Appendix 8A

Aquafact Marine Survey Report

Malachy Walsh & Partners (MWP)

Benthic Survey

Ros an Mhíl Harbour 2025

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List of Acronyms/Glossary

CD	Chart Datum
DAFM	Department of Agriculture, Food and the Marine
DDV	Drop-down video
LOI	Loss On Ignition
MDS	Multidimensional Scaling
NMBAQC	Northeast Atlantic Marine Biological Analytical Quality Control
PSA	Particle Size Analysis
RPS	RPS Group Ltd
MWP	Malachy Walsh & Partners

1. Introduction

Ros an Mhíl Harbour is located on the north-east shore of Cashla Bay near the village of Ros an Mhíl in Connemara. Ros an Mhíl Harbour serves primarily as a fishing port for the Irish and foreign fishing fleet operating off the Galway coast. The Department of Agriculture, Food and the Marine (DAFM) was permitted to commence the development of a deep-water quay facility at the Ros an Mhíl Harbour in 2023. A map of the development site in Ros an Mhíl prior to any construction is shown in **Figure 1.1**. A

Figure 1.1: Location of development site in Ros an Mhíl Harbour prior to construction (Map credit: MWP).

Works carried out to date (2023 - 2024) for the development at Ros an Mhíl Harbour include:

i. Mobilisation and development of the construction compound and facilities.
ii. Reclamation works – Rock fill material was imported to reclaim land from the sea and raise the ground level to the high-water mark (+5mCD). This reclaimed land was then used as a construction surface.
iii. An existing slipway used by islanders was part of the reclamation site and decommissioned. A new slipway was constructed 310m northwest of the site prior to the decommissioning.

iv. Sequential construction and movement of the 20 drilling and blasting platforms over the quay wall and berthing pocket using imported quarry rock.
v. Dredging works to remove the blasted seabed and construct the protective berm around the quay wall trench.
vi. installation of 75m of rock armour revetments on the northern and southern ends of the reclamation area.
vii. Installation of the on-site concrete batching plant.
viii. Offsite manufacture and delivery of precast concrete caissons. 358 were manufactured and 92 were delivered to site.
ix. Offsite manufacture of the L-shaped blocks for wall and foundation beams.
x. Installation of 48m of quay wall foundations.

A map of the development site as of 2025 is shown in **Figure 1.2**.

Figure 1.2: Development carried out in Ros an Mhíl Harbour as of 2025. Dredging in boundary area of berthing pocket, turning circle and approach channel remain to be completed (shaded area).

Works that remained to be completed in the future to finish the development include:

i. Re-establishment of the temporary site compound and temporary concrete batching plant.
ii. Delivery of the needed pre-cast concrete beams (24), caissons (346) L-wall units (121). This will be completed over a period of 5 months.
iii. Preparatory dredging and cleaning of the quay wall trench.
iv. Installation of the remaining 152m of foundation for the quay wall.
v. Quay wall construction, which involves placement of pre-cast caisson units on top of the foundation beams/plinths and caisson units will be filled with concrete as the wall height increases.
vi. Construct the entire 200m length of the quay wall and *c.* 40m return walls at the northern and southern ends.
vii. Upon completion of the caisson wall, the 121 L-shaped wall units will be connected to the top of the wall on the seaside to reach the full height of the quay wall.
viii. Backfill behind the quay wall using rockfill to the new ground level. This rockfill will be sourced from the temporary bund around the perimeter of the quay wall that protects the construction activities for divers. An additional 10,000m^3 of imported material will also be used for fill.
ix. Completion of rock armour for revetments on north and south side of reclaimed area behind the quay wall before the surfacing works, which is already 50% complete.
x. Installing of underground ducts and drains required for the proposed services along the quay wall.
xi. Laying of reinforced concrete deck/apron slab behind the quay wall with service ducts and openings where required. This will be 36m wide x 200m long.
xii. Backfill the remainder of the site with imported rockfill layer at *c.* 800mm. This will require an additional 2m of fill material on the existing ground levels.
xiii. Lay a surface dressing of the reclaimed area using a bitumen coat with stone chips.
xiv. Lay an asphalt roadway connecting the concrete apron at the quayside to the existing road at the southern end the site.
xv. Install lighting columns, electricity supply lines, outfalls, inceptor, foul pumping station and rising main to connect to existing services.
xvi. Construct new ESB electrical substation for dedicated power provision to the new deep-water quay, as well as an underground connector cable to the existing substation adjacent to the site.
xvii. Excavation by dredging and rock blasting, if required, of the approach channel including *c.* 1,000m^3 of rock in isolated locations on each side of the channel to provide for a deep approach channel of -7m Chart Datum. This will take place in parallel with the remaining quay construction works.

A digital representation of the deep-water quay development when the works are completed is illustrated in **Figure 1.3**.

Figure 1.3: Digital interpretation of the proposed deep-water quay development in Ros an Mhíl Harbour upon completion of works (Photo credit: MWP).

AQUAFACT was commissioned to undertake a marine ecological assessment at Ros an Mhíl Harbour on behalf of Malachy Walsh & Partners (MWP). The purpose of the marine benthic survey carried out on 30th June 2025 was to update the marine ecological information baseline survey previously undertaken by AQUAFACT in 2017. The objectives of the survey comprised of the following:

a) Record benthic habitats and determine substrate type in advance of grab survey campaign.
b) Record benthic habitats and associated infaunal communities.
c) Understand background radioactivity concentrations, granulometry and metal concentrations of sediments that could be impacted by the development.
d) Assess impact of the remaining development activities on the receiving marine environment.
e) Compare current benthic survey findings (2025) to previous benthic survey findings (2017).

2. Materials & methods

2.1 Video Survey (Drop-down video)

A Drop-down video (DDV) survey was conducted to assess the suitability of the subtidal substrate for a benthic faunal and sediment contaminants survey. The video survey also served to identify suitable survey locations for faunal grab sample collection. Planned DDV stations included grab stations and drop-down stations from the previous survey. Additional stations were surveyed for potential as alternative grab stations. These stations are displayed in **Table 2.1** and were used as the basis for the subtidal video survey.

The video survey was carried out on the 30th of June 2025 from the RPS Marine Vessel, *MV Madelen*. AQUAFACT's underwater drop camera video system, the STR SeaSpyder Nano was used in this survey. The equipment, consisting of camera, umbilical, and video overlay software was deployed through a snatchblock attached to the A-frame of the vessel and was lowered manually by a member of AQUAFACT staff. The live footage was monitored by another staff member who gave instruction on whether to raise or lower the unit.

At each location the camera was lowered on approach to the proposed sampling position. The vessel would then pass over the point and continue along its transect line. The visibility was relatively good but due to tidal conditions on the day, many of the shallow stations (previous grab and drop-down video stations) could not be surveyed. Instead, the vessel approached as close to these stations as possible and this area was surveyed. A number of grab stations were moved as a result of the drop-down video survey due to unsuitable substrate.

Figure 2.1 shows the locations of the drop-down video survey stations.

Table 2.1: Drop-down video stations.

Station	Latitude	Longitude	Station	Latitude	Longitude
DDV01	53.2636689	-9.5724329	DDV11	53.25929423	-9.5732733
DDV02	53.2617512	-9.57207544	DDV12	53.2617625	-9.5702923
DDV03	53.26607618	-9.57430018	DDV13	53.2643502	-9.5702387
DDV04	53.2667385	-9.5755104	DDV14	53.264012	-9.5715212
DDV05	53.26688722	-9.57606656	DDV15	53.26726234	-9.56880039
DDV06	53.26856217	-9.577064992	DDV16	53.26711892	-9.56685232
DDV07	53.267833	-9.5755278	DDV17	53.26619052	-9.56993918
DDV08	53.26588575	-9.57135968	DDV18	53.26710767	-9.57152269
DDV09	53.26289786	-9.57011979	DDV19	53.26347022	-9.569893113
DDV10	53.2615046	-9.5726143	DDV20	53.26354062	-9.57162206

Figure 2.1: Drop-down video tracks conducted as part of the survey in Ros an Mhíl Harbour, Connemara, Co. Galway.

2.1.1 Selection of grab locations from DDV

All benthic grabs (subtidal grabs) were undertaken on the 30th of June 2025. The potential grab stations were confirmed during the drop-down video surveys on the same day. From the video survey, each station was assessed for suitability for grab sampling based on the standard operating procedure (SOP) for station selection for benthic sampling using drop-down video survey (T2-SOP-Field Methods-04 - **Appendix 1**). The SOP was followed on the vessel to identify and assess suitability of substrates prior to benthic sampling. Decisions on whether sampling was to be carried out at a location was based on the following criteria:

- Presence or absence of biogenic and non-biogenic reefs (see **Table 2.2**).
  Areas with biogenic and non-biogenic reefs identified during the video survey would not be sampled and sampling would be redirected to suitable areas identified during the video survey. Where reef habitats are identified, sampling would be restricted to video surveying only. No deployment of survey equipment was conducted in areas of reef habitat.
- Sampling would also not be carried out in areas where the presence of fauna or flora could be adversely impacted by the sampling (see

- Table 2.3).
- The suitability of sediment type for grab sampling.
- Selection of stations for sediment sampling is based on sediment type suitability which is outlined in **Table 2.4**.
- Any other considerations that could impact the surrounding environment or affect benthic sampling (see **Table 2.5).**

The final locations of the grab sampling locations selected are provided in **Table 2.6**. The stations were moved following DDV survey. **Table 2.6** shows the final grab stations relative to the previously planned grab locations and the DDV stations.

Table 2.2: Station Selection Based on Reef Classification.

Feature	Feature Description	Suitability for Benthic Sampling
Biogenic Reef	Any reef made by a living organism.	NOT SUITABLE
Non-Biogenic Reef	The structure of reefs varies from bedrock to boulders or cobbles while topography ranges from horizontal to vertical and the reefs may have numerous ledges and crevices. The geology includes limestone, shale, granite, schists and gneiss. Brown fucoid algae generally dominate the intertidal down to shallow subtidal areas. The latter are characterised by kelp species, frequently with an understorey of red foliose algae. Below the kelp and down to about 30 m, red algae characterise the substratum with very few brown algae. Below this, the habitat is characterised by faunal species; very few foliose or filamentous red algae occur although encrusting red algae may be common.	NOT SUITABLE
Serpula Reefs	The polychaete worm *Serpula vermicularis* secretes a calcareous tube and is common as a solitary worm. The worms aggregate and form structures	NOT SUITABLE

Feature	Feature Description	Suitability for Benthic Sampling
	which may be up to 1 m in height and about 2 m in diameter.	
Sabellaria Reef	These are constructed by the polychaete worm *Sabellaria spinulosa* and *Sabellaria alveolata.* The reefs are constructed of sand grains by the worm and form a substrate for many other species that would not normally be present in the area in the absence of the reefs. The reefs can be up to a metre in thickness.	NOT SUITABLE
Bivalve Reefs	Reefs caused by accumulations of bivalve populations.	NOT SUITABLE
Cold Water Coral Reefs	Cold water coral reefs are from 200–1600 m, where the water temperature is 4–8ºC and the salinity is 32–36%. Coral reefs found to date are generally associated with carbonate mounds, features that rise up to 300-500 m above the sea floor.	NOT SUITABLE

Table 2.3: Station Selection Based on Identifiable Fauna/Flora.

Feature	Feature Description	Suitability for Benthic Sampling
Fauna	• Any bottom fixing fauna species. • Any large populations or accumulations of benthic species.	NOT SUITABLE
Flora	Any bottom fixing flora species.	NOT SUITABLE
Drift Flora	Any non-attached drift flora.	SUITABLE

Table 2.4: Station Selection Based on Sediment Classification.

Feature	Feature Description	Suitability for Benthic Sampling
Boulders/Cobbles/Pebbles	• Boulders (>256 mm) • Cobbles (64 – 256 mm) • Pebbles (4-64 mm)	NOT SUITABLE
Small Granules	• Shell/Gravel (*c.* 4 mm)	SUITABLE
Coarse Sediments	• Gravel(G) • sandy Gravel (s-G) • gravelly Sand (G-s)	SUITABLE
Mixed Sediments	• muddy Gravel (m-G) • muddy sandy Gravel (m-s-G) • gravelly Mud (g-m) • gravelly muddy Sand (g-m-S)	SUITABLE
Mud	• Mud	SUITABLE
Sand	• Sand	SUITABLE

Table 2.5: Other Considerations that Influence Station Selection.

Feature	Feature Description	Suitability for Benthic Sampling
Man Made Structures	• Any visible mad man structure	NOT SUITABLE
Wrecks or Similar Archaeological Material	• Any visible archaeological material.	NOT SUITABLE
Large Accumulation of Marine Litter	• Any visible large accumulation of marine litter.	NOT SUITABLE

Table 2.6: Final subtidal grab station locations.

Station	Latitude	Longitude	Type of sediment analysis
Station 1	53.26338833	-9.57012	Fauna, Sed. Chem. & Radiology
Station 2	53.26308333	-9.571433333	Fauna, Sed. Chem. & Radiology
Station 3	53.26383333	-9.570416667	Fauna & Sed. Chem.
Station 4	53.26685	-9.568116667	Fauna & Sed. Chem.
Station 5	53.267045	-9.5668	Fauna & Sed. Chem.
Station 6	53.26733667	-9.568121667	Fauna & Sed. Chem.
Station 7	53.26157	-9.570708333	Fauna & Sed. Chem.

Figure 2.2: Map showing DDV stations, previous grab locations and new grab stations at Ros an Mhíl Harbour, Connemara, Co. Galway.

2.2 Benthic Grab Survey

Each location was chosen based on suitable sediment type determined from the video survey results. As with the video survey, the grab survey was carried out from the RPS Marine Vessel. The 0.1m^2 stainless steel Day Grab was deployed by winch. The grab stand was positioned underneath the frame and secured to the deck. At each station, staff collected three grab samples, one for sediment Particle Size Analysis (PSA) and organic carbon (LOI) and two for faunal analysis. The locations of the subtidal grab sampling are shown in **Table 2.6**.

2.2.1 Biological Sampling

AQUAFACT has in-house SOPs for benthic sampling, and these were followed for this project. Additionally, AQUAFACT follows the Northeast Atlantic Marine Biological Analytical Quality Control (NMBAQC) standard for benthic sampling and analysis (Worsfold *et al.,* 2010). The subtidal biological samples were collected using a 0.1m^2 Day Grab sampler**.** The stations deemed suitable for sampling with AQUAFACT's Day Grab are listed in **Table 2.6. Figure 2.1**. also illustrates the drop-down video stations along with previous selected grab locations and updated grab locations.

On arrival at each sampling station, the vessel location was recorded using GPS (Lat/Long & ING). A total of seven sites were sampled for faunal analysis with two faunal grabs and one sediment grab collected at each. The grab deployment and recovery rates did not exceed 1 metre/sec and were <0.5 m/sec for the last 5 metres for water depths up to 30m and for the last 10m for depths greater than 30m.

A digital image of each sample (including the sample label) was taken, and its reference number was entered in the sample data sheet. These images can be made available on request. The grab sampler was cleaned between stations to prevent cross contamination.

Each grab sample was carefully and gently sieved on a 1 mm mesh sieve as a sediment water suspension to separate fauna. Great care was taken during the sieving process to minimise damage to taxa such as spionids, scale worms, phyllodocids and amphipods due to their fragility. The sample residue was carefully flushed into an internally and externally labelled container. The samples were stained immediately with Rhodamine 110 (biological staining agent) and fixed with 4% w/v buffered formaldehyde solution (10% w/v buffered formaldehyde solution for samples with notably high organic content).

All grab samples were sieved on a 1 mm mesh sieve and fixed in 4-10% w/v buffered formalin solution upon returning to the laboratory (within 24 hours).

2.2.2 Sediment Sampling

SOCOTEC UK Ltd was the accredited laboratory contracted to analyse sediment samples for parameters as laid out in the Marine Institute criteria for the assessment of dredged material in Irish waters (Cronin *et al.,* 2006; Marine Institute, 2019). The seven sediment samples were analysed for the following parameters:

- Visual inspection, to include colour, texture, odour, presence of animals, *etc*.
- Water content, density (taking into account sample collection and handling).
- Granulometry including % gravel (> 2mm fraction), % sand (< 2mm fraction) and % mud (< 63µm fraction).
- The following determinants in the sand-mud (< 2mm) fraction* must be measured:
    - total organic carbon
    - carbonate
    - mercury, arsenic, cadmium, copper, lead, zinc, chromium, nickel, lithium, aluminium.
    - organochlorines Hexachlorobenzene and γ-Hexachlorocyclohexane (Lindane), and PCBs (to be reported as the 7 individual CB congeners: 28, 52, 101, 118, 138, 153, 180.
    - total extractable hydrocarbons.
    - tributyltin (TBT) and dibutyltin (DBT)
    - Polycyclic aromatic hydrocarbons (PAH) - Acenaphthene, Acenaphthylene, Anthracene, Benzo (a) anthracene, Benzo (a) pyrene, Benzo (b) fluoranthene, Benzo (ghi) perylene, Benzo (k) fluoranthene, Chrysene, Dibenz (a,h) anthracene, Flourene, Fluoranthene, Indeno 1,2,3 – cd pyrene, Naphthalene, Phenanthrene, Pyrene.
    - Toxicity tests (Microtox or whole sediment bioassay) using appropriate representative aquatic species. (This requirement will depend on the results of the chemical analyses.)
- Folk (1954) sediment classification.
- An estimate of organic matter (LOI %) Or total organic content
- Dry solids (%)

- Sum of USEPA 16 PAHs[1]: acenaphthene, acenaphthylene, anthracene, benzo[a,h]anthracene, benzo[b]fluoranthene, benzo[k]flouranthene, benzo[a]pyrene, benzo[g,h,i]perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene, and pyrene.

- Sum of the seven ICES polychlorinated biphenyls: PCB 028, PCB 052, PCB 101, PCB 118, PCB 138, BCB 153 and PCB 180.

- DDT, DDD, DDE and DDX.

**where the gravel fraction (> 2mm) constitutes a significant part of the total sediment, this should be taken into account in the calculation of the concentrations).*

Upon retrieval of the grab after deployment, a digital image was taken through the grab window and then the sediment transferred to a stainless-steel tray positioned beneath the grab jaws. Another image was then taken of the tray. These images are available on request. The sediment was subsequently transferred to the appropriate containers for analysis. This included 3x500 ml plastic tubs and 2x amber jars with tinfoil barriers on the lids for each station. The grab sampler was cleaned with Decon90 (dilute Potassium Hydroxide solution) between stations to prevent cross-contamination of sediment contaminants.

Samples were couriered to the SOCOTEC UK Laboratories in Burton on Trent. **Table 2.7** details the analysis method for each parameter.

Two samples for radiological analysis were sent to the EPA Office of Radiation Protection and Environmental Monitoring where analysis was carried out by high resolution gamma spectrometry.

Table 2.7: Method of analysis for each parameter by SOCOTEC.

Method	Sample and Fraction Size	Method Summary
Total Solids	Wet Sediment	Calculation (100%-Moisture Content). Moisture content determined by drying a portion of the sample at 120°C to constant weight.
Particle Size analysis	Wet Sediment	Wet and dry sieving followed by laser diffraction analysis.
Total Organic Carbon (TOC)	Air dried and sieved to <2mm	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Carbonate	Air dried and sieved to <2mm	Quantitative digestion with Hydrochloric Acid back titration with 1M Sodium Hydroxide to pH 7
Metals	Air dried and sieved to <2mm	Microwave assisted HF/Boric extraction followed by ICP analysis.

Method	Sample and Fraction Size	Method Summary
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-FID analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Solvent extraction and clean up followed by GC-FID analysis.
Polychlorinated Biphenyls (PCBs)	Air dried and sieved to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.
Organochlorine Pesticides (OCPs)	Air dried and sieved to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.

2.3 Lab Analysis

2.3.1 Sediment Processing

In addition to SOCOTEC sediment chemistry analysis, granulometry and organic content of sediment samples was determined for each sample by expressing it as a percentage the sediment weight loss following combustion over the initial weight of the sediment. In general, Loss Of carbon Ignition (LOI) correlates with sediment particle size with fine-grained sediments typically containing higher levels of organic matter than coarse sediments.

For the granulometric analysis of sediment samples, the <63 µm (Silt-Clay) fraction was determined by laser diffraction following sieving of the coarser fractions. Coarser fractions comprising the sediment samples were determined by mechanical dry sieving through a series of Wentworth sieves; >4 mm (Fine Gravel), 2-4 mm (Very Fine Gravel), 1-2 mm (Very Coarse Sand), 0.5-1 mm (Coarse Sand), 0.25-0.5mm (Medium Sand), 125-250 µm (Fine Sand), 62.5-125 µm (Very Fine Sand). For each station, the weight of each fraction of the sediment retained on the sieve was expressed as a percentage of the total sample. The relative proportion of sediments in each fraction was used to classify sediments at the station *sensu* Folk (1954). **Table 2.8** shows the classification of sediment particle size ranges into size classes. Sieves, which corresponded to the range of particle sizes were used in the analysis.

Table 2.8: The classification of sediment particle size ranges into size classes (adapted from Buchanan, 1984).

Range of Particle Size	Classification	Phi Unit
<63µm	Silt/Clay	>4 Ø
63-125 µm	Very Fine Sand	4 Ø, 3.5 Ø
125-250 µm	Fine Sand	3 Ø, 2.5 Ø
250-500 µm	Medium Sand	2 Ø, 1.5 Ø
500-1000 µm	Coarse Sand	1 Ø, 1.5 Ø
1000-2000 µm (1 – 2mm)	Very Coarse Sand	0 Ø, -0.5 Ø
2000 – 4000 µm (2 – 4mm)	Very Fine Gravel	-1 Ø, -1.5 Ø
4000 -8000 µm (4 – 8mm)	Fine Gravel	-2 Ø, -2.5 Ø
8 -64 mm	Medium, Coarse & Very Coarse Gravel	-3 Ø to -5.5 Ø
64 – 256 mm	Cobble	-6 Ø to -7.5 Ø
>256 mm	Boulder	< -8 Ø

2.4 Data Analysis

2.4.1 Sediment Data

Organic content of sediment samples was determined for each sample by expressing it as a percentage the sediment weight loss following combustion over the initial weight of the sediment. In general, Loss of carbon Ignition (LOI) correlates with sediment particle size with fine-grained sediments typically containing higher levels of organic matter than coarse sediments.

For the granulometric analysis of sediment samples, the <63 µm (Silt-Clay) fraction was determined by weight loss following wet sieving. Coarser fractions comprising the sediment samples were determined by mechanical dry sieving through a series of Wentworth sieves; >4mm (Fine Gravel), 2-4mm (Very Fine Gravel), 1-2mm (Very Coarse Sand), 0.5-1mm (Coarse Sand), 0.25-0.5mm (Medium Sand), 125-250µm (Fine Sand), 62.5-125µm (Very Fine Sand). For each station, the weight of each fraction of the sediment retained on the sieve was expressed as a percentage of the total sample. The relative proportion of sediments in each fraction was used to classify sediments at the station *sensu* Folk (1954).

2.4.2 Fauna Data

Uni- and multi-variate statistical analysis of the faunal data was undertaken using PRIMER v.6 (Plymouth Routines in Ecological Research). Epifaunal and colonial fauna was removed from the dataset prior to analysis.

2.4.2.1 Univariate Indices

Using PRIMER, the infaunal data was used to produce a range of univariate indices. Univariate indices are designed to condense species data in a sample into a single coefficient that provides quantitative estimates of biological variability (Heip *et al*., 1998; Clarke and Warwick, 2001). Univariate indices can be categorised as primary or derived indices.

Primary biological indices used in the current study include:

- number of taxa (S) in the samples and
- number of individuals (N) in the samples.

Derived biological indices, which are calculated based on the relative abundance of species in samples, used in the study include:

- Margalef's species richness index (D) (Margalef, 1958),

$$D = \frac{S - 1}{\log_2 N}$$

where: N is the number of individuals and S is the number of species

Margalef's species richness (D) is a measure of the total number of species present for a given number of individuals.

- Pielou's Evenness index (J) (Pielou, 1977)

$$J = \frac{H'(\text{observed})}{H'_{max}}$$

where: H'_{max} is the maximum possible diversity, which could be achieved if all species were equally abundant (= $\log_2 S$)

Pielou's evenness is a measure of how evenly the individuals are distributed among different species.

- Shannon-Wiener diversity index (H') (Pielou, 1977)

$$H' = -\sum_{i=1}^{S} p_i(\log_2 p_i)$$

where: p_I is the proportion of the total count accounted for by the i^{th} taxa

Shannon-Wiener diversity index takes both species abundance and species richness into account quantify diversity (Shannon & Wiener, 1949).

- Simpson's Diversity Index (Simpson, 1949)

$$1-\lambda' = 1-\{\Sigma_i N_i(N_i-1)\} / \{N(N-1)\}$$

where N is the number of individuals of species i.

- The Shannon-Wiener based Effective Number of Species (ENS) (Hill, 1973; Jost, 2006)

$$H = \exp(H')$$

where H' is the Shannon-Wiener diversity index.

The Shannon-Wiener index diversity index is converted to ENS to reflect 'true diversities' (Hill, 1973, Jost, 2006) that can then be compared across communities (MacArthur, 1965; Jost, 2006). The ENS is equivalent to the number of equally abundant species that would be needed in each sample to give the same value of a diversity index, *i.e.,* Shannon-Wiener Diversity index. The ENS behaves as one might intuitively expect when diversity is doubled or halved, while other standard indices of diversity do not (Jost, 2006). If the ENS of one community is twice that of another, then it can be said that the community is twice as diverse as the other.

2.4.2.2 Multivariate Analysis

The PRIMER programme (Clarke & Warwick, 2001) was used to carry out multivariate analyses on the station-by-station faunal data. All species abundance data from the grab surveys was square root transformed and used to prepare a Bray-Curtis similarity matrix in PRIMER. The square root transformation allows some of the less abundant species to be upweighted in the similarity calculation. Various ordination and clustering techniques can then be applied to the similarity matrix to determine the relationship between the samples.

Multidimensional scaling (MDS) is a technique that ordinates samples as points in 2D or 3D space based on similarity in species distribution data. MDS performed on the Bray-Curtis similarity matrix produce ordination maps whereby the placement of samples reflects the similarity of their biological communities, rather than their simple geographical location (Clarke & Warwick, 2001).

An indication of how well the similarity matrix is represented by the ordination is given by stress values calculated by comparing the interpoint distances in the similarity matrix with the corresponding interpoint distances on the ordinations. Perfect or near perfect matches are rare in field data, especially in the absence of a single overriding forcing factor such as an organic enrichment gradient. Stress values increase, not only with the reducing dimensionality (lack of clear forcing structure), but also with increasing quantity of data (it is a sum of the squares type regression coefficient). Clarke & Warwick (2001) have provided a classification of the reliability of MDS plots based on stress values, having compiled simulation studies of stress value behaviour and archived empirical data.

This classification generally holds well for ordinations of the type used in this study. Their classification is given below:

- Stress value < 0.05: Excellent representation of the data with no prospect of misinterpretation.
- Stress value < 0.10: Good representation, no real prospect of misinterpretation overall structure, but very fine detail may be misleading in compact subgroups.
- Stress value < 0.20: This provides a useful picture, but detail may be misinterpreted, particularly nearing 0.20.
- Stress value 0.20 to 0.30: This should be viewed with scepticism, particularly in the upper part of the range, and discarded for a small to moderate number of points such as < 50.
- Stress values > 0.30: The data points are close to being randomly distributed in the ordination and not representative of the underlying similarity matrix.

Each stress value must be interpreted both in terms of its absolute value and the number of data points. In the case of this study, the moderate number of data points indicates that the stress value can be interpreted more or less directly. While the above classification is arbitrary, it does provide a framework that has proved effective in this type of analysis.

Hierarchical Agglomerative Clustering (HAC) is used to cluster samples based on between-sample similarities into groups in dendrograms. Similarity Profiling (SIMPROF) is used to test if differences between HAC derived similarity-based clusters are significant. Similarity Percentages (SIMPER) analysis can be used to determine the characterising species of each cluster of stations identified either arbitrarily (by eye) from HAC dendrograms or statistically using SIMPROF testing (Clarke and Warwick, 2001; Clarke and Gorley, 2006; Anderson *et al*., 2008).

The species, which are responsible for the grouping of samples in CLUSTER analyses, were identified using the PRIMER programme SIMPER (Clarke & Warwick, 1994). This programme determined the percentage contribution of each species to the dissimilarity/similarity within and between each sample group.

2.4.3 Video & Image Stills Data

The video and stills data were analysed following the JNCC Guidance on Assigning Benthic biotopes using EUNIS or the Marine Habitat Classification of Britain and Ireland (Parry, 2019). However, statistical analyses are not applied to species identified from video and still images data as the species identification and number is usually of low resolution. The video data provides a broader picture of the habitat while the image stills allow identification of smaller and less conspicuous species over smaller areas. The video and stills data capture different sections of the community and as a result they are analysed separately. Generally, for each species identified from the video or stills, both abundance and SACFOR is provided per video section or per still, but sometimes only presence/absence is used. In situations where *Sabellaria* reef are found, the guidance provided by Gubbay (2007) is followed to cover techniques to map, avoid disturbance and conserve *Sabellaria* reef.

2.4.4 Assigning Biotope

After analysis, the data from the infauna identified are then matched with the broadscale habitats (EUNIS) data derived from particle size analysis and video/still data and a biotope is assigned according to the Marine Habitat Classification of Britain and Ireland (Parry, 2019). The biotope name assigned to data should accurately describes the physical environment as well as the biological community. The following steps are followed to assign biotope:

(i) Select physical zone for each sampling point based on depths, light, indicator species, geospatial maps (EMODnet Seabed Habitats Map Viewer).

(ii) Define substrate category (rock, coarse, sediment, missed sediment, sand and muddy sand, and mud and sandy mud). The four sediment categories depend on the relative proportions of mud, sand, and gravel as defined in Folk classification (Folk, 1954).

(iii) Check physical samples based on

- PSA analysis
- grab images and deck logs to get a broader picture of the sediment retained in the whole grab.
- Cross-check any visual samples taken at the same station (including video footage).

(iv) Check visual samples based on

- Notes logs.

- Raw data -video footage.
- PSA results.
- Functional traits of species present giving an indication of the substrate type.

(v) Select energy /mobility category for each sample.

For rock samples:

- Check energy regime on field notes.
- Energy category should reflect types of communities present. Select energy category which best fits community present.
- If energy regime cannot be determined from field data, sample points can be overlain onto EUSeaMap energy class layer from EMODnet Seabed Habitats map viewer.

For sediment samples:

- Check mobility of samples.
- Video footage to gauge mobility of sediment.
- Features such as sand ripples can indicate the mobility of sediment.

(vi) Select salinity category for each sample based on notes in logs, geographic location or any salinity readings taken.

For each sample, the faunal communities are identified which is used to refine the description of the biotope. In the situation where there is any mismatch between the biological community and the habitat type, a number of approaches are taken to clearly indicate that the physical environment differs from the description of the biological community present (Parry, 2019).

2.5 Desk Study

A comprehensive desk-based review was undertaken to assess the existing environmental baseline conditions for marine mammals in Ros an Mhíl harbour. The study focused on identifying species presence, distribution, seasonal usage patterns. Key data sources included statutory datasets from the National Parks and Wildlife Service (NPWS), conservation objectives for nearby designated sites (*e.g.* Kilkieran Bay and Islands SAC), and published literature such as Berrow *et al*. (2002, 2008), O'Brien (2009, 2013), and Hammond *et al*. (2021). Grey and harbour seal haul-out data were drawn from NPWS surveys and the SMRU seal database, while cetacean occurrence in Galway Bay was informed by records from the Irish Whale and Dolphin Group (IWDG) and scientific studies.

This information was used to identify key marine mammal receptors, define their spatial and seasonal presence, and determine appropriate thresholds for impact assessment and mitigation planning.

2.6 Impact Assessment

The assessments of impacts to benthic ecology, marine mammals, fish species, invasive alien species (IAS), and water quality was undertaken through a combination of desk-based review and application of best-practice guidance. Existing environmental data was reviewed to identify sensitive habitats and species, potential sources of impact and the significance of these effects

The impact assessment applied a source-pathway-receptor (SPR) framework to evaluate the likely magnitude and duration of impacts, identify appropriate mitigation, and determine any residual impacts.

3. Results

3.1 Drop-down video

The Drop-down video (DDV) survey identified areas suitable for grab survey (for fauna and sediment contaminants) as well as identifying locations of potential reef habitat. Two main broadscale habitats and two biotopes were identified from the DDV recordings and image stills. No reef system, as per Irving (2009), was identified during the survey**. Figure 3.1** and **Figure 3.2** below show the habitats and biotopes identified during the DDV survey.

Ros an Mhíl Harbour is a turbid environment with strong currents and can have considerable suspended solids. As a result, visibility was often poor in the video footage. There were only a few images captured to assess the substrate and biotopes along the transects.

Images of the seabed were captured from the video footage recorded at each of the stations where dropdown video was deployed. Analysis of the epibenthic communities based on the video footage along with representative still images is presented below. The distance between the green lasers in each image is 20 cm. Full video footage from each recording is available by request if required.

The photo stills captured from the video transects are poor in resolution due to very high turbidity during the survey. Only usable image stills are presented in this section.

Table 3.1: The biotope classifications (JNCC 2024) identified for each Drop-Down Video station.

Station	Biotope Code	Biotope Classification
DDV01	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp.SSgr.Zmar	*Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand
DDV02	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp	Sublittoral macrophyte-dominated communities on sediments
DDV03	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp	Sublittoral macrophyte-dominated communities on sediments
DDV04	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp	Sublittoral macrophyte-dominated communities on sediments
DDV05	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp	Sublittoral macrophyte-dominated communities on sediments
DDV06	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp	Sublittoral macrophyte-dominated communities on sediments
DDV07	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp	Sublittoral macrophyte-dominated communities on sediments
	SS.SMp.SSgr.Zmar	*Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand
DDV08	SS.SMx.CMx	Circalittoral mixed sediment
DDV09	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SCS.CCS.SpiB	*Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
DDV10	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp.SSgr.Zmar	*Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand
	SS.SMp.KSwSS	Kelp and seaweed communities on sublittoral sediment
DDV11	SS.SMx.CMx	Circalittoral mixed sediment
DDV12	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp	Sublittoral macrophyte-dominated communities on sediments
DDV13	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp.KSwSS	Kelp and seaweed communities on sublittoral sediment

Station	Biotope Code	Biotope Classification
	CR.HCR.XFa.FluCoAs.SmAs	*Flustra foliacea*, small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders
DDV14	SS.SMx.CMx	Circalittoral mixed sediment
	CR.HCR.XFa.FluCoAs.SmAs	*Flustra foliacea*, small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders
DDV15	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp	Sublittoral macrophyte-dominated communities on sediments
DDV16	SS.SMx.CMx	Circalittoral mixed sediment
DDV17	SS.SMx.CMx	Circalittoral mixed sediment
DDV18	SS.SMx.CMx	Circalittoral mixed sediment
DDV19	SS.SMx.CMx	Circalittoral mixed sediment
	SS.SMp	Sublittoral macrophyte-dominated communities on sediments
DDV20	SS.SMx.CMx	Circalittoral mixed sediment
	CR.HCR.XFa.FluCoAs.SmAs	*Flustra foliacea*, small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders
Secondary Biotopes		
DDV07	SS.SMP.SSgr.Zmar	*Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand
DDV09	CR.HCR.XFa.FluCoAs.SmAs	*Flustra foliacea*, small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders
DDV12	CR.HCR.XFa.FluCoAs.SmAs	*Flustra foliacea*, small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders
DDV18	CR.HCR.XFa.FluCoAs.SmAs	*Flustra foliacea*, small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders
DDV19	CR.HCR.XFa.FluCoAs.SmAs	*Flustra foliacea*, small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders

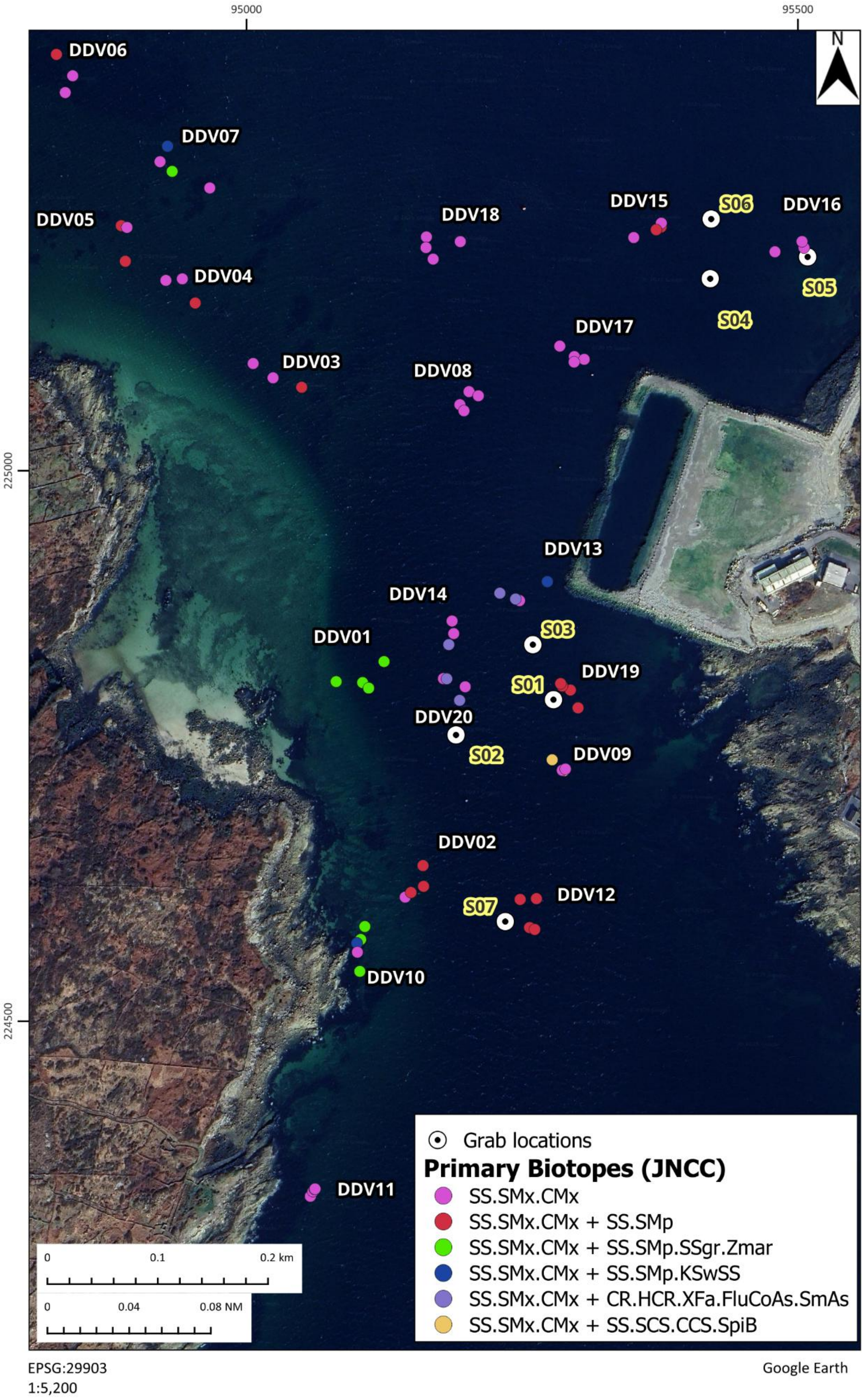

Figure 3.1: Identification of biotopes based on Drop-Down Video survey.

