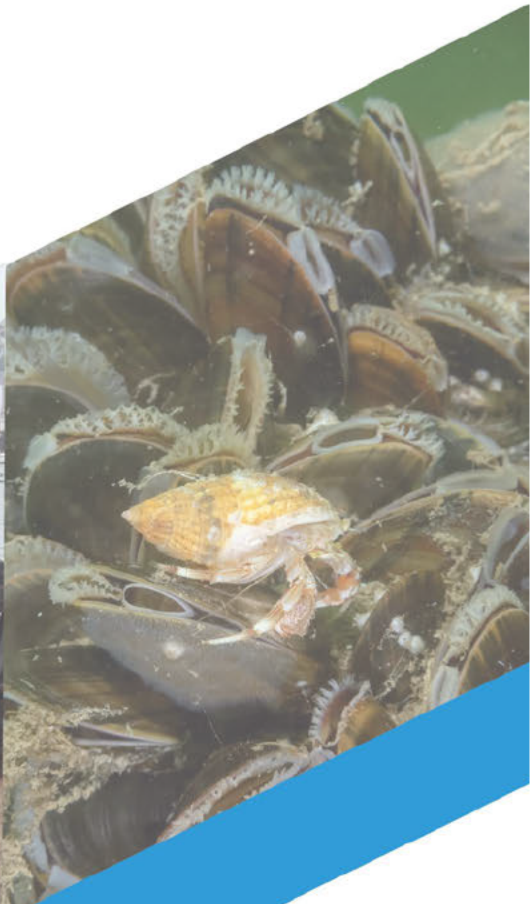

CAMEL FISH CRAB & LOBSTER

BIOME ALGAE

Port of Quin kelp farm

Mooring design

Report for Biome Algae

ARC document number: **P-0049-0110-RPT-0001-B**						
Revision	Date	Description	Originator	Checked	Approved	Client
A	28-May-24	Issued for client comment	JIG	MMK	HS	
B	30-May-24	Issued for use	JIG	MMK	HS	

Revision record sheet			
Revision	Reason for change	Page number(s)	Comment
B	Modifications to suit client comments	Throughout	Minor

[redacted]

[redacted]

EXECUTIVE SUMMARY

Biome Algae Ltd (Biome) and partner Camel Fish are applying for a Marine Management Organisation (MMO) and Crown Estate licence for a 100.8 hectare seaweed farm in Port Quin Bay, Cornwall. The farm is split into two sites East and West which are side-by-side separated by a 50 m gap. This is a confidential report for Biome and not for public use.

The seaweed farm will consist of 288-off (144 per site) x 160 m long-lines, orientated north-south and spaced 20 m apart. The long lines are arranged in columns of 4 making (288/4 =) 72 columns of long lines. The total physical farmed area (based on physical infrastructure alone) is 10.08 Ha (10%) total.

To achieve absolute stability of the farm in 50 yr storm conditions, combined with minimum water depths and in accordance with DNV-OS-E301: Position Moorings, the minimum required submerged weight at each mooring point (on seabed, 2 per long line) is [redacted]. This is conservatively based on a worst-case taut riser line configuration and unfavourable metocean directionality. Note that the taut lines make for the worst-case loading scenario due to their inability to dampen out some of the dynamic behaviour under hydrodynamic loading.

Two solutions have been considered to provide the required [redacted] submerged weight:

1. Screw anchors
2. reef cube® gravity-based anchors

Screw anchors have been discounted on the basis of the following three points:

- caution was expressed by two screw anchor suppliers with regards to the feasibility of their screw anchors in sandy Gravel (sG) seabeds.
- evidence from the wave hub site demonstrates that there are significant areas of low lying bedrock in these sG classified seabeds. These would cause anchor refusal.
- Subsurface survey would be required to provide confidence in the performance of screw anchors and for micro-siting the installation location.

Gravity based anchors are feasible and avoid the issues associated with the above. The required [redacted] tonnef equates to [redacted] off RC2000 reef cubes® at each mooring point regardless of the seabed type. The seabed footprint for a typical [redacted]-off RC2000 anchor is approx. 20 m^2 which is less than 0.005% of the site.

For the entire site of 288 long lines there needs to be 576-off anchor points (one at each end of each long line). With a requirement of [redacted]-cubes per anchor point this equates to a total of [redacted]-

off RC2000 cubes. The total maximum surface area footprint of the anchors equates to [redacted] x 20m^2 = [redacted] m^2 (1.14% of the site footprint).

Recommendations have been included for the next phase of engineering in Section 6.2.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background

Biome Algae Ltd (Biome) and partner Camel Fish are applying for a Marine Management Organisation (MMO) and Crown Estate licence for a 100.8 hectare seaweed farm in Port Quin Bay, Cornwall (Figure 1). The farm is split into two sites East and West which are side-by-side separated by a 50 m gap.

The seaweed farm will consist of 288-off (144 per site) x 160 m long-lines, orientated north-south and spaced 20 m apart. The long lines are arranged in columns of 4 making (288/4 =) 72 columns of long lines. The total physical farmed area (based on physical infrastructure alone) is 10.08 Ha (10%) total.

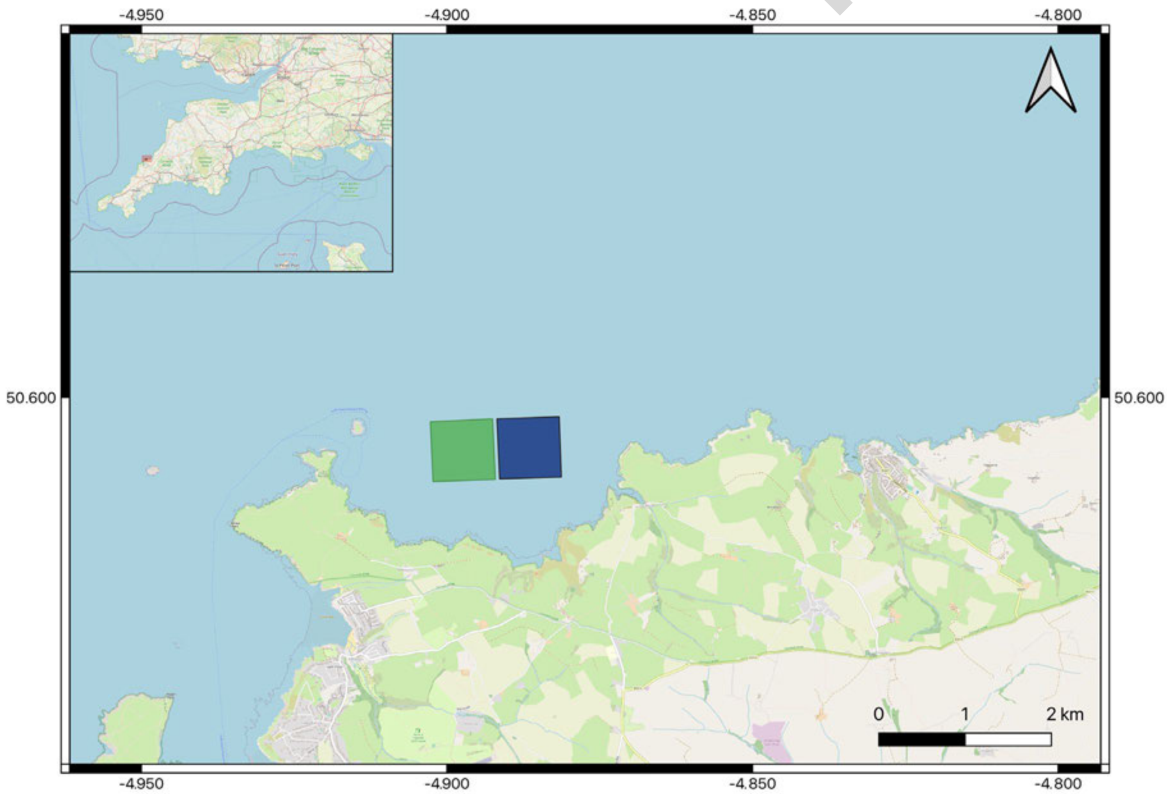

Figure 1 Proposed seaweed farm location, Port Quin Bay

ARC Marine Ltd (ARC) is supporting Biome in the mooring design of their seaweed units and is potentially supplying Biome with suitably sized [redacted] or marine armour units to act as the mooring anchors.

[redacted] are a low-carbon mooring clump weight that act as artificial reefs for marine life on the seabed.

1.2 Objective

Design a suitable mooring and anchor arrangement for a single seaweed cultivation long line configuration.

1.3 Purpose of this document

This document contains the results of the mooring analysis and the subsequent recommendations regarding a feasible and practicable mooring and anchor solution.

1.4 Seaweed terminology

The main terms relating to seaweed are as follows:

- Blade: Flattened part of a seaweed that resembles a leaf.
- Holdfast: Base of a seaweed that attaches it to its anchor point; this resembles roots.
- Stipe: Stalk of a seaweed between holdfast and blade; this resembles a stem.
- Frond: Term used to refer to stipe and blade together.
- Float: Air-filled bladder to keep seaweed afloat, not present in all seaweeds.

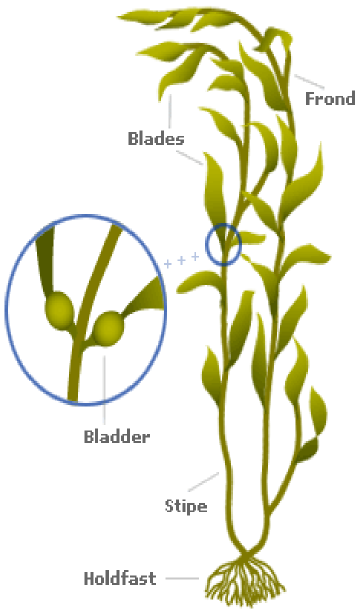

Figure 2 Seaweed terminology schematic

1.5 Abbreviations

Table 1 Abbreviations

Abbreviation	Definition
ARC	Accelerating reef creation
CHS	Circular hollow section
CPT	Cone penetration test
DNV	Det Norske Veritas
ED	European datum
GB	Great Britain
HAT	Highest astronomical tide
IMO	International Maritime Organization
ISO	International Standards Organisation
JONSWAP	Joint north sea wave observation project
LAT	Lowest astronomical tide
LID	Lynn and Inner Dowsing
MLWN	Mean low water neaps
MLWS	Mean low water springs
MHWN	Mean high water neaps
MHWS	Mean high water springs
MSL	Mean sea level
OCIMF	Oil Companies International Marine Forum
OWF	Offshore wind farm
QTF	Quadratic transfer function
RAO	Response amplitude operator
RP	Reference point (or recommended practice)
ULS	Ultimate limit state
UTM	Universal transverse mercator
WGS	World Geodetic System

2 CODES AND STANDARDS

2.1 Primary codes and standards

The mooring design has been conducted in accordance with the principles of

- **DNV-OS-E301** – Position mooring.

Under this standard the [redacted] mooring is considered a gravity-based anchoring system and therefore the relevant section of DNV-OS-E301 for gravity anchors will be applied. This code refers to DNV-OS-C101 for specific details regarding gravity base foundations.

Supporting standards and guidelines have been applied as follows:

- Recommended design practice for offshore and nea shore seaweed growing systems, Version 1.0 2023.
- DNV-RP-C205 – Environmental loads and conditions (for hydrodynamic coefficients and wave theory applicability)
- DNV-RP-C212 – Offshore soil mechanics and geotechnical engineering (for soil anchor interaction mechanics)
- ISO-19901-4 – Petroleum and natural gas industries – specific requirements for offshore structures – Part 4: Geotechnical and foundation design considerations (for determining the resistance hold capacity of a shallow foundation/sled type anchor)
- ISO-19901-7 – Petroleum and natural gas industries – specific requirements for offshore structures – Part 7: Stationkeeping (for supporting guidance around fluke/drag embedment anchors)

3 BASIS OF DESIGN

3.1 Design life

The expected design life for the seaweed farm is 50 years. The design life of the mooring units is determined by the rate of corrosion degradation in the mooring attachment points which in turn is determined by the material selection, coating and cathodic protection offered to the attachment points. Typically a corrosion allowance is included in the thickness of the attachment points to cater for any loss of steel due to corrosion, in addition a wear allowance will be included. The exact design of the mooring attachment will need to be investigated further in detailed design to ensure that the 50 yr design life can be achieved.