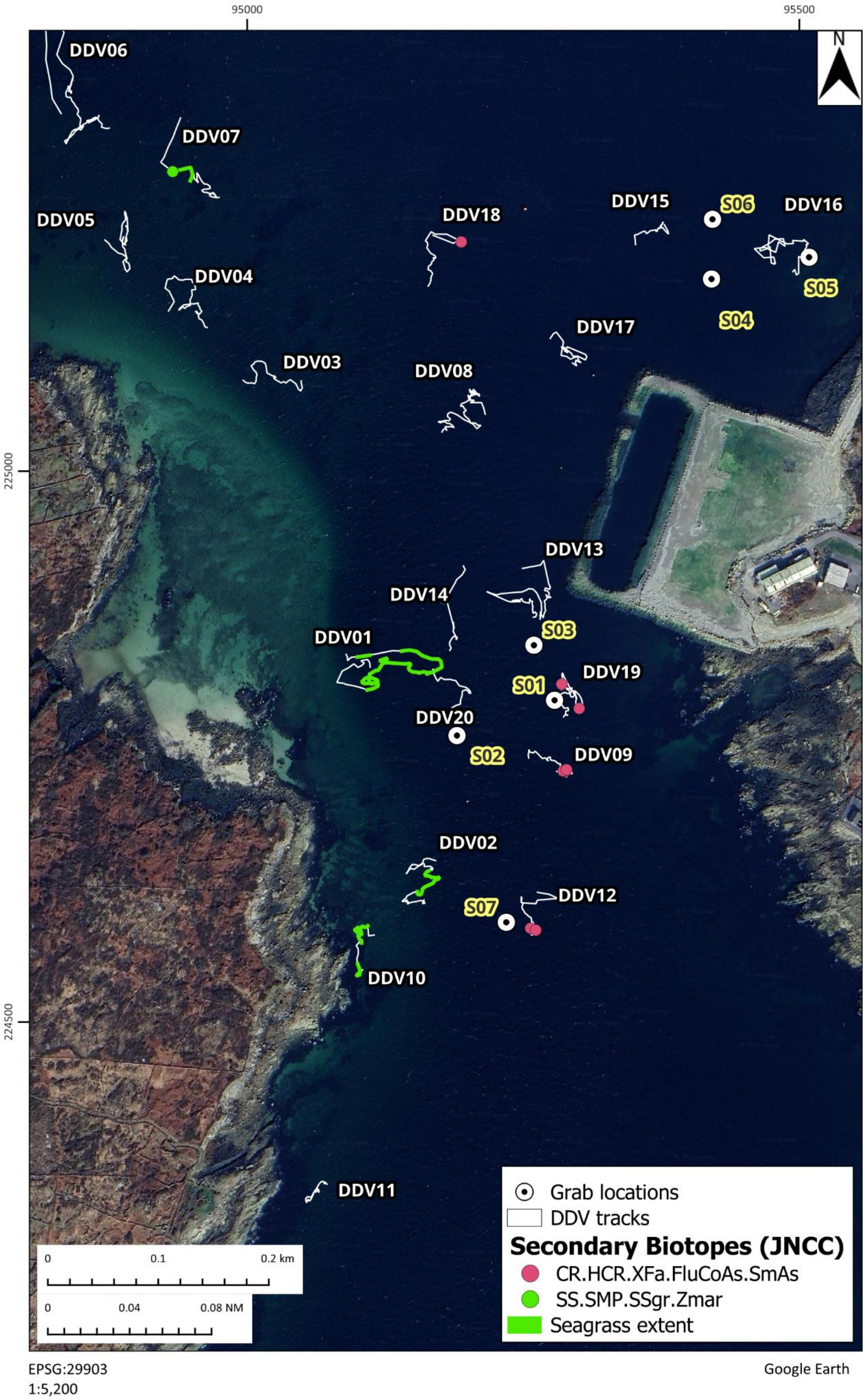

Figure 3.2: Identification of secondary biotopes identified by Drop-Down Video survey.

3.1.1 DDV Track 1

The substrate consisted of fine sand with stretches of dense stands of the seagrass *Zostera marina*. The associated infauna depends on the nature of the substrate. This biotope can be classified as the JNCC biotope 'SS.SMp.SSgr.Zmar - *Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand (EUNIS: MB5223) overlapping with the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment (**Figure 3.3** to **Figure 3.6**).

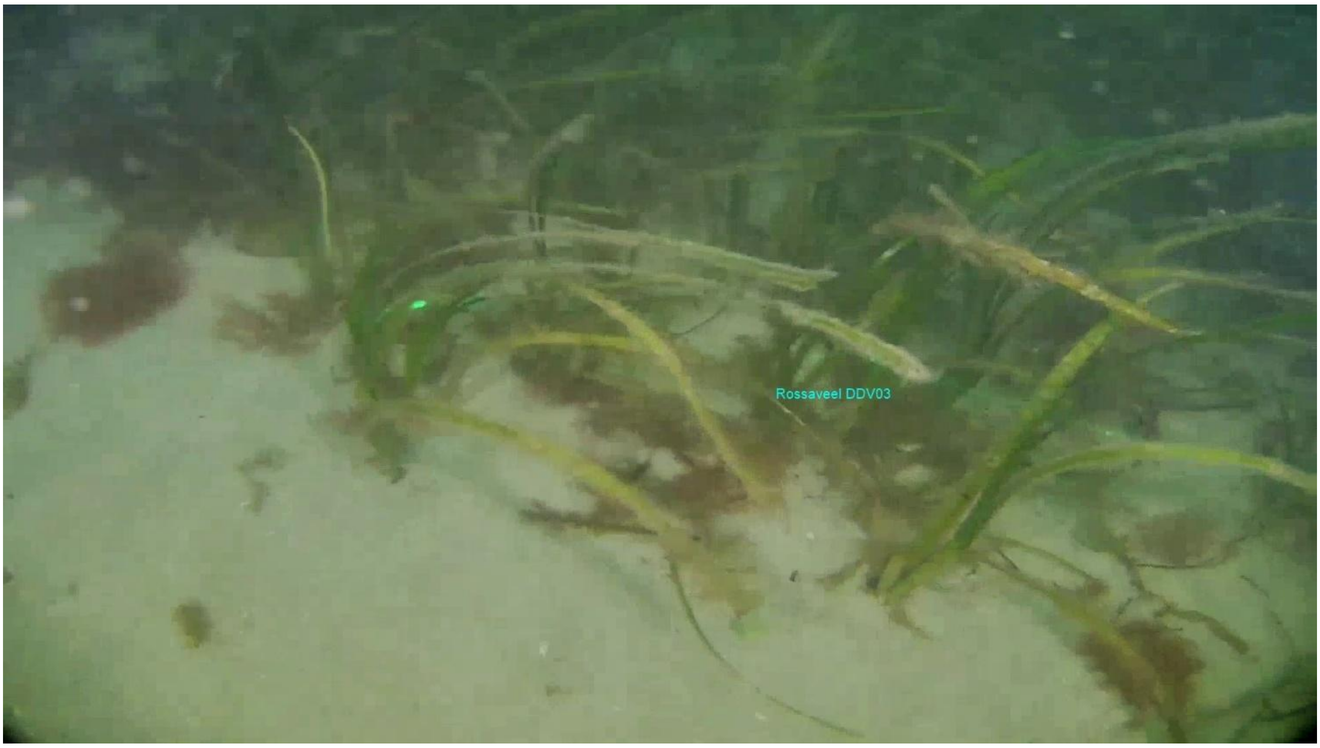

Figure 3.3: DDV Track 1 - seagrass *Zostera marina* and red algae on sand.

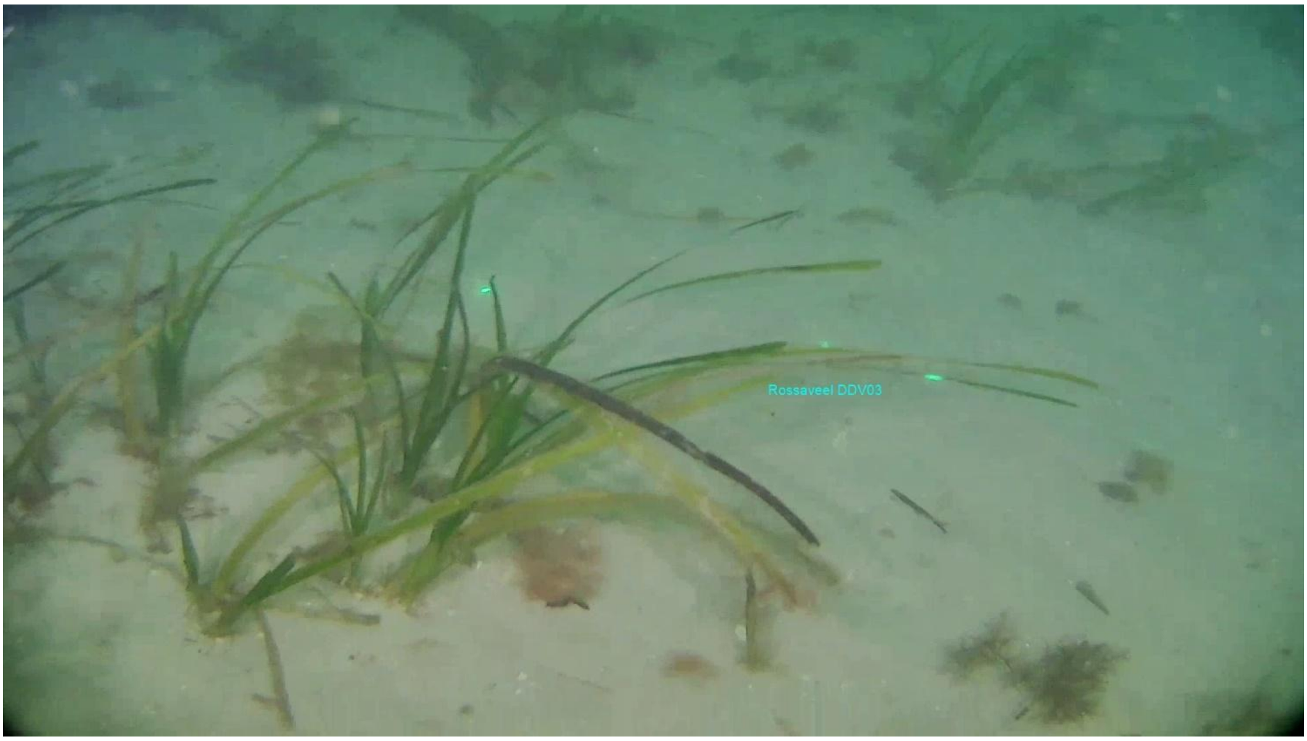

Figure 3.4: DDV Track 1 - seagrass *Zostera marina* and red algae on sand.

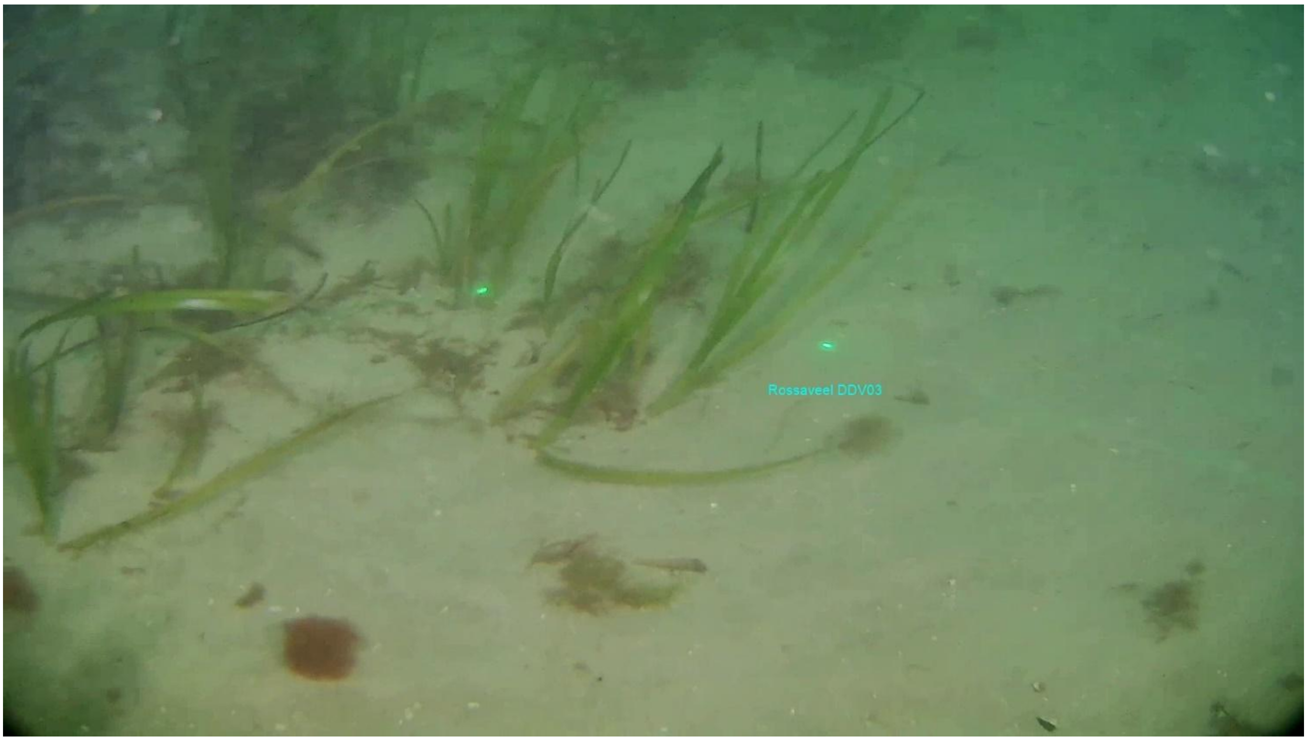

Figure 3.5: DDV Track 1 - seagrass *Zostera marina* and red algae on sand.

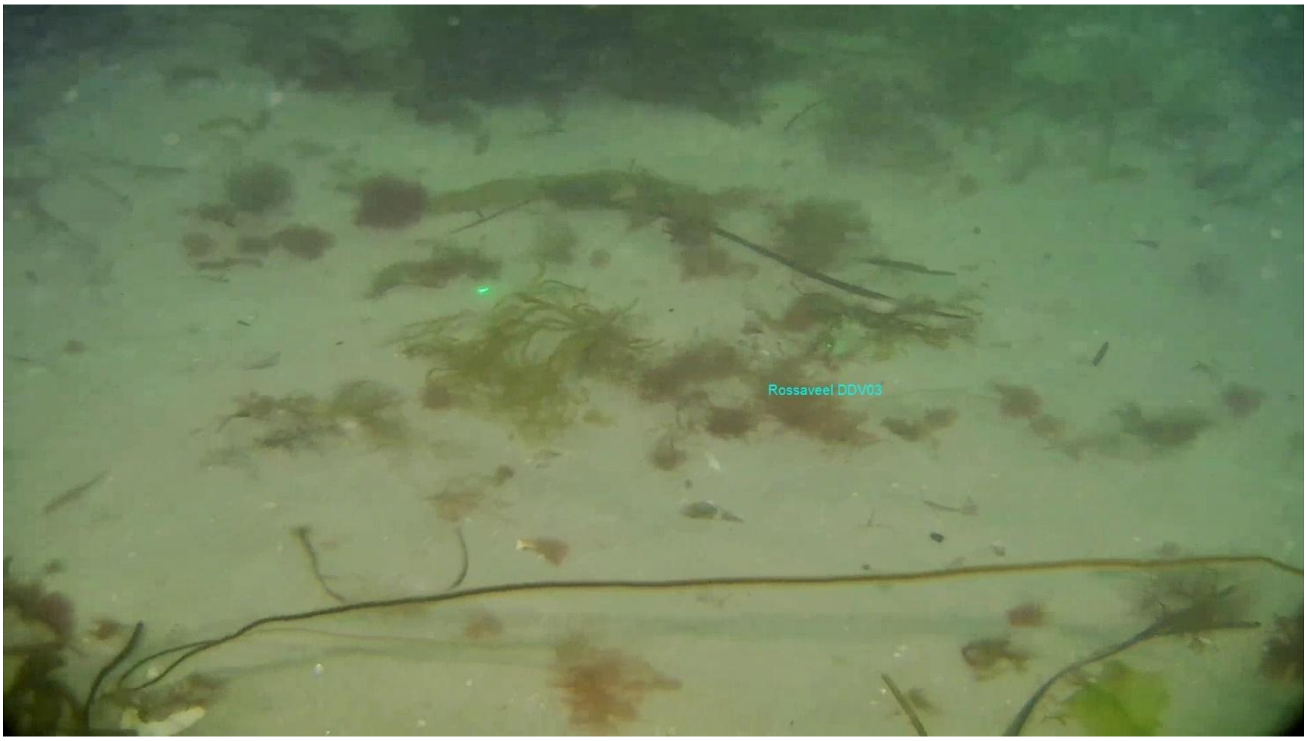

Figure 3.6: DDV Track 1 - seagrass *Zostera marina* and red algae on sand.

3.1.2 DDV Track 2

The substrate consisted of sand with scattered shell material and cobbles with stands of the seagrass *Zostera marina* and drift red/brown macroalgae. Biotope classification: There is a mosaic of two broadscale habitats namely, SS.SMx.CMx Circalittoral mixed sediment and SS.SMp - Sublittoral macrophyte-dominated communities on sediments together with some SS.SMx.CMx.FluHyd- *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (EUNIS code MC4214). Additionally, the JNCC biotopes 'SS.SMp.SSgr.Zmar - *Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand (EUNIS code MB5223) and 'SS.SCS.CCS.SpiB' – *Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles' (EUNIS code MC3211) were also recorded along the transect. Notable epifauna included the harbour crab *Polybius depurator*, a goby (Gobiidae), and a starfish (unidentifiable) (**Figure 3.7** to **Figure 3.10**).

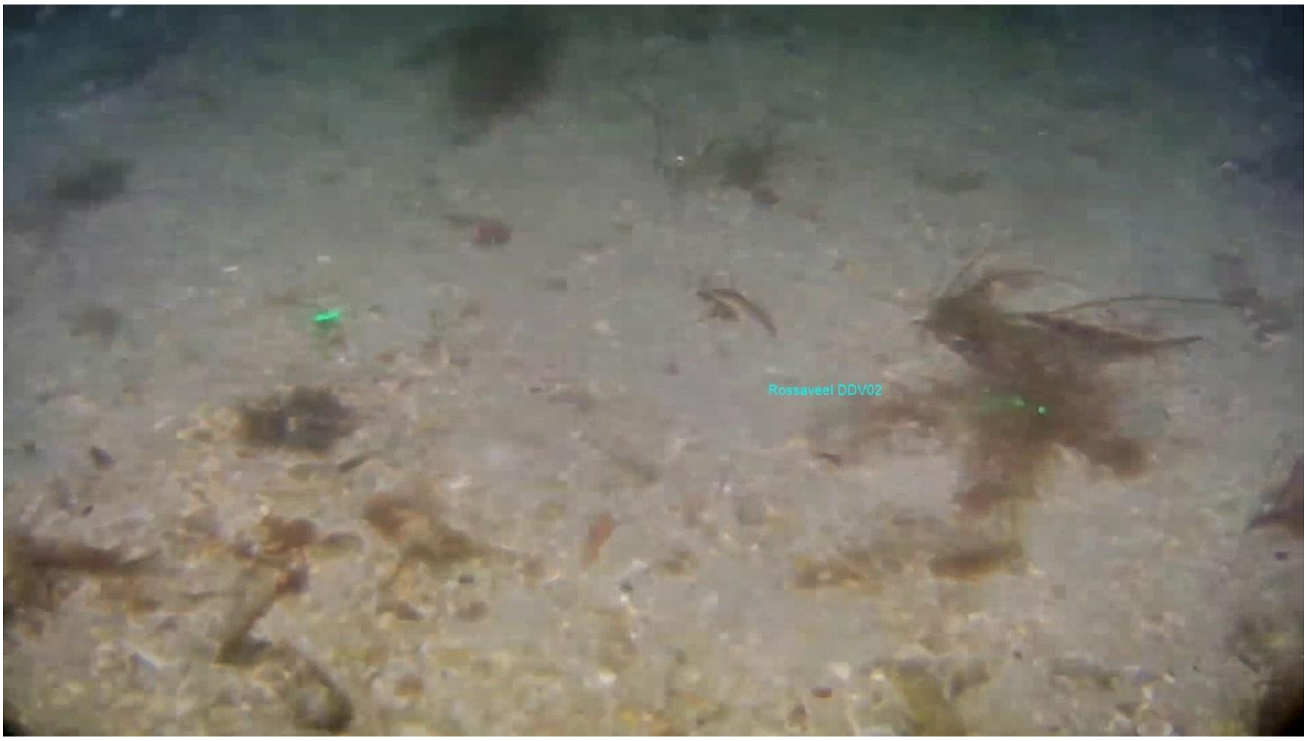

Figure 3.7: DDV Track 2 - sand substrate with shells and drift red/brown macroalgae.

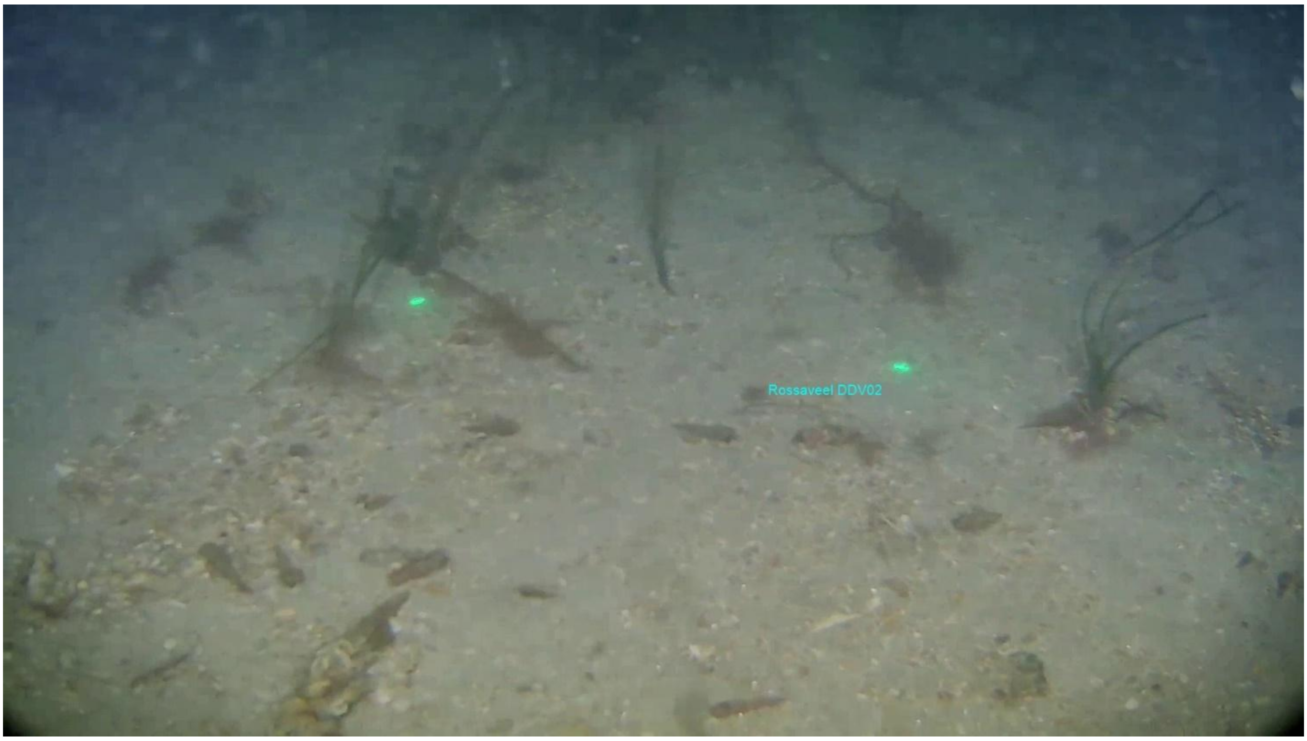

Figure 3.8: DDV Track 2 - sand substrate with shells, stands of *Zostera marina* and drift red/brown macroalgae.

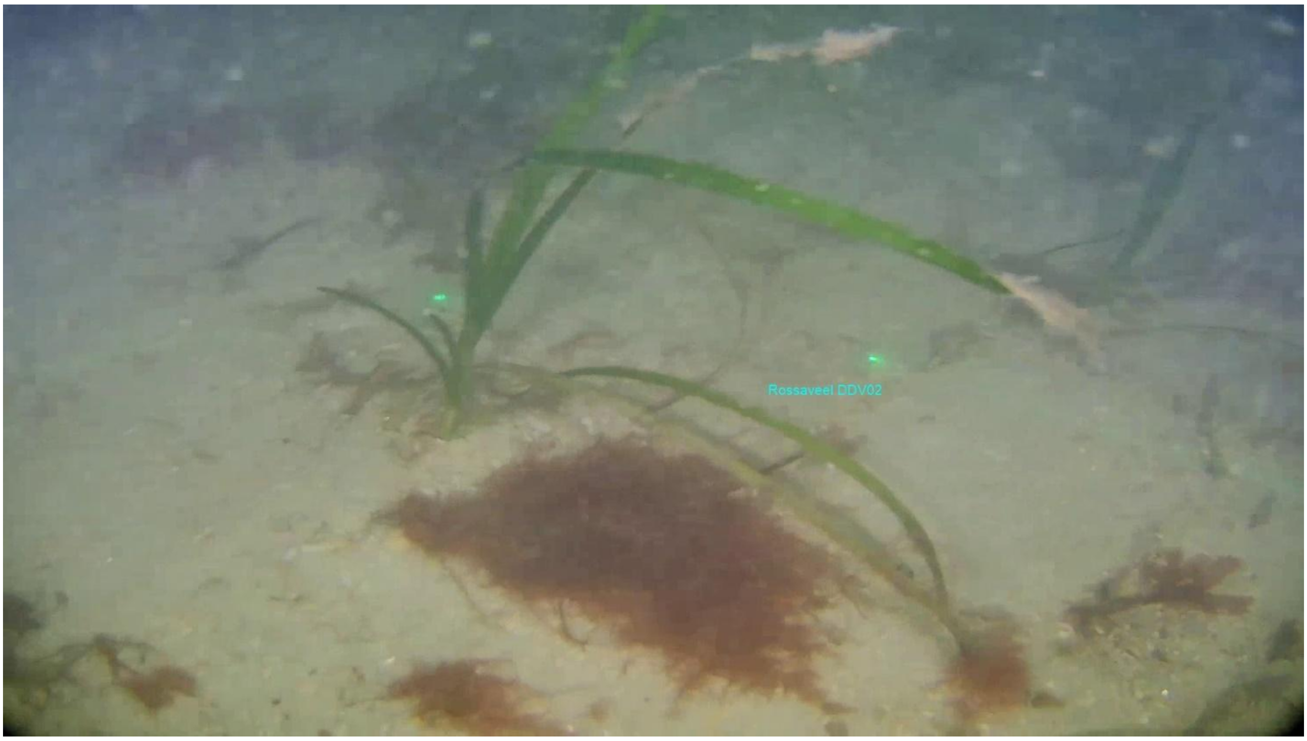

Figure 3.9: DDV Track 2 - sand substrate with shells, stands of *Zostera marina* and drifting red/brown macroalgae.

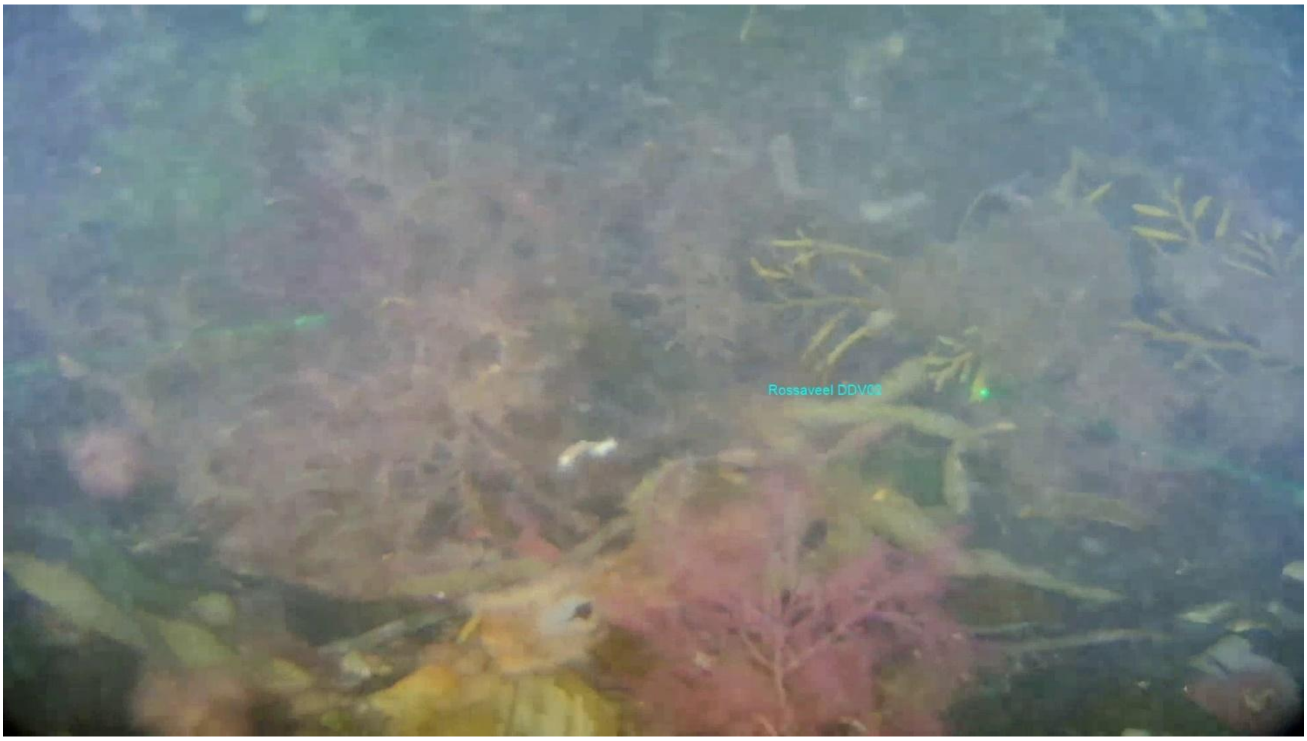

Figure 3.10: DDV Track 2 - dense assemblage of macrophytes (Green, brown and red macroalgae) together with stands of *Zostera marina.*

3.1.3 DDV Track 3

The substrate consisted of sand with scattered shell material with some cobbles. Drift and attached red/brown macroalgae and thongweed (*Himanthalia elongata*) could be observed along this transect. Notable fauna included the harbour crab *Polybius depurator*, sea lace (*Chorda filum*), sugar kelp (*Saccharina latissima*) and a starfish (unidentifiable) (**Figure 3.11** to **Figure 3.13**). The broadscale habitats can be classified as SS.SMx.CMx Circalittoral mixed sediment and SS.SMp – Sublittoral macrophyte-dominated communities on sediments (EUNIS code MC4214).

Figure 3.11: DDV Track 3 - sand substrate with shell materials with drift red/brown macroalgae.

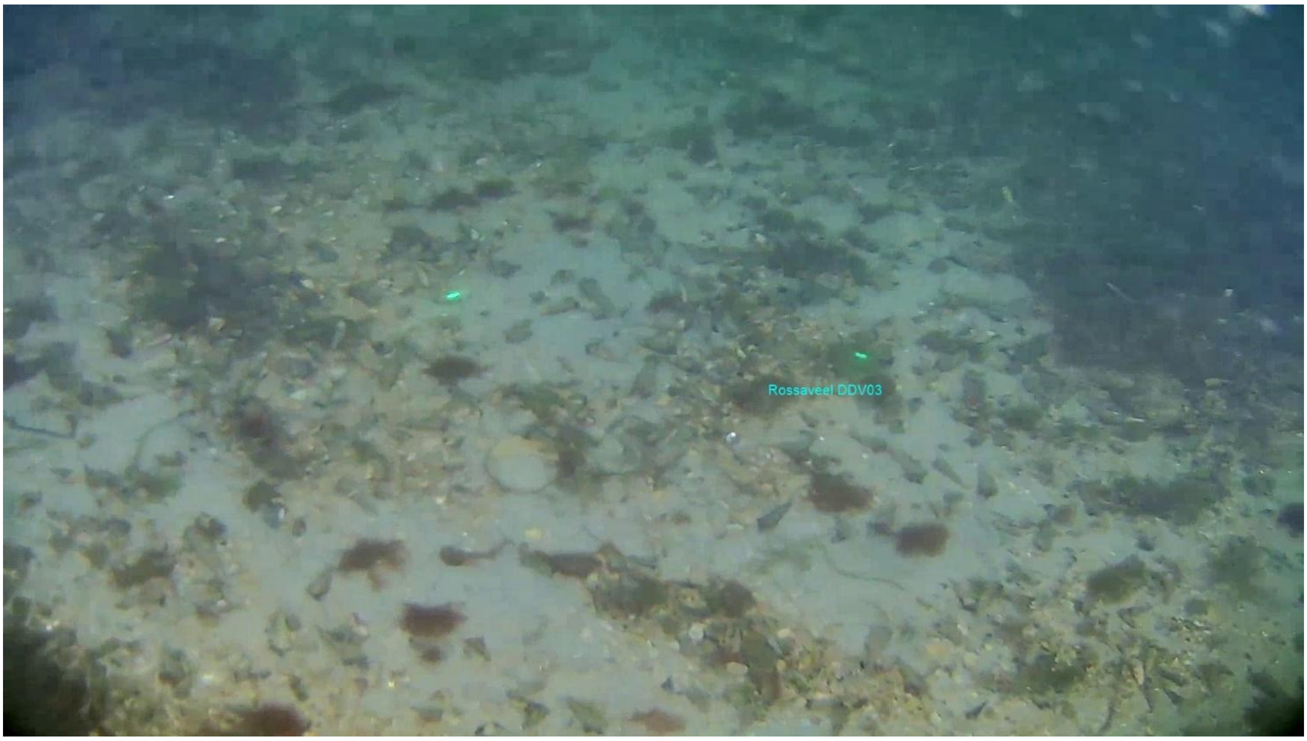

Figure 3.12: DDV Track 3 - sand with shell materials with drift red/brown macroalgae.

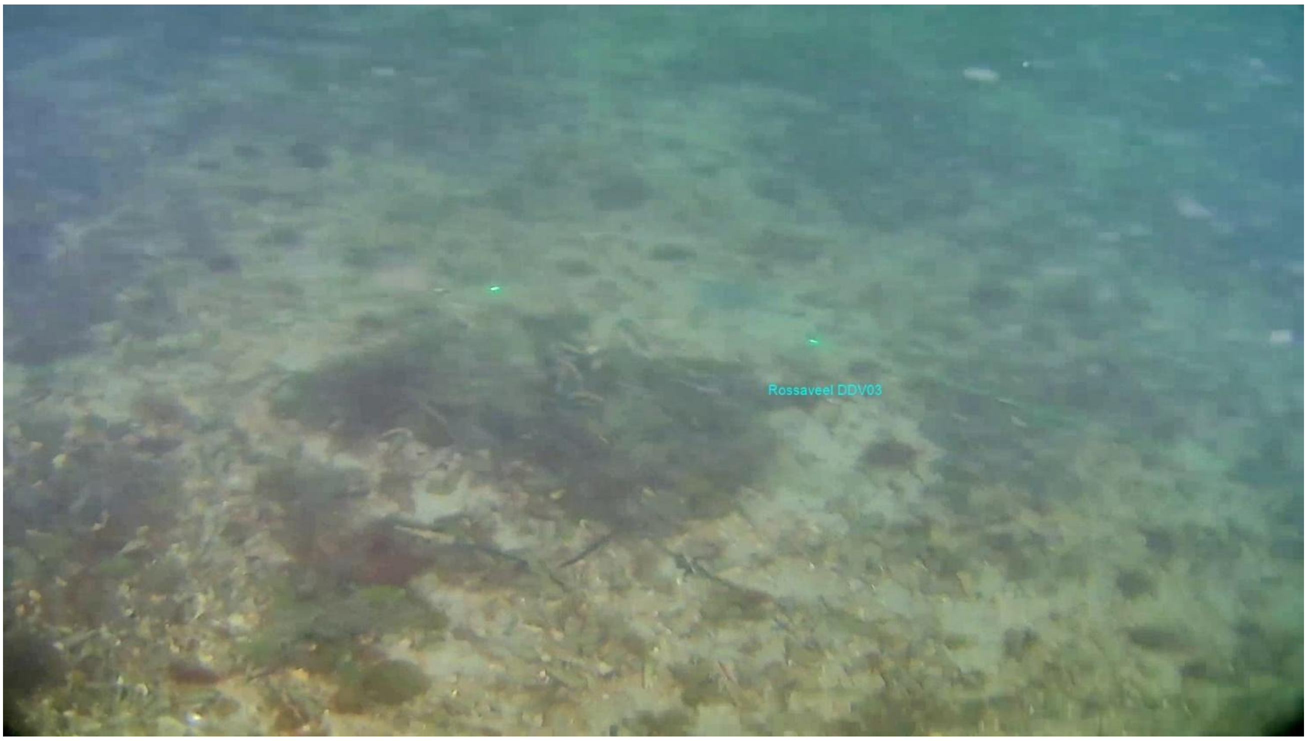

Figure 3.13: DDV Track 3 - sand with shell materials with drift red/brown macroalgae.

3.1.4 DDV Track 4

The substrate consisted of sand with scattered shell material with some cobbles. Drift and attached red/brown macroalgae and thongweed (*Himanthalia elongata*). Notable fauna included a swimming crab, a hermit crab (Paguridae), a starfish, and a goby (Gobiidae) (**Figure 3.14** to **Figure 3.16**). The biotope can be classified as the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment.

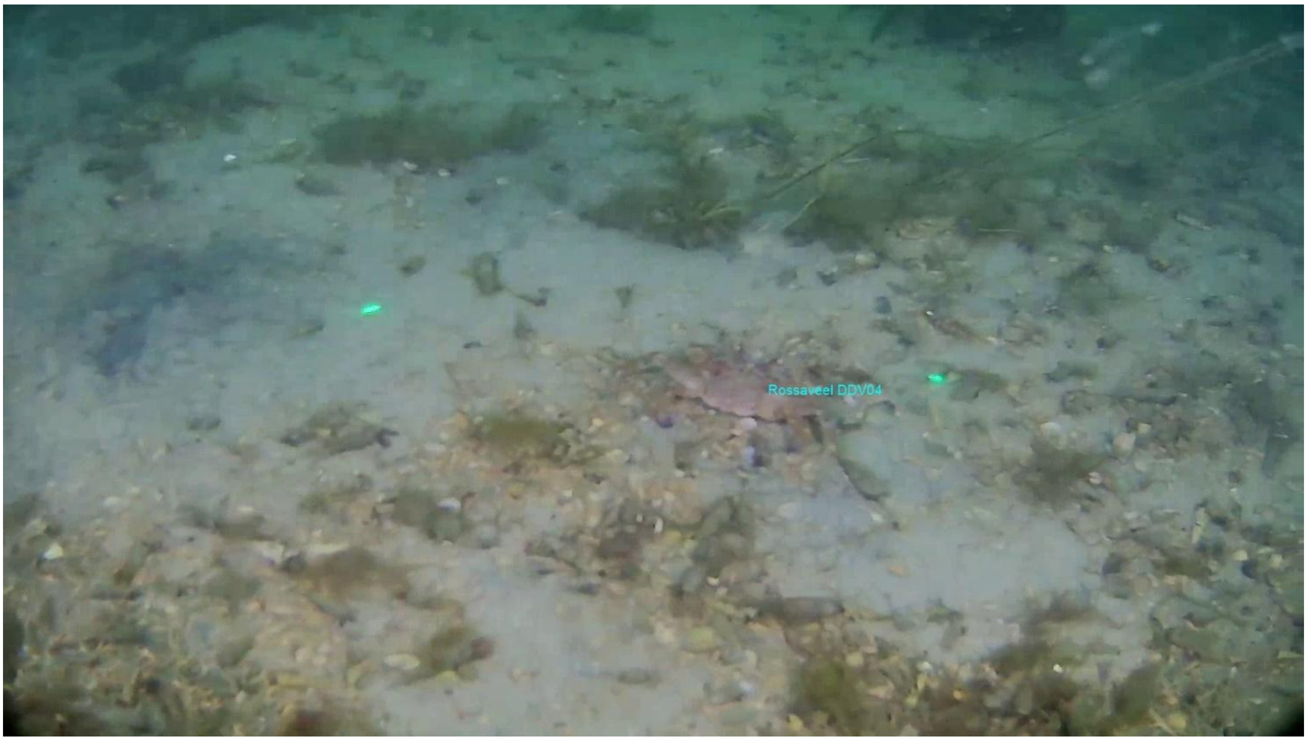

Figure 3.14: DDV Track 4 - sand substrate with shell debris, drift green macroalgae and solitary crab.

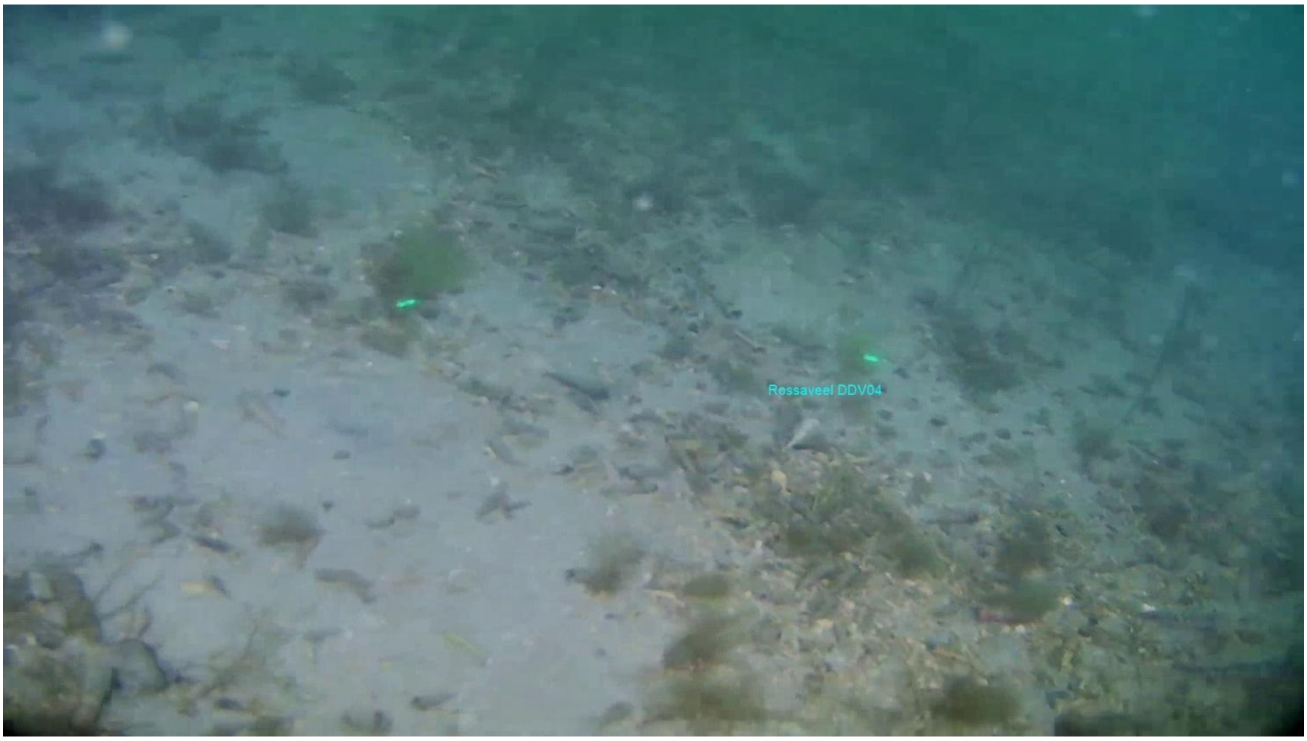

Figure 3.15: DDV Track 4 -sand substrate with shell, drift green and red/brown macroalgae.

Figure 3.16: DDV Track 4 - sand substrate with shell, drift green and red/brown macroalgae.

3.1.5 DDV Track 5

The substrate again consisted of sand with scattered shell material with cobbles. Drift red/brown macroalgae and presence of thongweed (*Himanthalia elongata*). Notable fauna included a crab and hermit crab (Paguridae), and Gobiidae fish (**Figure 3.17** to **Figure 3.19**). There is a mosaic of two broadscale habitats namely, SS.SMx.CMx Circalittoral mixed sediment and SS.SMp – Sublittoral macrophyte-dominated communities on sediments (EUNIS code MC4214).

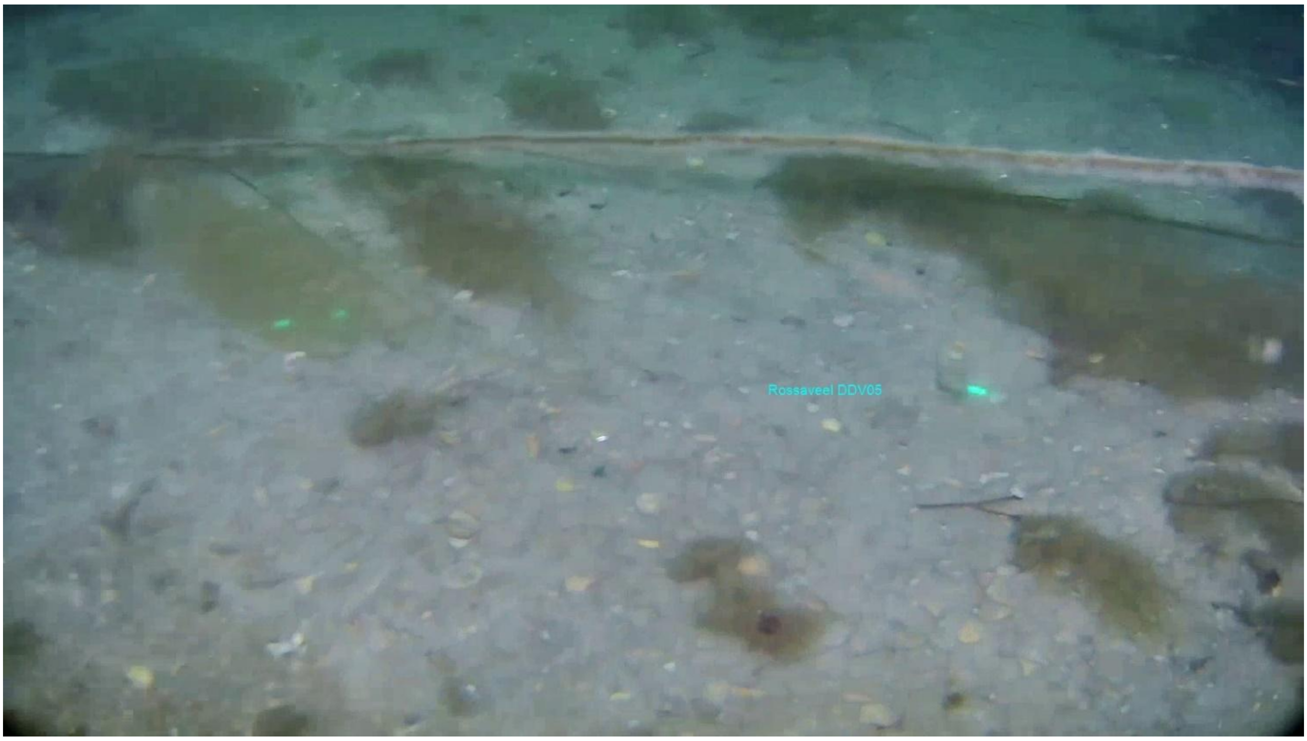

Figure 3.17: DDV Track 5 - sand substrate with shell material and drift macroalgae.

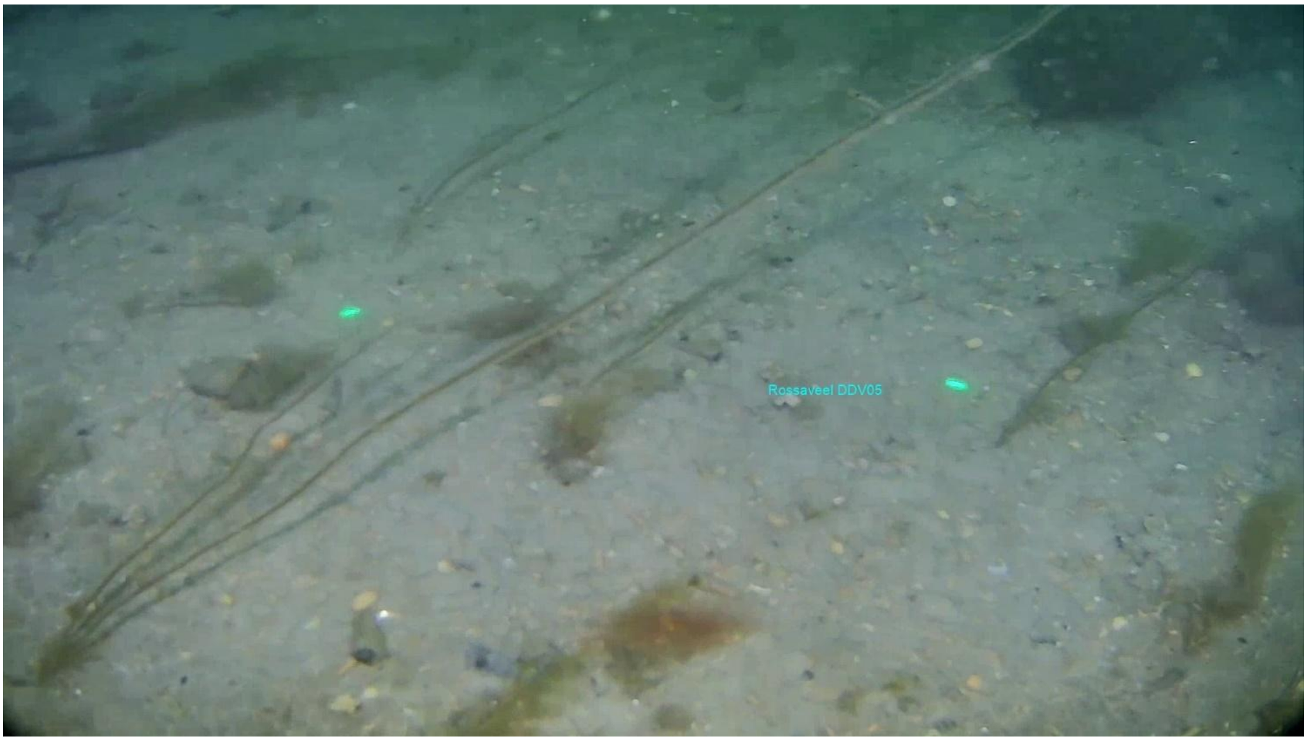

Figure 3.18: DDV Track 5 - sand substrate with shell material and drift macroalgae.

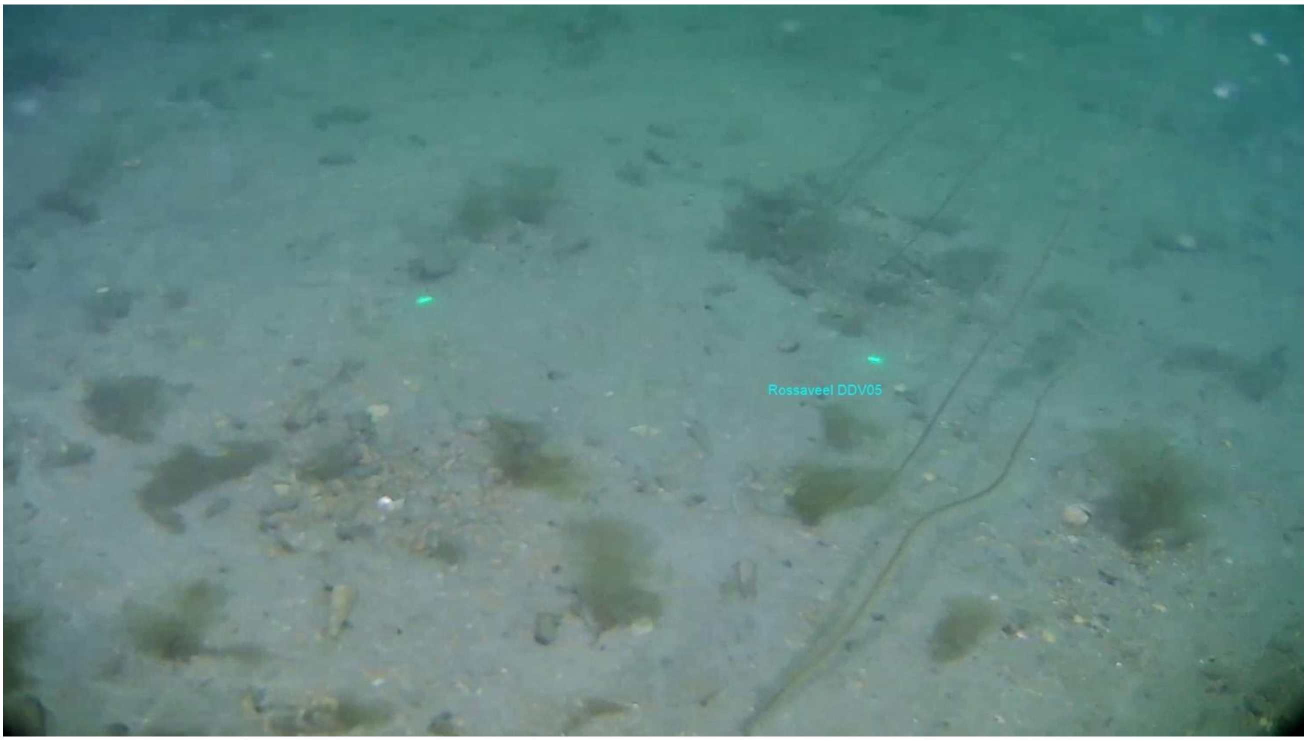

Figure 3.19: DDV Track 5 - sand substrate with shell material and drift macroalgae.

3.1.6 DDV Track 6

The substrate consisted of sand with scattered shell material with some cobbles. Drift red/brown macroalgae and presence of thongweed (*Himanthalia elongata*). Notable fauna included a swimming crab, a hermit crab (Paguridae), a starfish (*Marthasterias glacialis*), and a goby (Gobiidae) (**Figure 3.20** to **Figure 3.22**). This habitat can be classified as SS.SMx.CMx Circalittoral mixed sediment and SS.SMp – Sublittoral macrophyte-dominated communities on sediments (EUNIS code MC4214).

Figure 3.20: DDV Track 6 - sand substrate with drift macroalgae.

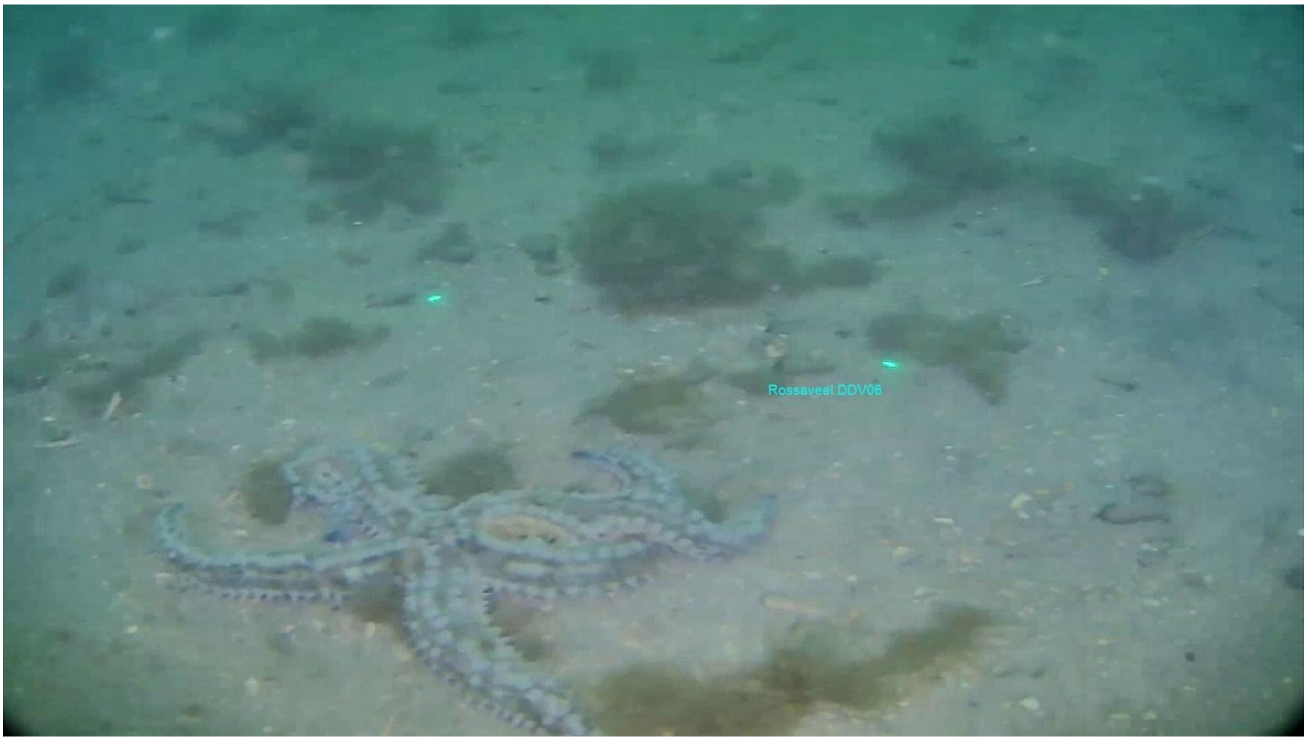

Figure 3.21: DDV Track 6 - Spiny starfish (*Marthasterias glacialis*) with drift macroalgae.

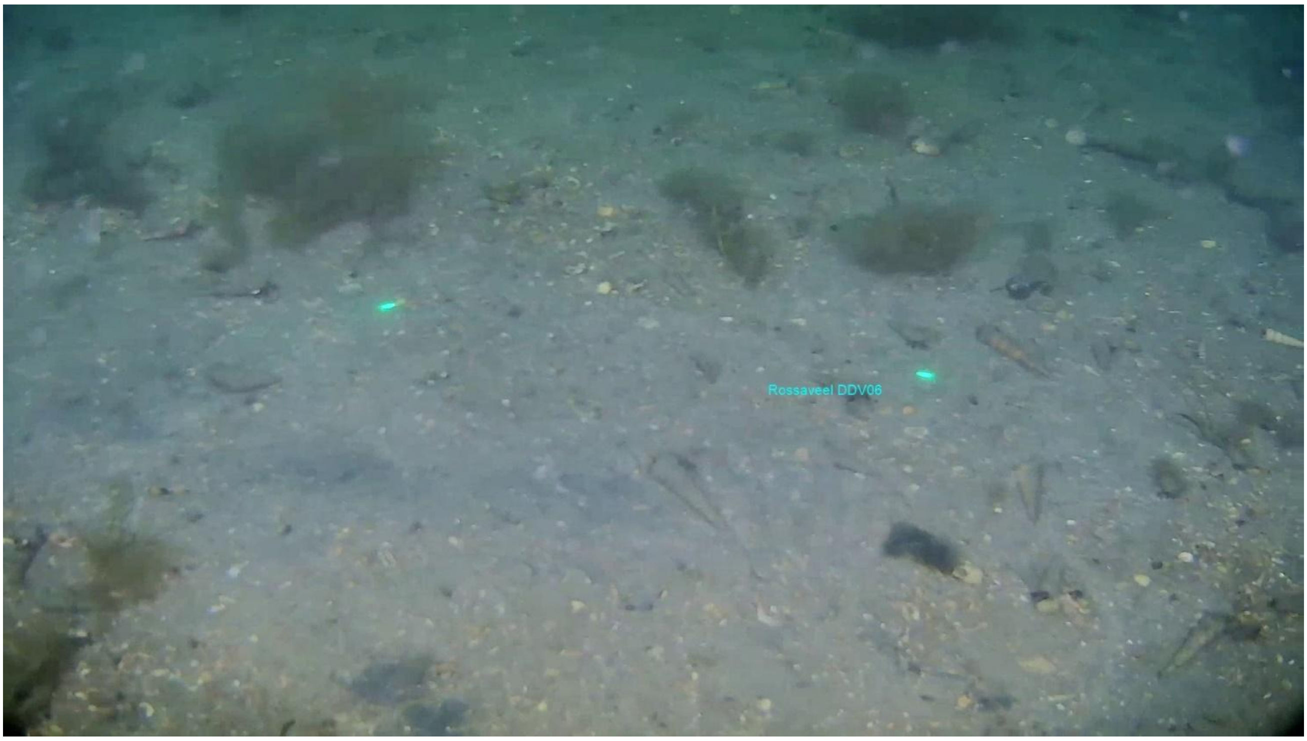

Figure 3.22: DDV Track 6 - sand substrate with shell debris and drift macroalgae.

3.1.7 DDV Track 7

The substrate consisted of sand with scattered shell (razor clam shells) and drift red/brown macroalgae and presence of seagrass *Zostera marina.* Notable fauna included a crab and a starfish (**Figure 3.23** to **Figure 3.26**). There is a mosaic of two broadscale habitats namely, SS.SMx.CMx Circalittoral mixed sediment and SS.SMp.KSwSS Kelp and seaweed communities on sublittoral sediment together with the JNCC biotope 'SS.SMp.SSgr.Zmar - *Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand (EUNIS: MB5223).

Figure 3.23: DDV Track 7 - sand substrate with assemblage of green, brown and red macroalgae.

Figure 3.24: DDV Track 7 - sand substrate with drift macroalgae.

Figure 3.25: DDV Track 7 -sand substrate with *Zostera marina* and filamentous macroalgae.

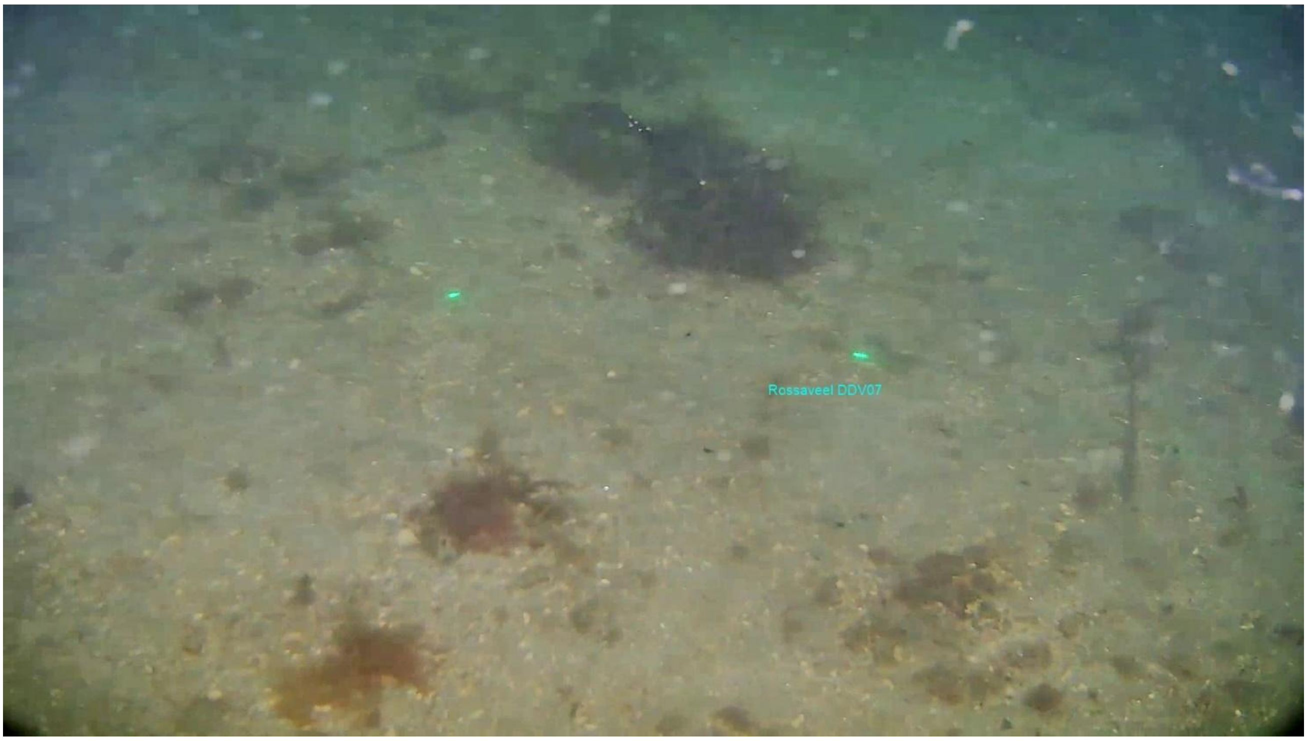

Figure 3.26: DDV Track 7 - sand substrate with drift brown and red macroalgae.

3.1.8 DDV Track 8

The substrate consisted of sand and gravel with scattered shell (razor clam shells), drift red/brown macroalgae and fragments of maërl and encrusting red algae. Notable fauna included a starfish (*Mathasterias glacialis*), Serpulid polychaete worms, hydroids, and bryozoans (**Figure 3.27** to **Figure 3.30**). There is a mosaic of two broadscale habitats namely, the JNCC biotopes SS.SMx.CMx Circalittoral mixed sediment with some sparse maërl.

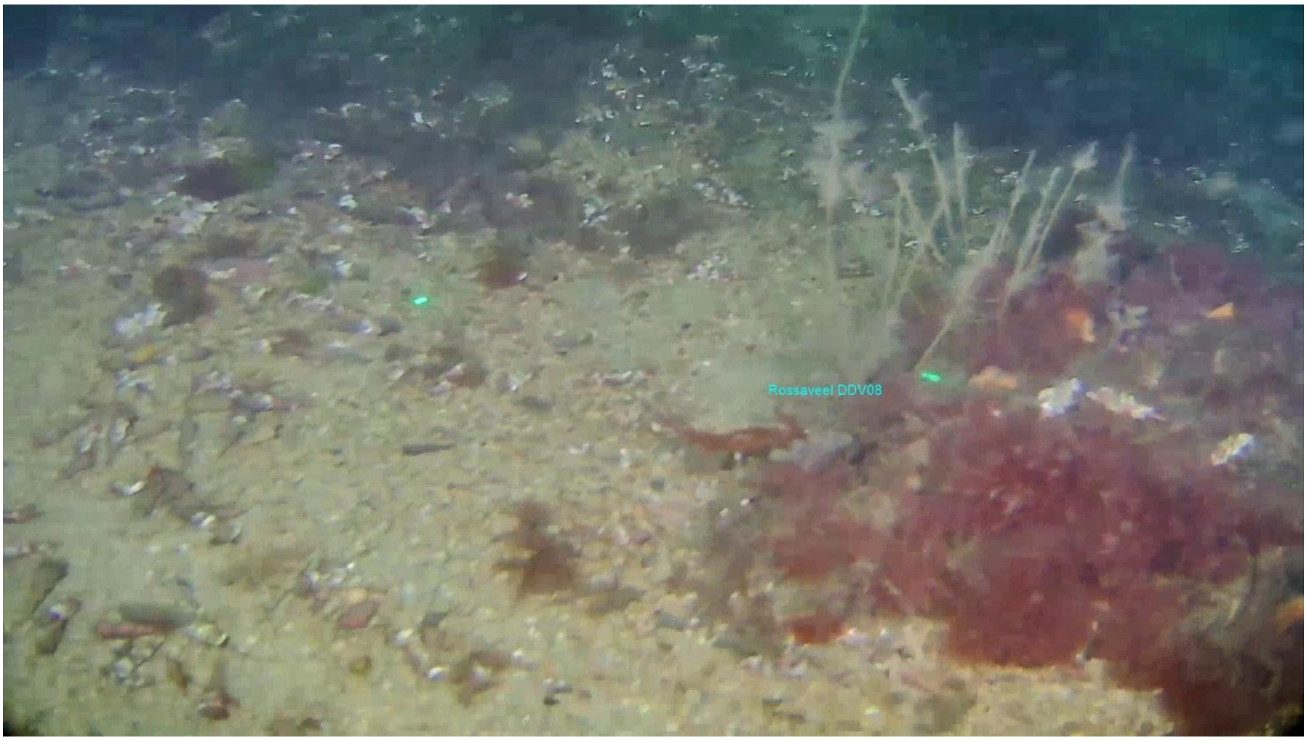

Figure 3.27: DDV Track 8 - gravelly sand substrate with filamentous red algae, hydroids, and serpulid worms.

Figure 3.28: DDV Track 8 - gravel substrate with the presence of the Spiny starfish, *Marthasterias glacialis*.

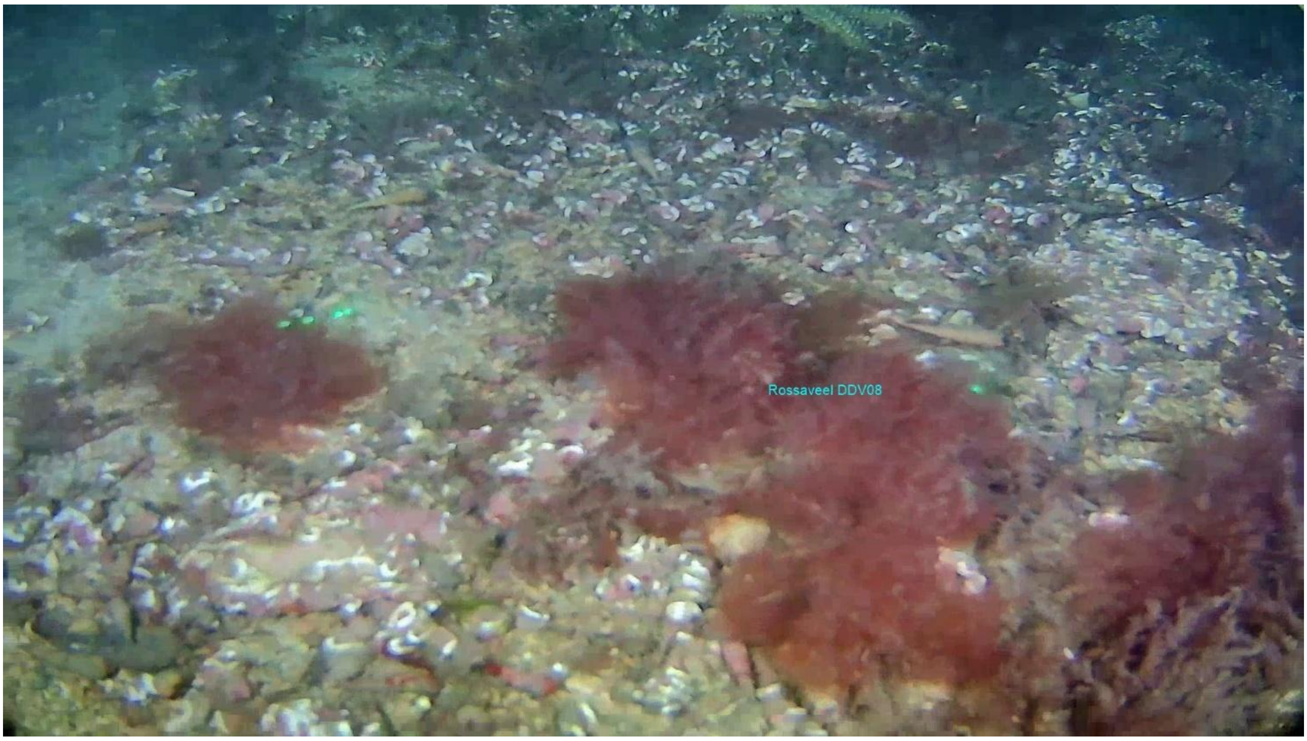

Figure 3.29: DDV Track 8 - serpulid worms on cobbles and shell materials along with filamentous red macroalgae.

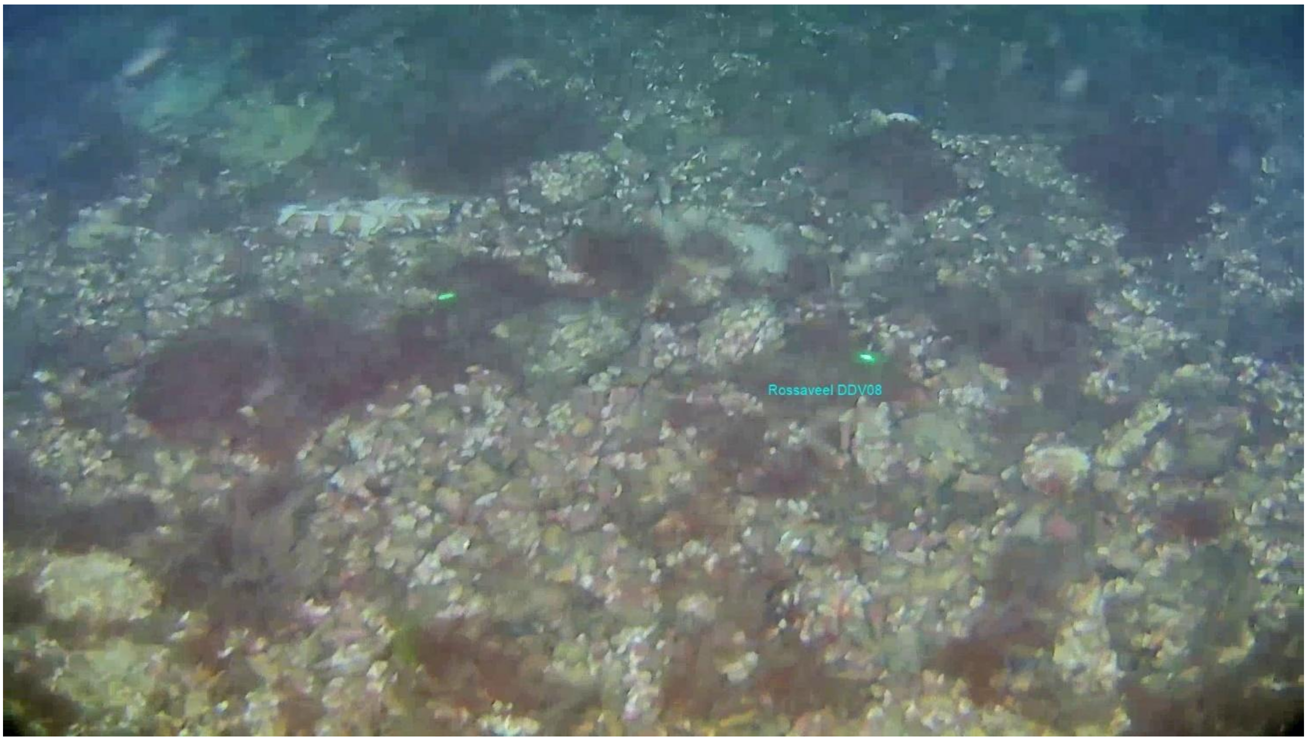

Figure 3.30: DDV Track 8 shows presence of serpulid worms on cobbles and shell materials along with filamentous red macroalgae.

3.1.9 DDV Track 9

The substrate consisted of sand, shell material and cobble with Serpulidae worms and filamentous and encrusting red algae with sparse maërl fragments. Notable fauna included a starfish (*Mathasterias glacialis*), sponges (Poriferans), Dead Man's Fingers (*Alcyonium digitatum*), and bryozoans (**Figure 3.31** to **Figure 3.34**). The biotope is classified as a mix of the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment and the JNCC biotope SS.SCS.CCS.SpiB *Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles (EUNIS code MC3211) and 'CR.HCR.XFa.FluCoAs.SmAs - *Flustra foliacea*, small solitary & colonial ascidians on tide swept circalittoral bedrock or boulders' (EUNIS code MC12162).

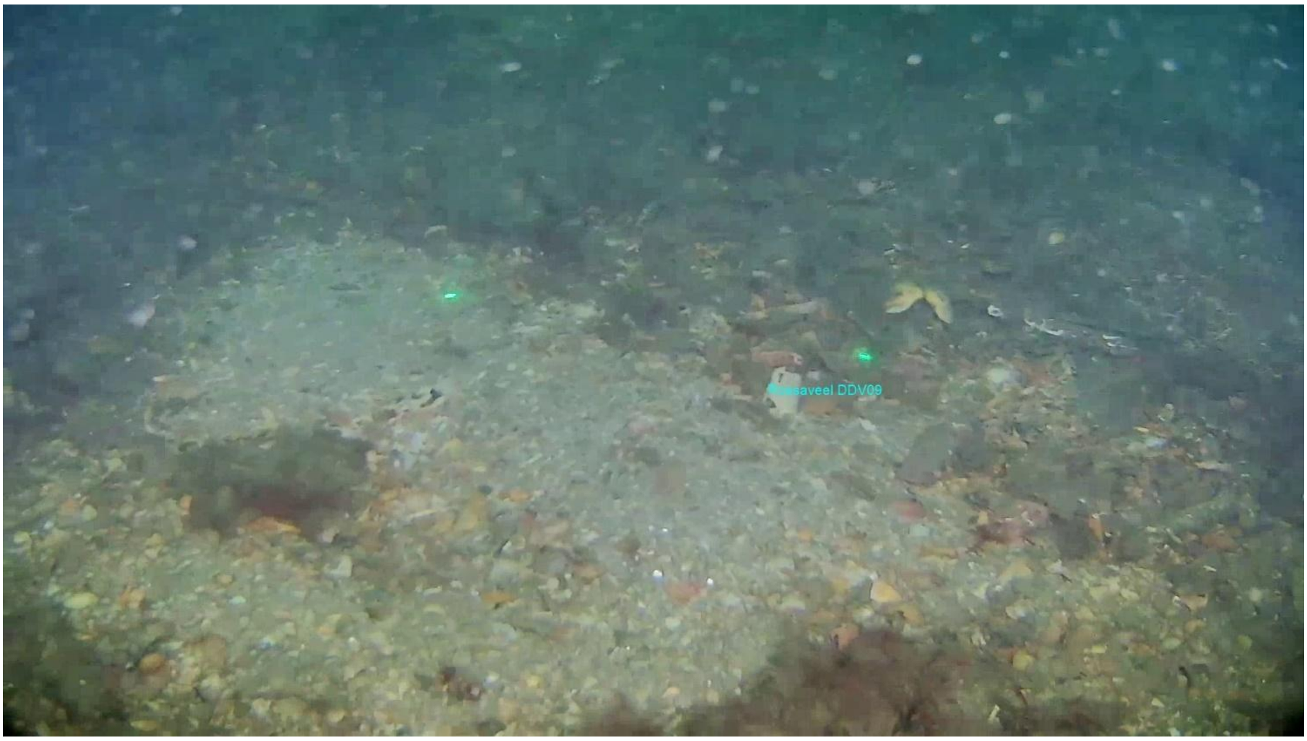

Figure 3.31: DDV Track 9 shows gravelly sand substrate with cobbles and maërl with serpulid worms and encrusting red algae.