3.2 Safety factors

3.2.1 Consequence class

The consequence class for the seaweed mooring is Class 1 based on meeting the following definition from DNV-OS-E301:

"Class 1 where mooring system failure is unlikely to lead to unacceptable consequences such as loss of life, collision with an adjacent platform, uncontrolled outflow of oil or gas, capsize or sinking."

Class 2 is where mooring system failure may well lead to unacceptable consequences of these types.

3.2.2 Partial safety factors on the design tension

Based on Class 1 for permanent units and application of a time domain analysis (DNV-OS-E301 Table 1) the following partial safety factors are applied in the anchor ULS design:

$\gamma_{pret} = 1.20$

$\gamma_{env} = 1.45$

Where the characteristic strength, S_c of the component (mooring line, anchor, shackles) must be such that:

$$S_c - T_{pret}\gamma_{pret} - T_{env}\gamma_{env} > 0$$

Where T_{pret} and T_{env} are the pretension and environmental load driven tensions respectively. For the seaweed farm, T_{pret} is effectively zero given the water depth.

Note that the recently released Recommended design practice for offshore and nearshore seaweed growing systems, Version 1.0 2023 has moderated the recommended design factors as follows for a dynamic analysis:

$\boldsymbol{\gamma_{pret} = 1.0}$

$\boldsymbol{\gamma_{env} = 1.3}$

These factors have been applied in this report.

3.3 Seaweed parameters

Table 2 contains details of the seaweed loading parameters.

Table 2 Seaweed loading parameters

Parameter	Value	Units
Vertical growth rate	[redacted]	m per year
Seaweed linear density (vertical direction) in air	[redacted]	kg/m^2
Seaweed submerged weight	Neutral	kgf
Drag loading of seaweed [Note 1]	50	N/m

Notes

[1] Seaweed drag loading has been calibrated to 50 N/m of seed line for a 1 m/s current. This calibration reference is taken from the work performed by Endresen et al at Sintef on current induced drag forces on cultivated sugar kelp [1].

[2] Seaweed is modelled as an increase in drag coefficient on the seed lines which is calibrated to give a 50 N/m drag at 1 m/s current.

3.4 Location

Figure 3 contains the proposed trial site located approximately 1 km North of Lundy Hole and 0.5 km West of Kellan Head. Table 3 contains the location coordinates for the site corner marker points.

Table 3 Seaweed site location

Item	WGS84 / ETRS89 [Decimal degrees]		ED50 (Intl. 1924) UTM Zone 31N [m]	
	Latitude [°]	**Longitude [°]**	**Easting [m]**	**Northing [m]**
Farm North West corner	50.597784	-4.891862	-58108.028	5635098.242
Farm North East corner	50.59801	-4.881677	-57385.854	5635046.307
Farm South East corner	50.591715	-4.881306	-57434.379	5634344.832
Farm South West corner	50.591518	-4.891385	-58148.816	5634399.182

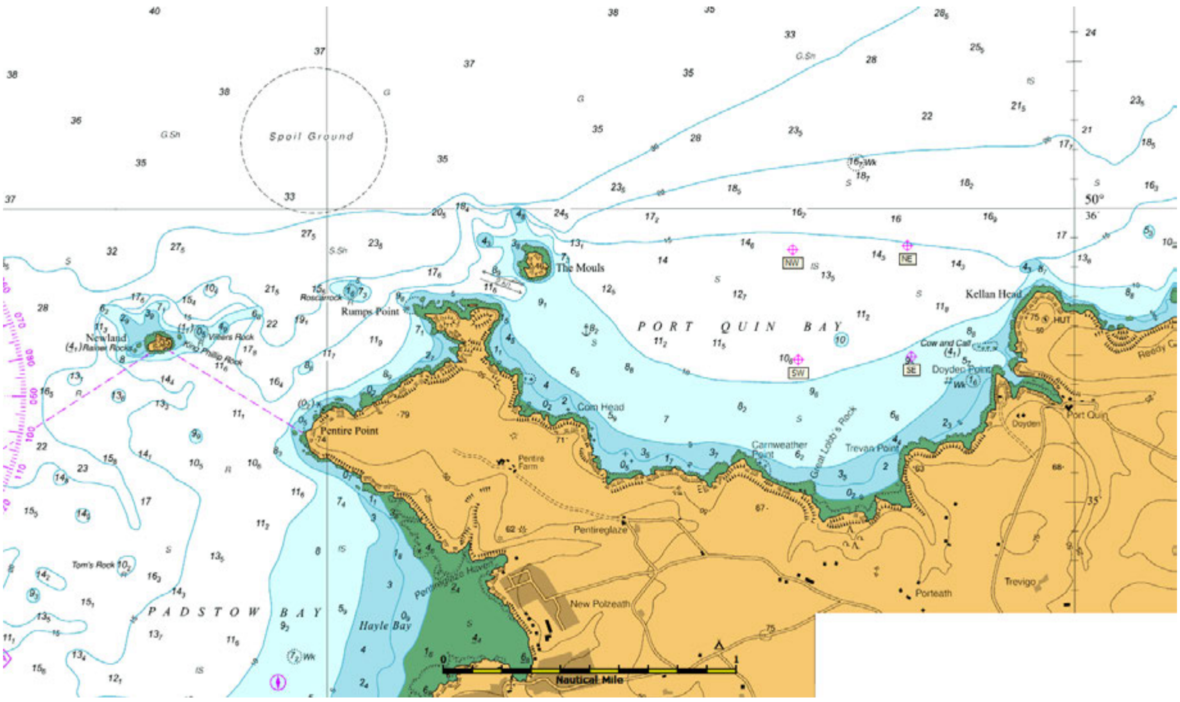

Figure 3 Admiralty/Marine chart showing proposed location of the seaweed farm

3.5 Basic seaweed rig configuration/specifications

Figure 4 contains an overview 3D view of the model in Orcaflex.

The farm consists of several independent long lines each 160 m in length. Each unit consists of [redacted] 160 m long [redacted] mm rope header lines (Item 1). Each header line is connected at equal spaces along its length to 8-off 300 litre mussel buoys (Item 2) via [redacted] mm drop lines (Item 3). The header lines are separated by links (Item 4) which keep the headers [redacted] m apart. The headers are kept on station by two [redacted] mm riser lines (Item 5) which are spliced to the ends of the header lines. The riser lines anchor the headers to the seabed via mooring anchors.

Seed lines (Item 6) are woven onto the header lines so that a [redacted] m catenary of [redacted] mm seedline hangs in the water column between the header lines. The seed lines contain [redacted] off [redacted] kg each clump weights (Item 7) spaced 1 m apart at the bottom of each seed line catenary. The seed line catenaries are spaced approx. 1 m apart along the length of the header lines.

All of the ropes will be made from [redacted] manufactured in accordance with EN ISO 1346:2004. The rope has a density of 910 kg/m³.

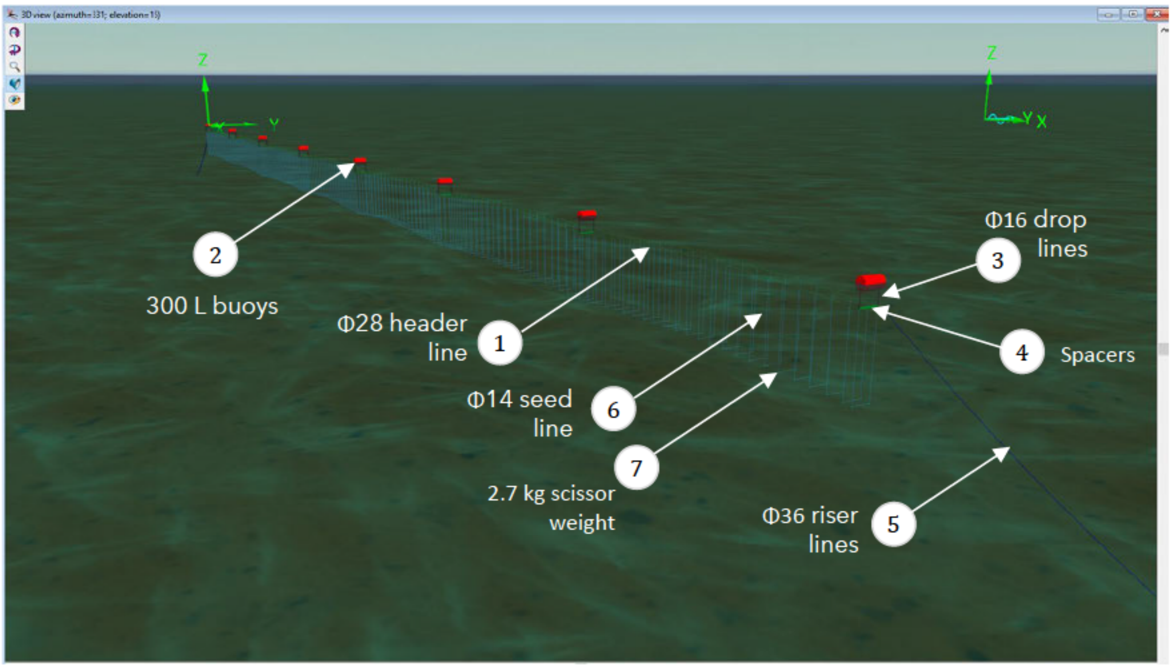

Figure 4 [redacted]

3.6 Load cases

Table 4 contains the matrix of cases applied in the mooring analysis.

DNV-OS-E301 stipulates that in Norwegian and UK sectors and some other extratropical locations, a combination employing both wind and waves with 100-year return periods together with current with a 10-year return period is usually acceptable.

DNV-OS-E301 also allows for the range of potentially critical cases to be covered based on a combination of reasoning, calculation and relevant experience.

For the mooring analysis herein, a combination of 50 year events with 10 year events as per Table 4 has been selected based on the following justifications:

- The consequence class is Class 1 as per DNV-OS-E301;
- The wave data applied is taken from a study which has calculated the extreme waves using models which tend to overestimate t e waves;
- The 50-yr wave significant wave height exceeds the theoretical breaking wave limit and therefore the limiting wave height has been applied. In reality, the waves will be less than this value due to the combined effects of shoaling, refraction and diffraction which aren't accounted for.
- Joint probability distributions of waves with current, waves with sea level and waves with wind often show that probability of joint occurrence of the extreme wave and the extreme current/sea level/wind are less than 0.1% based on industry experience;
- In most cases during a storm event the sea water level has a positive storm surge which increases the water depth;
- The tide will change during a 3-hr storm event.

Table 4 Load cases

Case Nos.	Wave return period [yrs]	Current return period [yrs]	Water level return period [yrs]	Wave directions [°N] [Note 1]	Current directions [°N]
1 – 8	50	10	1	0 - 315	[Note 2]
9 – 16	10	50	1	0 - 315	[Note 2]
17 – 24	50	10	1	0 - 315	[Note 3]
24 – 32	10	50	1	0 - 315	[Note 3]

Table 4 Load cases

Case Nos.	Wave return period [yrs]	Current return period [yrs]	Water level return period [yrs]	Wave directions [°N] [Note 1]	Current directions [°N]

Notes

[1] Wave directions broken down into cases at 45° apart (i.e. N, NE, E, SE, S, SW, W, NW) – North is taken as 0°

[2] Current direction co-linear with wave direction

[3] Current direction perpendicular (90°) to wave direction

3.7 Water depths

Figure 5 contains the bathymetry contour plot in the Port of Quin Bay and surroundings relative to MSL. An elevation profile running South to North shows that the water depth ranges from -10 to -15 m. The seabed slope is linear and the angle is approximately 0.37°. Over a 200 m length for a typical long line arrangement this equates to a 1.29 m seabed elevation change.