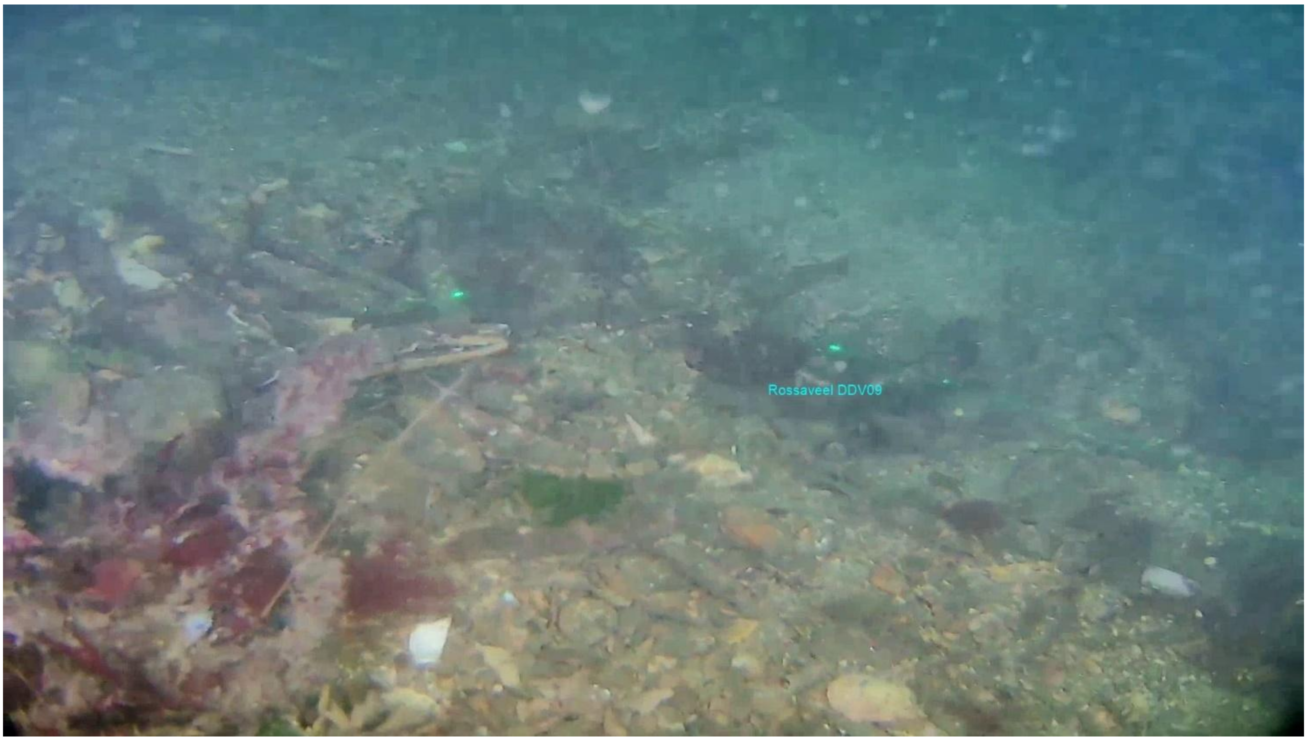

Figure 3.32: DDV Track 9 - gravel substrate with cobbles and encrusting red algae.

Figure 3.33: DDV Track 9 - shell debris with serpulid worms, encrusting red algae, *Alcyonium digitatum*, and sponges.

Figure 3.34: DDV Track 9 - boulder with red macroalgae, Spiny starfish *Marthasterias glacialis, Alcyonium digitatum,* and sponges.

3.1.10 DDV Track 10

The substrate consisted of sand, shell material with drift macroalgae. Notable fauna included a sand eel (Ammodytidae) and an anemone (unidentifiable) (**Figure 3.35** to **Figure 3.39**). This biotope can be classified as a mosaic of the JNCC biotope 'SS.SMp.SSgr.Zmar - *Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand (EUNIS: MB5223) and the two broadscale habitats SS.SMx.CMx Circalittoral mixed sediment and SS.SMp.KSwSS Kelp and seaweed communities on sublittoral sediment.

Figure 3.35: DDV Track 10 - sand substrate with *Zostera marina* and drift red macroalgae.

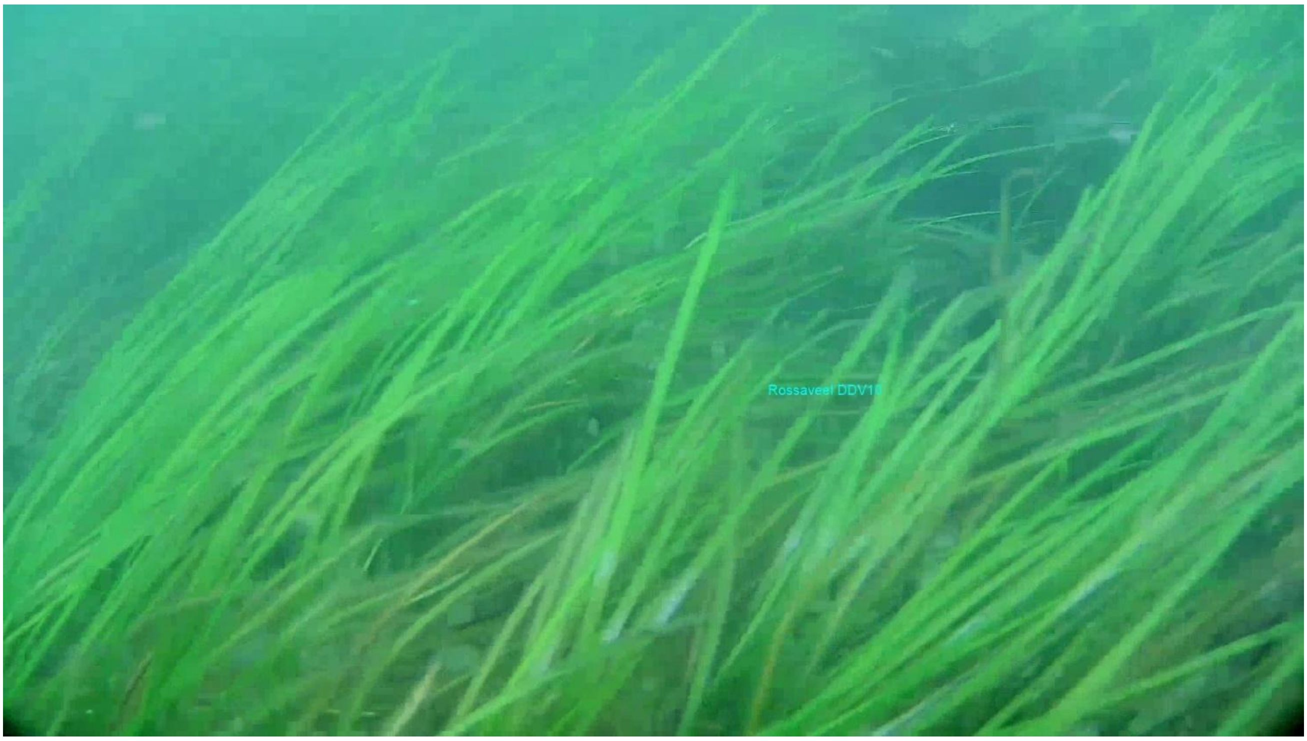

Figure 3.36: DDV Track 10 sand substrate with *Zostera marina*.

Figure 3.37: DDV Track 10 - sand substrate with *Zostera marina* and Kelp.

Figure 3.38: DDV Track 10 - sand substrate with drift macroalgae.

Figure 3.39: DDV Track 10 - sand substrate with *Zostera marina* and red macroalgae.

3.1.11 DDV Track 11

The substrate consisted of sand with scattered shell material with some cobbles. Drift and attached red/brown macroalgae and presence of thongweed (*Himanthalia elongata*). Notable fauna included an anemone and fish (unidentifiable) (**Figure 3.40** to **Figure 3.43**). This biotope can be classified as a mosaic of the two broadscale habitats SS.SMx.CMx Circalittoral mixed sediment and SS.SMp - Sublittoral macrophyte-dominated communities on sediments.

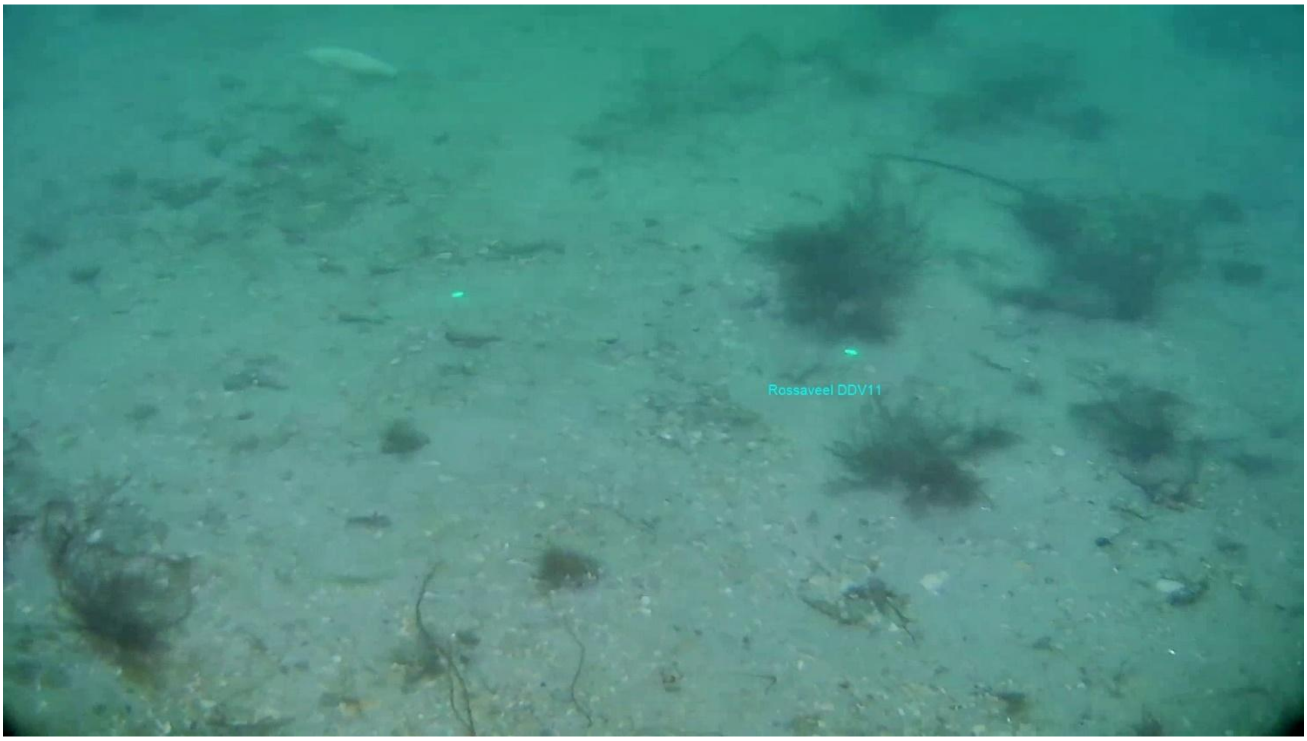

Figure 3.40: DDV Track 11 - sand substrate with drift macroalgae.

Figure 3.41: DDV Track 11 - sand substrate with drift macroalgae.

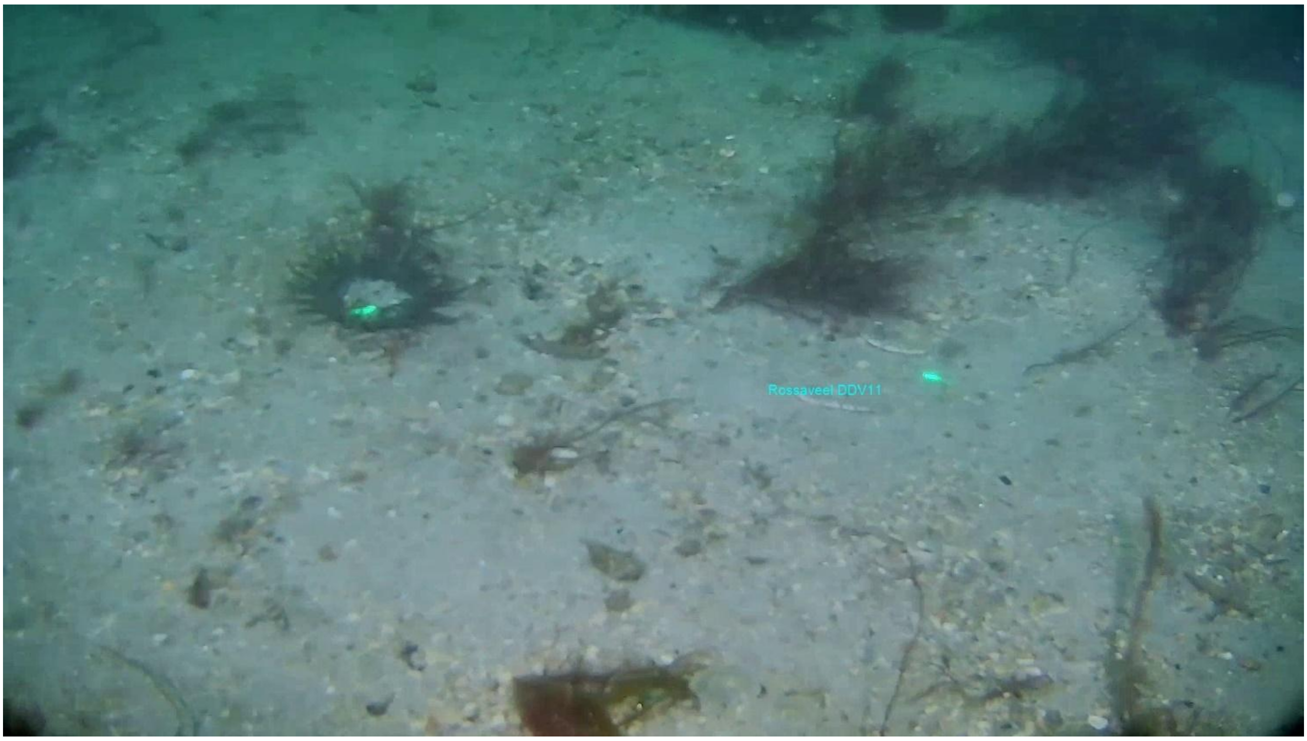

Figure 3.42: DDV Track 11 - sand substrate with macroalgae and an anemone.

Figure 3.43: DDV Track 11 - sand substrate with mostly attached and some drift macroalgae.

3.1.12 DDV Track 12 (Station 7)

The substrate consisted of sand, shell material and cobbles along some drift macroalgae and seagrass. Notable fauna included a goby (Gobiidae), scallop, starfish (*Marthasterias glacialis*) and harbour crabs (*Polybius depurator*) along with bryozoans (**Figure 3.44** to **Figure 3.47**). This biotope can be classified as a mosaic of the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment and the JNCC biotope 'CR.HCR.XFa.FluCoAs.SmAs - *Flustra foliacea*, small solitary & colonial ascidians on tide swept circalittoral boulders' (EUNIS code MC12162) overlapping with the broadscale habitat SS.SMp – Sublittoral macrophyte-dominated communities on sediments.

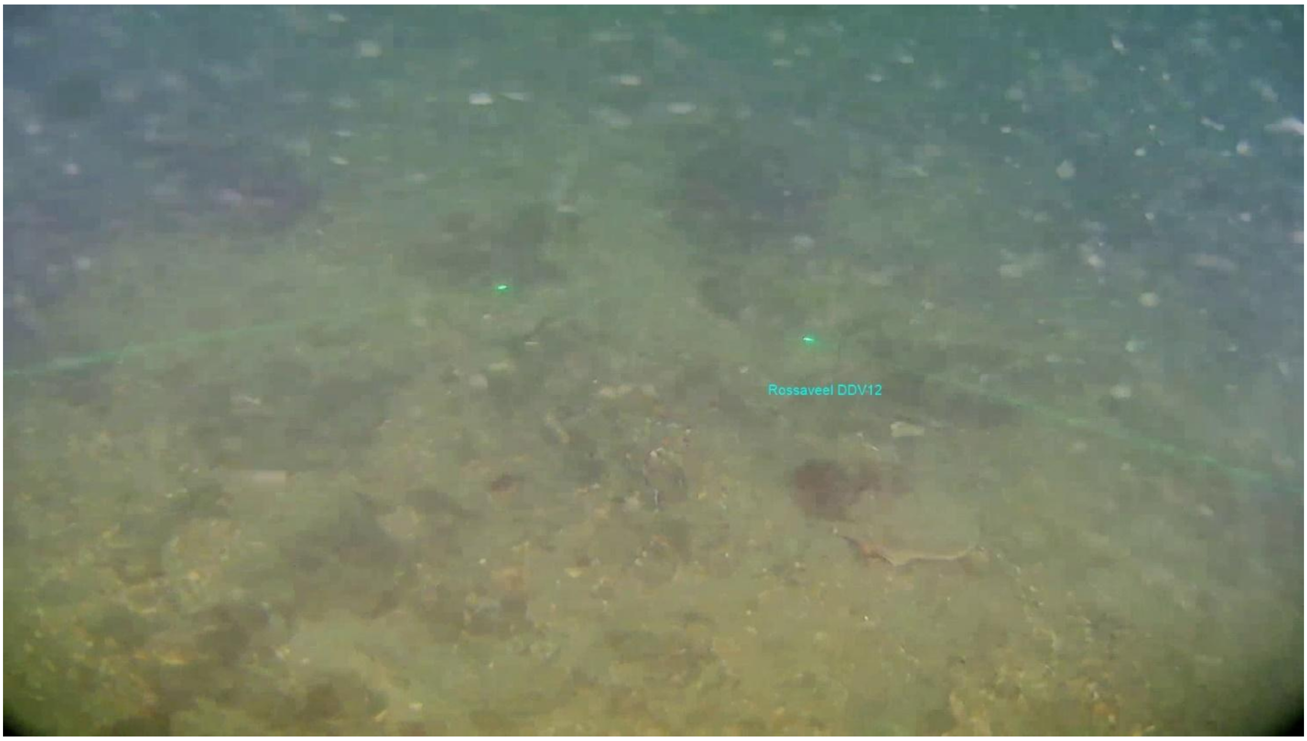

Figure 3.44: DDV Track 12 - mixed sediment substrate with scattered shells and red algae.

Figure 3.45: DDV Track 12 - mixed sediment substrate with Spiny starfish (*Martasterias glacialis*).

Figure 3.46: DDV Track 12 - mixed sediment substrate with red algae and bryozoa.

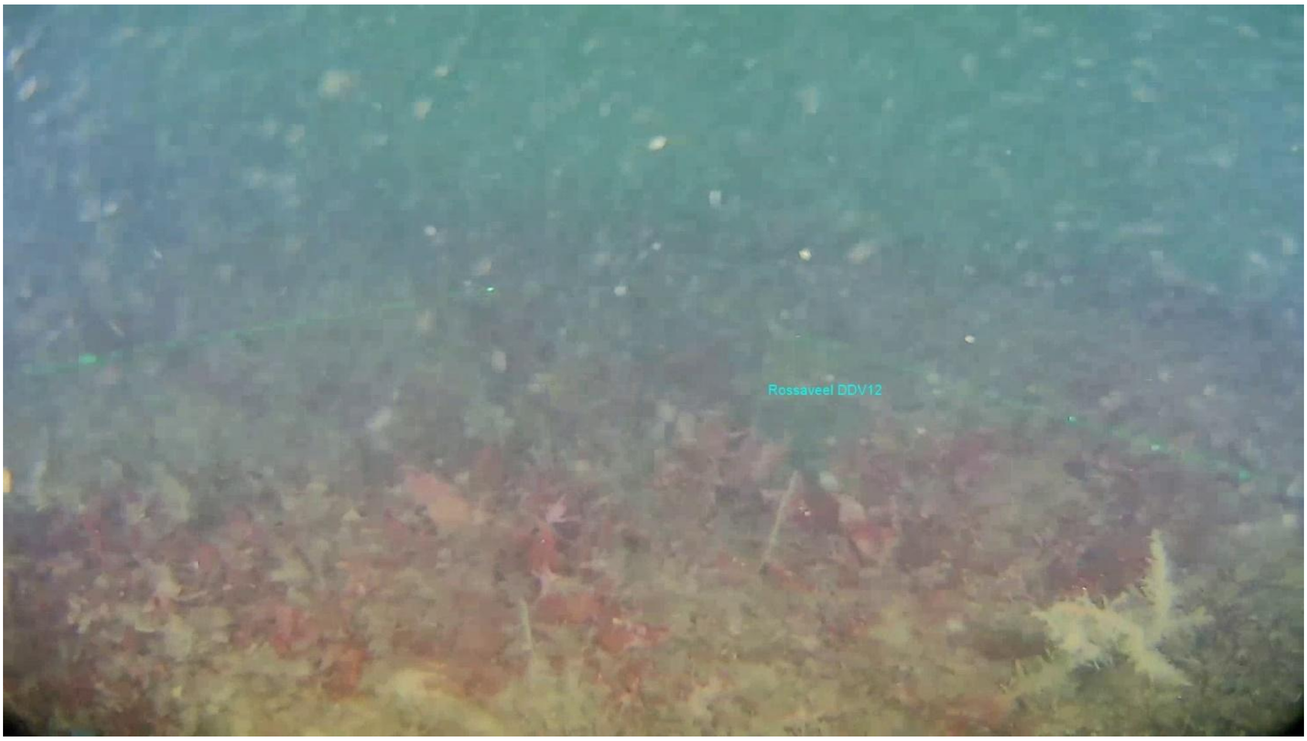

Figure 3.47: DDV Track 12 - mixed sediment substrate with red algae and bryozoa.

3.1.13 DDV Track 13 (Station 3)

The substrate consisted of boulders, sand, shell, cobble, brown macroalgae (*Laminaria* sp.), green macroalgae (*Ulva* sp.), other macroalgae, sand eels, fish, urchin, sponge and/ or soft coral, and bryozoan (**Figure 3.48** to **Figure 3.51**). This biotope can be classified as a mosaic of the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment and SS.SMp.KSwSS Kelp and seaweed communities on sublittoral sediment with the JNCC biotope 'CR.HCR.XFa.FluCoAs.SmAs - *Flustra foliacea*, small solitary & colonial ascidians on tide swept circalittoral bedrock or boulders' (EUNIS code MC12162).

Figure 3.48: DDV Track 13 - mixed sediment substrate with kelp fronds.

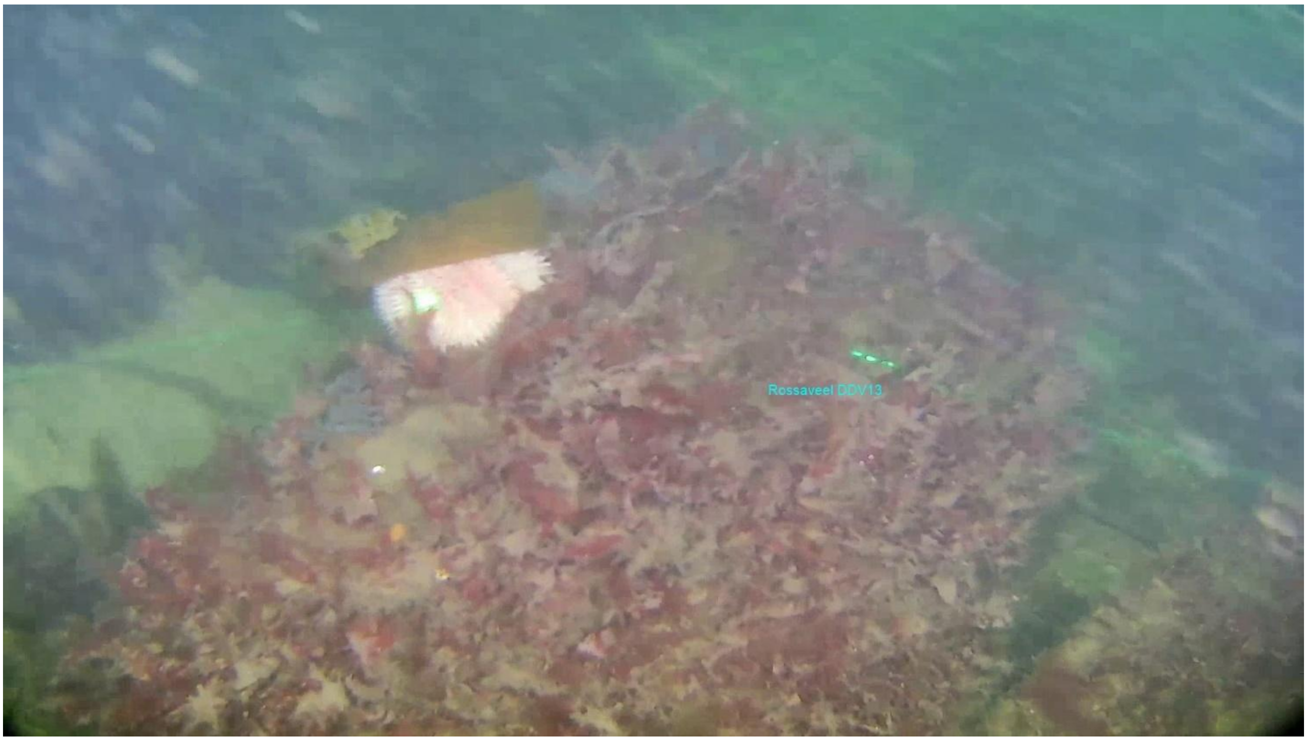

Figure 3.49: DDV Track 13 - Boulders with red algae growth, bryozoan, and a sea urchin (*Echinus esculentus*).

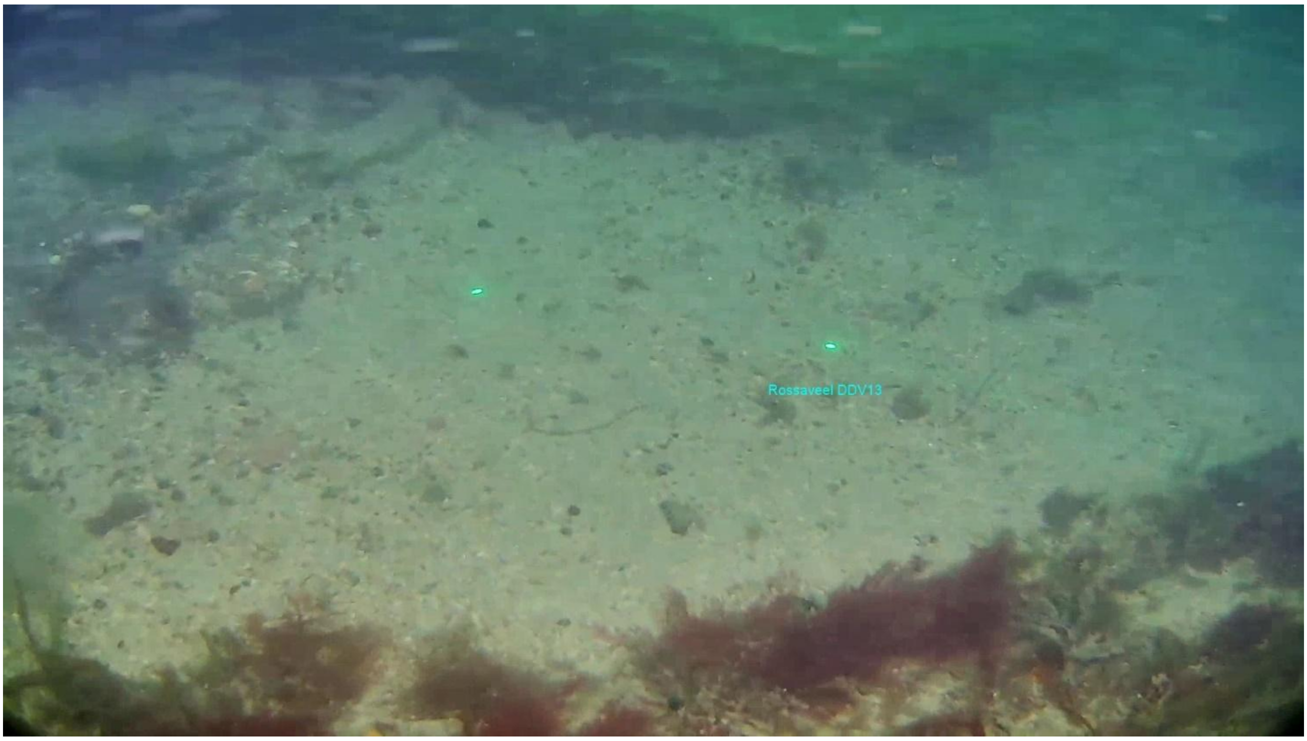

Figure 3.50: DDV Track 13 - mixed sediment substrate with sparse red algae.

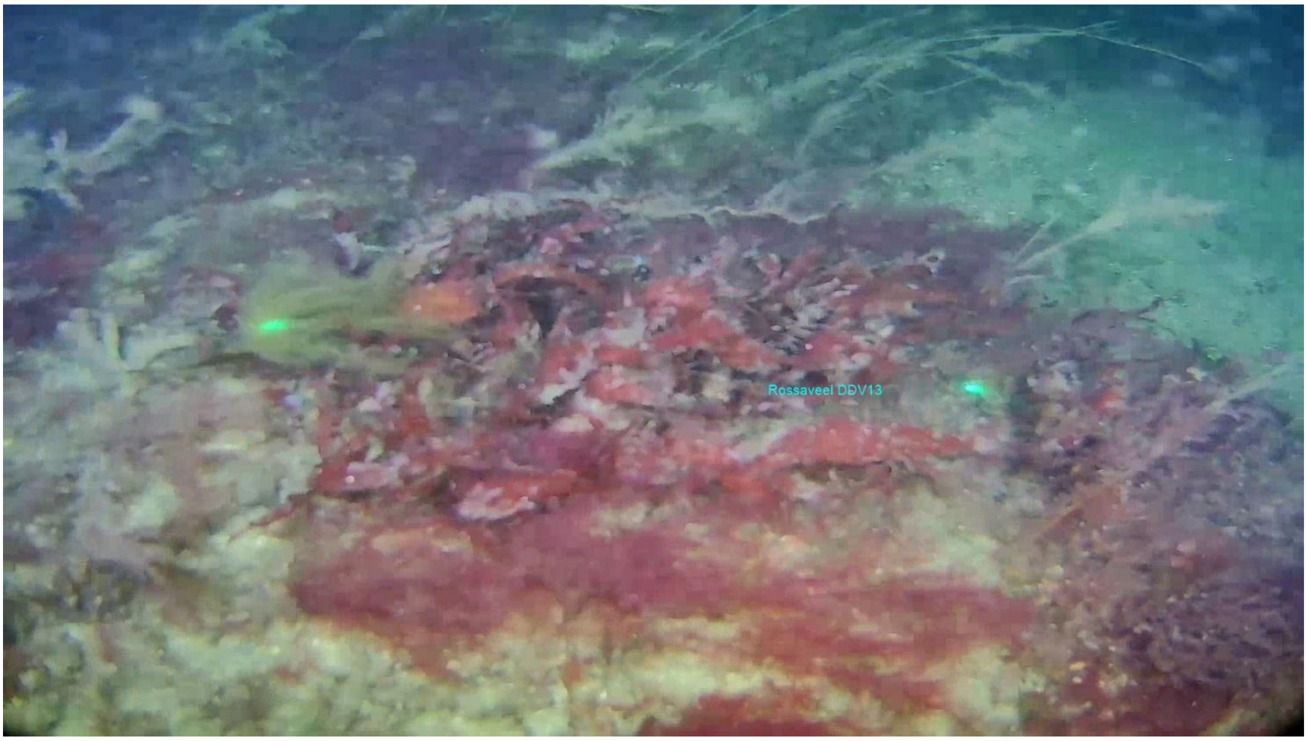

Figure 3.51: DDV Track 13 - mixed sediment substrate with red algae and bryozoans.

3.1.14 DDV Track 14

The substrate consisted of boulder, sand, shell material and maërl beds with drifting macroalgae. Notable fauna included bryozoan, sponges and starfish (**Figure 3.52** to **Figure 3.54**). This biotope can be classified as a mosaic of the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment with some sparse maërl. A second type of mosaic biotope found was SS.SMx.CMx and CR.HCR.XFa.FluCoAs.SmAs.

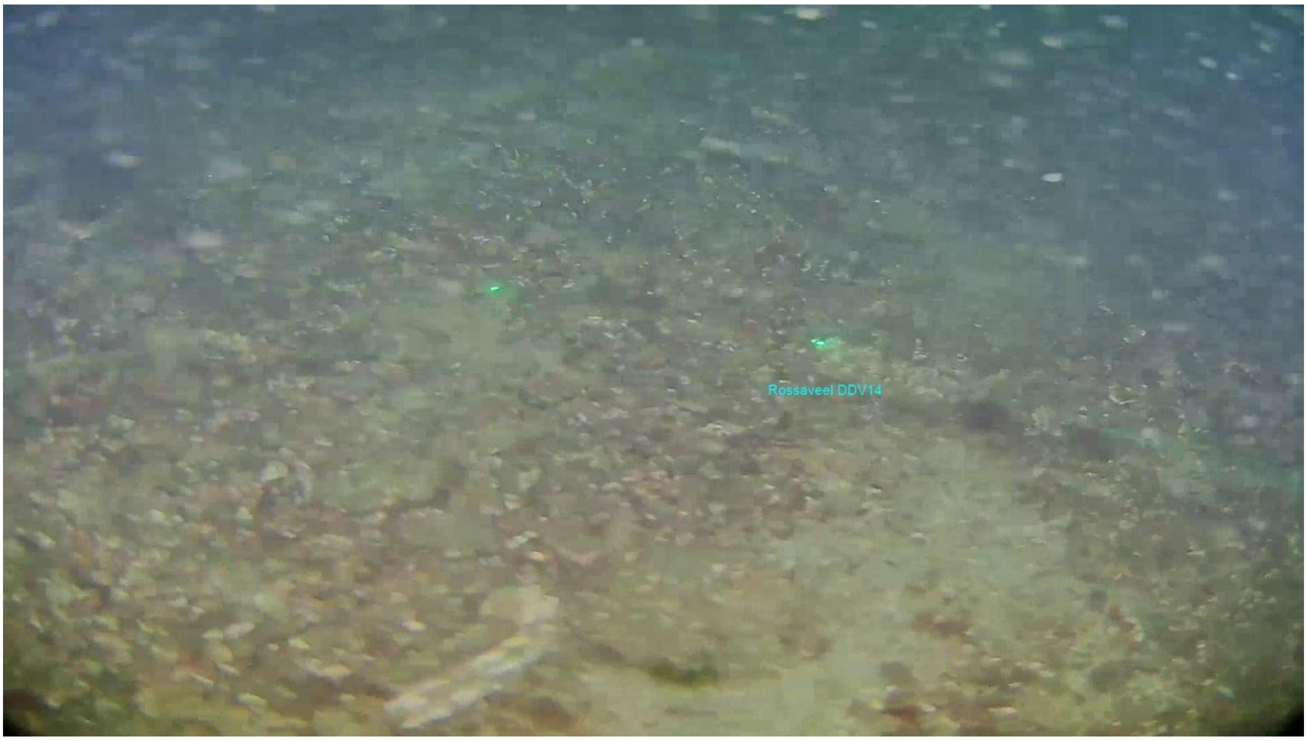

Figure 3.52: DDV Track 14 - mixed sediment substrate with serpulid worms and encrusting red algae.

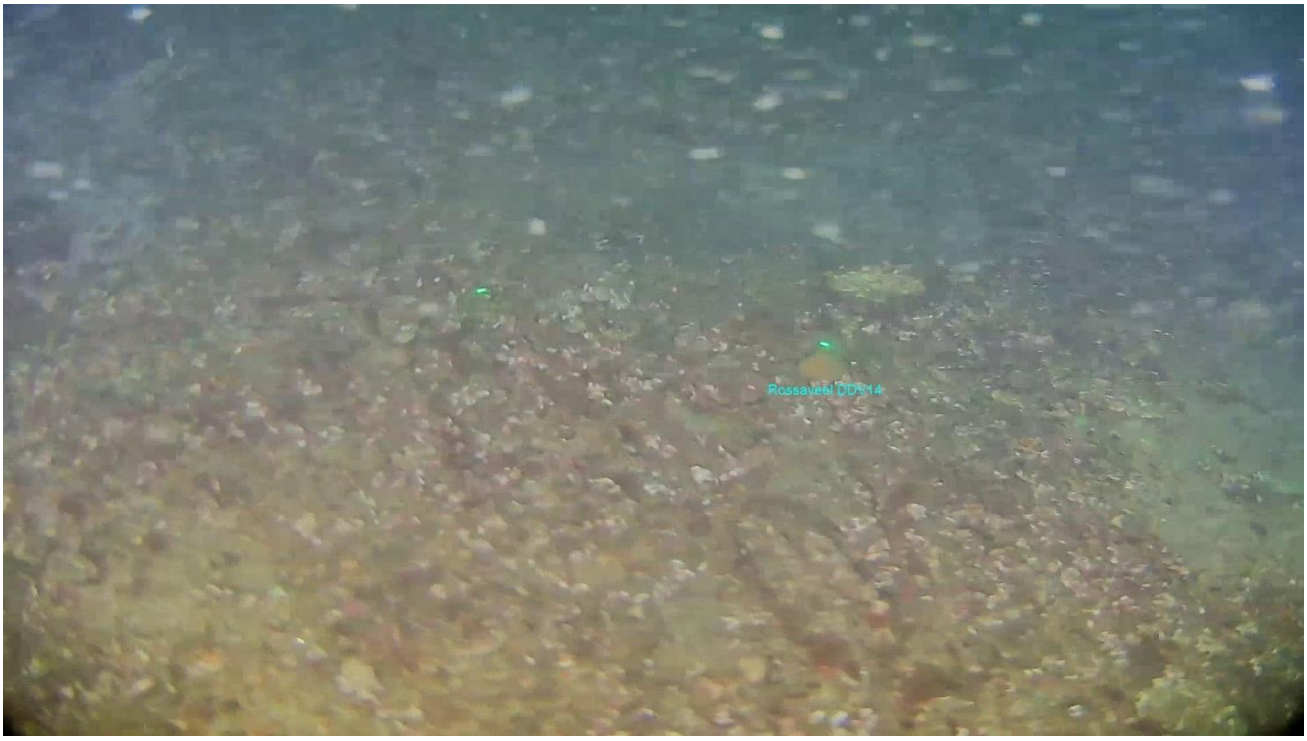

Figure 3.53: DDV Track 14 - mixed sediment substrate with cobbles and maërl fragments.

Figure 3.54: DDV Track 14 - mixed sediment substrate with red algae and bryozoa.

3.1.15 DDV Track 15

The substrate consisted of sand, shell, cobble, auger shells, drift & attached macroalgae, algal turf/filamentous red, starfish, scallop, bryozoan, fish, harbour crabs, and marine litter (**Figure 3.55** to **Figure 3.58**). This biotope can be classified as a mosaic of the two broadscale habitats SS.SMx.CMx Circalittoral mixed sediment and SS.SMp - Sublittoral macrophyte-dominated communities on sediments.

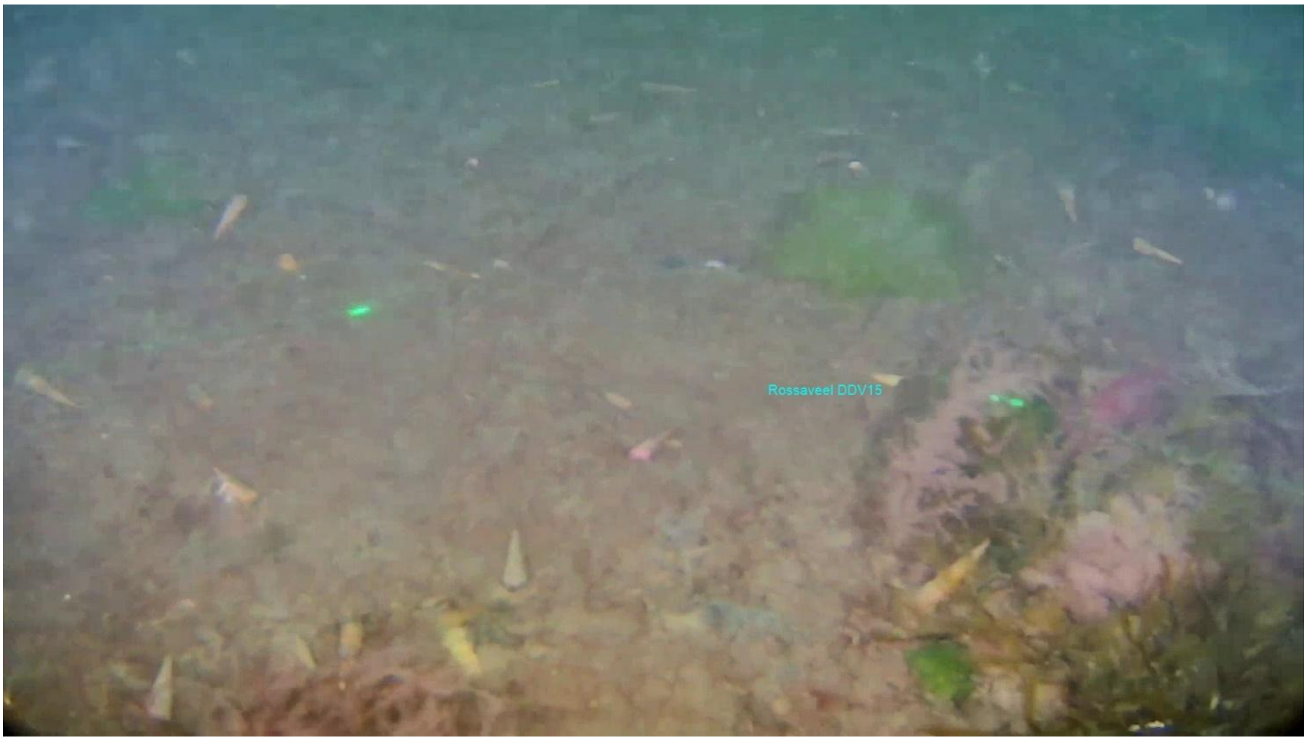

Figure 3.55: DDV Track 15 - filamentous red and green algae, auger shells (*Turitellinella tricarinata*), and bryozoans.

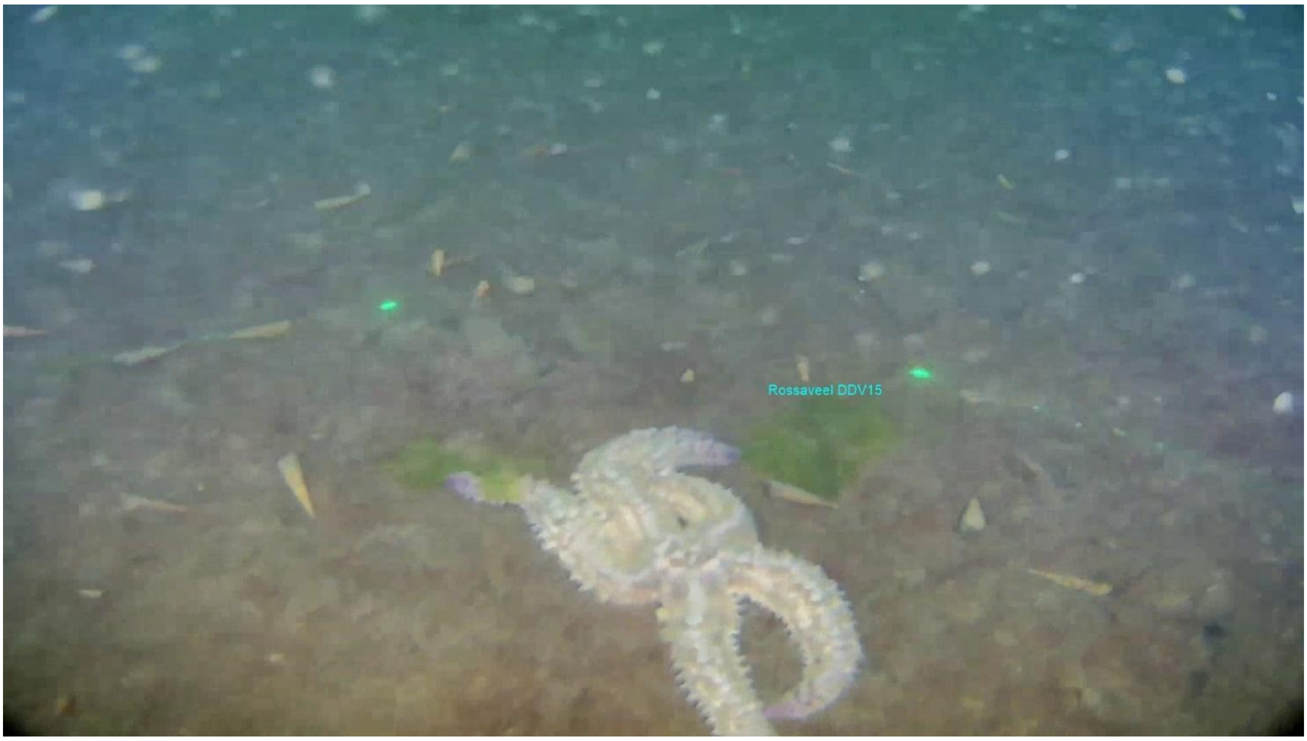

Figure 3.56: DDV Track 15 - filamentous red algae, auger shells (*Turitellinella tricarinata*) and Spiny starfish (*Martasterias glacialis*).

Figure 3.57: DDV Track 15 - filamentous red algae, green algae, a scallop (*Pecten maximus*), and auger shells (*Turitellinella tricarinata*).

Figure 3.58: DDV Track 15 - mixed sediment substrate with filamentous red algae, auger shells (*Turitellinella tricarinata*) and Spiny starfish (*Martasterias glacialis*).

3.1.16 DDV Track 16 (Stations 4, 5, & 6)

The substrate consisted of sand, with sparsely attached filamentous algae, auger shells (*Turitellinella tricarinata*) and starfish. (**Figure 3.59** to **Figure 3.61**). This biotope can be classified as the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment.

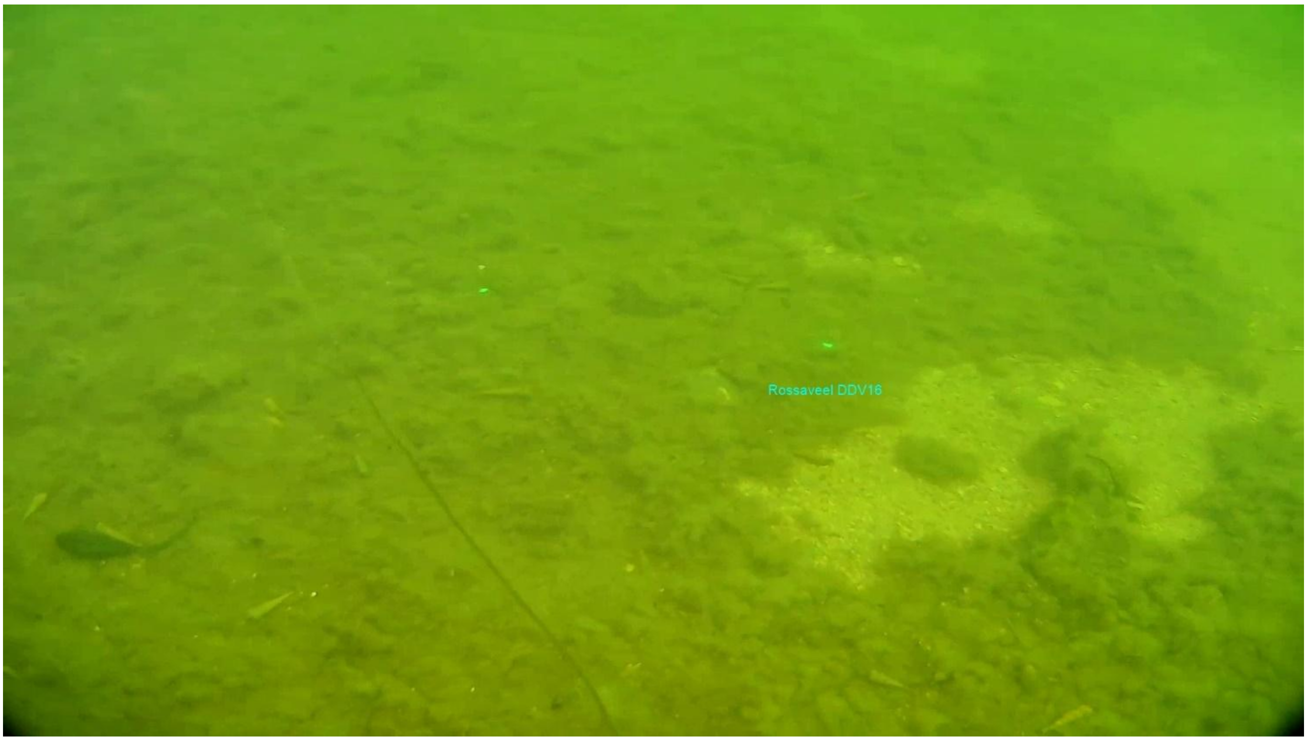

Figure 3.59: DDV Track 16 - mixed sediment substrate a filamentous red algae mat and auger shells (*Turitellinella tricarinata*).

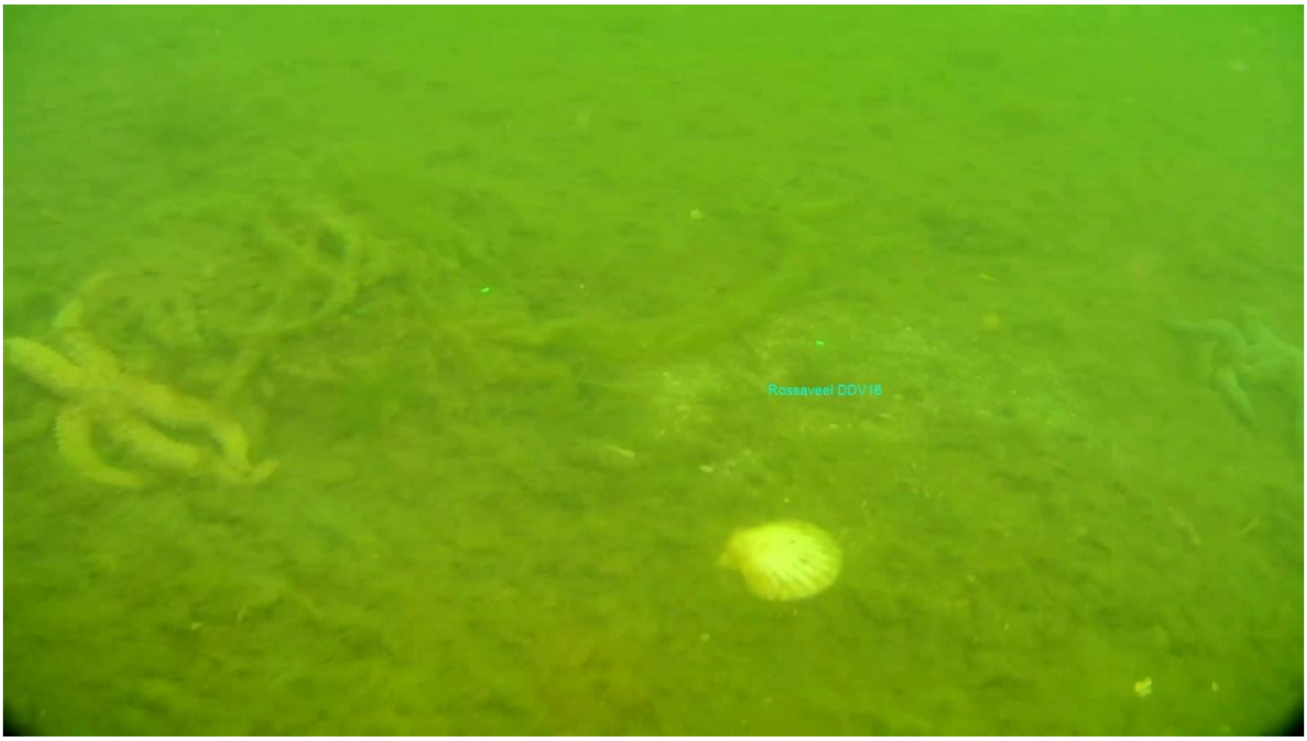

Figure 3.60: DDV Track 16 - mixed sediment substrate with scallop shell and Spiny starfish (*Martasterias glacialis*).

Figure 3.61: DDV Track 16 - mixed sediment substrate with auger shells (*Turitellinella tricarinata*).

3.1.17 DDV Track 17

The substrate consisted of sand, cobbles, boulder, shell material, sparse maërl, bryozoan, fish, sponge or soft coral, starfish and auger shells and drifting macroalgae (**Figure 3.62** to **Figure 3.65**). This biotope can be classified as a mosaic of the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment.

Figure 3.62: DDV Track 17 - mixed sediment substrate with filamentous red algae and Spiny starfish (*Martasterias glacialis*).

Figure 3.63: DDV Track 17 -mixed sediment substrate with filamentous red algae, Serpulid worms, and auger shells (*Turitellinella tricarinata*).

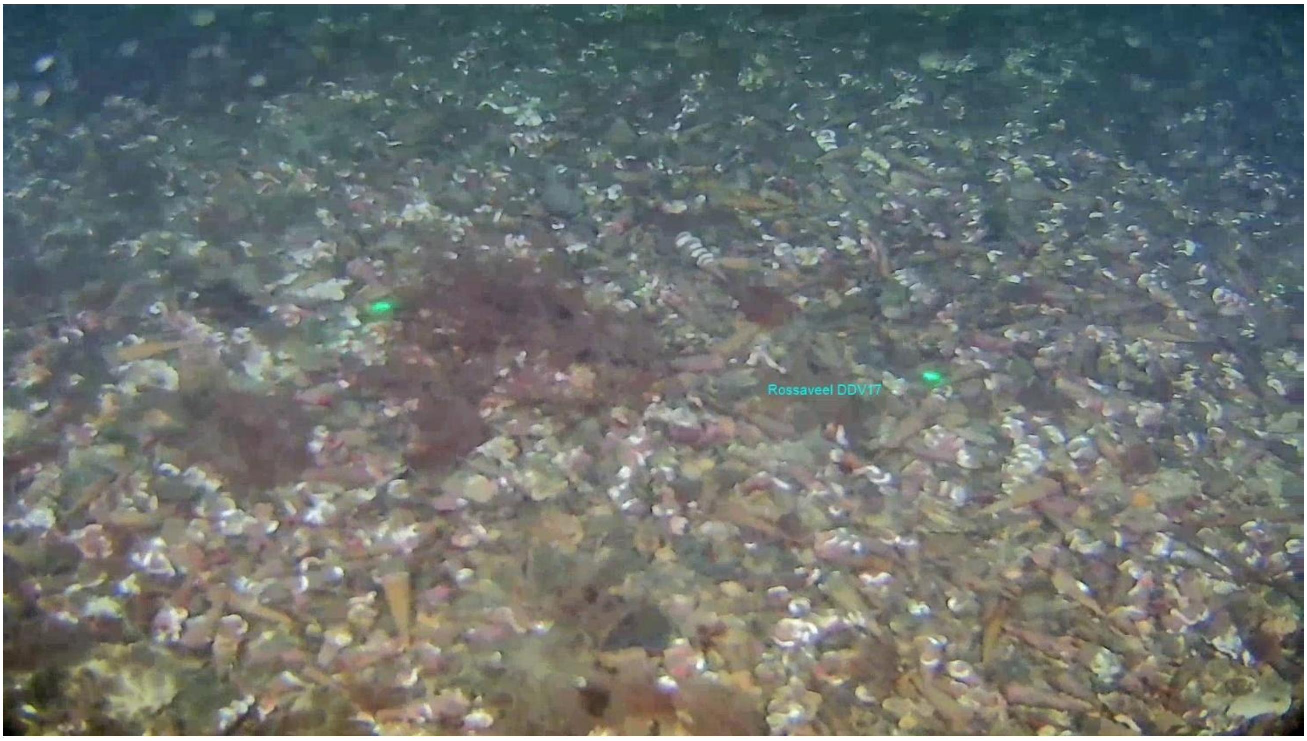

Figure 3.64: DDV Track 17 - mixed sediment substrate with filamentous red algae, auger shells (*Turitellinella tricarinata*), and Serpulid worms.

Figure 3.65: DDV Track 17 - mixed sediment substrate with filamentous red algae, auger shells (*Turitellinella tricarinata*) and Serpulid worms.

3.1.18 DDV Track 18

The substrate consisted of sand, cobbles, boulder, shell material, sparse maërl, bryozoan, fish, sponge or soft coral, starfish and auger shells and drifting macroalgae (**Figure 3.66** to **Figure 3.69**). This biotope can be classified as a mosaic of the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment with an assemblage of CR.HCR.XFa.FluCoAs.SmAs.

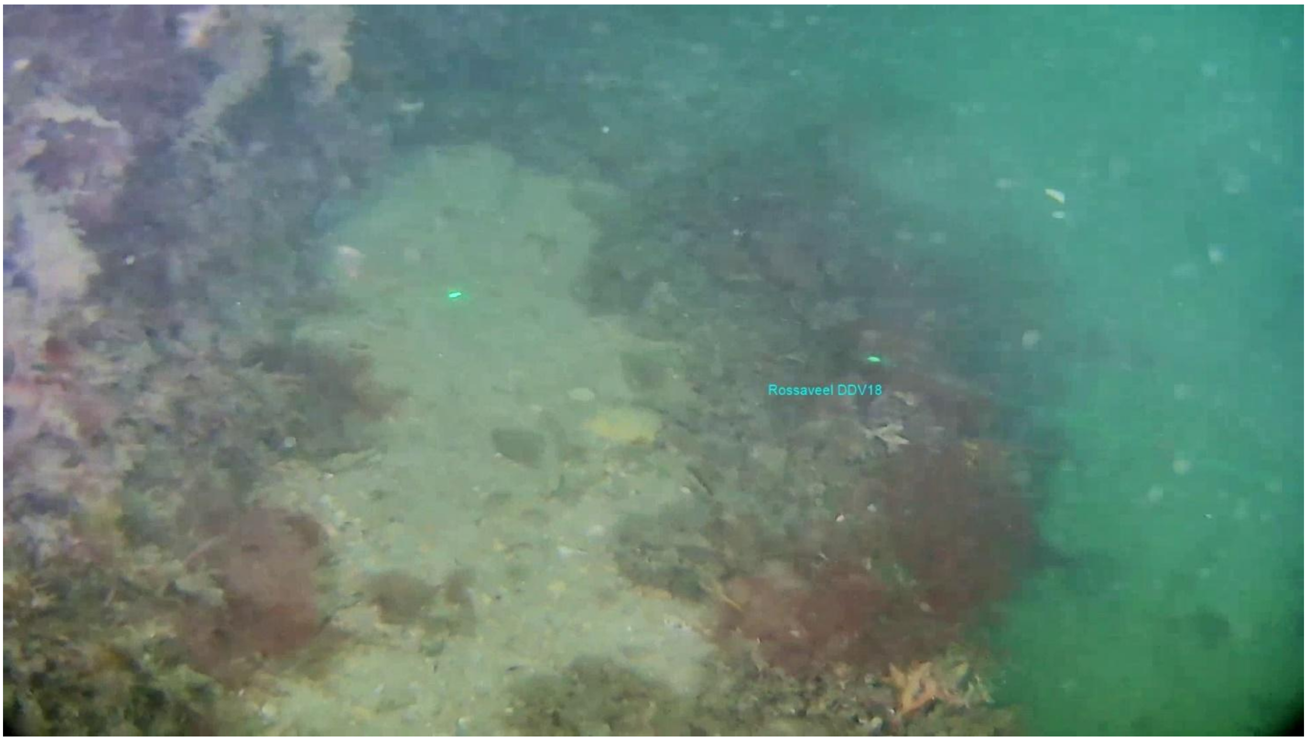

Figure 3.66: DDV Track 18 - mixed sediment substrate with filamentous red algae and bryozoans.

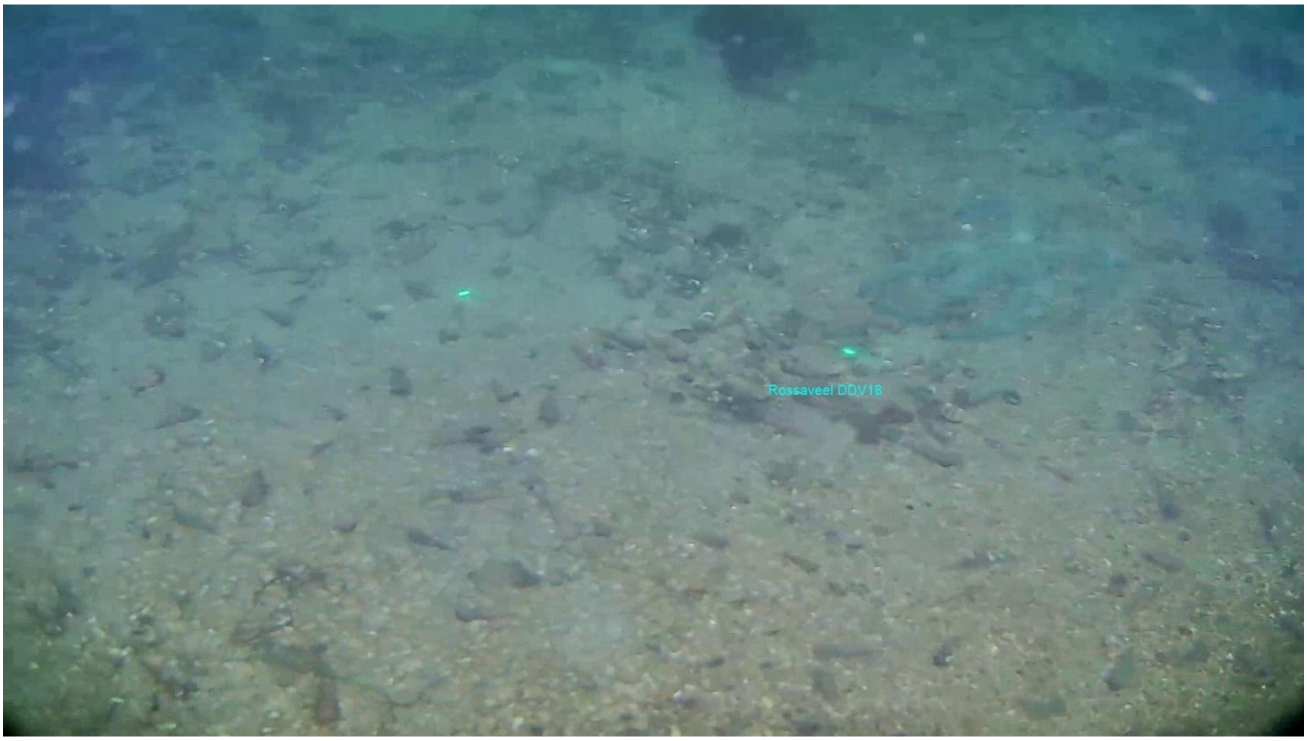

Figure 3.67: DDV Track 18 - mixed sediment substrate with filamentous red algae, auger shells (*Turitellinella tricarinata*), and serpulid worms.

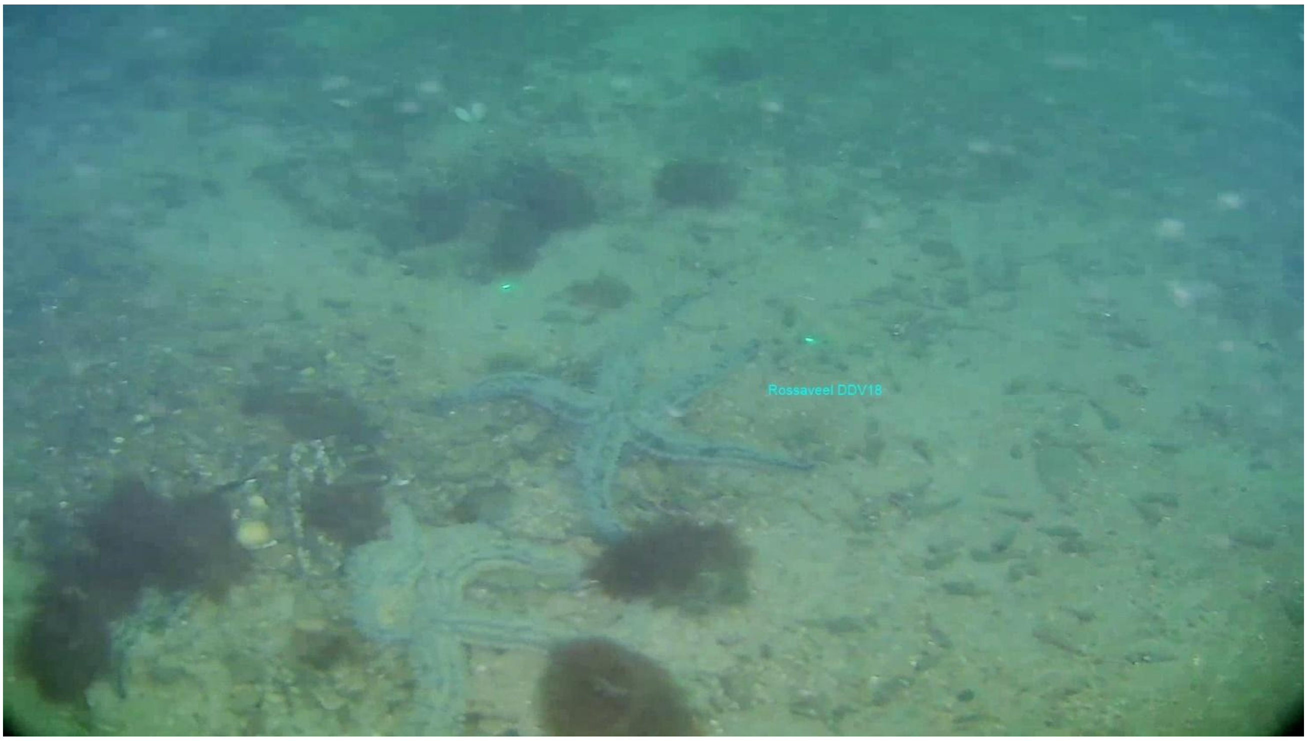

Figure 3.68: DDV Track 18 - mixed sediment substrate with filamentous red algae, auger shells (*Turitellinella tricarinata*), and Spiny starfish.

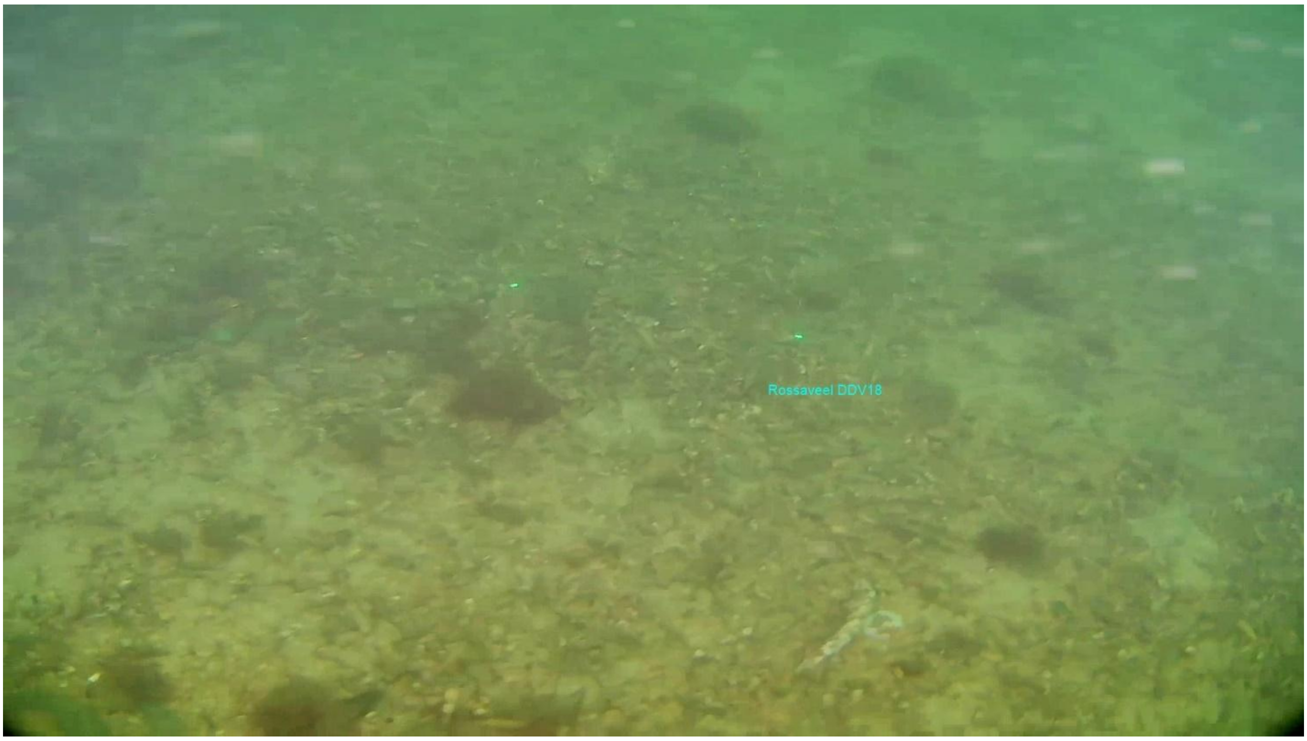

Figure 3.69: DDV Track 18 - mixed sediment substrate with filamentous red algae, auger shells (*Turitellinella tricarinata*), and Serpulid worms.

3.1.19 DDV Track 19 (Station 1)

The substrate consisted of sand, cobbles, boulder, shell (scallop), sparse maërl, bryozoan, fish, boring sponges, starfish and auger shells and drifting macroalgae (**Figure 3.70** to **Figure 3.73**). This biotope can be classified as a mosaic of the two broadscale habitats SS.SMx.CMx Circalittoral mixed sediment and SS.SMp - Sublittoral macrophyte-dominated communities on sediments. A second biotope found was CR.HCR.XFa.FluCoAs.SmAs.

Figure 3.70: DDV Track 19 - mixed sediment substrate with filamentous red algae, auger shells (*Turitellinella tricarinata*), green macroalgae (*Ulva sp.*), and serpulid worms.

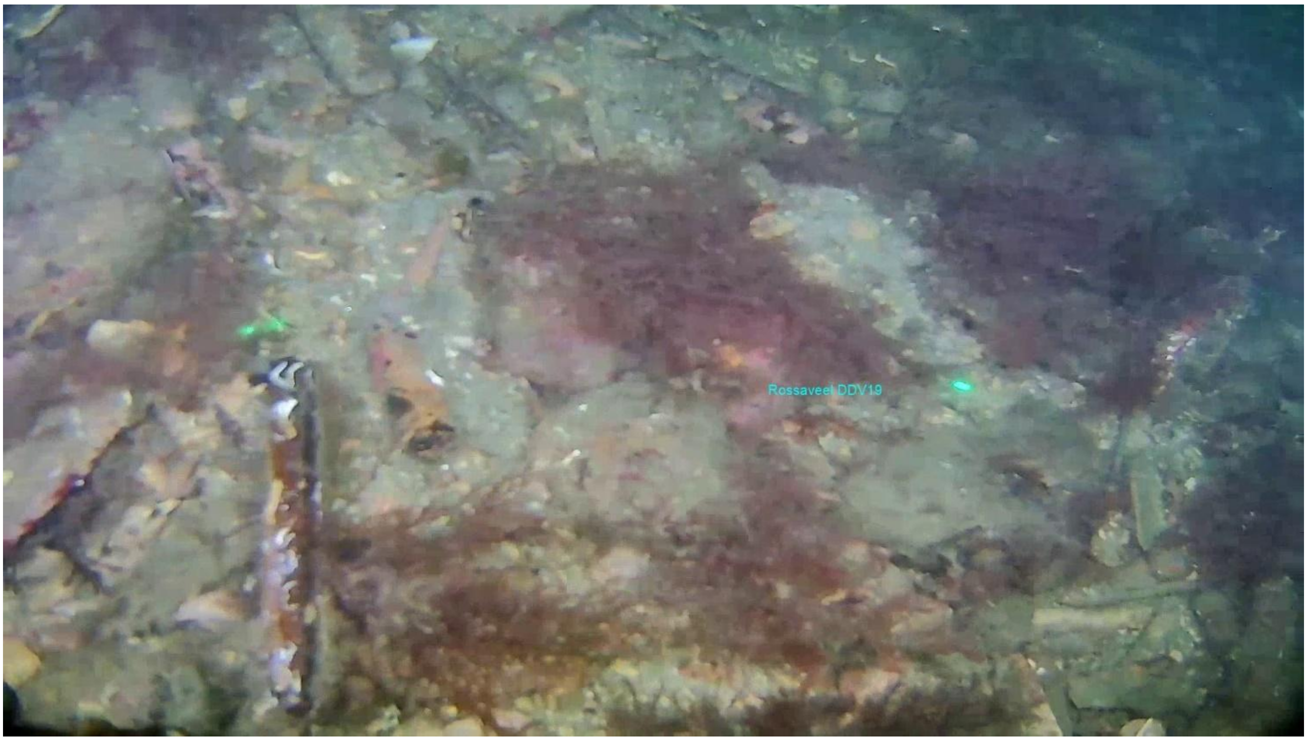

Figure 3.71: DDV Track 19 - mixed sediment substrate with filamentous and encrusting red algae, auger shells (*Turitellinella tricarinata*), and serpulid worms.

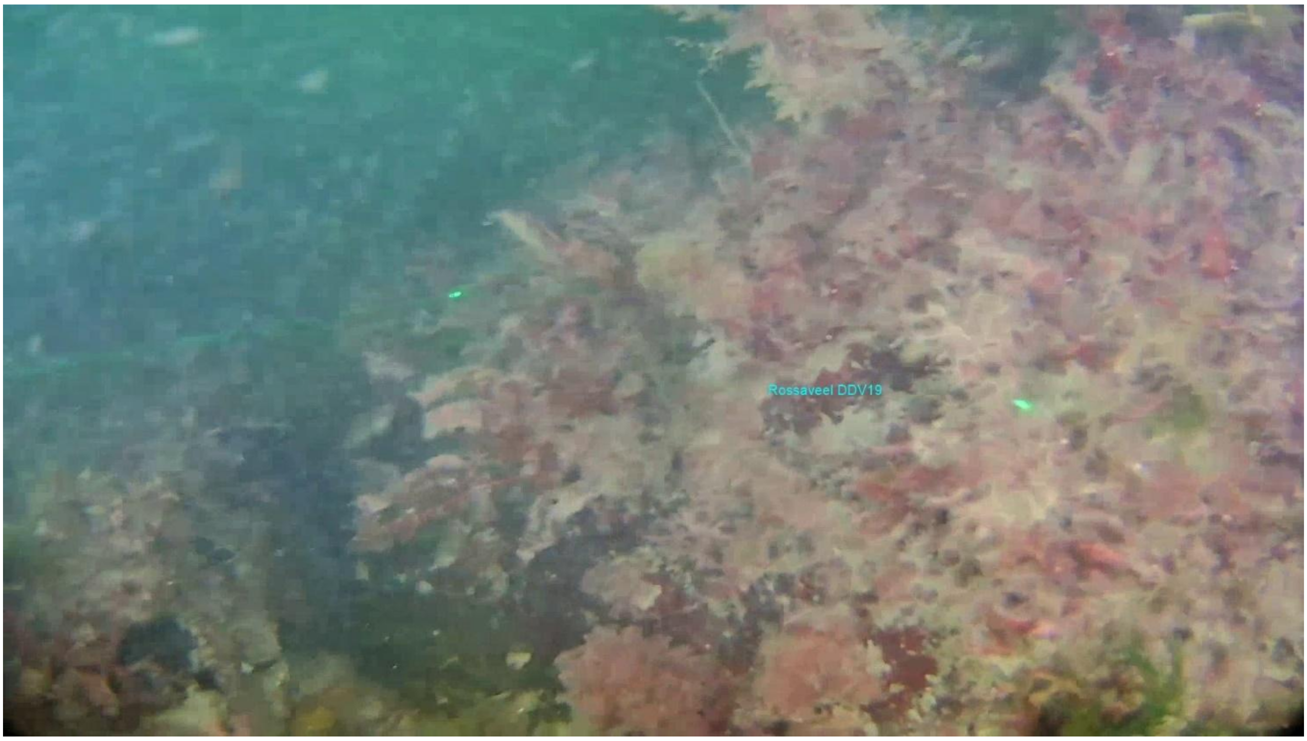

Figure 3.72: DDV Track 19 -assemblage of red and green algae and bryozoans on boulders.

Figure 3.73: DDV Track 19 - assemblage of red algae, bryozoans and drift kelp.

3.1.20 DDV Track 20 (Near to Station 2)

The substrate consisted of sand, boulder, shell material with macroalgae. Notable fauna included starfish, sponge or soft coral, fish and bryozoan (**Figure 3.74** to **Figure 3.77**). This biotope can be classified as a mosaic of the broadscale habitat SS.SMx.CMx Circalittoral mixed sediment with the JNCC biotope CR.HCR.XFa.FluCoAs.SmAs.