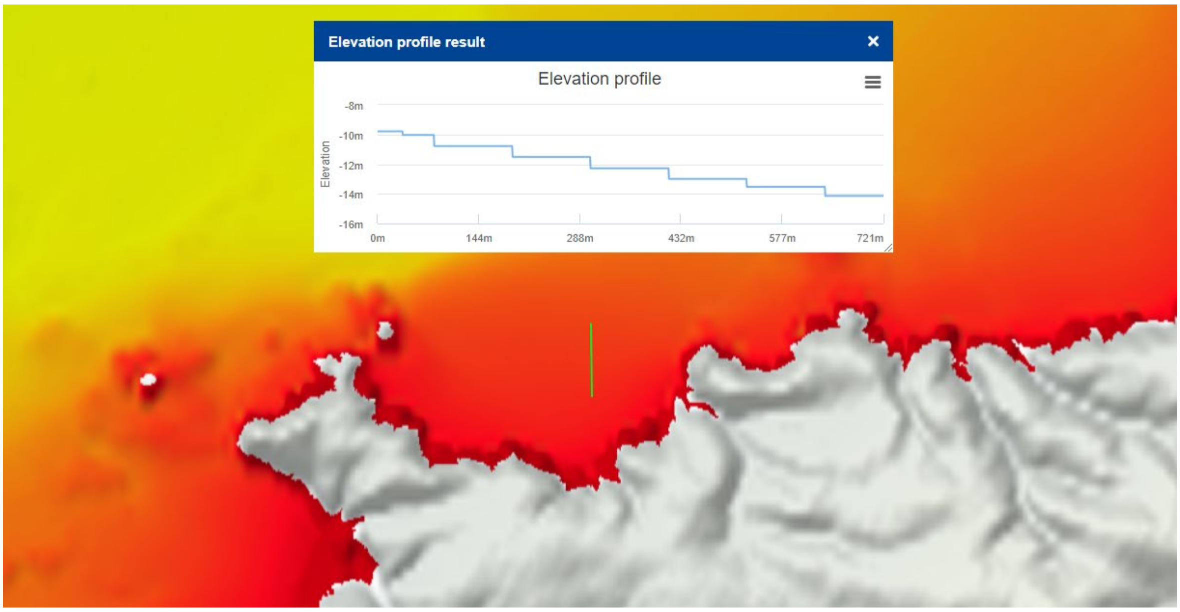

Figure 5 Bathymetry profile along South-North line across the proposed site [2]

3.8 Extreme water levels

Table 5 and Table 6 contain the extreme tidal and extreme storm surge water levels respectively. The negative storm surge levels are based on the data provided in Figure 6 taken from the DHI Metocean database [3].

Table 5 Tidal water levels [3]

Water level	Elevation relative to LAT [m]
HAT	+4.34
MHWS	+3.56
MHWN	+1.75
MSL	+0.00
MLWN	-1.70
MLWS	-3.43
LAT	-4.00

Table 6 Storm surge levels [3]

Return period [yrs]	-ve storm surge [m]
1	-0.15
5	-0.35
50	-0.65
100	-0.75

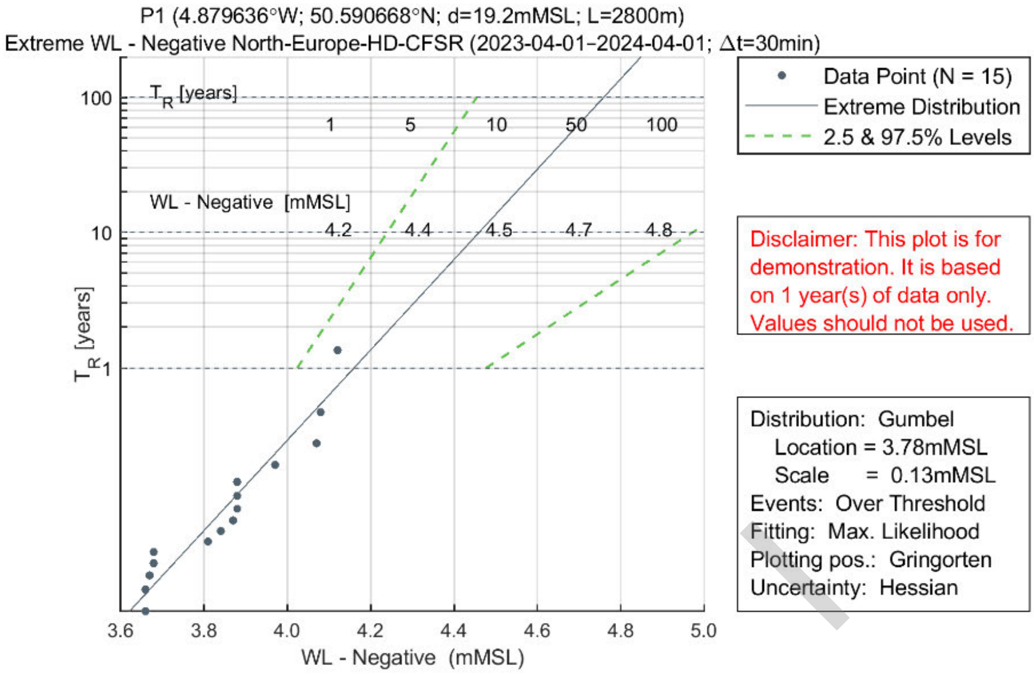

Figure 6 Negative storm surge levels against return period [3]

3.9 Winds

Direct wind loading has been discounted as negligible in this assessment relative to the loading due to the hydrodynamics.

3.10 Waves

Table 7 contains the omni-directional significant wave height and peak period by return period. The significant wave heights have been taken from the DHI metocean database [3] and the peak periods matched by calculating the peak periods against significant wave height from the data for the Celtic Sea [4].

Waves have been modelled using both irregular wave theory defined by a JONSWAP spectrum (gamma = 1.644 – see details below in Section 3.10.1) and regular wave theory defined by Dean Stream Order 9 theory (chosen based on DNV-RP-C205 Figure 3-4 with parameters H/gT^2 = 0.004 and d/gT^2 = 0.008 for 1 year wave)

Note that the water depth will limit the waves to the breaking wave limit which is a function of the water depth (approx. 0.75 * d depending on the wave theory applied). This limiting wave height will be applied in the assessment.

3.10.1 *JONSWAP peakedness parameter definition*

In accordance with DNV-OS-E301 the JONSWAP peakedness parameter can be defined by: $\gamma_p = e^{5.75-1.15\frac{T_p}{\sqrt{H_s}}}$ for $3.6 \leq \frac{T_p}{\sqrt{H_s}} < 5$

Applying the 50 yr omni-directional significant wave (H_s = 8.0 m, T_p = 12.92 s):

$$\frac{T_p}{\sqrt{H_s}} = 4.568$$

Therefore $\gamma_p = 1.644$

Table 7 Omni-directional significant wave heights and peak periods by return period [3]

Return period [yrs]	Significant wave height, Hs [m]	Peak wave period, Tp [s]
1	5.5	11.54
5	6.5	12.02
10	7.0	12.32
50	8.0	12.92
100	8.5	12.92

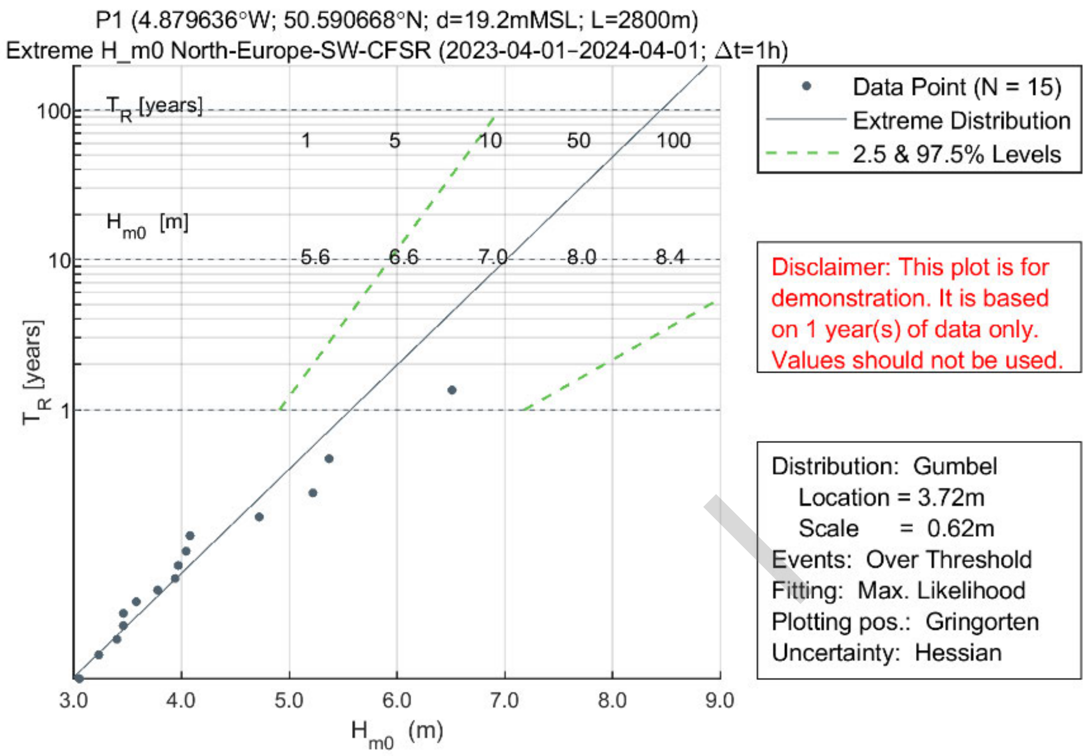

Figure 7 Significant wave height versus return period [3]

3.10.2 Wave directionality

Figure 8 contains the wave rose for the site. As expected there predominance of waves travelling from West to East from the Atlantic Ocean. This data is based on macro UK wide modelling and is unlikely to capture the nuances of wave diffraction in and around the Rumps Point, The Mouls and into the Bay. However, anecdotal evidence from a mussel farm operator towards The Mouls has confirmed that closer to the Mouls the diffraction is strong however towards Doyden Bay and Port of Quin the degree of diffraction is less pronounced. For this study a conservative approach will be taken assuming the waves are perpendicular to the long lines.

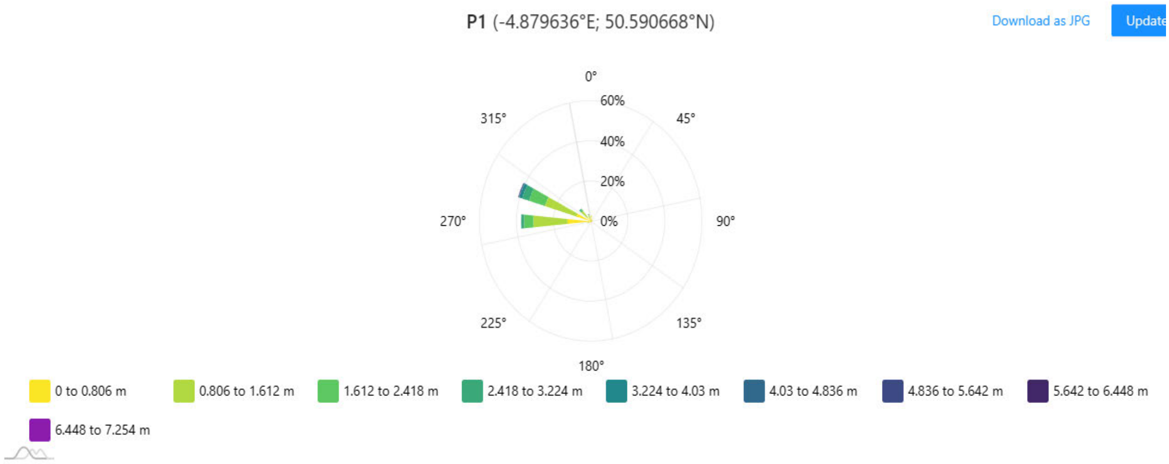

Figure 8 Wave rose for waves into Port of Quin (last year)

3.11 Currents

Table 8 contains the extreme surface current speeds by return period. This data is extracted from Figure 9 taken from [3].

Figure 10 contains the current rose for Port of Quin over the last year of data taken from [3]. This data shows a strong SW-NE directionality. Based on this data a current will be applied perpendicular to the long lines for conservatism.

Table 8 Extreme currents [3]

Return period [yrs]	Current speed (at surface) [m/s]
1	0.96
5	1.01
10	1.03
50	1.07
100	1.09

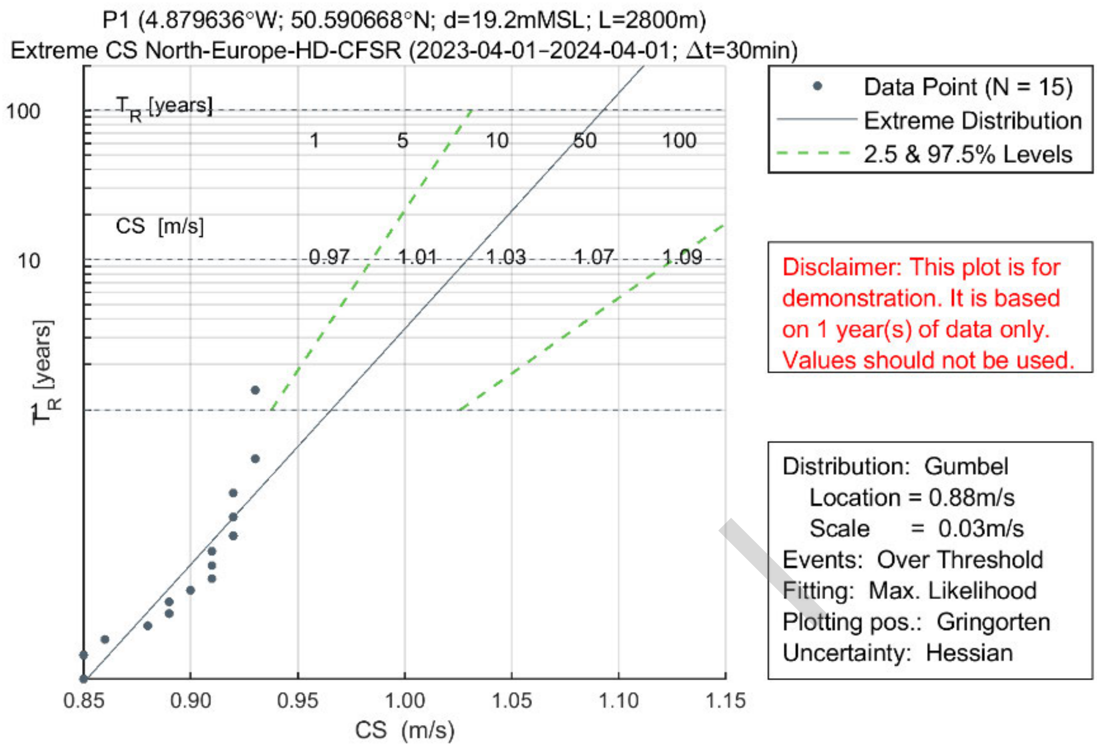

Figure 9 Current speeds versus return period [3]

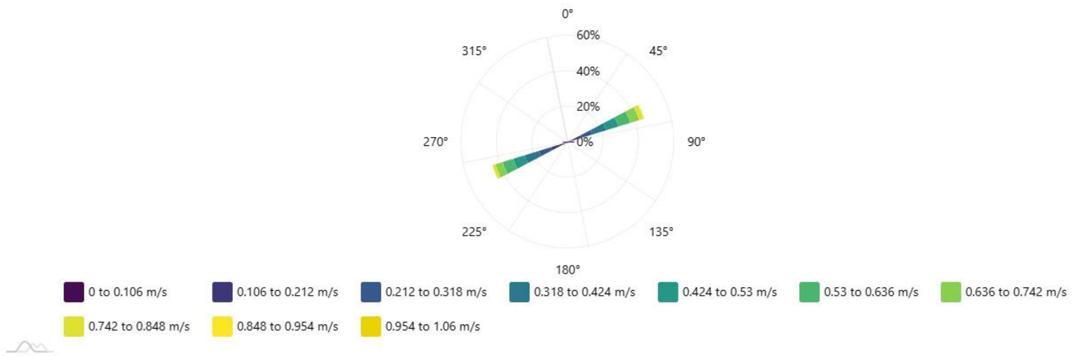

Figure 10 Current rose Port of Quin (last year) [3]

3.12 Marine growth

The assessment assumes 50 mm marine growth over the lifetime on [redacted].

3.13 Geotechnical data

Table 9 contains the soil parameters assumptions. Several other assumptions have been made regarding the soils data. See individual calculations regarding this data.

Table 9 Soil parameters

Parameter	Value	Ref
Soil type/stratigraphy	Assumed to be homogeneous over the depths of interest	
Vertical stiffness	>50 kN/m^2	
Seabed roughness	1 x 10^{-5} m	Assumed based on fine sand
Unit soil weight	11.75 kN/m^3	
Internal friction angle (angle of repose)	30°	

Table 10 contains the generic soil parameters that will be applied in the design. Coefficients of friction, Young's moduli and Poisson's ratios will be derived based on these parameters using the formulae below:

Coefficient of friction $\mu = \alpha . \tan(\varnothing)$

Where,

α is the friction reduction factor dependent on the relative roughness defined as the ratio between the roughness of the interface and the median grain size of the soil. This is assumed to 1.0 for the reef cube® in contact with the seabed.

∅ is the sand internal friction angle.

Table 10 Geotechnical parameters

Soil type		Roughness	Submerged unit weight	Internal friction angle	Friction coefficient
Grain size	**Condition**	**[m]**	**[kN/m³]**	**[°]**	**[-]**
Fine sand	Compact	1×10^{-5}	13.5	32	0.62
	Firm	1×10^{-5}	12.5	29	0.55
	Loose	1×10^{-5}	11.0	27	0.51
Medium sand	Compact	4×10^{-5}	11.75	40	0.84
	Firm	4×10^{-5}	10.75	34	0.67
	Loose	4×10^{-5}	9.75	30	0.58
Coarse sand	Compact	1×10^{-4}	10.0	45	1.00
	Firm	1×10^{-4}	9.0	38	0.78
	Loose	1×10^{-4}	8.5	32	0.62
Fine pebbles	-	3×10^{-4}	11.0	30	0.58
Course pebbles	-	2×10^{-3}	11.0	30	0.58

3.14 Hydrodynamic coefficients

Table 11 contains the hydrodynamic coefficients applied for the different elements in the analysis.

Hydrodynamic coefficients (drag, inertia) have been applied as per DNV-RP-C205 for the mussel floats. For the ropes, coefficients have been applied in accordance with DNV-OS-E301.

Table 11 Cable hydrodynamic coefficients

Parameter	Coefficient of drag, C_D [Note 1]	Coefficient of lift, C_L	Inertia coefficient, C_M = (1 + Ca) [Note 2]
reef cube® on seabed	0.94	0.5	1.68 [Note 3]
Rope/mooring lines (spiral rope with plastic sheathing)	1.2	0	1.0
300 l mussel floats	0.65 normal 1.6 axial	0	0.69

Notes

[1] Axial drag coefficient for ropes assumed to be negligible as per DNV-OS-E301.
[2] Added mass in the axial direction for ropes is assumed to be negligible as per DNV-OS-E301.
[3] Added mass coefficient for cuboid is 0.68.

3.15 O[redacted]

3.15.1 Overview

The mooring analysis has been performed in Orcaflex and Orcawave versions 11.4. Orcaflex is used to determine the tensions that will be imparted into the seabed anchors due to the hydrodynamic loading during worst case storm events.

3.15.2 Buoys

The buoys are modelled as a series of individual elements (6D buoys) each with their own mass, inertia and hydrodynamic properties.

3.15.3 Down lines and seed lines

The down lines and seed lines are modelled as line elements with appropriate inputs for mass/unit length, drag areas, axial stiffness, hydrodynamic coefficients etc. The lines are modelled with zero compression and torsional stiffness to reflect the flexibility in the chain. The seed lines have a modified coefficient of drag to account for the additional drag caused by the seaweed. This drag coefficient has been tuned to provide a 50 N/m force for a 1 m/s current in accordance with the worst-case findings in [1].

No mass or buoyancy is added for the seaweed as it is assumed that the seaweed has near negligible/neutral buoyancy.

3.15.4 Mooring riser lines

The mooring lines are modelled as line elements with appropriate inputs for mass/unit length, drag areas, axial stiffness, hydrodynamic coefficients etc. The lines are modelled with zero compression and torsional stiffness.

3.15.5 Spacer rods

The spacers are modelled as fixed links with negligible mass.

3.15.6 Scissor weights

Any weights are modelled as clump masses attached to the lines as required.

4 MOORING TENSION RESULTS

4.1 Loads at anchors

Table 12 contains a summary of the maximum anchor loads witnessed across all the cases and analyses.

A peak anchor load of [redacted] kN ([redacted]) was witnessed for case 15. Figure 11 contains the full 100 second snapshot of the tension history for this case.

As expected the highest loads are found when the environmental loading due to waves and current are collinear and acting perpendicular to the long line.

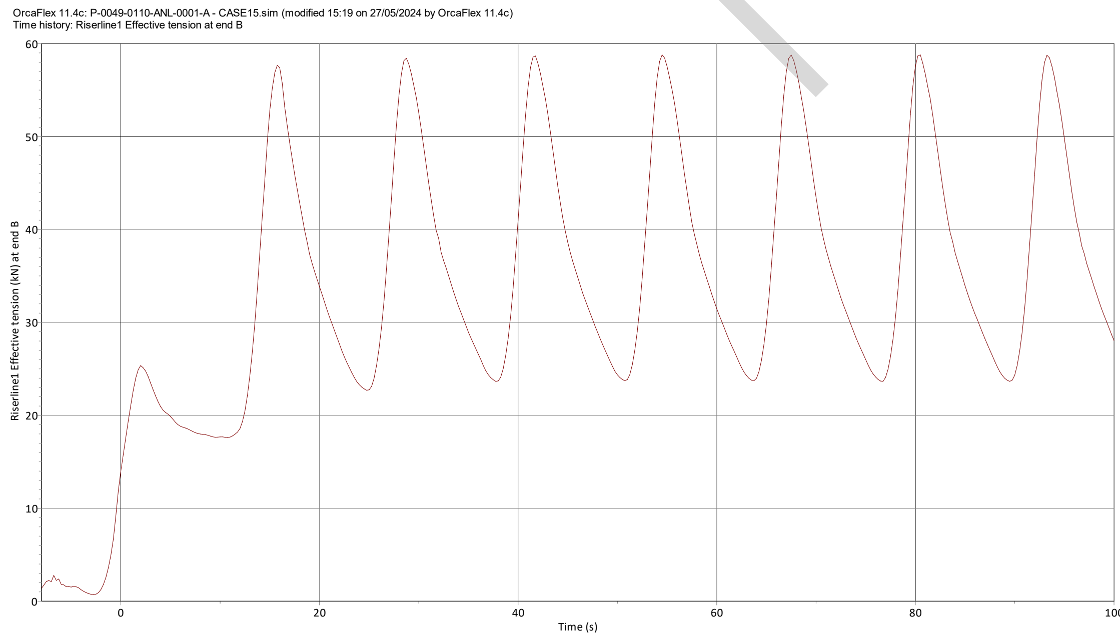

Figure 11 Riser line tension (Riser line 1) for Case 15 (worst case)