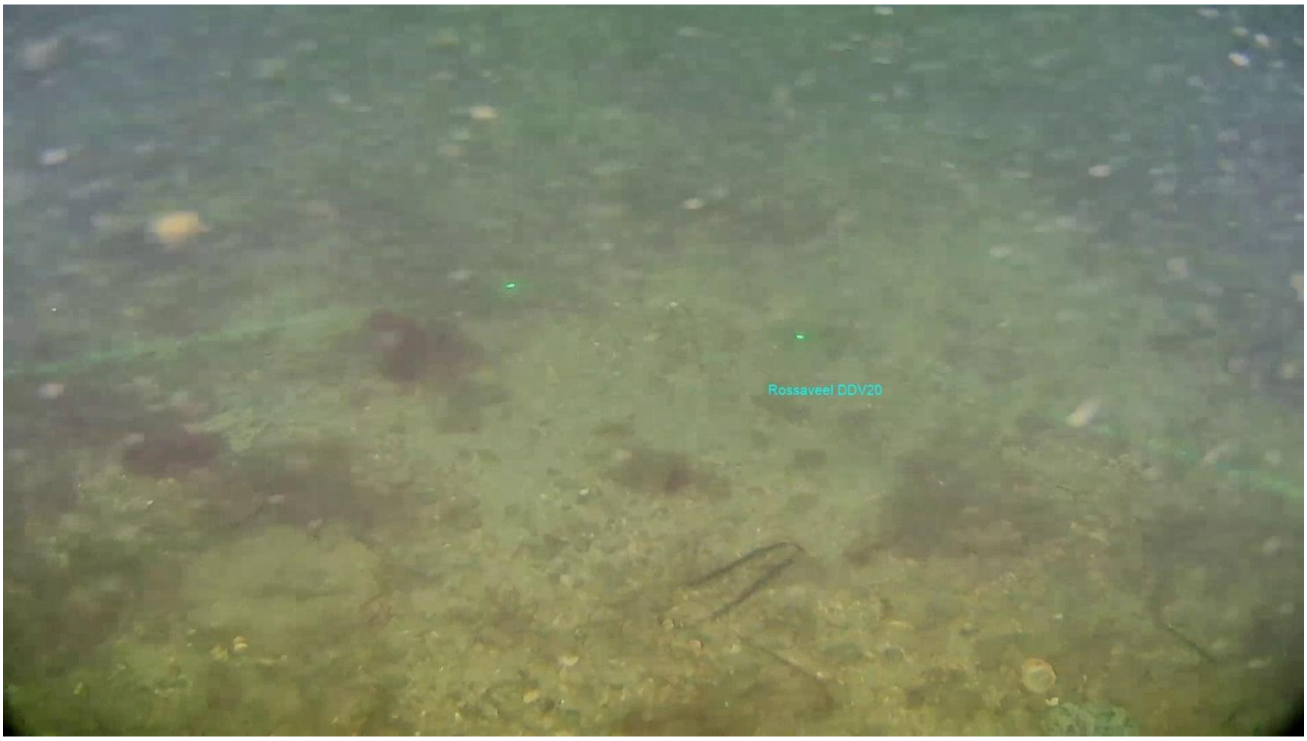

Figure 3.74: DDV Track 20 - mixed sediment substrate with filamentous red algae and auger shells (*Turitellinella tricarinata*.

Figure 3.75: DDV Track 20 - mixed sediment and boulder substrate with filamentous red algae and auger shells (*Turitellinella tricarinata*).

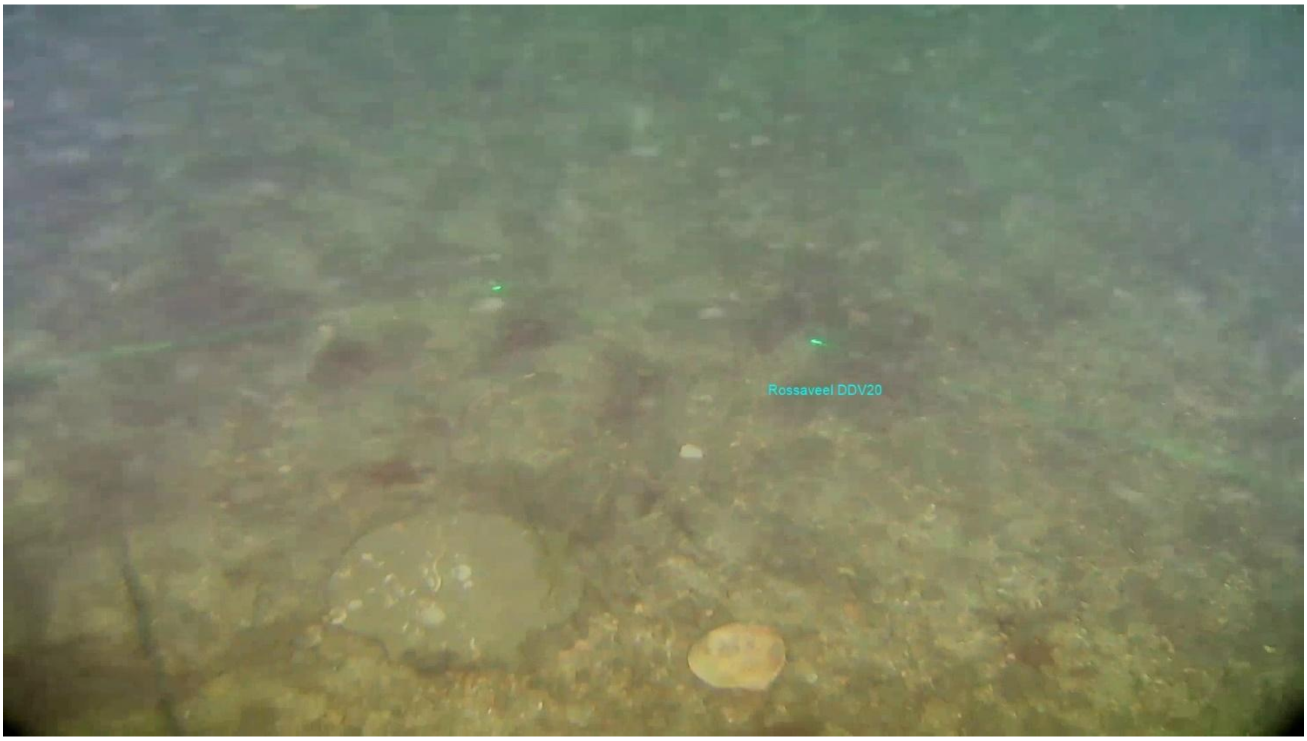

Figure 3.76: DDV Track 20 - mixed sediment substrate with filamentous red algae, auger shells (*Turitellinella tricarinata*), and Serpulid worms.

Figure 3.77: DDV Track 20 - mixed sediment substrate with filamentous red algae, auger shells (*Turitellinella tricarinata*), and Serpulid worms.

3.2 Benthic Fauna Results

Taxonomic identification of benthic fauna across all seven subtidal grab stations surveyed in the vicinity of the Ros an Mhíl Harbour yielded a total count of 255 taxa comprising 6,052 individuals ascribed to nine phyla. Of the 225 taxa identified, 155 were identified to species level. The remaining 70 taxa could not be identified to species level due to life stage (juveniles) or damage. The full faunal abundance species list can be seen in **Appendix 2**.

Of the 255 taxa recorded (225 infaunal taxa infauna and 33 epifaunal or colonial taxa), 1 was a foraminiferan, 2 were poriferans (sponges), 3 were cnidarians (anemones, soft-corals), 3 were nemertean (ribbon worm), 1 was a nematode (round worm), 112 were annelids (segmented worms), 63 were arthropods (crabs, shrimps, insects *etc.*), 52 were molluscs (mussels, cockles, snails *etc.*), 7 were echinoderms (brittle stars, sea urchins *etc.*), 3 were ascidians (sea squirts), 7 were bryozoans (moss animals), and 1 was a phoronid (horse shoe worm).

3.2.1 Univariate Analysis

Univariate statistical analyses were carried out on the station-by-station faunal data. The following parameters were calculated and can be seen in **Table 3.2**; Total number of taxa, Total number of Individuals, Richness, Evenness, Shannon-Wiener diversity, Effective Number of Species (ENS), and Simpson's Diversity.

The number of taxa ranged from 36 (Station 5) to 139 (Station 3). The number of individuals ranged from 519 (Station 2) to 1,466 (Station 4). Richness ranged from 5.07 (Station 5) to 19.95 (Station 3). Evenness ranged from 0.64 (Station 5) to 0.84 (Station 1). Shannon-Wiener diversity ranged from 2.30 (Station 5) to 4.01 (Station 3). Simpson's diversity ranged from 0.84 (Station 5) to 0.97 (Station 1 & 3). Effective number of species ranged from 10.01 (Station 5) to 54.93 (Station 3). indicating that Station 3 is approximately 5.5 times more diverse than Station 5. **Figure 3.78** shows these community indices in graphical form.

Table 3.2: Univariate measures of community structure for the subtidal samples.

Station	No. Taxa	No. Individuals	Richness	Evenness	Shannon-Wiener Diversity	Effective Number of Species	Simpson's Diversity
	S	N	d	J'	H'(loge)	EXP(H')	1-Lambda
Station 1	101	574	15.74	0.84	3.88	48.60	0.97
Station 2	95	519	15.04	0.82	3.72	41.07	0.96
Station 3	139	1009	19.95	0.81	4.01	54.93	0.97
Station 4	42	1466	5.62	0.76	2.86	17.39	0.92
Station 5	36	997	5.07	0.64	2.30	10.01	0.84
Station 6	53	731	7.89	0.66	2.64	13.98	0.86
Station 7	119	756	17.80	0.77	3.67	39.33	0.94

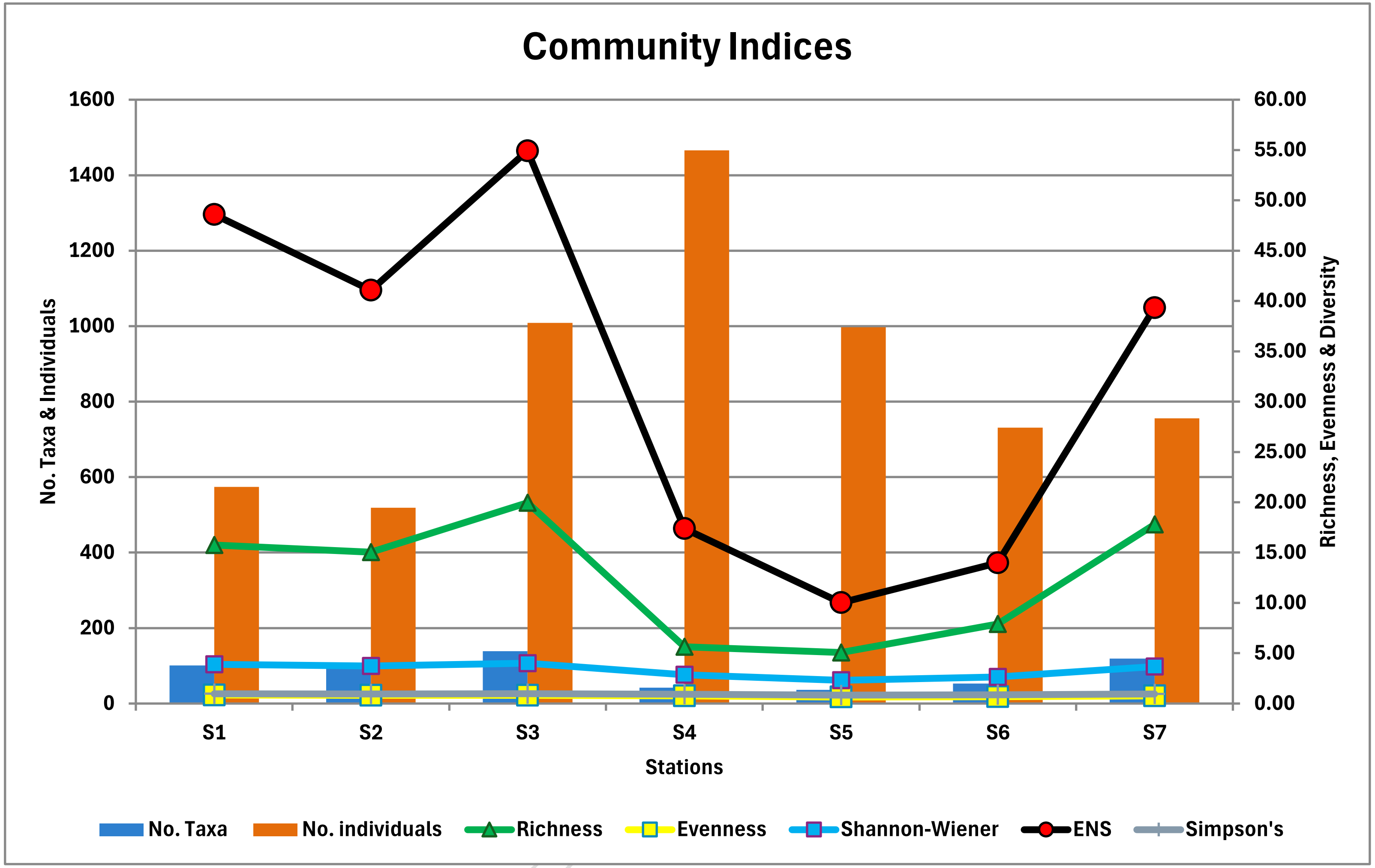

Figure 3.78: Subtidal community indices. Diversity is expressed in Effective Number of Species (ENS), Shannon-Wiener Diversity Index and Simpson's Diversity Index.

3.2.2 Multivariate Analysis

The same data set used above for the univariate analyses was also used for the multivariate analyses. The dendrogram and the MDS plot can be seen in **Figure 3.79** and **Figure 3.80**, respectively. SIMPROF analysis revealed three statistically significant groupings between the seven stations (the samples connected by red lines cannot be significantly differentiated). The stress level (0.01) on the MDS plot indicates an excellent representation of the data with no prospect of misinterpretation.

A clear divide (66.39% dissimilarity) can be seen between **Groups a & b** which had a gravelly muddy sand substrate and **Group c** which had a higher silt content (see **Section 3.4.2** below).

Group a

Group a consisted of a single station 2. **Group a** separated from **Group b** at a 44.63% dissimilarity level. **Group a** contained 95 taxa comprising 519 individuals. Fifty-six of the 95 taxa were present twice or less. Nine taxa accounted for over 53% of the faunal abundance: the polychaetes *Mediomastus fragilis* (70 individuals, 13.49% abundance), *Aponuphis bilineata* (40 individuals, 7.71% abundance), Paraonidae (28 individuals, 5.39% abundance), *Aonides oxycephala* (27 individuals, 5.20% abundance), *Melinna palmata* (19 individuals, 3.66% abundance), *Euclymene oerstedii* (17 individuals, 3.28% abundance), the tanaid *Tanaopsis graciloides* (30 individuals, 5.78% abundance), the amphipod *Metaphoxus simplex* (28 individuals, 5.39% abundance), and the decapod Paguridae (20 individuals, 3.85% abundance). SIMPER analysis could not be carried out for this group as it consisted of a single station.

Aponuphis bilineata and *Metaphoxus simplex* are very sensitive to organic enrichment and are present in unpolluted conditions. *Mediomastus fragilis, Aonides oxycephala, Melinna palmata,* and *Tanaopsis graciloides* are tolerant to excess organic matter enrichment, occurring under normal conditions but their populations are stimulated by organic enrichment. Paraonidae, *Euclymene oerstedii,* and Paguridae do not have assigned ecological groups. **Group a** can be classified as exhibiting many of the characteristics of the JNCC biotope 'SS.SCS.CCS.MedLumVen *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (EUNIS code MC3212) (Tillin & Watson, 2024).

Group b

Group b consisted of stations 1, 3 and 7. and separated from **Group a** at a 44.63% dissimilarity level and had a within group similarity level of 62.09%. **Group b** contained 191 taxa comprising 2,339 individuals. Of the 191 taxa, 84 were present twice or less. Nine taxa accounted for over 47% of the faunal abundance: the polychaetes *Mediomastus fragilis* (292 individuals, 12.48% abundance), *Aponuphis bilineata* (101 individuals, 4.32% abundance), *Pholoe inornata* (*sensu* Petersen) (74 individuals, 3.16% abundance), Paraonidae (74 individuals, 3.16% abundance), and *Aricidea (Acmira) cerrutii* (68 individuals, 2.91% abundance), the tanaid *Tanaopsis graciloides* (150 individuals, 6.41% abundance), the amphipods *Metaphoxus simplex* (161 individuals, 6.88% abundance) and *Metaphoxus fultoni* (66 individuals, 2.82% abundance), and the gastropod *Turritellinella tricarinata* (116 individuals, 4.96% abundance).

Metaphoxus simplex, Metaphoxus fultoni, Aponuphis bilineata, and Aricidea (Acmira) cerrutii are very sensitive to organic enrichment and are present in unpolluted conditions. *Turritellinella tricarinata* and *Pholoe inornata* (*sensu* Petersen) are indifferent to enrichment and are typically present in low densities with non-significant variations over time. *Mediomastus fragilis* and *Tanaopsis graciloides* are tolerant to excess organic matter enrichment, occurring under normal conditions but their populations are stimulated by organic enrichment. SIMPER analysis revealed additional characterising species of this group, namely Nematoda, the tanaid *Chondrochelia savignyi,* and the polychaetes *Paradoneis lyra* and *Prionospio fallax*.

Group b can also be classified as exhibiting many of the characteristics of the JNCC biotope 'SS.SCS.CCS.MedLumVen *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (EUNIS code MC3212) (Tillin & Watson, 2024). **Group a** and **Groub b** can be seen to have similar biotope and are not markedly different in terms of taxa present.

<u>**Group c**</u>

Group c consisted of stations 4, 5 and 6 had a within group similarity level of 52.25% and separated from **Groups a** & **b** at a 66.39% dissimilarity level. This group contained 72 taxa comprising 3,194 individuals. Of the 72 taxa, 26 were present twice or less. Seven taxa accounted for over 65% of the faunal abundance: the tanaids *Tanaopsis graciloides* (490 individuals, 15.34% abundance) and *Chondrochelia savignyi* (131 individuals, 4.10% abundance), the oligochaete *Tubificoides benedii* (459 individuals, 14.37% abundance), the gastropod *Turritellinella tricarinata* (413 individuals, 12.93% abundance), and the polychaetes *Euclymene oerstedii* (286 individuals, 8.95% abundance), *Mediomastus fragilis* (202 individuals, 6.32% abundance), and *Prionospio* sp. (129 individuals, 4.04% abundance).

Tanaopsis graciloides, *Chondrochelia savignyi, Mediomastus fragilis* and *Turritellinella tricarinata* are tolerant to excess organic matter enrichment, occurring under normal conditions but their populations are stimulated by organic enrichment. *Tubificoides benedii* is a first order opportunist that proliferate in reduced sediments. *Prionospio* sp. and *Euclymene oerstedii* do not have assigned ecological groups. SIMPER analysis also revealed additional characterising taxa for this group; the bivalve *Kurtiella bidentata*, and the polychaetes *Notomastus* sp., *Glycera alba* and *Melinna palmata*.

Group c can be classified as exhibiting many of the characteristics of the JNCC biotope 'SS.SMu.ISaMu.MelMagThy *Melinna palmata* with *Magelona* spp. and *Thyasira* spp. in infralittoral sandy mud' (EUNIS code MB6244) (De-Bastos & Watson*,* 2023).

The different biotopes identified from the faunal grabs within the vicinity of Ros an Mhíl Harbour are shown in **Figure 3.81.**

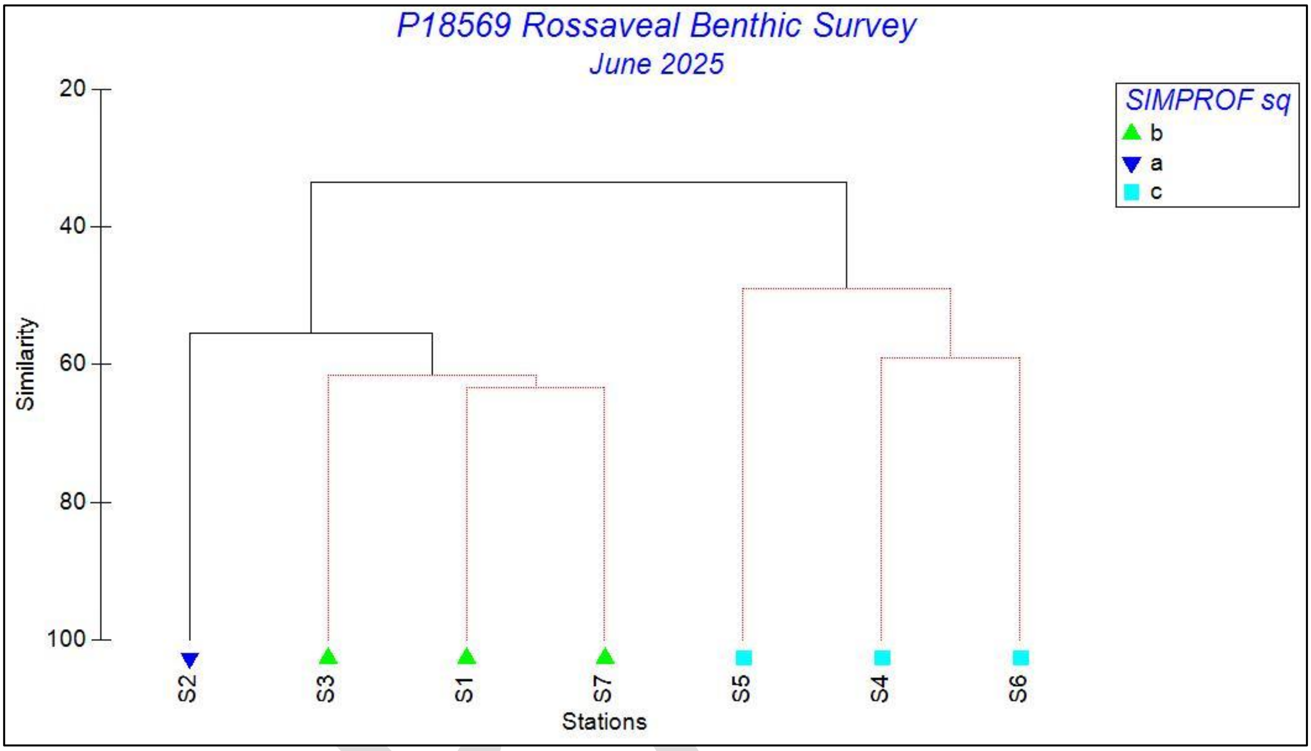

Figure 3.79: Dendrogram produced from Cluster analysis of the subtidal data.

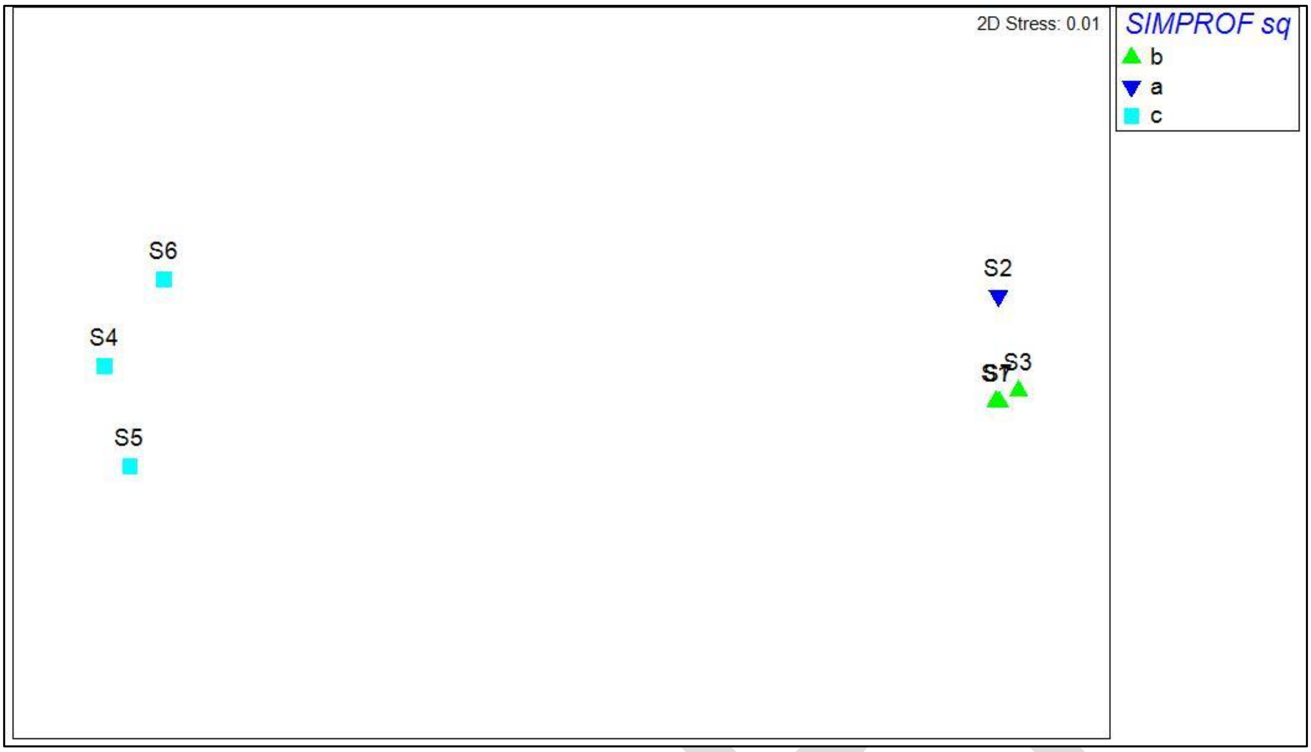

Figure 3.80: MDS Plot of the subtidal data.

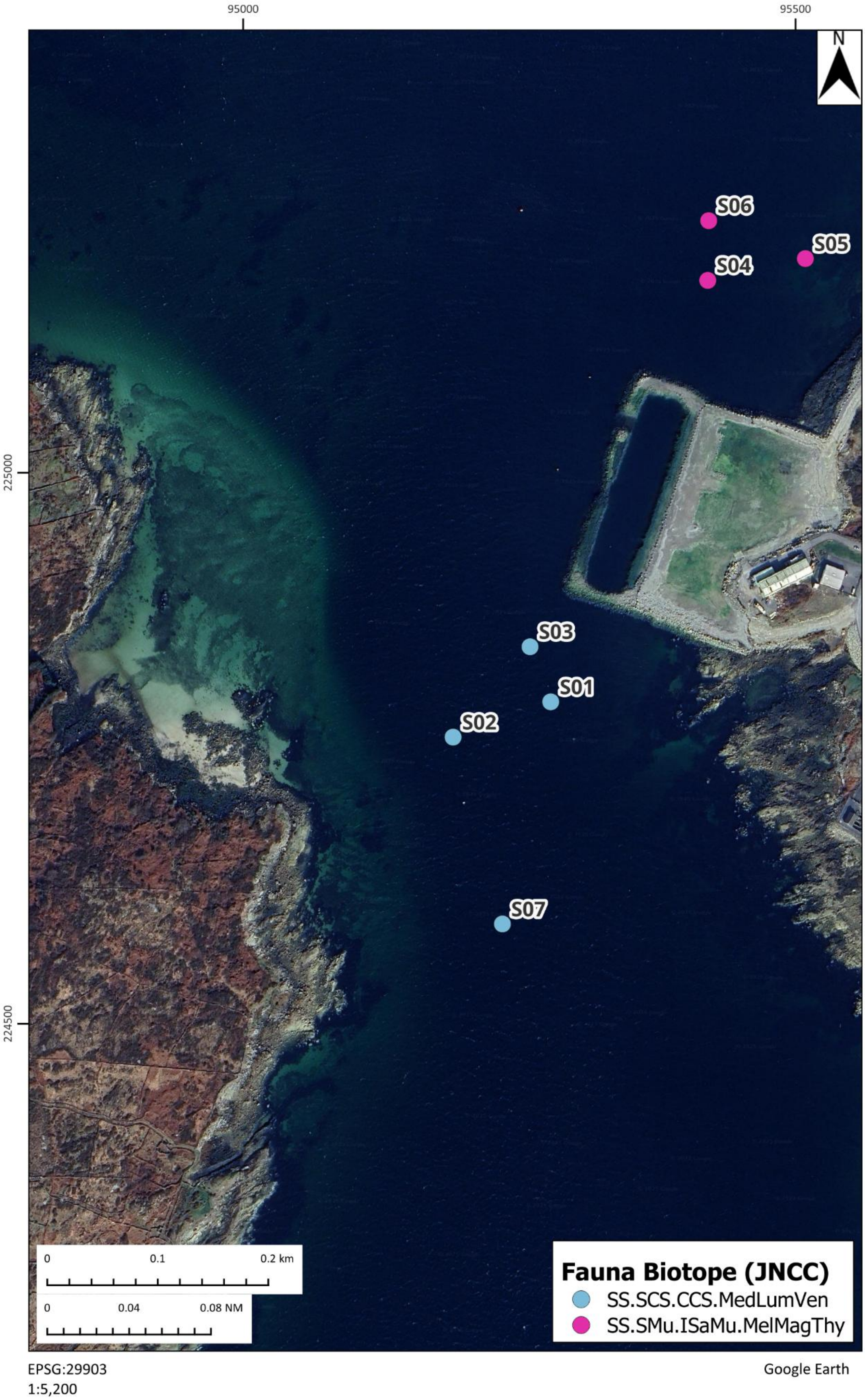

Figure 3.81: Biotopes classification based on infauna species identified in the vicinity of Ros an Mhíl Harbour, Co. Galway.

3.3 Marine Mammals

Harbour seals *Phoca vitulina* are known to haul out in Cashla Bay (Cronin *et al*., 2004) outside of the footprint of the Development (see **Figure 3.82)**. Numbers ranged from 1 to 12 in 2003 (Cronin *et al*., 2004). More recent monitoring surveys recorded maximum counts in inner Cashla Bay of 108, 77 and 77 in 2009, 2010 and 2011 respectively (NPWS, 2012).

While no newer site-specific limits have been published, haul-out data from Cashla Bay were included in a national statistical modelling study by Rakka and Minto (2015), which investigated how environmental and observational factors influence haul-out counts. The study found that haul-out behaviour is significantly affected by variables such as tide height, air temperature, time of day, and seasonality, with peak activity typically occurring around low tide during the moulting season in August. These findings highlight the importance of considering such variables when interpreting seal count data and suggest that observed interannual variability in Cashla Bay likely reflects both population dynamics and environmental influences. Harbour seals remain a qualifying interest of the nearby Kilkieran Bay and Islands SAC.

Grey seals (*Halichoerus grypus*) have the potential to occur within Cashla Bay, although they generally prefer offshore islands for haul-out and breeding. There are currently no confirmed grey seal haul-out or breeding sites within Cashla Bay itself (O'Cadhla *et al*., 2005; O'Cadhla & Strong, 2007). However, regional aerial surveys (Duck and Morris, 2013) and environmental assessments indicate that grey seals are present in broader Galway Bay, suggesting occasional or transitory use of inner bay areas such as Cashla cannot be ruled out (EPA, 2016).

A number of small cetaceans have the potential to occur in the vicinity of the proposed development. Berrow *et al*. (2002) reported that Harbour porpoises *Phocoena phocoena* were the most frequently recorded species in Galway Bay, with most records reported between June and August with fewer sightings in the winter and spring. Berrow *et al*. (2002) also reported concentrations of sightings of Bottlenose dolphins *Tursiops truncatus* in Galway Bay, with sightings increasing rapidly from April to June, suggesting an inshore movement, which peaked in August. However, in more recent years O'Brien (2009) found that this was not the case. Harbour porpoises were the most regularly recorded species with dolphin sightings of any species being very rare. Berrow *et al*. (2008) showed an overall density of porpoises of 0.73 per km^2 with an abundance of 402 ± 84.

More recent monitoring from the Irish Whale and Dolphin Group (IWDG) confirms that common dolphin, harbour porpoise, and bottlenose dolphin continue to be among the most frequently reported species nationwide. In 2023, IWDG validated 515 harbour porpoise sightings (≈19%), 483 bottlenose dolphin sightings (≈18%), and 571 common dolphin sightings (≈21%), highlighting that porpoises remain abundant but common dolphins (*Delphinus delphis*) are now more abundant than porpoises nationally (IWDG, 2023). Although data specific to Galway Bay during that period are limited, these national trends suggest that harbour porpoises remain regularly present, with bottlenose dolphins recorded occasionally, particularly in nearshore and city areas (e.g. Nimmo's Pier resident bottlenose dolphin, "Nimmo", recorded annually since 2015).

In addition to these more common species, an additional 13 species have been recorded from Galway Bay and these include killer whale *Orcinus orca*, minke whale *Balaenoptera acutorostrata*, pilot whale *Globicephala macrorhynchus*, Risso's dolphin *Grampus griseus*, sperm whale *Physeter macrocephalus* and false killer whale *Pseudorca crassidens* (O'Brien, 2013). All cetaceans are protected under Annex IV of the EU Habitats Directive while Bottle-nosed dolphin and Harbour Porpoise are also listed under Annex II.

Otter *Lutra lutra*, an Annex II species which is a Qualifying Interest of the Kilkieran Bay and Islands SAC and the Connemara Bog Complex SAC does have the potential to forage within the coastal strip of Cashla Bay and this includes the area of the proposed deep-water quay.

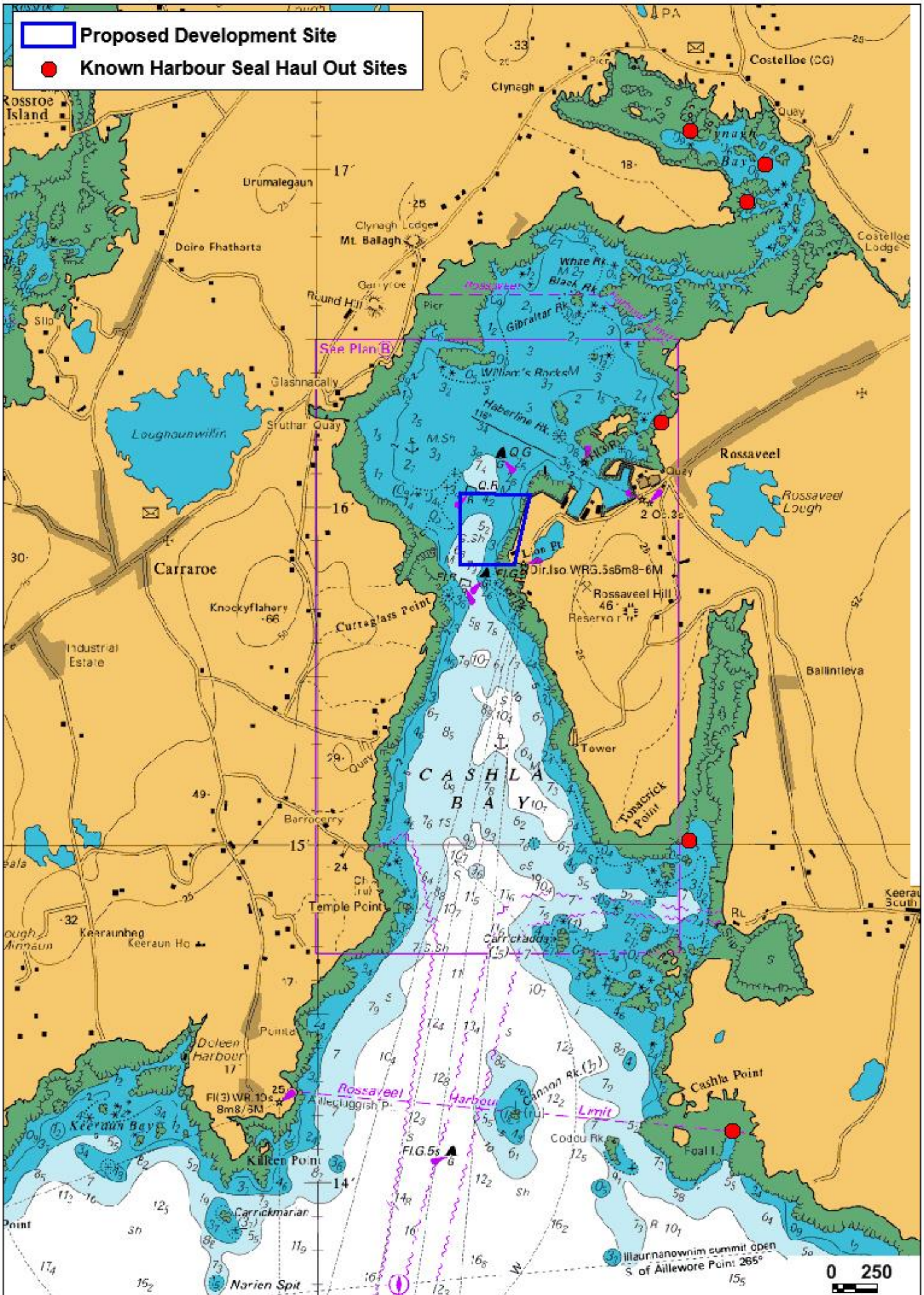

Figure 3.82: Known Harbour seal haul out sites in the vicinity of the proposed development.

3.4 Sediment Chemistry Results

This section will deal with the results of the sediment chemistry analysis. The full laboratory report from SOCOTEC is available in **Appendix 3.**

3.4.1 Visual Analysis

Table 3.3 shows the visual inspection information provided by SOCOTEC, which includes colour and sediment type.

Table 3.3: Visual analysis of sediment.

Station	Description
Station 1	Grey, gravelly SAND. Gravel is shell fragments
Station 2	Grey, gravelly SAND. Gravel is shell fragments
Station 3	Grey, gravelly SAND. Gravel is shell fragments
Station 4	Grey, gravelly SAND. Gravel is shell fragments
Station 5	Brown, grey slightly gravelly silty CLAY. Gravel is shell fragments.
Station 6	Brown, grey silty CLAY
Station 7	Grey gravelly SAND. Gravel is shell fragments.

3.4.2 Physico-Chemical Analysis

Table 3.4 displays the physico-chemical parameters analysed by SOCOTEC. The moisture content of the sediment analysed ranged from 39.7 % (Station 7) to 68.6 % (Station 6). Sediment density ranged from 2.54 mg/m³ (Station 6) to 2.75 mg/m³ (Station 3). The Total Organic Carbon (TOC) results ranged from 1.08 % m/m (Station 3) to 4.47% m/m (Station 6). Carbonate results ranged from 22.3 % m/m (Station 6) to 42.0 % m/m (Station 7). Granulometry results for the sediment composition in percentages for gravel (>2 mm), sand (63-2000 μm), and silt (<63 μm) are shown in **Figure 3.83**. Gravel percentage composition ranged from 5.50 % (Station 6) to 21.71 % (Station 3). Sand percentage composition ranged from 27.49 % (Station 6) to 69.70 % (Station 3). Silt percentage composition ranged from 8.59 % (Station 3) to 67.0 % (Station 6). Sediment particles varied between gravelly muddy sand to gravelly mud (see **Table 3.5** and **Figure 3.84**). The comprehensive laboratory results are available in **Appendix 3**.

Table 3.4: Physico-chemical results of each station.

Station	Total Moisture @120°C (%)	Total Solids	Gravel (>2mm) (%)	Sand (63-2000 µm) (%)	Silt (<63 µm) (%)	Particle Density mg/m^3	TOC (%m/m)	Carbonate Equivalent (% CO_3) (%m/m)
Station 1	47.2	52.8	10.22	63.44	26.33	2.69	1.46	40.0
Station 2	42.3	57.7	12.25	69.18	18.56	2.68	1.50	41.5
Station 3	45.2	54.8	21.71	69.70	8.59	2.75	1.08	41.0
Station 4	53.1	46.9	11.65	31.76	56.59	2.57	2.76	32.3
Station 5	44.7	55.3	7.57	59.94	32.49	2.67	2.14	31.8
Station 6	68.6	31.4	5.50	27.49	67.00	2.54	4.47	22.3
Station 7	39.7	60.3	12.36	65.82	21.82	2.68	1.36	42.0

Table 3.5: Sediment characteristics of the sediment chemistry.