Table 12 Tension loads at anchor points – summary results

						Riser line 1			**Riser line 2**		
Case No.	**Wave return period [yrs]**	**Current return period [yrs]**	**Water level return period [yrs]**	**Wave directions [°N]**	**Current directions [°N]**	**Maximum riser tension [kN]**	**Maximum declination angle [°]**	**Minimum declination angle [°]**	**Maximum riser tension [kN]**	**Maximum declination angle [°]**	**Minimum declination angle [°]**
1	50	10	1	0	0	32.7	81.9	78.7	2.2	167.1	3.8
2	50	10	1	45	45	46.1	83.8	61.6	34.6	82.5	70.7
3	50	10	1	90	90	57.9	83.0	65.0	58.0	84.4	67.4
4	50	10	1	135	135	34.4	82.5	75.1	45.9	83.8	82.0
5	50	10	1	180	180	2.2	177.5	15.4	33.0	82.4	79.6
6	50	10	1	225	225	34.4	81.6	75.1	45.7	98.4	61.9
7	50	10	1	270	270	57.9	83.0	78.5	58.0	84.2	78.1
8	50	10	1	315	315	46.0	100.1	60.5	34.6	93.8	50.9
9	10	50	1	0	0	33.7	81.8	79.3	2.2	162.0	14.5
10	10	50	1	45	45	47.4	83.1	81.4	35.2	82.6	76.0
11	10	50	1	90	90	58.8	83.1	65.0	58.8	83.9	49.7
12	10	50	1	135	135	35.2	81.7	75.2	47.0	84.2	81.3
13	10	50	1	180	180	2.3	168.3	17.8	34.0	82.5	79.7
14	10	50	1	225	225	34.9	83.2	72.5	47.0	115.7	67.9
15	**10**	**50**	**1**	**270**	**270**	[redacted]	**83.1**	**78.6**	[redacted]	**84.2**	**78.9**
16	10	50	1	315	315	47.4	93.7	71.2	35.2	85.8	51.8
17	50	10	1	0	90	37.5	82.1	79.9	26.5	84.4	70.7
18	50	10	1	45	135	32.5	101.5	48.6	37.4	104.3	62.2
19	50	10	1	90	180	28.4	84.5	71.2	40.7	82.7	75.2
20	50	10	1	135	225	11.4	82.9	69.4	31.5	82.3	79.5
21	50	10	1	180	270	26.5	82.0	77.1	37.8	82.9	80.2
22	50	10	1	225	315	37.0	87.3	63.5	32.5	100.3	38.4
23	50	10	1	270	0	40.6	81.9	74.0	28.3	87.2	72.3

Table 12 Tension loads at anchor points – summary results

						Riser line 1			Riser line 2		
Case No.	Wave return period [yrs]	Current return period [yrs]	Water level return period [yrs]	Wave directions [°N]	Current directions [°N]	Maximum riser tension [kN]	Maximum declination angle [°]	Minimum declination angle [°]	Maximum riser tension [kN]	Maximum declination angle [°]	Minimum declination angle [°]
24	50	10	1	315	45	31.6	81.5	78.8	11.5	83.3	71.8
25	10	50	1	0	90	38.4	82.2	80.1	27.6	90.6	73.5
26	10	50	1	45	135	32.8	96.4	64.0	38.3	83.5	77.6
27	10	50	1	90	180	28.1	84.7	71.2	41.1	82.7	75.3
28	10	50	1	135	225	12.0	82.3	69.8	32.4	82.4	79.7
29	10	50	1	180	270	27.6	82.1	77.3	38.6	83.0	80.4
30	10	50	1	225	315	37.8	86.0	60.3	32.9	110.6	53.4
31	10	50	1	270	0	40.9	82.0	74.0	28.0	87.4	72.2
32	10	50	1	315	45	32.4	81.6	79.1	12.0	82.9	71.7

5 ANCHOR DESIGN

5.1 Screw anchors

A review has been performed on the feasibility of screw anchors. Two suppliers of screw anchors have been approached. Both of these suppliers had reservations in regards to the feasibility of their products when used in gravel soils albeit not impossible. The consistent message was that a sub-surface seabed geotechnical survey would be required to determine the exact design of the screw anchors.

A review of the experience in the region was conducted. Survey data from the wave hub site, which lies in an identical soil classification as the Port of Quin site (Sandy Gravel), highlights that there are many areas of low lying bedrock which are often covered in a very thin veneer of surficial sediment. These pose a risk to anchor refusal.

Based on the assessment above, **screw anchors have been considered as not feasible for the Port of Quin site.**

5.2 [redacted] gravity base anchors

Table 13 contains the required net submerged weights to anchor the long lines considering vertical, overturning and horizontal stability of the anchors and the various seabed types that may be encountered. These results include factors of safety and are based on an absolute stability criterion (i.e. zero allowable movement of the anchors).

The required submerged weight is [redacted] at each anchor point.

This equates to 5-off RC2000 [redacted] at each anchor point.

Full calculations are contained in Appendix A.

Table 13 reef cube® anchor results

Seabed type	Required submerged weight [tonnef]			RC2000 submerged weight each [kgf]	Required no. of RC2000 [redacted] per anchor point
	Vertical stability	Overturning stability	Horizontal sliding stability		
Loose find sand	5.2	21.5	29.5	[redacted]	[redacted]
Loose medium sand			26.6	[redacted]	[redacted]
Loose coarse sand			25.2	[redacted]	[redacted]
Pebbles			26.6	[redacted]	[redacted]

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The following conclusions can be drawn:

- Screw anchors have been considered as not feasible for the Port of Quin site.
- The required submerged weight is [redacted] at each anchor point. This is based on stability in worst case 50 yr storm conditions and includes code defined safety factors.
- A submerged weight of [redacted] equates to 5-off [redacted]® at each anchor point.
- [redacted]-off RC2000 cubes has a worst-case seabed footprint, of 6 m x 4 m per anchor point assuming a configuration where all the cubes are in contact with the seabed. This equates to a worst-case surface area footprint on the seabed of [redacted] m^2 per anchor point.
- Using [redacted]-off RC2000 [redacted]® per anchor point the current configuration of long lines will remain stable and on-station in 50 yr storm conditions (assuming the integrity of the configuration is maintained).

6.2 Recommendations

It is recommended that:

- Biome Algae pursues gravity-based anchors at the Port of Quin seaweed farm moorings.
- Biome Algae pursues a modular based system to achieve the required net submerged weight at each anchor point to minimise the requirement for heavy lifting offshore and for ease of retrieval upon cessation of operations.
- Biome Algae undertakes a detailed engineering phase for the moorings which considers the requirement to ensure that the full mass of the gravity anchors acts concomitantly through the tether point to riser line 1 in all metocean conditions i.e. to prevent walking of the anchors.
- Introducing elasticity into the mooring connections is worth considering however finding an off-the-shelf item that has sufficient fatigue strength may be challenging. Introducing elasticity could help to smooth out the storm load

profile. It will not necessarily reduce the peak load magnitude but could reduce the fatigue loading.

7 REFERENCES

[1] Endresen, P.C., Norvik, C., Kristiansen, D., Birkevold, J. and Volent, Z., 2019, June. Current induced drag forces on cultivated sugar kelp. In International Conference on Offshore Mechanics and Arctic Engineering (Vol. 58837, p. V006T05A007). American Society of Mechanical Engineers.

[2] Bathymetric metadata and Digital Terrain Model data products have been derived from the EMODnet Bathymetry portal - http://www.emodnet-bathymetry.eu.

[3] DHI metocean database, MetOcean Data Portal (dhigroup.com).

[4] OTO 01030, Wind and wave frequency distributions for sites around the British Isles, HSE report, 2001.

APPENDIX A GRAVITY ANCHOR CALCULATION

[redacted]

Seaweed gravity anchor stability

Calculation for Biome Algae

[redacted]

ARC document number: P-0049-0110-CAL-0001
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CONTENTS

1.0 INTRODUCTION & PURPOSE OF CALCULATION

This calculation determines the required [redacted] size and quantity to act as a gravity anchor to stationkeep the seaweed farm long lines.

2.0 REFERENCES

[1] DNV-OS-E301, Position mooring.
[2] Recommended design practice for offshore and nearshore seaweed growing systems, Version 1.0 2023.

3.0 DESIGN CRITERIA & ASSUMPTIONS

- SEE CALC

4.0 INPUT DATA

4.1 Standard reef cube properties

$\rho_c := 2150\ kg \cdot m^{-3}$

$V_{RC2000} := 5.341\ m^3$

$l_{RC2000} := 2\ m$

4.2 Tether loads

$T_{max} := 58.8\ kN$ Maximum tension

$\vartheta_{Tmax} := 83.1°$ Maximum declination

$\vartheta_{Tmin} := 78.6°$ Minimum declination

4.3 Geotechnical properties

$\mu := \begin{bmatrix} 0.51 \\ 0.58 \\ 0.62 \end{bmatrix}$

$Seabed :=$ Soil: Medium sand — Select seabed type

$k_b := Seabed_2$ Seabed roughness $k_b = 0.04\ mm$

4.4 Environmental parameters

$Case :=$ Case: 100 yr W + 10 yr C — Select environmental case (drop down)

$\rho_w := 1025\ kg \cdot m^{-3}$ Density of seawater

$d_{sea} := 5.85\ m$

$Surge_{neg} := -0.87 \cdot m$ Negative storm surge (100 yr)

$v_{curr100} := 1.07 \cdot m \cdot s^{-1}$ 100 yr omni-directional current velocity acting at ref height zr

$v_{curr10} := 1.03 \cdot m \cdot s^{-1}$ 10 yr omni-directional current velocity acting at ref height zr

$\vartheta_c := 90 \cdot deg$ Angle between current and asset (90 deg is perpendicular)

$H_{w100} := 4.563 \cdot m$ 100 yr significant wave height. Note this will be converted to maximum wave if selected above

$H_{w10} := 4.095 \cdot m$ — 10 yr significant wave height. Note this will be converted to maximum wave if selected above

$t_{wave100} := 12.92 \cdot s$ — 100 yr associated wave period

$t_{wave10} := 12.32 \cdot s$ — 10 yr associated wave period

$\vartheta_w := 90 \cdot deg$ — Angle between wave and asset (90 deg is perpendicular)

$z_r := d_{sea}$ — Height above seabed for the reference current velocity

$C_d := 1.0$ — [redacted] on seabed drag coefficient

$C_l := 1.0$ — [redacted] lift coefficient

$C_M := 2$ — [redacted] inertia coefficient

$t_{mg} := 50\ mm$ — Marine growth thickness

4.5 Safety factors

$\gamma_p := 1.0$ — Permanent load factor

$\gamma_{env} := 1.3$ — Environmental load factor

$\gamma_{mat} := 1.2$ — Material factor

$j := 1, 2 .. 3$ — Cases for seabeds

5.0 CALCULATIONS

5.1 Submerged weights

$m_{RC2000} := V_{RC2000} \cdot \rho_c$	Mass in air RC2000	$m_{RC2000} = 11483.15\ kg$
$\omega_{RC2000} := V_{RC2000} \cdot g \cdot (\rho_c - \rho_w)$	Submerged weight RC2000	$\omega_{RC2000} = 6008.63\ kgf$

5.2 Resolve tether loads

$V_{max} := T_{max} \cdot \cos(\vartheta_{Tmin})$	Maximum vertical tether load	$V_{max} =$ [redacted] kN
$H_{max} := T_{max} \cdot \sin(\vartheta_{Tmax})$	Maximum horizontal tether load	$H_{max} =$ [redacted] kN

5.2 Environmental load case

$v_{curr} :=$ if $Case = 0 \lor Case = 1$: $v_{curr100}$; else: v_{curr10}	Design case current velocity	$v_{curr} = 1.03\ m \cdot s^{-1}$
$H_w :=$ if $Case = 0 \lor Case = 2$: H_{w100}; else: H_{w10}	Design case significant wave height	$H_w = 4.56\ m$
$t_{wave} :=$ if $Case = 0 \lor Case = 2$: $t_{wave100}$; else: t_{wave10}	Design case significant wave height	$t_{wave} = 12.92\ s$

5.3 Hydrodynamic forces

$A_l := l_{RC2000}^{\ 2}$	Lift area of RC2000	
$A_d := (l_{RC2000} + 2 \cdot t_{mg})^2$	Drag area of RC2000	
$d_{min} := d_{sea} + Surge_{neg}$	Minimum water depth	$d_{min} = 4.98\ m$

5.6 Wave kinematics

$L_w := \sqrt{g \cdot d_{sea}} \cdot t_{wave}$	Shallow water wavelength	$L_w = 97.86\ m$

$$U_w := \left(\frac{\pi \cdot H_w}{t_{wave}} \cdot \frac{\cosh\left(2 \cdot \pi \cdot \frac{l_{RC2000}}{L_w}\right)}{\sinh\left(2 \cdot \pi \cdot \frac{d_{sea}}{L_w}\right)}\right)$$

Peak wave orbital particle velocity at the top of the asset taken from Ref [5]

$U_w = 2.91\ m \cdot s^{-1}$

$$v_{wave} := U_w \cdot \sin(\vartheta_w)$$

Resolve peak orbital particle velocity normal to the asset

$v_{wave} = 2.91\ m \cdot s^{-1}$

$$a_w := \left(\frac{2 \cdot \pi^2 \cdot H_w}{t_{wave}^2} \cdot \frac{\cosh\left(2 \cdot \pi \cdot \frac{l_{RC2000}}{L_w}\right)}{\sinh\left(2 \cdot \pi \cdot \frac{d_{sea}}{L_w}\right)}\right)$$

Peak wave orbital particle acceleration at the top of the asse taken from Ref [5]

$a_w = 1.41\ m \cdot s^{-2}$

$$a_{wave} := a_w \cdot \sin(\vartheta_w)$$

Resolve peak orbital particle acceleration normal to the asset

$a_{wave} = 1.41\ m \cdot s^{-2}$

5.7 Currents

$$U_c := v_{curr} \cdot \left(\frac{\ln\left(\frac{l_{RC2000}}{m}\right) - \ln\left(\frac{k_b}{m}\right)}{\ln\left(\frac{z_r}{m}\right) - \ln\left(\frac{k_b}{m}\right)}\right)$$

Boundary layer averaged current velocity over the asset diameter Ref [1]

$U_c = 0.94\ m \cdot s^{-1}$

$$v_c := U_c \cdot \sin(\vartheta_c)$$

Boundary layer averaged current velocity perpendicular to the asset

$v_c = 0.94\ m \cdot s^{-1}$

$$v_{total} := v_{wave} + v_c$$

Total water velocity due to combined waves and currents

$v_{total} = 3.85\ m \cdot s^{-1}$

5.8 Hydrodynamic forces on reef cube®

$i := 1, 2 .. 360$ — Wave phase angle

$$v_{tot_i} := v_{wave} \cdot \sin(i \cdot deg) + v_c$$

Combined wave and current velocities over the wave phase cycle

$$a_{tot_i} := a_{wave} \cdot \cos(i \cdot deg)$$

Wave accelerations over wave phase cycle

$$F_{d_i} := \frac{1}{2} \cdot \rho_w \cdot A_l \cdot C_d \cdot \left|v_{tot_i}\right| \cdot \left(v_{tot_i}\right)$$

Drag force

$$F_m := V_{RC2000} \cdot \rho_w \cdot C_M \cdot a_{tot}$$

Inertia force

$$F_l := 0.5 \cdot \rho_w \cdot A_l \cdot C_l \cdot \left(\max\left(v_{tot}\right)\right)^2$$

Lift force

$$F_{htot_i} := \left|F_{d_i} + F_{m_i}\right|$$

Total horizontal hydrodynamic force acting on the asset

5.4 Vertical stability

$\omega_{req\_v} := V_{max} \cdot \gamma_p + F_l \cdot \gamma_{env}$

Minimum required submerged weight for vertical stability

$\omega_{req\_v} = 5206\ kgf$

5.5 Overturning stability

$\omega_{req\_over} := \gamma_p \cdot \left(V_{max} + 2 \cdot H_{max}\right) + \gamma_{env} \cdot \left(F_l + \max\left(F_{htot}\right)\right)$

Minimum required submerged weight for overturning stability

$\omega_{req\_over} = 21476\ kgf$

5.5 Horizontal sliding stability

$\omega_{req\_h} := \frac{\gamma_{mat}}{\mu} \cdot \left(\gamma_{env} \cdot \max\left(F_{htot}\right) + \gamma_p \cdot H_{max}\right) + V_{max} \cdot \gamma_p + F_l \cdot \gamma_{env}$

Minimum required submerged weight for horizontal stability

[redacted] kgf

5.6 Required submerged weight

$\omega_{req_j} := \max\left(\omega_{req\_v}, \omega_{req\_over}, \omega_{req\_h_j}\right)$

Minimum required submerged weight for each seabed type

[redacted] tonnef

5.7 Number of reef cubes

$N_c := \mathrm{ceil}\left(\frac{\omega_{req}}{\omega_{RC2000}}\right)$

Minimum number of RC2000 cubes required per anchor point for each seabed type

[redacted]

6.0 SUMMARY

$$\omega_{req} = \begin{bmatrix} 29.48 \\ 26.55 \\ 25.17 \end{bmatrix} \textit{tonnef}$$

Required submerged weight per anchor point

$$N_c = \begin{bmatrix} 5 \\ 5 \\ 5 \end{bmatrix}$$

Required no. of RC2000 [redacted]

DIVE SAFE SERVICES LIMITED

BIOME ALGAE Ltd

SEAWEED FARMS
PORT QUIN - CORNWALL
December 2023 – January 2024

UXO DESK BASED ASSESSMENT

DSS Project # 012-23-24

DIVE SAFE SERVICES LIMITED

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Executive Summary

Dive Safe Services Limited has been commissioned by BIOME Algae Ltd to conduct a desk-based assessment for potential unexploded ordnance contamination at the Port Quin Bay, Seaweed Farms, North Cornwall.

This document will provide an overview for UXO risk for potential upcoming documentation relating to the seaweed farms construction, design and management.

This desk-based assessment summaries the UXO threat using a range of available sources, including the site-specific Marine Archaeology Assessment.

On completion of the UXO threat review, the available evidence presents a possible likelihood for UXO to be present within the site.

The assessment summarises with a conclusion and offers recommendations for further UXO risk management to reduce Health and Safety risk to personnel to As Low As Reasonably Practicable (ALARP), including project and operational risks.

Contents

Figures

Tables

Abbreviations

WW1	World War 1
WWII	World War 2
ALARP	As Low As Reasonably Practicable
DSS	Dive Safe Services Limited
DBA	Desk Based Assessment
UXO	Unexploded Ordnance
AOI	Area of Interest
pUXO	Potential Unexploded Ordnance
AA	Anti- Aircraft
RAF	Royal Air Force
RNAS	Royal Navy Air Station
GP	General Purpose
ASW	Anti-Submarine Warfare
LSA	Land Service Ammunition
HAA	Heavy Anti-Aircraft
LAA	Light Anti-Aircraft
M	Metre
Km	Kilometre
SAA	Small Arms Ammunition
NEQ	Net Explosive Quantity
TNT	Trinitrotoluene
RA	Risk Assessment
RMS	Risk Management Strategy

*Abbreviations are listed as they appear within the text

1.0 Introduction

1.0.1 Dive Safe Services Ltd were contracted by BIOME Algae Ltd to provide a desk-based assessment (DBA) based around the potential of unexploded ordnance (UXO) at the location of a proposed seaweed farm offshore at Port Quin Bay, North Cornwall, United Kingdom. For purposes of this assessment the seaweed farm area will be referred to as "the site".

1.0.2 This report was requested in response to the findings of the MSDS Marine report[1] whereby there has been identified a "bombing/gunnery" range within the site perimeter. Due to the restricted time available the report research has been focussed on the site only and the potential sources of UXO within the North Cornwall area which may affect the site. The threat has also been focussed on air-dropped weapons rather than sea or land mines, due to the nature and location of the site.

1.0.3 The UK coast-line and offshore waters present a significant risk for UXO in areas where previous military activity; (principally relating to the World Wars but, including post-war dumping) has resulted in the use of ordnance. The frequency of ordnance finds has increased exponentially with the offshore renewables industry, predominantly around the East and South coast of the UK however, the continued use of offshore areas will present further issues with regard to UXO.

1.0.4 This report reviews the information presented by MSDS Marine by way of the indicated "bombing/gunnery" range at the site and the potential for there to be UXO. It will also identify the potential sources of such UXO and tabulate the potential types which may be present. The report will identify the process of risk mitigation and offer recommendations to reduce the UXO risk to As Low As Reasonably Practicable (ALARP) status.

2.0 Legislation, policy and guidance

2.0.1 Relevant legislation, policy and guidance consulted for the preparation of this DBA includes (but not limited to):-

- Health & Safety at Work Act 1974;
- Management of Health & Safety at Work Regulations 1999;
- CIRIA C681 – Unexploded Ordnance (UXO), A guide for construction industry, 2009;
- CIRIA report C754 – Marine UXO Management Guide, 2015; and
- Construction (Design & Management) Regulations, 2015.

[1] MSDS Marine, *Port Quin Seaweed Farms. Marine Archaeology Assessment*. 2023/MSDS23265/1.

3.0 Methodology

3.0.1 This section provides an overview of the methods used to undertake the assessment. Data sources will be documented followed by the UXO study focus.

3.1 Study Area

3.1.1 The site is located within the Port Quin Bay c.~ 1 to 2.7 km to the northwest of Port Quin, off the north coast of Cornwall. This DBA has focussed on two specific airfields within c.~ 15 km from the site in a south westerly direction and a known bombing and gunnery range c.~ 10 km west-north-west from site.

3.2 Data/Information Sources

3.2.1 Due to restricted time the source of information has been limited to the below readily available resources. These have focussed on the location of airfields within the Study Area and the military planes which operated from these airfields. The role of the aircraft has also been reviewed and this has been used to inform the likely types of ordnance that would be used to fulfil such roles. Although site visits and specific resource venues have not been undertaken the reviewed sources provide sufficient information to inform a credible assessment of the presence or absence of potential UXO (pUXO).

3.2.2 Consulted sources comprise:

- Military and historic records of:
  - Airfields;
  - Aircraft;
  - Munition payloads;
  - Ordnance types and, roles;
  - Aerial bombing-/-gunnery practice;
  - Airfield defence;
  - Training practice bombing and gunnery;
- Client supplied data (including MSDS Marine, 2023);
- UXO discoveries within or close to the site; and
- UXO specialist knowledge.

3.2.3 Ordnance types have been identified by way of subject matter expert information and sources available to DSS Ltd.

4.0 Unexploded Ordnance (UXO) Hazard Assessment

4.0.1 Cornwall played an important role in WWII with fighter aircraft supporting bomber aircraft on raids over France but also in support of the D-Day landings in Normandy, France. During the early years of WWII, Cornwall was at risk from the air and sea by the Luftwaffe and Kriegsmarine respectively, with thousands of bombs being dropped on

Cornwall. There were even airborne landings of enemy troops[2]. Anticipating enemy attack the sea ports were heavily defended and beaches were protected from landings by the laying of defensive mines, barbed wire, pillboxes and gun emplacements. Beaches that posed a threat to amphibious landings were heavily defended and access roads were blocked by anti-tank obstacles and defended road blocks, which in some cases extended inland by up to five miles.

4.0.2 Anti-aircraft (AA) guns were stationed around major strategic targets such as Falmouth Docks and decoy sites were constructed in open country-side, which, at night, resembled airfields and towns to confuse the German bombers.

4.1 Cornish Airfields WWI and WWII

4.1.1 Planes stationed at Cornwall's airfields were part of the Royal Air Force (RAF) Coastal Command and initially deployed to scour the coasts for intelligence on any enemy landings. In 1940 and 1941 when the German bombing campaign was at its height, aircraft from Cornwall's airfields defended against enemy raiders, protecting merchant shipping convoys from German bombing and U-Boat activity.

4.1.2 When the invasion threat was alleviated, Cornwall's military aviation diverted to offensive action against occupied French ports and German shipping. Airfield expansion was undertaken prior to the invasion of North Africa to support the increasing volumes of equipment, troops and planes.

4.1.3 RAF Portreath, c.~ 46 km south west from the site, was the initial main airbase in Cornwall, with other airfields including:

- RAF Cleave;
- RAF Davidstow Moor;
- RAF Parranporth;
- RAF Predannack;
- RAF Trebelzue;
- RNAS St Merryn (HMS Curlew-/-HMS Vulture II – see below); and
- RAF St Eval (see below).

4.1.4 To investigate the potential that the site was used for aerial bombing practice (as suggested by the identification of a former bombing/gunnery target), two Cornish airfields within the Study Area have been researched further and the findings discussed below.