Stations	% Gravel (>2 mm)	% Sand (63-2000 µm)	% Mud (<63 µm)	Folk (1954)
1	10.22%	63.44%	26.33%	Gravelly Muddy Sand
2	12.25%	69.18%	18.56%	Gravelly Muddy Sand
3	21.71%	69.70%	8.59%	Gravelly Muddy Sand
4	11.65%	31.76%	56.59%	Gravelly Mud
5	7.57%	59.94%	32.49%	Gravelly Muddy Sand
6	5.50%	27.49%	67.00%	Gravelly Mud
7	12.36%	65.82%	21.82%	Gravelly Muddy Sand

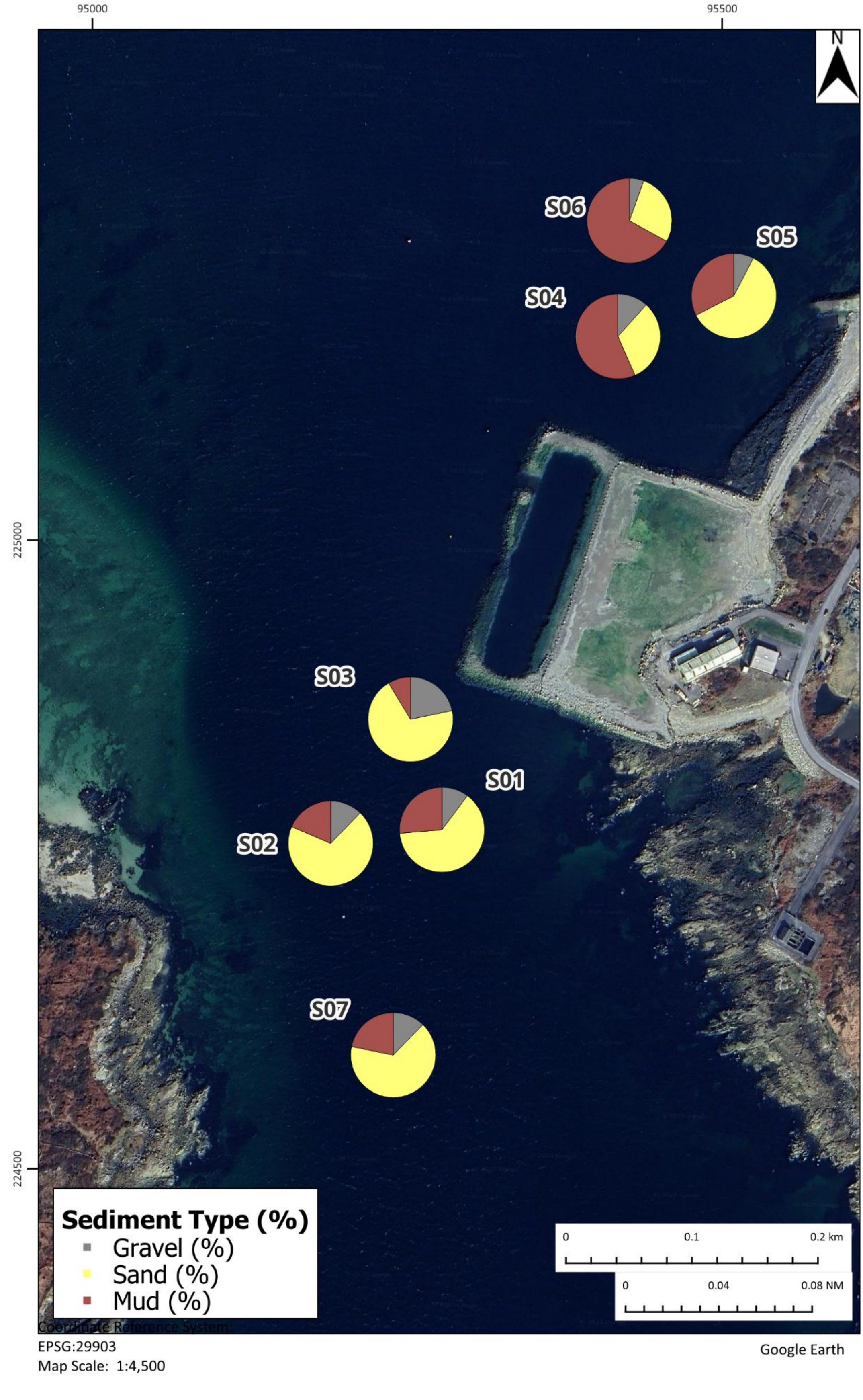

Figure 3.83: Sediment type at each of the stations according to Folk (1954).

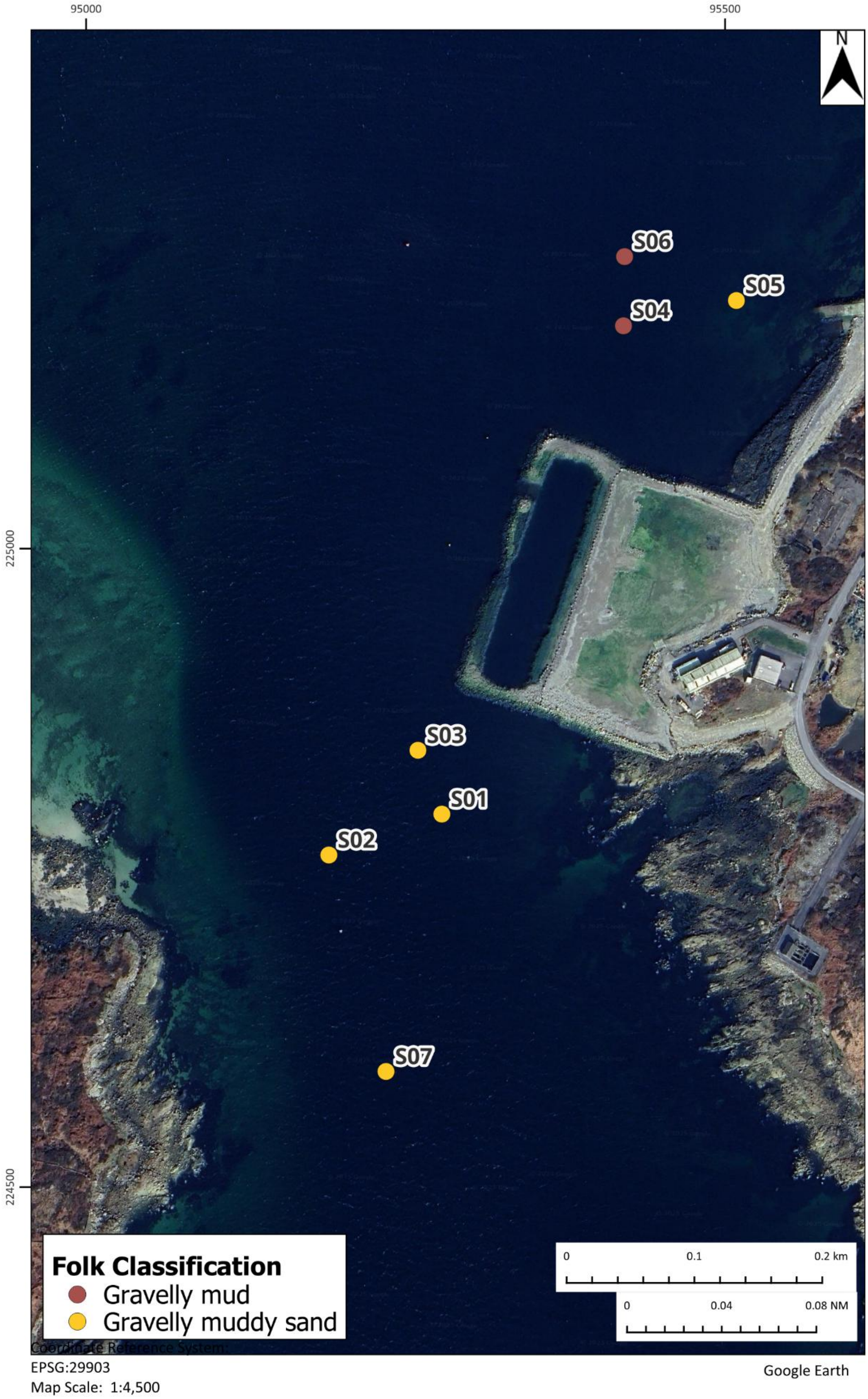

Figure 3.84: Sediment Classification (Folk, 1954).

3.4.3 Contaminants Group

All sediments tested for contaminants, were below the lower and upper-level guidance values outlined in Cronin *et al*. (2006).

3.4.3.1 Trace Metals

Table 3.6 shows the metal results, along with the upper and lower guidance values for metals (Cronin *et al*., 2006). Arsenic and Nickel lower-level limits have been updated to reflect the guideline addendum (Cronin *et al.,* 2019). No exceedances were recorded across all the stations.

Table 3.6: Trace metal and guidance values (Cronin *et al*., 2006).

Determinant mg/kg	Lower Level	Upper Level	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7
Al	N/A	N/A	15900	12500	16700	19300	19800	28500	14600
Cd	0.7	4.2	0.14	0.08	0.08	0.35	0.33	0.35	0.08
Hg	0.2	0.7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
As	20	70	8.4	9.1	17.9	9.8	12.1	13.5	9.6
Cr	120	370	15.4	13.8	21.7	24.3	28.2	39.2	13.2
Cu	40	110	7.1	3.3	2.5	7.7	8.1	12.2	3.4
Pb	60	218	18.3	11.3	30.4	15.8	19.2	25.6	10.4
Ni	40	60	7.3	5.9	4.1	12.4	13.5	18.2	5.3
Zn	160	410	29.6	23.2	28.1	52.9	48.4	59.1	21.8

3.4.3.2 Organochlorines and PCBs

Table 3.7 shows the organochlorines including ɣ-HCH (Lindane) and PCB results, along with the upper and lower guidance values for organochlorines and PCBs (Cronin *et al.,* 2006). All PCBs, HCB and ɣ-HCH were below the guidance level at all stations.

Table 3.7: Organochlorine and PCB results and guidance values.

Determinant µg/kg	Lower Level	Upper Level	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7
AHCH	N/A	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BHCH	N/A	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
GHCH	0.3	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DIELDRIN	N/A	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HCB	0.3	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DDE	N/A	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DDT	N/A	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DDD	N/A	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PCB28	1	180	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PCB52	1	180	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PCB101	1	180	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PCB118	1	180	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PCB138	1	180	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PCB153	1	180	<0.08	<0.08	<0.08	<0.08	<0.08	0.09	<0.08
PCB180	1	180	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

3.4.3.3 Total Extractable Hydrocarbons

Table 3.8 shows the total extractable hydrocarbon results, along with the lower guidance values for Hydrocarbons (Cronin *et al.,* 2006). Values ranged from less than 0.01350 g/kg (Station 2) to 0.17800 g/kg (Station 6). All values across all stations were below the lower guidance level.

Table 3.8: Total Extractable Hydrocarbon results and guidance values.

Determinant g/kg	Lower Level	Upper Level	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7
TEH	1.0	N/A	0.0463	0.0135	0.0231	0.0626	0.0594	0.178	0.0368

3.4.3.4 Tributylin (TBT) and Dibutylin (DBT)

Table 3.9 shows the TBT and DBT results, along with the upper and lower guidance values for DBT and TBT (Cronin *et al.,* 2006).

Table 3.9: shows the TBT and DBT results, along with the Annex I upper and lower guidance values for sum of DBT and TBT (Cronin *et al.,* 2006).

Determinant mg/kg	Lower Level	Upper Level	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7
Dibutyltin (DBT)	N/A	N/A	<5	<5	<5	<5	<5	<5	<5
Tributyltin (TBT)	N/A	N/A	<5	<5	<5	<5	<5	<5	<5

3.4.3.5 Polycyclic Aromatic Hydrocarbons

Table 3.10 shows the PAH results and lower guidance values for sum of 16 PAHs. Sum of 16 PAHs was below the lower limit for all stations.

Table 3.10: Polycyclic Aromatic Hydrocarbon results and guidance values.

Determinant µg/kg	Lower Level	Upper Level	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7
Acenaphthene	N/A	N/A	<5	<5	<5	<5	<5	<5	<5
Acenaphthylene	N/A	N/A	<5	<5	<5	<5	<5	<5	<5
Anthracene	N/A	N/A	<5	<5	<5	<5	<5	<5	<5

Determinant µg/kg	Lower Level	Upper Level	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7
Benzo (a) anthracene	N/A	N/A	25.8	<5	<5	<5	<5	<5	<5
Benzo (a) pyrene	N/A	N/A	18.2	<5	<5	<5	<5	<5	<5
Benzo (b) fluoranthene	N/A	N/A	15.7	<5	<5	11.1	<5	<5	<5
Benzo (ghi) perylene	N/A	N/A	<5	<5	<5	<5	<5	<5	<5
Benzo (k) fluoranthene ug kg^{-1}	N/A	N/A	19.2	<5	<5	<5	<5	20.3	<5
Chrysene	N/A	N/A	25.8	<5	<5	<5	<5	16.5	<5
Dibenz (a,h) anthracene	N/A	N/A	<5	<5	<5	<5	<5	<5	<5
Fluorene	N/A	N/A	<5	<5	<5	<5	<5	<5	<5
Fluoranthene	N/A	N/A	38.8	<5	<5	17.0	<5	29.4	<5
Indeno (1,2,3–cd) pyrene	N/A	N/A	9.47	<5	<5	<5	<5	<5	<5
Naphthalene	N/A	N/A	<5	<5	<5	11.8	<5	<5	<5
Phenanthrene	N/A	N/A	<5	<5	<5	14.0	<5	<5	<5
Pyrene	N/A	N/A	35.1	<5	<5	14.2	<5	23.3	<5
∑ 16 PAHs	4000	N/A	< 228.07	< 80	< 80	< 123.1	< 80	< 149.5	< 80

3.4.3.6 Radiological Analysis

Table 3.11 shows the results of the radiological analysis from 2025. The Office of Radiation Protection and Environmental Monitoring were sent two sediment samples from Ros an Mhíl Harbour collected on 30th June 2025 for analysis.

The samples were prepared by placing an aliquot in a well-defined counting geometry and then measured on a high-resolution gamma spectrometer. Appropriate density corrections were applied to the resultant spectra to take account of the differences in sample density. Dry to wet weight ratio was determined for the sample. Results are quoted on a dry weight basis. The results indicated that dumping of these materials at sea will not result in a radiological hazard.

Table 3.11: Radiological analysis results (2025). N.D. indicates Not Detected.

Stations	K-40	I-131	Cs-134	Cs-137	Ra-226	Ra-228	Am-241	Pb-210	U-235	U-238
1	183 ± 3	N.D.	N.D.	0.38 ±0.01	5.6 ± 0.1	5.4 ± 0.1	0.41 ± 0.04	27.0 ± 2.1	0.49 ± 0.02	17.1 ± 0.6
2	249 ± 3	N.D.	N.D.	1.19 ± 0.02	9.5 ± 0.2	9.5 ± 0.2	<0.25	70.5 ± 3.0	0.79 ± 0.03	24.4 ± 0.8

4. Impact Assessment

This section presents an assessment of the potential impacts to marine ecology and biodiversity associated with the remaining construction activities associated with the Ros an Mhíl deep water quay development. This assessment is structured by individual receptors, defined by the environmental, ecological or human elements that may be affected by the project. For each receptor, both remaining construction-phase and operational-phase impacts are considered, taking into account the nature, likelihood scale, duration and significance of potential changes.

The approach follows established environmental impact assessment methodologies, evaluating direct, indirect, cumulative, and residual effects where applicable. Mitigation measures are identified and discussed for each receptor to reduce or manage adverse impacts.

4.1 Benthic Habitats

Remaining construction of the deep-water quay involves extensive in-water and nearshore works including, drilling, blasting, and dredging. These activities have the potential to impact the subtidal marine biotopes identified during the survey. Remaining dredging operations (quay wall trench, berthing pocket, turning circle, main approach channel) are likely to cause low to heavy siltation as well as physical damage and permanent loss of macroinvertebrates from the seabed. Sediment deposition and sediment extraction are likely to significantly impact macroinvertebrates communities. The nature of dredging works involves the removal of substrate and therefore, cause a change in the structure of the natural habitat inhabited by the infauna. The biotopes sensitivities have been assessed and is presented in **Table 4.1.**

Table 4.1: Biotopes and sensitivities to physical pressures.

Biotopes	Sensitivity of biotopes to identified likely pressures		
	Physical – Smothering & Siltation Light siltation (<5cm)	**Physical – Smothering & Siltation Heavy siltation (>30cm)**	**Habitat Structure Changes – Removal of substratum (Extraction)**
SS.SCS.CCS.MedLumVen *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel	Low	Medium	Medium
SS.SMu.ISaMu.MelMagThy *Melinna palmata* with *Magelona* spp. and *Thyasira* spp. in infralittoral sandy mud	Not sensitive	Low	Medium
SS.SCS.CCS.SpiB *Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles.	Not sensitive	Low	Medium
CR.HCR.XFa.FluCoAs.SmAs - *Flustra foliacea*, small solitary & colonial ascidians on tide swept circalittoral bedrock or boulders	Low	Medium	Not relevant

Biotopes	Sensitivity of biotopes to identified likely pressures		
	Physical – Smothering & Siltation Light siltation (<5cm)	Physical – Smothering & Siltation Heavy siltation (>30cm)	Habitat Structure Changes – Removal of substratum (Extraction)
SS.SMx.CMx.FluHyd - *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment	Not sensitive	Low	Medium
SS.SMp.SSgr.Zmar - *Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand.	Medium	High	High if substrate is removed – But dredging works do not overlap with seagrass biotope

4.1.1 Physical Smothering & Siltation

The impacts of siltation from remaining dredging activities on the biotope SS.SCS.CCS.MedLumVen is considered to have 'Medium' sensitivity at a benchmark threshold of up to 30 cm (Heavy deposition) of fine material added to the seabed in a single discrete event (see MarLIN[2]). However, for light siltation, this biotope is considered to have 'Low' sensitivity at a benchmark threshold of up to 5 cm of fine material added to the seabed in a single discrete event (see MarLIN[2]).

The biotope SS.SMu.ISaMu.MelMagThy is likely to resist smothering at the benchmark level (a 'light' deposition of up to 5 cm of fine material added to the seabed in a single, discrete event). The majority of the associated fauna are burrowing infauna making them adaptive to light sediment deposition conditions. Their resistance is therefore assessed as 'High', and resilience 'High' with their overall sensitivity assessed as 'Not Sensitive' at benchmark level (see MarLIN[3]). Under heavy deposition conditions, bivalves and polychaetes have been reported to migrate through depositions of sediment greater that the benchmark (30 cm of fine material added to the seabed in a single discrete event) (see MarLIN[3]). Some mortality of the characterizing species is likely to occur depending on the type of substrate and thickness of substrate being deposited. Resistance is therefore assessed as 'Low' (25-75% loss) and resilience as 'High' and the biotopes are considered to have 'Low' sensitivity to a 'heavy' deposition of up to 30 cm of fine material in a single discrete event (see MarLIN[3]).

The presence of the characterizing species within SS.SCS.CCS.SpiB is considered to have high resistance to light siltation and smothering. Its sensitivity is assessed to be 'Not sensitive' based on the consideration that sediments are fairly quickly removed from the biotope subject to water movements and that the scour tolerance of the characterizing species and encrusting corallines would reduce mortalities. Damage and abrasion may still occur. However, if sediment deposit remained in place due to lack of water flow or intensity of sedimentation is high, then resistance would be assessed as lower and higher sensitivity. Heavier sediment deposition will likely cause complete burial and loss of characterising species. The biotope is exposed to frequent abrasion and scouring (impact may be reduced if sediment is removed rapidly). Therefore, resistance is assessed as 'Medium'. Larval recolonization by *Spirobranchus triqueter* may occur and therefore resilience is assessed as 'High' based on re-growth of the biotope and sensitivity is therefore assessed as 'Low' (See MarLIN[4]).

For the characterising infauna of the biotope CR.HCR.XFa.FluCoAs.SmAs, a deposit of 5 cm of fine sediment could cause smothering and damage of small fauna while larger fauna such as *Flustra foliacea* is likely to show more resistance. Deposited sediment would likely be disperse quickly given the high energy area where the biotope occurs. Therefore, the biotope is considered to have medium resistance, high resilience and low sensitivity (see MarLIN[5]). Heavy silt deposition (30 cm of fine sediment) would likely smother and damage the majority of the faunal community. In the high energy environment that the biotope occurs, deposited sediment would probably be removed fairly quickly. Resistance under heavy siltation conditions is therefore assessed as 'Low', resilience as 'Medium' and sensitivity as 'Medium' (see MarLIN[5]).

Light siltation may bury some of the characterising species within the biotope SS.SMx.CMx.FluHyd at the benchmark level (5 cm of deposition). This biotope occur in areas of moderate water movement and sediment is likely to be removed fairly rapidly. The biotope typically experience occasional sand deposition and therefore, resistance is assessed as 'High', resilience as 'High' and the biotope is assessed as 'Not sensitive' at the benchmark level. Under heavy silt deposition (30 cm of sediment), most characterizing species except for those on large boulders and would be loss. Resistance is, therefore, assessed as 'Medium', resilience as 'High' and sensitivity as 'Low' (see MarLIN[6]).

The biotope SS.SMp.SSgr.Zmar, where the seagrass *Zostera marina,* is likely to be significantly impacted by siltation both light and heavy deposition depending on the depths of burial and sediment type (see MarLIN[7]). The benchmark level (5 cm of fine material added to the seabed in a single event) is likely to cause some degree of mortality and biomass loss may occur. Therefore, this biotope is assessed as having low resistance. Some plants may survive, and rhizome reestablishment may occur closer to the sediment surface after disturbance. Resilience is therefore assessed as 'Medium' at the pressure benchmark. In addition, seagrass beds occur in low energy environments, suggesting that silt deposition may not be quickly flushed away. Therefore, sensitivity of this biotope is considered as 'Medium' to siltation at the pressure benchmark (see MarLIN[7]). As described above, seagrass is likely to be highly impacted by low siltation. High siltation is likely to cause significant damage to such biotopes with all individuals highly likely not to survive. Resistance to sedimentation at the pressure benchmark (30 cm of added material) is therefore assessed as 'None', with resilience as 'Low' to 'Very Low'. Sensitivity of this biotope is therefore assessed as 'High' (see MarLIN[7]).

4.1.2 Habitat Structure Changes – Removal of Substratum (Extraction)

The impacts of remaining dredging activities (removal of seabed substratum) may have an impact on the characterising species of the biotope SS.SCS.CCS.MedLumVen. Extraction of the sediment swill remove the characterising and associated species present and therefore resistance is assessed as 'None'. Resilience is assessed as 'Medium' as some species may require longer than two years to re-establish and sediments may need to recover (where exposed layers are different). The sensitivity of the biotope SS.SCS.CCS.MedLumVen is therefore assessed as 'Medium' (see MarLIN[2]).

The remaining dredging works will likely extract at least 30 cm of sediment from the seafloor and will remove the characterizing species of the biotopes SS.SMu.ISaMu.MelMagThys. Resistance is assessed as 'None', resilience is therefore judged as 'Medium', based on the recruitment dispersal limitation of the characterizing fauna (see MarLIN[3]). The sensitivity of this biotope has been assessed as 'Medium'.

The characterising species of SS.SCS.CCS.SpiB are epifaunal in nature, occurring on cobbles and pebbles. The removal of the substratum would remove the habitat, and the characterising species attached. Resistance is assessed as 'None' within the extraction footprint, and resilience is assessed as 'High' if habitat is restored. Sensitivity is therefore assessed as 'Medium'. If all habitat is removed and restoration does not occur, recovery will be prolonged, and sensitivity will be higher (see MarLIN[4]).

The species characterizing the biotope CR.HCR.XFa.FluCoAs.SmAs are epifauna or epifloral occurring on rock and would be sensitive to the removal of the habitat from remaining dredging in the development area. As the extraction of approximately 1000 m^3 of rock substratum is planned as part of widening the main approach channel for the development, this impact is considered likely, though recovery is also likely.

The species characterizing the biotope SS.SMx.CMx.FluHyd are epifaunal or epiflora, occurring mostly on cobbles and pebbles. The extraction of the substratum through remaining dredging activity for the development will likely cause the removal of the habitat (boulders, cobbles and pebbles) and the attached characterizing epifauna. The resistance of this biotope is assessed as 'None' within the extraction footprint), resilience is assessed as 'Medium' if habitat is restored and if the underlying substrate remains the same and sensitivity is, therefore, assessed as 'Medium'. Recovery will likely be prolonged with a higher sensitivity if the entire habitat is complete removed and restoration (artificial or natural) to the previous state does not occur (see MarLIN[6]).

Marine invertebrates quickly re-colonise the seabed after a disturbance such as burial under sediment deposition and it is anticipated that the same species that were previously recorded will be re-establishing themselves within two or more years after remaining dredging activities for the development.

Typically, the extraction of sediments to 30 cm (the benchmark) within the pressure footprint of dredging will cause the complete removal of seagrass beds from the biotope SS.SMp.SSgr.Zmar - *Zostera marina*/*angustifolia* beds on lower shore or infralittoral clean or muddy sand. The uprooting of roots and rhizomes will occur buried no deeper than 20 cm below the surface. The resistance of this biotope is assessed as 'None', resilience is considered 'Very Low' resulting in a sensitivity score of 'High' (see MarLIN[7]). Given that this biotope falls outside of the immediate footprint of the remaining dredging zone, it is unlikely that seagrass beds will be impacted in this way.

4.2 Marine Mammals

Completing the construction of the deep-water quay involves extensive in-water and nearshore works including completion of rock armour placement on the northern and southern sides of the quay, drilling and underwater blasting in the berthing pocket and 1000 m^3 of bedrock in the main channel as well as dredging in the berthing pocket, turning circle and main channel approach. These activities have the potential to impact marine mammals through a range of pathways, primarily underwater noise, physical disturbance, habitat exclusion, and possible displacement from foraging areas.

4.2.1 Noise

Noise disturbance is the most significant concern, particularly associated with remaining underwater blasting and drilling. These activities generate impulsive and continuous sound sources capable of disturbing or displacing sensitive marine mammals such as harbour porpoise, bottlenose dolphin, grey seal and harbour seal, which are known to use the broader Galway Bay area and in the case of the harbour seal, haul out in Cashla Bay (Section **Marine Mammals**).

Otters, a qualifying interest of both the Kilkieran Bay & Islands SAC and the Connemara Bog Complex SAC, are likely to forage along the coastal margins of Cashla Bay, including areas adjacent to the quay wall trench. While less sensitive to underwater noise than cetaceans, they may be temporarily displaced by the remaining construction activity.

The explosive energy from remaining rock blasting, even when conducted below fill material and in contained berms, has the potential to propagate underwater and may cause behavioural disturbance within a radius extending several hundred metres to kilometres depending on substrate, depth, and local bathymetry. Harbour porpoises are particularly sensitive to such sounds, with auditory injury thresholds (temporary or permanent hearing loss) being exceeded within several hundred metres under some blasting scenarios. In the absence of mitigation, injury could occur at distances of up to 400 m for seals and potentially 1–2 km for porpoises (Southall *et al*., 2019; JNCC, 2017).

Remaining drilling activity using hydraulic equipment (e.g. DT145) also contributes to elevated underwater noise over prolonged periods. Drilling is generally acknowledged to produce moderate levels of continuous omnidirectional sound at low frequency (several tens of Hz to several thousand Hz and up to c.10 kHz). Source sound pressure levels have generally been reported to lie within the 145-190 dB re: 1 µPa range (Richardson et al., 1995; OSPAR, 2009a; 2014). Continuous noise from the remaining hydraulic drilling and dredging operations also pose a risk of temporary threshold shift (TTS) or behavioural disruption, particularly during prolonged operations.

Even when injury thresholds are not exceeded, behavioural impacts such as avoidance, displacement, altered dive patterns and disruption of foraging are well documented in marine mammals exposed to construction noise. For example, studies have shown significant reductions in porpoise activity near piling and blasting operations, with animals avoiding areas up to 7–15 km from the source and taking days to return (Brandt *et al*., 2011; Graham *et al*., 2019). Vessel activity and general construction noise can also interfere with foraging behaviour and acoustic communication, particularly in narrow or enclosed areas such as Cashla Bay. While grey seals are less frequently observed in the bay and prefer offshore haul-out sites, harbour seals and harbour porpoises using the area may be susceptible to such disturbance, particularly during sensitive periods such as the moulting season (August–September) or during peak foraging periods. In order to reduce potential impacts, standard mitigation measures should be implemented for remaining drilling, blasting and dredging, including visual monitoring by MMOs (Marine Mammal Observers) who will advise on measures such as soft-start procedures where appropriate. Monitoring and exclusion zones will be established around the remaining blasting areas, with activity postponed if marine mammals are observed within a critical radius. The use of rock platforms rather than jack-up barges also reduces the propagation of noise through open water, possibly helping to attenuate received levels in the wider bay.

Overall, the risk of direct injury to marine mammals from the remaining works is considered low if mitigation measures are properly implemented. However, there remains a moderate potential for short-term behavioural disturbance and temporary displacement from the immediate and adjacent marine area. Given the known importance of the area for harbour seals and the regular occurrence of harbour porpoise, cumulative disturbance, particularly from repeated blasts or prolonged drilling, may affect the use of the site by these species during key periods. With continued adherence to best-practice construction protocols and real-time monitoring from trained MMOs, these impacts are considered manageable but will require ongoing assessment throughout the remainder of the remaining works.

In addition to in-water construction activities, increased vehicle traffic onshore may contribute to ambient noise levels in the coastal environment during the remaining works. While air-borne sound transmits poorly into water, in shallow, enclosed bays such as Cashla Bay, onshore noise can enter the water column through vibration transfer along structures such as quay walls, ramps, and rock revetments. This may contribute to a cumulative increase in background noise levels, potentially masking biologically important sounds for species such as harbour porpoise and seals. In this context, heavy machinery, haul trucks, and frequent vehicle movement near the shoreline may cause temporary avoidance of the immediate area by sensitive species. To minimise disturbance, remaining construction traffic should be managed to reduce peak noise levels near the shoreline, and noise-reducing measures such as vehicle mufflers and scheduling high-noise activities away from periods of high marine mammal activity should be considered. With these mitigation strategies in place, the overall risk of noise from the remaining in-water works to marine mammals is considered low to moderate and temporary in nature.

Following completion of the construction phase, the operational phase of the deep-water quay will involve ongoing vessel traffic, cargo handling, and associated onshore activities such as vehicle movements and loading operations. Operational protocols should incorporate noise-minimisation strategies and continued observation of marine mammal presence near the quay.

4.2.2 Sedimentation Related Impacts

The remaining quay wall construction works, blasting of bedrock to widen the approach channel and dredging of the berthing pocket, turning circle and approach channel, will result in increased levels of suspended sediments and localised turbidity in Cashla Bay. While marine mammals are not directly dependent on water clarity for navigation or communication, elevated turbidity can influence them indirectly through effects on their prey base (e.g., fish, cephalopods), and through potential irritation of sensitive sensory systems such as vibrissae in seals. Harbour porpoises, for example, rely heavily on echolocation to hunt for fish, and reductions in prey availability or behavioural changes in prey species due to sediment plumes can disrupt foraging efficiency. Similarly, seals may experience reduced foraging success in areas where visual cues and prey behaviour are altered by persistent turbidity.

Increased sedimentation can also be associated with the release of fine particles and organic material, potentially leading to localised oxygen depletion in benthic habitats or temporary smothering of important feeding grounds for marine mammals. Remaining dredging activity will result in episodic turbidity spikes within Cashla Bay. These impacts are of particular relevance during periods of high marine mammal activity such as the harbour seal moulting season (August–September), when animals may spend extended periods in nearshore waters.

To minimise sedimentation-related impacts, several mitigation measures should be implemented for the remaining in-water works. These include scheduling high-risk sediment-generating activities during periods of low marine mammal presence where possible and ensuring that all rockfill material is clean and well-graded to reduce fines. Real-time turbidity monitoring can also be used to ensure that sediment levels remain within acceptable thresholds, triggering adaptive responses if exceedances occur. Monitoring of marine mammal presence during peak construction phases should be maintained to assess any displacement potentially linked to turbidity. With these mitigation strategies in place, the overall risk from sedimentation to marine mammals is considered low to moderate and temporary in nature.

4.3 Fish Species

4.3.1 Noise

The remaining drilling, blasting and dredging works required to complete the deep-water quay development has the potential to impact local fish populations through underwater noise. The drilling and blasting of bedrock to widen the approach channel and dredging of the berthing pocket, turning circle and approach channel are likely to generate high levels of impulsive and continuous underwater noise which can result in a range of impacts on fish, depending on the species, life stage and proximity to the source. Impulsive noise from blasting is of particular concern, as it can cause physical injury or mortality to fish within close range, especially those with swim bladders, such as herring (*Clupea harengus*) and salmonids (Hawkins *et al.,* 2015).

Studies have shown that exposure to high-pressure shock waves can result in internal injuries or barotrauma, particularly in juvenile or larval stages. Behavioural effects, including startle responses, changes in schooling behaviour, avoidance of noisy areas, and temporary loss of hearing sensitivity (temporary threshold shift/TTS), are also well documented and may reduce feeding or spawning success if persistent (Popper and Hawkins, 2019).

Continuous noise from dredging and drilling can also mask biologically relevant cues, including acoustic signals used in courtship, predator detection, and navigation, potentially impacting fish reproductive success and increasing predation risk (Popper and Hastings, 2009). Migratory species such as Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*), which use coastal and estuarine areas during transitions between marine and freshwater environments, may be particularly vulnerable if construction noise disrupts migration corridors or results in delayed passage during key periods (Thorstad *et al*., 2005).

In order to mitigate for this source on impact on salmon, blasting will not be carried out between 1st April and 31st July as this is the time of year when adult fish will be passing through Cashla Bay on their way up to the Cashla River to spawn and juveniles (smolts) will be passing southwards on their way to sea. This restriction of when blasting can be carried out will also mitigate impacts on seals in the area.

4.3.2 Sedimentation Related Impacts

Increased sedimentation due to in-water works can also adversely affect fish. Elevated turbidity can impair visual foraging efficiency, especially for species that rely on sight to hunt prey and can clog gill structures causing stress or behavioural avoidance (Wegner *et al*., 2017). Sediment deposition may also smother eggs on the benthos or reduce habitat quality for juvenile fish in spawning or nursery areas.

To mitigate these impacts blasting should continue to follow best-practice protocols including soft-start procedures, environmental monitoring and appropriate seasonal timing to avoid key fish migration or spawning windows as discussed in the section above on noise related impacts.

Turbidity barriers or phased dredging may help limit sediment spread, and real-time turbidity monitoring can be used to trigger adaptive mitigation responses. With these measures in place, the risk of significant, long-term impacts on fish species is considered low to moderate, and temporary in nature.

4.4 Water Quality

4.4.1 Sedimentation Related Impacts

The remaining construction works of the deep-water quay at Cashla Bay involves substantial in-water and near-shore works. The completion of the quay wall construction will include pre-dredging and cleaning of quay wall trench, foundation laying and actual quay wall construction followed by backfilling behind the quay wall. An estimated 10,000 m^3 of imported material will be used for backfilling with additional rock armour revetments on the northern and southern side of the new quay (*c.* 50%). Dredging in the berthing pocket, the turning circle and drilling, blasting of the approach channel, all of which will have the potential to affect local coastal water quality. The primary concerns relate to increased turbidity, suspended sediment concentrations (SSC), and the potential release of contaminants from disturbed seabed material.

The processes of land dredging, construction, backfilling and rock armouring are likely to generate material dust particles that can access adjacent water and cause localised elevated turbidity levels, which may reduce light penetration and negatively affect primary productivity, particularly for benthic algae and phytoplankton.

The drilling and blasting of bedrock to widen the approach channel and dredging of the berthing pocket, turning circle and approach channel are likely to cause significant major suspension of sediments from the seabed. The potential plume of sediment suspension generated is likely to cause smothering of seabed fauna and flora during resettlement.

In addition to sediment-related effects, there is potential for accidental spills or leaks of fuels, oils, or hydraulic fluids from construction equipment operating near or on the water. Such events, though unlikely if managed properly, could cause localised contamination and acute toxicity to marine organisms.

To mitigate these risks, best-practice construction environmental management must be maintained. Key measures include phased dredging to minimise the spatial and temporal extent of sediment disturbance, real-time turbidity monitoring with defined trigger levels and stop-work thresholds, bunded fuel storage, spill kits, and regular equipment checks to prevent hydrocarbon leaks and timing in-water works outside biologically sensitive periods, where possible. With these controls in place, the residual impact to water quality is predicted to be low, temporary, and localised.

4.5 Invasive Alien Species

The completed and remaining construction works and operation phases of the deep-water quay at Ros an Mhíl present potential pathways for the introduction and spread of invasive alien species (IAS) in the marine environment. Marine infrastructure developments often act as vectors for IAS through increased vessel traffic, ballast water discharge, and the attachment of non-native organisms to construction materials, equipment, and vessel hulls (Minchin and Nunn, 2013). Quay structures, pontoons, and submerged surfaces can also serve as new hard substrates for colonisation by opportunistic non-native fouling organisms, which may subsequently spread to surrounding natural habitats.

Species of concern in Irish coastal waters include *Didemnum vexillum* (carpet sea squirt), *Crepidula fornicata* (slipper limpet), and *Undaria pinnatifida* (wakame), all of which can outcompete native flora and fauna, alter benthic community structure, and impact commercial aquaculture and fisheries (BIM, 2023). The risk is heightened when construction involves equipment or materials transported from other regions, particularly from areas where IAS are already established. Furthermore, increased post-construction vessel traffic, particularly from non-local operators, may elevate the risk of IAS arrival and establishment via biofouling or ballast water.

To minimise the introduction and spread of IAS, a suite of biosecurity measures should be implemented during both the construction and operational phases. These include cleaning and inspection of all marine plant, vessels, and construction equipment before deployment on site, sourcing materials such as rock fill from terrestrial, non-marine locations and avoiding material with prior aquatic exposure, ensuring that ballast water management practices comply with IMO Ballast Water Management Convention standards, regular monitoring of new structures for colonisation by non-native species, especially during the initial years of operation, Development of a Biosecurity Risk Assessment and, if needed, a Rapid Response Plan for any detected IAS.

With proper controls, the likelihood of IAS establishment due to the development is considered low, though continued vigilance during the remainder of the construction phase and the operational phase remains important, particularly given the quay’s role in facilitating marine access and transport.

5. Discussion

An update to the marine ecological survey conducted at Ros an Mhíl Harbour, Co. Galway in 2017 was carried out to characterise the seafloor physical properties and the benthic communities present in the subtidal marine environment on the 30th of June 2025.

The survey consisted of two components:

(i) A drop-down video survey to carry out a preliminary sea floor investigation. The survey covered the area in the vicinity of Ros an Mhíl Harbour and identified areas of potential reef or hard substrate as well as finer silt and sand substrates. This enabled the development of the grab survey plan where suitable substrate types could be targeted. Note that DDV station locations in 2025 differed from those in 2017 as to avoid the area of reclaimed land where the quay will be completed post June 2025.

(ii) A benthic grab survey – faunal sampling was carried out at seven stations identified as suitable for grab sampling. This facilitated an assessment of the benthic faunal communities present in the survey area. Additional sediment grabs sampling was carried out for sediment particle size analysis and organic carbon content by SOCOTEC UK Limited. Note that grab sample locations in 2025 differed from those in 2017 as to avoid the area of reclaimed land where the quay will be completed post June 2025, as well as the identification of unsuitable habitat for grab sampling identified via DDV.