4.2 RNAS St Merryn[3] (HMS Curlew-/-HMS Vulture II)

4.2.1 RNAS St Merryn, c.~ 15 km south west from the site, was initially built for civilian use and was rebuilt in 1940 to accommodate the Fleet Air Arm for the purpose of training

[2] https://bodminkeep.org.uk/museum-history/exhibitions/coastal-fortifications-of-the-second-world-war.

[3] RNAS St Merryn Airfield 1937-1956 – Grid Ref SW8892707130 – The Gazetteer of WWII airfields by Willis & Holliss

airborne observers and carrier fighter pilots. The layout of the runways differs from that of traditional RAF airfields in that the runways were shorter and facing in opposite directions. This was to replicate the conditions of take-off from an aircraft carrier. Throughout its service it supported circa 52 Naval air squadrons and a wide range of aircraft.

4.2.2 A satellite of RNAS St Merryn was the bombing and gunnery range at HMS Vulture II c.~ 10 km north west from site. Ground targets were laid out on the cliff edge and in 1944, the main part of the range was staged as a Japanese-held area, with dummy tanks, a bridge, a road convoy and landing strip. Aircrews of fighter and torpedo bomber aircraft operating from carriers were trained at these locations.

4.3 RAF St Eval[4]

4.3.1 RAF St Eval, c.~ 15 km south-south-west from the site, was built for RAF Costal Command to provide anti-submarine and anti-shipping patrols off the south west coast of England. In 1940, the airfield sustained bombing damage whereby some hangars were severely damaged.

4.3.2 Some of the first aircraft sent out to tackle the German U-Boat threat took off from St Eval. These were initially the outdated Whitely bombers and were gradually replaced by Wellington bombers. These aircraft would have been carrying munitions capable of attacking surface ships and submarines.

[4] RAF St Eval Airfield – Airfield Research Group Ltd – Works & Bricks - Paul Francis

Figure 1 Proximity of the airfields & HMS Vulture bombing & gunnery range to the project site.

4.4 HMS Vulture II

4.4.1 HMS Vulture II was an aerial bombing and gunnery range at Treligga c.~ 2 km west of Delabole, Cornwall and c.~ 10 km west-north-west from the project Site. The station was a satellite of the Fleet Air Arm base at St Merryn. Initially a glider site the Admiralty requisitioned 260 acres (1.1 km^2) of land between Tregardock and Backwater Cove in late 1939 for the purpose of constructing a bombing (air to ground) and gunnery (air to sea) range. Targets were also positioned near Port Isaac Bay for air to sea attacks. Near the cliff at Dannon Chapel was a quadrant shelter (equipped with a quadrant) which was used to assess the accuracy of attacks on floating targets. The shelter was removed in the late 1990's by the National Trust.

4.5 Morte Bay practice bombing range[5]

4.5.1 Morte Bay, although c.~ 80 km north east from the site, has a record of a floating target moored at this location which was used for practice bombing runs. The accuracy of the bomb drop would be witnessed from the observation post shoreside. The interpretation from the research is that the floating targets were made from cork and would possibly be designed to look like a submarine conning tower. Planes from other

[5] Morte Bay practice bombing range – GR 442, 418.

airfields would use the ranges for dive-bombing practice, these being spitfires, Beaufort's and later Vampire jets.

Figure 2 range target indicator.

4.6 Port Quin modern bombing range, modern target

4.6.1 Although not found in any other research the Historic England[6] record would identify a bombing and gunnery range within the location of the project site. It would therefore be a fair judgement to assume that similar activities were conducted at the Port Quin bombing range as at the Morte Bay range. The description within the HER is as follows;

'Six anchored gunnery/bombing targets in Portquinn Bay. It is assumed that they are connected with either Crugmeer WW1 airfield (166866) and or St Merryn airfield (50377) as air to ship gunnery or bombing targets(b1). A similar set are to be found south of Gulland Rock to the west (170158). Associated sites include observation posts (166650, 167312, 50279) and target indicators (50279, 50336).'

Figure 3 Bombing or gunnery anchored target markers in Port Quin Bay.

5 Aircraft, munitions and ordnance

5.1 The role of the Cornish airfields has been established and the mention of circa 52 squadrons being operated during the military operational cycle of St Merryn. It is important to consider the mission objective and then match the aircraft for that role and subsequently the munitions to be carried '*payload*' to achieve that role and a successful outcome to each sortie flown. On review of both airfields it can be assumed that St Merryn was used more for a training role than St Eval. However, again it would

[6] HER# 170159, Port Quin bombing range, modern target

be fair to assume that both airfields, and others in Cornwall, would have used the bombing and gunnery range identified as HMS Vulture II at Treligga, near Delabole, North Cornwall and possibly those mentioned at Morte Bay and Port Quin.

5.1.1 The payloads carried would vary significantly between aircraft and also between mission target objectives. In figures 4 & 5 there is clear evidence of the use of depth charges (*250lb, Mk VIII*) being loaded onto a bomber and general-purpose air dropped bombs (*500lb, GP*) being removed from a 'Bomb' store within the location of the airfield at St Eval.

Figure 4 Armourers unload 250lb depth charges from a bomb trolly and load onto a Consolidated Liberator GR Mk VA of No 53 Squadron RAF at St Eval 1944

Figure 5 loading 500lb GP bombs onto a train from the bomb store. RAF St Eval.

5.1.2 Some of the aircraft that would have potentially used HMS Vulture II can be seen in table 1 below. These were all stationed within Cornwall at some time during WWII.

	Aircraft Name	Capabilities
1	AVRO Lancaster	Long range bomber (day & night) carrying all sizes of payloads and also specific anti-submarine depth charges.
2	AVRO Shackleton	Long range maritime patrol aircraft. Payload **Bombs:** 10,000 lb (4,536 kg) of bombs, torpedoes, mines, or conventional or nuclear depth charges, such as the Mk 101 Lulu.
3	Da Haviland Mosquito	Multirole combat aircraft. Payload 4,000lb capacity.
4	Fairey Barracuda	A carrier-borne torpedo and dive bomber. Payload; **Bombs:** 1× 1,620 lb (735 kg) aerial torpedo *or* 4× 450 lb (205 kg) depth charges *or* 6× 250 lb (110 kg) bombs.
5	Fairey Swordfish	A biplane torpedo & dive bomber. Payload; torpedo, RP-3 rocket, depth charges.
6	Hawker Hurricane	Single seat fighter aircraft. Payload; **Bombs:** 2 × 250 or 500 lb (110 or 230 kg) bombs.
7	Lockheed P-2 Neptune	Maritime patrol & anti-submarine warfare (ASW). **Bombs:** 8,000 lb (3,629 kg) including free-fall bombs, depth charges, and torpedoes

8	Short Sunderland	Flying boat bomber. Payload; **Bombs:** up to 2,000 lb (910 kg) of bombs, mines and depth charges internally, winched out under the wings through hatches in the fuselage sides.
9	Supermarine Spitfire	Fighter / interceptor. Payload; RP-3 rockets
10	Bristol Beaufort	Anti-shipping and mine laying along the coast of northern Europe. Payloads, various but include torpedoes, depth charges and mines.

Table 1 Aircraft using the bombing and gunnery range at HMS Vulture II.

6.0 Anti-Aircraft Artillery (AA) & Land Service Ammunition (LSA)

6.0.1 Land Service Ammunition (LSA) covers all items of ordnance that are propelled, placed or thrown during land warfare. They may be filled or charged with explosives, smoke or pyrotechnics. Items of ammunition that fail to function correctly after initiation are termed “Blinds”. It is assessed that between 4% and 10% of LSA fails to function during peacetime usage, with the figure rising to as high as 30% during times of conflict.

6.0.2 Focusing on the airfields within the project search area and their active involvement in WWII it would be assumed that the airfields had some protection form German air raids. This is more likely to have been mobile Heavy Anti-Aircraft (HAA) or Light Anti-Aircraft (LAA) guns rather than heavy entrenched and bunkered gun emplacements there were rocket batteries (ZAA) firing 3 inch or 3.7 inch rockets with a maximum altitude of 5,800m and a ground range of 9 km, typically these were permanent emplacements. In addition, there was a wide variety of costal defences along the UK coast line during WWI & WWII. The gun calibres would have included but not limited to; 3.7 inch, 6 inch and 9.2 inch. There were also many pillboxes, which are potentially a local source of small arms ammunition (SAA) and small LSA items on the beach and intertidal areas.

6.0.3 These weapon systems lacked the modern-day accuracy and would have often produced shells/projectiles missing the target and continuing until their trajectory and energy brought them back to either the land or sea. The range of HAA & LAA during WWII was circa 27 km from the firing point; although this would depend on the calibre, barrel angle & shell trajectory and could be spread over a wide area. Therefore, resulting in the potential for projectiles to be present within the project area. Any size of projectile could be present however, it would be more likely to find small munitions with a low net explosive quantity (NEQ) of between 2kg-5kg.

Figure 6 WWII, 40-mm Bofors LAA gun.

Figure 7 Various projectiles

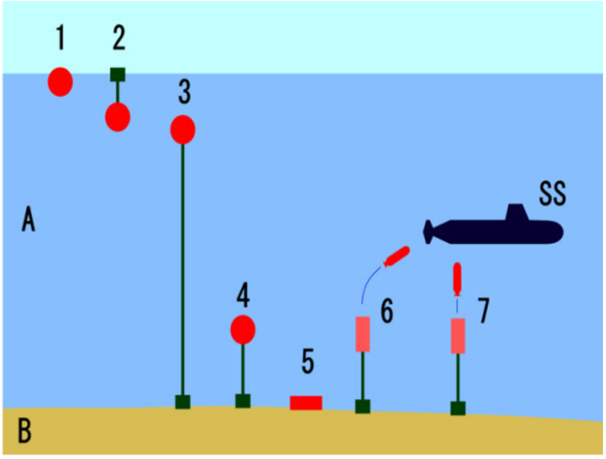
7.0 The threat from sea mines (WWI & WWII)

7.0.1 A naval mine is a self-contained explosive device placed in water to damage or destroy surface ships or submarines. Unlike depth charges, mines are deposited and left to wait until they are triggered by the approach of, or contact with, any vessel or a particular vessel type, akin to anti-infantry or anti-vehicle mines. Naval mines can be used offensively, to hamper enemy shipping movements or lock vessels into a harbour; or defensively, to protect friendly vessels and create "safe" zones. Mines allow the minelaying force commander to concentrate warships or defensive assets in mine-free areas giving the adversary three choices: undertake an expensive and time-consuming minesweeping effort, accept the casualties of challenging the minefield, or use the unmined waters where the greatest concentration of enemy firepower will be encountered.

7.0.2 Although international law requires signatory nations to declare mined areas, precise locations remain secret, and non-complying nations might not disclose minelaying. While mines threaten only those who choose to traverse waters that may be mined, the possibility of activating a mine is a powerful disincentive to shipping. In the absence of effective measures to limit each mine's lifespan, the hazard to shipping can remain long after the conflict in which the mines were laid is over. Unless detonated by a parallel time fuze at the end of their useful life, naval mines need to be found and dismantled after the end of hostilities; an often prolonged, costly, and hazardous task.

7.0.3 Modern mines containing high explosives detonated by complex electronic fuze mechanisms are much more effective than early gunpowder mines requiring physical ignition. Mines may be placed by aircraft, ships, submarines, or individual swimmers and boatmen.

7.0.4 Minesweeping is the practice of the removal of explosive naval mines, usually by a specially designed ship called a minesweeper using various measures to either capture or detonate the mines, but sometimes also with an aircraft made for that purpose. There are also mines that release a homing torpedo rather than explode themselves.



Types of naval mines:
A-underwater, **B**-bottom, **SS**-submarine. **1**-drifting mine, **2**-drifting mine, **3**-moored mine, **4**-moored mine (short wire), **5**-bottom mines, **6**-torpedo mine/CAPTOR mine, **7**-rising mine.

Figure 8 Types of naval mines

Figure 9 German parachute-retarded magnetic mine. Dropped by Luftwaffe bomber during WWII and landed on the ground. Fuse mechanisms are visible

Figure 10 British WWII buoyant mine

8.0 Torpedoes, depth charges and practice bombs

8.0.1 The relevance of aircraft launched torpedoes and depth charges based on the types and roles of aircraft, see table 1 above and figure 4, has been considered for this DBA. The use of torpedoes and depth charges from surface ships and submarines has not been included.

8.1 Aircraft launched torpedoes

8.1.1 The use of torpedoes launched from aircraft was very effective during WWII. The outdated biplane, Fairey Swordfish, was particularly effective with a low air speed she was able to drop torpedoes at low altitudes and the reduced speed resulted in les impact on entering the water. Although the low speed did have disadvantages with evasion of German fighter aircraft. Significant for this aircraft and the torpedo was the damage caused to the German Battleship Bismarck on 11-12 November 1940 whereby Fairey Swordfish of the Fleet Air Arm were able to attack her using torpedoes and bombs.

8.1.2 The standard British airborne torpedo for the first half of WWII was the 18 inch Mark XII, a 450mm diameter design weighing 1,548 lb (702 kg) with an explosive charge of 388 lb (176 kg) of trinitrotoluene (TNT). The American airborne torpedo at the time was the Mk 13, although not as reliable as the British Mk XII it would be assumed that these were used on aircraft flown out of the Cornish airfields by the US Airforce in support of combined operations later in WWII. Later they would develop the Mk 24 (FIDO) an acoustic torpedo which entered service in 1943. The British Mark XV superseded the previous model and was then again updated to the Mark XVII.

Figure 11 RAF Costal Command, 1939-1945. Armourers loading a MK XII ariel torpedo into a Bristol Beaufort Mk 1 of No 42 Squadron. No 42 Squadron were stationed at RAF St Eval in 1941.

8.2 Aircraft dropped depth charges[7]

8.2.1 A depth charge is an anti-submarine (ASW) weapon and intended to destroy or incapacitate a submarine by being dropped in the water within the vicinity, effective range, of the submarine and detonating on impact or hydrostatically when a predetermined depth has been achieved. On detonating a powerful hydraulic shock is generated. They were widely used in WWI and WWII remaining part of the anti-submarine warfare weapons for many navies. They have gradually been replaced by homing torpedoes.

8.2.2 Depth charges and depth bombs were deployed in large numbers during WWII from RAF costal patrol aircraft. Submarines were attacked with depth charges from surface vessels and aircraft. As with torpedoes the failure rate was high resulting in many reaching the seabed without functioning. Due to the thin skin design they would have perished by way of corrosion over time however, explosive residue (TNT, Torpex, Hexanite) may remain from the charge weight which can vary from net explosive quantity (NEQ) of 50 kg – 200 kg. Towards the end of WWII some NEQ's were as high as 1,000 kg. Refer to figure 4 & 12, whereby aircraft at RAF St Eval are being loaded with 250 lb Mk VIII depth charges in 1944.

[7] Royal Air Force Historical Society, Journal 45, 2009. British Air-dropped depth charges and anti-submarine torpedoes, HAYWARD. Roger

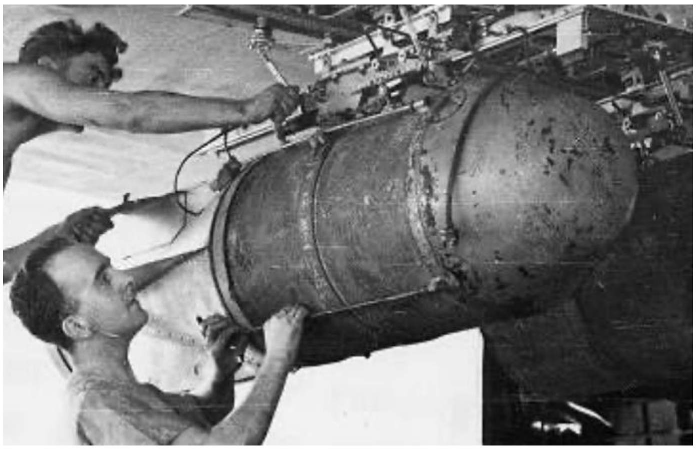


Figure 12 A MKVII depth charge being armed on a Sunderland bomber.

8.3 Practice bombs

8.3.1 Practice bombs were specifically designed for purpose although there were a few designs from service issue bombs filled with sand, water or chalk/lime solution. Standard practice bombs generally emit a smoke spotting charge to indicate accuracy. Practice bombs are painted white with two light green bands or those with a spotting charge fired by an exploder will be black with a red band. Time spent submerged will affect the paint surface of the munition therefore caution must be exercised to determine model variant.

8.3.2 Practice bombs are sometimes classed as 'inert' which means there is no explosive content within the munition. However, almost all practice munitions have some charge whether it is a charge for ejecting a marker (smoke) or small bursting charge to enable the spotter to more easily identify where the bomb has hit the target, or not.

Figure 13 WWII USAAF AN-M30 100 Lb ariel practice bomb

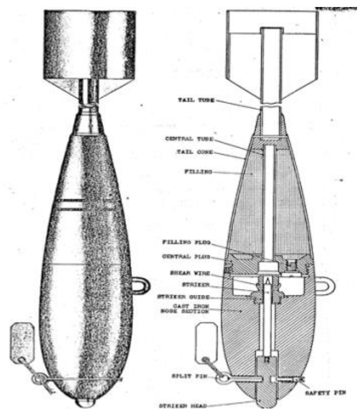


Figure 14 British 25 lb practice bomb

9 Likelihood of UXO contamination

9.0.1 Bombing ranges provide a potential UXO hazard from live and practice bombs, additionally other ordnance may be encountered which have failed to detonate as designed. Marine environment ranges are less likely to have been cleared on completion of use. The typical concentration of munitions would be expected around the target its self.

9.0.2 After the above research has been conducted, it is concluded that there is a possible likelihood of UXO to be found within the site based on the research findings. The term possible is used as there is only the evidence research to suggest that the site was set up for a bombing and gunnery range but no specific reference to evidence of this being used and by what means and munitions. The assumption is based on what research has found on similar bombing and gunnery ranges within a reasonable distance from the site.

9.0.3 The likelihood of encountering a UXO can be further speculated by the percentage of interaction with the sea bed within the project site area. As the research evidence shows the bombing and gunnery ranges were used by aircraft for practice bombing and therefore UXO would be intensified around the known target location. However due to the inaccuracy of munitions and human error some munition spread must be allowed for.

Level	Likelihood Term	Meaning
1	Very Unlikely	Very unlikely to encounter UXO but cannot be discounted entirely.
2	Unlikely	Some evidence of UXO within the wider region but unlikely to encounter.
3	Possible	Evidence/research suggest there is a possibility of encountering UXO within the area.
4	Likely	Strong evidence to suggest an encounter with UXO within the area
5	Very Likely	Specific clear evidence to undeniably expect UXO encounter within area.

Table 2 Likelihood of UXO encounter terms & definitions.

9.1 Likelihood at site from UXO contamination

9.1.1 The evidence within the research has shown that there has been ariel bombing and gunnery in the wider area notably at Morte Bay bombing and gunnery range and no specific reference to the bombing and gunnery range at Port Quin with the exception to the HER reference. However it would suggest that the use of Port Quin as an active bombing and gunnery range cannot be discounted. Therefore the table below is the assessment of Dive Safe Services for what potentially could be expected at the Port Quin bombing and gunnery range.

UXO Hazard	Likelihood of encounter	Comments
Anti-Aircraft projectiles/shells	2 Unlikely	Along the cost of the study area there is evidence of costal defences and it can be assumed that there was activity from these emplacements. Additionally the airfields within the search area would have had air defence as air raids occurred resulting in the use of defensive anti-aircraft guns. Due to the small calibre of these weapons they present a negligible threat to project activities.
Land service Ammunition (LSA)	1 Very Unlikely	The weapons used for the expected costal defence within the research area would be of a small calibre and potentially concentrated around the costal defence

		positions. Therefore the expectance of encountering LSA at the project site is very unlikely.
Sea mines (buoyant & ground)	1 Very Unlikely	The research has not produced any evidence or reference to sea mines within the project site or wider area which will affect munition subsea movement into the project site area.
Torpedoes	2 Unlikely	The evidence produced from the research would suggest that there is a potential that the project site and the specific area of the noted bombing target could have been used by the squadrons based within the search area for the use of aerial launched aircraft torpedoes. However, there needs to be some consideration to the inaccuracy of the launching technique and the distance of run for the torpedo within the confides of the project site therefore lowering the likelihood of encounter.
Depth charges	2 Unlikely	Although large number were used during WWI & WWII by the aircraft operating from the search area airfields it is felt that the use of this munition for practice would be unlikely.
Practice bombs	3 Possible	Due to the potential presence of a known target and the research findings of practice sea placed bombing and gunnery ranges on the north coast of Devon & Cornwall the presence of practice bombs is assessed as possible. However this does not mean to say that any encounter with such items will incur as the site area is significant compared to the specific location of the known target.
Air dropped bombs	2 Unlikely	It would not be expected that any live munitions would have been used at the Port Quin Bay bombing and gunnery range based on research conducted.

Table 3 Likelihood of UXO encounter at the seaweed farm site, Port Quin.

10 Munition burial and movement

10.0.1 The seabed expected at the site for munition burial and movement assumption is taken from the MSDS report[8] stating sand and gravels as the seabed sediment. Due to the small size of the expected UXO it would be prudent to assume that UXO remaining within the site would have some degree of coverage and burial.

10.0.2 In all cases there is a potential for UXO migration. The site is affected by high energy hydrodynamic processes which could potentially result in the movement of UXO from its original position. Additionally, the area has been used for bottom trawling which can cause UXO to be caught in fishing equipment and again moved from its original position.

[8] MSDS Marine, *Port Quin Seaweed Farms. Marine Archaeology Assessment*. 2023/MSDS23265/1. Section 5.3 Geology: Quaternary sediments.

11 UXO Risk management framework

11.0.1 On the information obtained through the DBA it has identified that the site has the possibility to contain UXO within the boundaries of the site. The types of UXO have also been identified within the DBA. From guidance[9], if the DBA identifies the potential for UXO then a suitable UXO Risk Assessment and UXO Risk Management Strategy will need to be developed. This will likely involve more in depth and physical investigations into the project area and can lead to geophysical surveys which will support design processes for any intrusive ground investigations or project design.

11.0.2 This DBA supports Phase 1 of the UXO risk management framework.

Phase	
1	UXO Threat Assessment Identify type(s), condition and density of UXO that may be present within an area of investigation
2	UXO Risk Assessment Likelihood of encountering and detonating UXO and the consequences of such detonation
3	UXO Risk Management Strategy Avoid or mitigate the risk
4	UXO Risk Mitigation (planning) Design and specification of risk mitigation. Appointment of UXO specialists
5	UXO Risk Mitigation (delivery) Delivery, sign off and monitoring

Table 4 UXO risk management framework.

12 Conclusions and recommendations

12.1 Conclusions

12.1.1 This UXO desk-based assessment has shown that there is a possible UXO hazard present at the proposed site of the seaweed farms at Port Quin Bay. The likelihood of potential types of UXO has been shown in Table 3. The determination has been based on the likely presence and density of UXO and is a subjective measure only. The risk varies with each seabed interaction and varies with size of footprint, location and dynamics at the location.

12.1.2 Due to the types of UXO expected within the project site area it is expected that there will be a percentage of burial. This will be determined by the type of munition and the sediment at the UXO location. The results of scour and bedform migration will also have an effect. Given the information within the MSDS report it is expected that UXO will be exposed to varying levels of burial. It has been assessed that there is a very likely possibility of UXO migration throughout the site due to fishing activities.

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[9] CIRIA report C754 – Marine UXO Management Guide, 2015

12.2 Recommendations

12.2.1 This UXO Desk Based Assessment has determined that a UXO hazard is present at the project site. The following reports will need to be produced:

- An Unexploded Ordnance Risk Assessment (RA) based on the findings of this DBA covering the area of the seaweed farms at Port Quin, north Cornwall.

- The RA should be supported by a Risk Mitigation Strategy (RMS), which should follow the ALARP principles that should cover all activities during the development of the seaweed farm and interactions with the sea bed. The RMS will outline the methodology and technical specifications for a UXO survey. The overall aim is to reduce Health & Safety risk to personnel to ALARP, including project and operational risks.