The sediment sampled in 2025 from the development area were classified according to Folk (1954) as a mix of Gravelly Muddy Sand, and Gravelly Mud. Though direct comparison among samples in 2017 and 2025 was not possible (as grab station locations were relocated in 2025 to avoid bedrock and other unsuitable habitats), the overall granulometry of stations agree well between the sampling campaigns. For example, in 2017, the one sample collected north of the development area was classified as Muddy Sand, while three samples collected to the north of the development area in 2025 were classified as either Gravelly Muddy Sand or Gravelly Mud. South of the quay development in the proposed berthing channel (that is to be dredged post June 2025), samples in 2017 indicated a mix of Gravelly Sand and Gravelly Muddy Sand here while 2025 samples were all identified as Gravelly Muddy Sand. The 2025 drop-down video survey identified areas of cobbles, boulders and potential reef throughout the survey area. These areas were deemed unsuitable for sediment sampling survey as the sediment type was too coarse (>5mm) for analysis. Additionally, areas with boulders and potential reef were not suitable for faunal grab surveying.

Analysis of the drop-down video footage indicated a number of broadscale habitats (JNCC and EUNIS). There were three main broadscale habitats identified within the surveyed area:

i. SS.SMx.CMx - Circalittoral mixed sediment

ii. SS.SMp.KSwSS - Kelp and seaweed communities on sublittoral sediment

iii. SS.SMp – Sublittoral macrophyte dominated communities on sediments

Three main biotopes were identified from the drop-down video survey. DDV transects frequently transitioned from one biotope into another:

i. SS.SMp.SSgr.Zmar - *Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand.

ii. SS.SCS.CCS.SpiB *Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles.

iii. CR.HCR.XFa.FluCoAs.SmAs - *Flustra foliacea*, small solitary & colonial ascidians on tide swept circalittoral bedrock or boulders.

Across the grab stations, **Station 1** was characterised by the main broadscale habitat SS.SMx.CMx with a combination of SS.SMp. The main broadscale habitat at **Station 1** transitioned from SS.SMx.CMx to CR.HCR.XFa.FluCoAs.SmAs. **Station 2** was characterised by the broadscale habitat SS.SMx.CMx with CR.HCR.XFa.FluCoAs.SmAs as secondary habitat. **Station 3** was characterised by the broadscale habitat SS.SMx.CMx with secondary habitat characterised by SS.SMp.KSwSS or a combination of SS.SMp.KSwSS and CR.HCR.XFa.FluCoAs.SmAs. **Station 4** was characterised by the main broadscale habitat SS.SMx.CMx. **Stations 5 and 6** were characterised by the main broadscale habitat SS.SMx.CMx, overlapping with **Station 4**. **Station 7** was characterised by the main broadscale habitat SS.SMx.CMx. Some areas were characterised as a combination of both SS.SMx.CMx as primary habitat with a combination of SS.SMp and CR.HCR.XFa.FluCoAs.SmAs. Sea grass, *Zostera marina*, was still observed along the western side of Cashla Bay. The extent of the sea grass can be seen in **Figure 3.2**. Sparse maërl was observed along the eastern side of the proposed development.

Though the benthic grab station locations from the 2025 survey were not identical to station locations in the 2017 survey, benthic infaunal communities identified in 2025 still agreed well with findings from 2017. The results of the faunal analysis in 2017 and 2025 both describe a diverse and species-rich community in and around the development area. All species observed typically inhabit gravelly sandy/muddy sandy habitat which has not changed significantly from 2017 to 2025. The results of the univariate analyses on the species data revealed high diversity in 2025. Three stations (1, 3 & 7) recorded more than 100 taxa. Stations 3 and 4 recorded more than 1000 individuals while Station 2 recorded the lowest number of individuals (519).

Multivariate analysis of the faunal samples revealed three statistically significant faunal groupings amongst the faunal grab stations. There was a clear divide between the stations with a coarse sand substrate and fine sandy mud substrate. Two distinct biotopes were identified to the three groupings:

- SS.SCS.CCS.MedLumVen *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (EUNIS code MC3212).
- SS.SMu.ISaMu.MelMagThy *Melinna palmata* with *Magelona* spp. and *Thyasira* spp. in infralittoral sandy mud' (EUNIS code MB6244).

Station 2 (**Group a**) and Stations 1, 3, 7 (**Group b**), were classified as the JNCC biotope SS.SCS.CCS.MedLumVen (EUNIS code MC3212) with characterising infaunal species such as the polychaete worms *Mediomastus fragilis*, *Aponuphis bilineata*, the tanaid *Tanaopsis graciloides*, the amphipods *Metaphoxus simplex*, and *Metaphoxus fultoni.* Stations 4, 5, 6 (**Group c**) were classified as belonging to the JNCC biotope SS.SMu.ISaMu.MelMagThy (EUNIS code MB6244) with characterising infaunal species namely *Melinna palmata* and *Notomastus* sp.

<u>Impacts on benthic habitat</u>

The impacts arising from the remaining works for the development will vary in their significance depending on the resistance, resilience and sensitivity of the characterising infauna of the biotopes existing at the site. From the sensitivity assessment described in **Section 4.1** above, three main impacts were identified that could potentially cause significant damage to the macroinvertebrates community based on the construction works to be undertaken as part of the development.

The *c.* 8,000m^2 area of land that was reclaimed for the construction of the quay and storage/working area landward of the quay resulted in the unavoidable permanent loss of the intertidal and subtidal habitats and associated species in this area.

Remaining dredging of the main navigation channel, turning circle (-6m) and berthing channel (-12m) will cause physical disruption of the habitat structure in which macroinvertebrate communities inhabit. This will result in the permanent removal/loss of these characterising species and biotopes within the immediate footprint of the dredging. The *c.* 130,000 m^2 area yet to be dredged in the main channel, turning circle and berthing pocket will lose its biotope and associated characterising species. However, marine invertebrates have the potential to quickly re-colonise the seabed after a disturbance such as dredging and it is anticipated that the characterising species will recover and re-establish within the same area within two or more years post-dredging. The seagrass beds of *Zostera marina* found along the shallow western side of Cashla Bay can be highly sensitive to both heavy siltation and substrate extraction. As remaining dredging operations will be carried out outside the boundary of the seagrass beds of *Zostera marina*, there will be no direct impact in relation to the uprooting or physical removal of this sensitive habitat.

Remaining dredging operations will induce fine sediment suspension that could lead to smothering of benthic communities. It is expected that smothering caused by particle sizes of <125µm will settle out onto the seabed up to 30 m from the dredger. Macroinvertebrate communities within the immediate footprint of the dredger will therefore be physically impacted. This gives an area of *c* 22,000m^2 that is estimated to be affected by sediments deposition. However, it is anticipated that based on the sensitivity of the biotopes identified, they may likely recover from the disturbance and recolonisation of the site is possible within two or more years after disruption. Finer sediment particles will likely remain in suspension long enough to be dispersed and settle out in volumes and depths that are considered minimal to have any effect on benthic communities. Localised temporary increases in suspended sediments will not be of the concentrations or duration that would be detrimental to the seagrass beds. Moreover, sediment suspension by dredging activities is unlikely to cause a significant impact to the nearby *Zostera* beds as the current flows in and out in a north to south direction, and therefore sediment suspension is likely to be carried and deposited south of the development in Cashla Bay.

The analysis of the sediment chemistry was carried out following the specifications of the Marine Institute's DaS suite to establish a baseline for the sediment chemistry within the red line boundary of the development. All sediments tested, were below the upper-level guidance values outlined in Cronin *et al*. (2006) and Marine Institute addendum (Marine Institute, 2019). None of the physical and chemical parameters analysed exceeded lower or upper-level guidance concentrations. Radiological analysis did not reveal any exceedances in radioactive elements

<u>Impacts on marine mammals</u>

The impacts of the construction of the deep-water quay at Ros an Mhíl Harbour on marine mammals was assessed in our previous report (2017). A range of potential short-term impacts to marine mammals, primarily through underwater noise (blasting, drilling, and dredging) and sedimentation have been reported. Similar impacts will be expected on marine mammals in the area during the remaining of the development works (blasting of bedrock, drilling and dredging of the approach channel, turning circles and berthing pocket). Underwater blasting and hydraulic drilling generate impulsive and continuous noise, which can lead to temporary hearing threshold shifts, behavioural disturbance, and spatial displacement of sensitive species such as harbour porpoise and harbour seal. While the risk of physical injury is considered low with the application of best-practice mitigation (*e.g.*, MMOs, soft-start procedures, and exclusion zones), cumulative behavioural impacts remain a moderate concern, particularly during sensitive periods such as the harbour seal moulting season.

Sedimentation impacts on marine mammals are less direct but may influence prey availability and foraging behaviour by increasing turbidity and altering habitat quality. Although most dredged material was coarse rock, episodic increases in suspended sediments could still affect prey species and feeding efficiency, particularly for echolocating porpoises and visually foraging seals.

Overall, if mitigation measures are consistently applied and real-time monitoring continues, the environmental risks to marine mammals are expected to be temporary, localised, and manageable. However, ongoing assessment throughout the remainder of the works is recommended to ensure early detection of any potential impacts.

Increased onshore vehicle activity during construction and operation may elevate ambient noise levels in the coastal environment, with vibration transfer through quay structures potentially contributing to underwater noise in shallow areas like Cashla Bay. To minimise disturbance to sensitive marine mammals, noise-reducing measures and activity scheduling should be implemented alongside ongoing monitoring during both construction and operational phases.

Impacts on fish

The construction of the deep-water quay Ros an Mhíl Harbour was previously assessed to impact fish populations in the area including salmonids. It is expected that the remaining construction activities, blasting, drilling and dredging of the approach channel, berthing pocket and turning circles present potential risks to local fish populations, primarily through underwater noise and increased sedimentation. Impulsive noise from blasting poses a risk of physical injury to fish, particularly species with swim bladders such as herring and salmonids, while continuous noise from drilling and dredging may interfere with biologically important behaviours including feeding, spawning, and migration. Migratory species like Atlantic salmon and sea trout are particularly sensitive, and mitigation includes a seasonal restriction on blasting between April and July to avoid key migration periods.

Increased sedimentation from dredging, backfilling, rock armouring, and reclamation can reduce water quality, impair gill function, and smother spawning grounds or benthic eggs. To mitigate these risks, best-practice protocols for blasting and dredging are in place, including soft-start procedures, seasonal timing, turbidity monitoring, and potential use of sediment control measures. With these controls implemented, the impacts to fish are expected to be temporary and of low to moderate significance.

Impacts on water quality

The remaining construction works at Ros an Mhíl involves extensive in-water works that pose potential risks to local water quality, primarily through increased suspended sediment concentrations and turbidity. It is anticipated that *c.* 150,000 m^3 of dredged material will be removed from the site. This will comprise *c.* 120,000 m^3 of rock and 30,000 m^3 other material mostly sand and gravel. These effects can reduce light penetration and impair primary productivity, particularly in benthic ecosystems. Additional concerns include the accidental release of hydrocarbons or other construction-related pollutants, which could cause localised contamination.

To address these risks, a range of mitigation measures are in place, including phased dredging, real-time turbidity monitoring with defined thresholds, spill prevention protocols, and scheduling to avoid ecologically sensitive periods. With the implementation of these best-practice measures, any deterioration in water quality is expected to be temporary, localised, and of low environmental significance.

Invasive Alien Species

The current and remaining construction works and hard structures remaining to be built at Ros an Mhíl can introduce potential pathways for the introduction and spread of IAS, primarily via vessel traffic, ballast water discharge, and the transfer of fouling organisms on submerged surfaces or construction equipment. The development may also provide new hard substrates for colonisation by marine IAS, including high-risk species such as *Didemnum vexillum*, *Crepidula fornicata*, and *Undaria pinnatifida*, which are known to disrupt native ecosystems and aquaculture operations.

To address these risks, biosecurity protocols will be implemented, including equipment inspection and cleaning, sourcing non-marine materials, adherence to international ballast water management standards, and monitoring of structures post-construction. With these measures in place, the risk of IAS establishment is considered low, although ongoing vigilance will be essential, particularly during the operational phase when marine traffic increases.

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7. Appendices

APPENDIX 1: Standard Operating Procedure – Field Method (T2-SOP-Field Methods-04)

Contents

1. Purpose and scope

Purpose:	The purpose of this SOP is to outline the methodologies used for in field benthic habitat classification from drop down video images/filming.
Scope:	The methods outlined in this SOP can be utilised for benthic habitat classification in field and station selection for benthic habitat sampling.

2. Ownership and implementation

Procedure owner:	It is the responsibility of the lead scientist conducting the station selection resulting from the DDV survey to ensure that the methodologies outlined in this SOP are consistent with best practice and any other specific classification requirements as outlined in the scope of works for a specific project.
Procedure user:	Any scientist involved in station selection for benthic habitat sampling resulting from DDV imaging.

3. Process Map

DDV Imaging

- DDV Image Received for pre-selected Proposed Station

Sediment Classification

- Sediment is Classified and deemed Suitable

Reef Classification/Fauna/ Flora

- The absence of any reef/fauna/flora that could be impacted by benthic sampling is confirmed.

Other Disqualifying Features

- The absence of any other disqualifying features such as man made infastructure/wrecks/marine litter is confirmed.

Station Deemed Suitable for Benthic Sampling

4. References

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- T2-SOP-FIELD-01-Particle Diameter Classification (Udden-Wentworth), Aquafact 2025
- T2-SOP-FIELD-02-Sediment Type Classification (FOLK), Aquafact 2025

5. Benthic Sampling Station Selection Using from Image Analysis

Drop down video (DDV) imaging can be used to determine the following for benthic sampling suitability;

(a) To determine whether the sediment type is suitable for benthic sampling.
(b) To determine whether there is any biogenic or non-biogenic reef present that would be negatively impacted by benthic sampling.
(c) To determine whether there is any present/accumulation of fauna or flora species that would be negatively impacted by benthic sampling.
(d) To determine whether there is any other considerations that could effect or be effected by benthic sampling.

1. Station Selection Based on Sediment Classification		
Feature	Feature Description	Suitability for Benthic Sampling
Boulders/Cobbles/Pebbles	• Boulders (>256 mm) • Cobbles (64 – 256 mm) • Pebbles (4-64 mm)	NOT SUITABLE
Small Granules	• Shell/Gravel (*circa* 4 m)	SUITABLE
Coarse Sediments	• Gravel(G) • sandy Gravel (s-G) • gravelly Sand (G-s)	SUITABLE
Mixed Sediments	• muddy Gravel (m-G) • muddy sandy Gravel (m-s-G) • gravelly Mud (g-m) • gravelly muddy Sand (g-m-S)	SUITABLE
Mud	• Mud	SUITABLE
Sand	• Sand	SUITABLE

2. Station Selection Based on Reef Classification

Feature	**Feature Description**	**Suitability for Benthic Sampling**
Biogenic Reef	• Any reef made by a living organism.	NOT SUITABLE
Non-Biogenic Reef	• The structure of reefs varies from bedrock to boulders or cobbles while topography ranges from horizontal to vertical and the reefs may have numerous ledges and crevices. The geology includes limestone, shale, granite, schists and gneiss. Brown fucoid algae generally dominate the intertidal down to shallow subtidal areas. The latter are characterised by kelp species, frequently with an understorey of red foliose algae. Below the kelp and down to about 30 m, red algae characterise the substratum with very few brown algae. Below this, the habitat is characterised by faunal species; very few foliose or filamentous red algae occur although encrusting red algae may be common.	NOT SUITABLE
Serpula Reefs	• The polychaete worm *Serpula vermicularis* secretes a calcareous tube and is common as a solitary worm. The worms aggregate and form structures which may be up to 1 m in height and about 2 m in diameter.	NOT SUITABLE
Sabellaria Reef	These are constructed by the polychaete worms *Sabellaria spinulosa* and *Sabellaria alveolata.* The reefs are constructed of sand grains by the worm and form a	NOT SUITABLE

	substrate for many other species that would not normally be present in the area in the absence of the reefs. The reefs can be up to a metre in thickness.	
Bivalve Reefs	• Reefs caused by accumulations of bivalve populations.	NOT SUITABLE
Cold Water Coral Reefs	• Cold water coral reefs are from 200–1600 m, where the water temperature is 4–8ºC and the salinity is 32–36%. Coral reefs found to date are generally associated with carbonate mounds, features that rise up to 300-500 m above the sea floor.	NOT SUITABLE

3. Station Selection Based on Identifiable Fauna/Flora		
Feature	**Feature Description**	**Suitability for Benthic Sampling**
Fauna	• Any bottom fixing fauna species. • Any large populations/accumulations of benthic species.	NOT SUITABLE
Flora	• Any bottom fixing flora species.	NOT SUITABLE
Drift Flora	• Any non-attached drift flora.	SUITABLE

4. Other Considerations that Influence Station Selection		
Feature	**Feature Description**	**Suitability for Benthic Sampling**
Man Made Structures	• Any visible mad man instructor	NOT SUITABLE
Wrecks or Similar Archaeological Material	• Any visible archaeological material.	NOT SUITABLE
Large Accumulation of Marine Litter	• Any visible large accumulation of marine litter.	NOT SUITABLE

6. Sample Station Elimination for Benthic Sampling from DDV Image Analysis

Project Name & No. P15458 Survey Team: AR + JS

Date: 11/10/24

Station Notes

Time	Station	Depth	Station Observations - Substrate, Fauna etc.
15:46	ST_05	18.5m	

Footage	Received	Saved
	✓	✓

SEDIMENT TYPE
- COBBLES

IDENTIFIABLE FAUNA
- SPONGES
- BRITTLE STAR (LARGE AREA COVERED)

NOT SUITABLE FOR BENTHIC SAMPLING

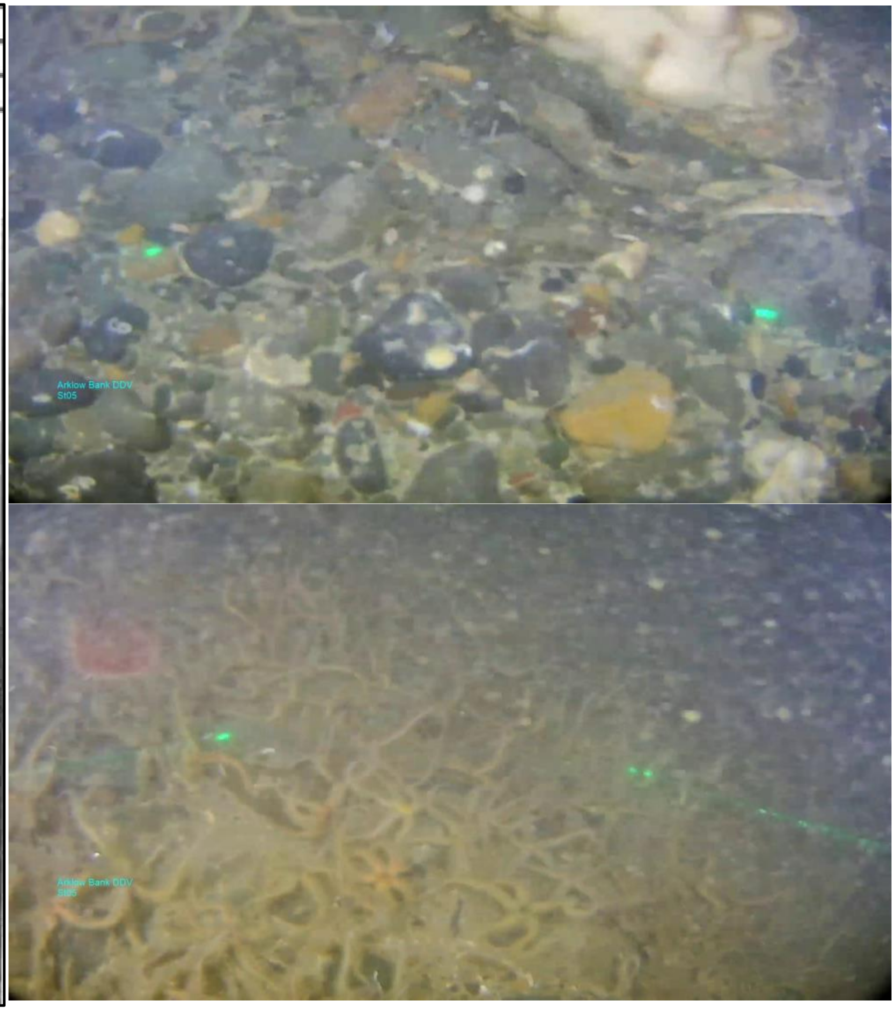

Figure 6.1 Sample Station Data Sheet for Eliminated Station for Aquafact job P15458.

The above station was eliminated as the transect revealed cobbles/boulders that are an unsuitable sediment type and there was also a large accumulation of brittle stars present.

Document End

APPENDIX 2 Fauna Species List

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Astrorhiza limicola	113843	0	0	3	0	0	0	0
Porifera	558	Present	0	0	0	0	0	0
Polymastia penicillus	170654	0	0	present	0	0	0	0
Actiniaria	1360	6	0	1	0	0	0	1
Sagartia	100776	0	0	11	0	0	0	0
Edwardsia claparedii	100880	0	0	3	0	0	0	0
Nemertea (unidentifiable)	152391	8	1	14	0	1	2	3
Tubulanus polymorphus	122637	3	1	2	0	3	2	5
Cerebratulus	122348	0	0	1	1	1	0	0
Nematoda	799	7	2	11	84	4	21	28
Golfingiidae	2032	17	1	16	0	0	1	11
Golfingia vulgaris	424332	0	0	0	0	0	1	0
Nephasoma constrictum	424371	0	0	12	0	0	0	0
Thysanocardia procera	136063	1	0	0	0	0	0	0
Phascolion strombus	266489	0	1	0	0	1	0	2
Polychaeta (unidentifiable)	883	0	0	1	0	0	0	0
Polynoidae (unidentifiable)	939	0	1	4	0	0	0	2
Malmgrenia darbouxi	863197	1	0	0	0	0	0	0

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Malmgrenia (unidentifiable)	147006	6	1	3	0	1	1	1
Harmothoe (unidentifiable)	129491	2	2	17	0	0	1	4
Pholoe (unidentifiable)	129439	0	1	0	17	0	1	0
Pholoe baltica (sensu Petersen*)*	130599	8	0	0	2	0	5	1
Pholoe inornata (sensu Petersen*)*	130601	39	2	22	0	0	0	13
Fimbriosthenelais zetlandica	131066	0	1	0	0	0	0	0
Phyllodocidae (unidentifiable)	931	6	3	6	0	0	0	3
Eteone longa	130616	2	4	1	1	0	4	7
Pseudomystides limbata	130683	0	0	4	0	0	0	0
Phyllodoce groenlandica	334506	0	0	0	1	0	0	0
Phyllodoce mucosa	334512	0	0	0	0	1	0	0
Eulalia bilineata	130624	1	0	0	0	0	0	0
Eumida sanguinea	130644	2	0	0	0	0	0	0
Paranaitis kosteriensis	130662	1	0	0	0	1	0	0
Glycera (unidentifiable)	129296	1	4	4	1	0	8	5
Glycera alba	130116	1	0	0	7	3	6	0
Glycera lapidum	130123	0	0	0	0	0	0	2
Glycera unicornis	130131	0	0	0	1	0	0	1
Glycera tridactyla	130130	0	1	0	0	0	0	0

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Glycinde nordmanni	130136	0	0	1	0	0	0	0
Sphaerodorum abyssorum	154985	0	0	1	0	0	0	1
Hesionidae (unidentifiable)	946	0	0	2	0	0	0	0
Psamathe fusca	152249	2	0	5	1	0	0	1
Syllidia armata	130198	0	1	6	0	0	0	1
Syllidae (unidentifiable)	948	0	0	3	0	0	0	0
Syllis (unidentifiable)	129680	2	0	0	0	0	0	1
Syllis armillaris	131415	2	0	2	0	0	0	0
Syllis cornuta	157583	0	1	0	0	0	0	0
Syllis pontxioi	196003	0	1	0	0	0	0	0
Eusyllis blomstrandi	131290	0	0	0	0	0	0	1
Exogone (unidentifiable)	129654	0	0	0	0	0	0	2
Parexogone hebes	757970	4	5	4	0	3	1	6
Exogone naidina	327985	0	0	2	0	0	0	0
Sphaerosyllis hystrix	131388	0	2	3	0	0	0	2
Myrianida (unidentifiable)	129659	0	0	3	0	0	0	1
Nereididae	22496	7	1	4	1	0	1	3
Eunereis longissima	130375	0	0	1	1	0	0	1
Nephtys (unidentifiable)	129370	3	5	6	0	0	0	6

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Nephtys hombergii	130359	0	1	0	0	0	0	0
Nephtys kersivalensis	130363	0	2	0	0	0	0	0
Euphrosine borealis	130081	0	0	1	0	0	0	1
Aponuphis bilineata	130452	24	40	52	0	0	0	25
Lysidice unicornis	742232	17	1	3	0	0	0	3
Lumbrineris (unidentifiable)	129337	0	0	3	0	0	0	1
Lumbrineris cingulata (aggregate)	130240	4	2	2	0	0	1	2
Lumbrineris latreilli	130248	3	3	2	0	0	0	3
Notocirrus scoticus	129861	0	0	0	0	0	0	1
Protodorvillea kefersteini	130041	6	4	8	49	50	3	6
Paraonidae (unidentifiable)	903	18	28	23	0	16	0	33
Aricidea cerrutii	130555	12	6	16	0	0	0	40
Cirrophorus branchiatus	130576	1	0	0	0	0	0	2
Cirrophorus furcatus	130577	0	0	0	0	0	0	1
Paradoneis (unidentifiable)	129433	16	6	2	1	33	0	14
Paradoneis lyra	130585	3	7	4	0	0	3	6
Paradoneis ilvana	130584	0	0	2	0	0	0	0
Spionidae (unidentifiable)	913	2	5	4	34	0	6	5
Aonides oxycephala	131106	15	27	10	0	0	0	35

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Laonice bahusiensis	131127	2	2	0	16	0	2	0
Prionospio cf. multibranchiata	131160	0	0	4	17	2	0	2
Dipolydora caulleryi	131116	1	1	1	0	0	0	2
Prionospio (unidentifiable)	129620	8	1	6	69	45	15	2
Prionospio fallax	131157	2	0	8	2	3	0	3
Pseudopolydora pulchra	131169	0	0	0	0	0	1	0
Magelona alleni	130266	0	0	2	0	0	0	0
Cirratulidae (unidentifiable)	919	1	5	2	16	0	0	1
Caulleriella alata	129943	1	13	9	0	0	0	9
Diplocirrus stopbowitzi	532139	1	0	0	0	0	0	0
Diplocirrus glaucus	130100	0	2	2	0	0	0	1
Flabelligena (juvenile)	325157	0	0	1	0	0	0	0
Capitella	129211	0	1	0	0	1	27	2
Mediomastus fragilis	129892	52	70	97	34	145	23	143
Notomastus	129220	0	3	1	46	10	19	1
Maldanidae (unidentifiable)	923	0	1	0	0	0	0	0
Leiochone tricirrata	328694	-1	2	0	0	0	0	0
Euclymene (unidentifiable)	129347	0	0	0	1	0	0	0
Euclymene oerstedii	130294	17	17	6	156	128	2	2

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Polyophthalmus pictus	130510	2	1	0	1	0	3	1
Scalibregma inflatum	130980	0	0	1	0	0	0	0
Scalibregma celticum	130979	3	2	2	0	0	0	2
Galathowenia oculata	146950	1	10	33	0	0	0	4
Owenia	129427	0	5	0	0	0	0	0
Sabellaria spinulosa	130867	1	0	0	0	0	0	0
Ampharetidae (unidentifiable)	981	0	1	0	0	0	0	0
Melinna palmata	129808	1	19	4	2	4	1	4
Ampharete lindstroemi	129781	0	0	1	0	0	0	0
Terebellides	129717	1	4	0	20	5	1	1
Terebellidae (unidentifiable)	982	1	2	0	1	0	3	2
Eupolymnia (unidentifiable)	129693	0	0	1	0	0	0	0
Lanice conchilega	131495	1	1	1	0	0	0	0
Pista mediterranea	131519	0	0	0	6	1	4	0
Polycirrus (unidentifiable)	129710	2	3	2	0	0	0	4
Sabellidae (unidentifiable)	985	2	0	1	0	0	0	1
Euchone rubrocincta	130909	0	0	0	0	0	0	1
Jasmineira elegans	130921	1	2	7	0	0	0	5
Hydroides norvegica	131009	2	2	6	0	0	0	2

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Spirobranchus (unidentifiable)	129582	21	56	50	16	16	0	6
Spirobranchus lamarcki	560033	5	11	40	0	0	0	11
Spirobranchus triqueter	555935	20	0	10	0	0	0	1
Spirorbinae	989	Present	0	0	0	0	0	0
Tubificoides (unidentifiable)	137393	0	2	1	0	0	0	0
Tubificoides amplivasatus	137570	0	0	0	32	0	12	0
Tubificoides benedii	137571	2	0	1	82	331	46	0
Tubificoides diazi	137574	0	0	0	0	0	0	1
Grania	137349	0	0	0	0	0	0	4
Achelia echinata	134599	0	0	1	0	0	0	2
Anoplodactylus petiolatus	134723	1	0	2	0	0	0	1
Verruca stroemia	106257	0	0	Present	0	0	0	0
Harpacticoida	1102	0	0	0	1	0	0	0
Longipedia	115403	1	1	2	0	0	1	6
Sunaristes paguri	115732	0	1	0	0	0	3	0
Thalestridae	115181	0	0	1	0	0	0	0
Miraciidae	115163	1	2	8	0	0	5	14
Rhodinicola	128632	0	0	1	0	0	0	0
Siphonostomatoida	1104	0	0	1	0	0	0	0

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Ostracoda (unidentifiable)	1078	0	0	1	16	0	0	0
Euphilomedes sinister	127866	2	0	0	16	0	4	3
Cylindroleberis mariae	238708	2	0	0	0	0	0	0
Amphipoda (unidentifiable)	1135	1	0	0	0	0	0	0
Perioculodes longimanus	102915	0	1	0	0	0	0	1
Pontocrates (unidentifiable)	101702	0	0	1	0	0	0	1
Apolochus neapolitanus	236495	0	0	0	0	0	0	1
Urothoe elegans	103228	0	3	3	0	0	0	1
Harpinia (unidentifiable)	101716	0	1	0	0	0	0	0
Metaphoxus simplex	102984	33	28	69	86	5	32	59
Metaphoxus fultoni	102981	17	9	44	75	32	15	5
Lysianassa ceratina	102605	0	0	0	0	0	0	1
Nototropis (juvenile)	101501	0	0	0	0	0	0	1
Nototropis guttatus	488957	1	0	0	0	0	0	0
Nototropis vedlomensis	179538	0	2	0	0	0	0	1
Dexamine spinosa	102135	2	0	2	0	0	0	4
Guernea coalita	102137	0	1	0	0	0	0	1
Ampelisca (unidentifiable)	101445	8	3	4	0	0	0	14
Ampelisca spinipes	101928	0	0	0	0	0	0	1

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Ampelisca tenuicornis	101930	0	0	5	0	0	0	4
Ampelisca typica	101933	6	4	3	0	0	0	4
Melitidae (unidentifiable)	101397	0	0	2	0	0	0	1
Animoceradocus semiserratus	531364	0	0	1	0	0	0	0
Cheirocratus (unidentifiable)	101669	9	6	24	0	0	0	20
Cheirocratus sundevallii	102798	0	1	2	0	0	0	0
Othomaera othonis	534781	2	0	0	0	0	0	2
Ampithoe (unidentifiable)	101459	0	0	1	0	0	0	0
Gammaropsis maculata	102364	0	0	0	0	0	0	3
Photis longicaudata	102383	5	0	3	0	0	0	3
Aoridae (unidentifiable)	101368	6	1	5	0	0	0	5
Microdeutopus anomalus	102043	1	0	1	0	0	0	0
Microdeutopus versiculatus	102053	6	0	9	0	0	2	2
Corophiidae (unidentifiable)	101376	4	2	1	0	0	0	2
Monocorophium sextonae	148603	1	0	7	0	0	0	0
Phtisica marina	101864	5	0	5	0	0	0	6
Gnathia	118437	5	3	4	0	0	0	0
Anthura gracilis	118467	2	0	6	0	0	0	1
Chondrochelia savignyi	880874	3	1	15	83	9	39	5

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Tanaopsis graciloides	136458	46	30	68	269	3	218	36
Cumella pygmaea	110567	0	0	1	0	0	0	0
Decapoda (zoea)	1130	0	0	1	0	0	0	0
Hippolytidae (unidentifiable)	106777	0	0	1	0	0	0	0
Paguridae (unidentifiable)	106738	4	20	3	17	0	0	0
Anapagurus hyndmanni	107217	0	14	0	0	0	0	0
Pagurus bernhardus	107232	0	3	0	0	2	4	0
Pagurus cuanensis	107235	0	3	1	0	0	0	0
Pisidia longicornis	107188	0	0	2	0	0	0	0
Brachyura (juvenile)	106673	0	1	0	0	0	0	1
Polybius (unidentifiable)	106928	1	0	1	0	0	0	0
Polybius depurator	1750291	0	1	0	0	0	0	0
Polybius pusillus	151200	0	0	1	0	0	0	0
Xantho pilipes	107441	0	0	1	0	0	0	0
Chironomidae larvae	118100	0	0	0	16	0	4	0
Leptochiton cancellatus	140201	12	0	32	0	0	0	4
Acanthochitona (juvenile)	137613	0	0	1	0	0	0	0
Steromphala (unidentifiable)	576164	0	0	1	0	0	0	0
Gibbula magus	141790	1	0	0	0	0	0	0

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Steromphala tumida	1477356	0	0	0	0	0	1	1
Tectura virginea	153552	0	0	1	0	0	0	0
Bittium reticulatum	139054	0	0	0	0	44	11	0
Turritellinella tricarinata	1381415	11	1	69	179	85	149	36
Alvania beanii	416615	0	0	2	0	0	0	3
Onoba semicostata	141320	0	0	0	0	0	4	0
Hydrobiidae (juvenile)	120	0	0	0	0	0	1	0
Hyala vitrea	140129	0	0	0	0	0	2	1
Caecum trachea	138957	0	0	2	0	0	0	1
Euspira nitida	151894	0	0	4	0	0	0	0
Melanella alba	139832	1	0	0	0	0	0	1
Tritia incrassata	876825	0	0	0	1	0	0	0
Tritia varicosa	1391526	0	0	3	0	0	0	0
Mangelia (unidentifiable)	137820	0	0	2	0	0	0	0
Sorgenfreispira brachystoma	847930	0	0	1	0	0	0	0
Odostomia	138413	0	0	0	0	0	1	0
Brachystomia eulimoides	491650	0	0	0	0	0	3	0
Philine (unidentifiable)	138339	0	0	0	0	0	1	0
Nudibranchia (unidentifiable)	1762	1	0	2	0	0	0	0

Taxon	**AphiaID**	**Station 1**	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**
Antalis entalis	150534	0	0	0	0	0	0	3
Bivalvia (unidentifiable)	105	2	1	0	0	0	0	0
Nucula nitidosa	140589	1	0	0	0	0	0	0
Nucula nucleus	140590	0	5	6	0	0	2	1
Modiolula phaseolina	140461	0	0	2	0	0	0	0
Musculus subpictus	506128	0	0	1	0	0	0	0
Anomiidae (juvenile)	214	4	2	23	0	0	0	0
Venerida (juvenile)	217	0	0	1	0	0	0	0
Myrtea spinifera	140287	0	0	0	0	1	0	0
Lucinoma borealis	140283	2	2	3	0	0	0	1
Thyasira (unidentifiable)	138552	0	0	2	0	1	0	4
Thyasira flexuosa	141662	0	13	1	5	17	1	3
Kurtiella bidentata	345281	3	4	18	16	3	5	2
Parvicardium (unidentifiable)	137739	1	0	2	0	0	0	0
Parvicardium exiguum	139008	0	0	2	0	0	0	0
Parvicardium pinnulatum	181343	0	0	4	0	0	0	4
Ensis (unidentifiable)	138333	0	1	0	0	0	0	0
Moerella donacina	147021	0	1	0	0	0	0	0
Abra alba	141433	0	2	1	0	2	1	1

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Abra nitida	141435	0	1	0	0	0	0	0
Veneridae (juvenile)	243	0	0	6	0	0	0	0
Gouldia minima	141916	0	0	4	0	0	0	1
Clausinella fasciata	141909	2	0	1	0	0	0	0
Polititapes rhomboides	745846	1	1	7	0	0	0	1
Dosinia (juvenile)	138636	0	0	6	0	0	0	0
Dosinia lupinus	141912	1	0	10	0	0	0	2
Hiatella arctica	140103	3	0	2	0	0	0	0
Thracia (juvenile)	138549	0	0	0	0	0	0	1
Thracia phaseolina	152378	1	0	0	0	0	0	0
Bryozoa	146142	Present	0	0	0	0	0	0
Crisia	111032	Present	0	0	0	0	0	Present
Crisia aculeata	111690	Present	0	0	0	0	0	0
Crisia denticulata	111695	Present	0	0	0	0	0	0
Crisia eburnea	111696	0	0	Present	0	0	0	0
Disporella	111044	0	0	Present	0	0	0	0
Aetea truncata	111067	0	0	Present	0	0	0	0
Phoronis	128545	1	2	0	0	0	0	1
Marthasterias glacialis	123803	1	0	0	0	0	0	0

Taxon	AphiaID	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Ophiothrix fragilis	125131	0	0	1	0	0	0	0
Amphiuridae (unidentifiable)	123206	1	0	2	0	0	0	1
Acrocnida brachiata	236130	0	0	1	0	0	0	0
Amphipholis squamata	125064	4	2	13	0	0	8	0
Ophiura albida	124913	0	1	0	0	0	0	0
Echinocyamus pusillus	124273	1	0	0	0	0	0	1
Didemnum maculosum	103570	Present	0	Present	0	0	0	0
Ascidiella aspersa	103718	Present	0	5	0	0	0	2
Molgula	103509	0	0	2	0	0	0	0

Appendix 3: SOCOTEC Sediment Physico-chemical Lab Report

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR02716
Issue Version:	1
Customer:	Aquafact International Ltd, Unit 9A/22B, Liosban Business Park, Tuam Road, Galway, Ireland, H91 K120
Customer Reference:	Rossaveel - Marine Institute Analysis
Date Sampled:	30-Jun-25
Date Samples Received:	02-Jul-25
Test Report Date:	30-Jul-25
Condition of samples:	Ambient Satisfactory

Opinions and Interpretations expressed herein are outside the scope of our UKAS accreditation
The results reported relate only to the sample tested
The results apply to the sample as received

JMColbourne

Authorised by: Jane Colbourne

Position: Customer Service Specialist

UKAS TESTING 1252

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR02716
Issue Version	1
Customer Reference	Rossaveel - Marine Institute Analysis

		Method No	SUB_02*
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Visual Description**
Rossaveel S01	MAR02716.001	Sediment	Grey gravelly SAND.Gravel is shell fragments
Rossaveel S02	MAR02716.002	Sediment	Grey gravelly SAND.Gravel is shell fragments
Rossaveel S03	MAR02716.003	Sediment	Grey gravelly SAND.Gravel is shell fragments
Rossaveel S04	MAR02716.004	Sediment	Grey gravelly SAND.Gravel is shell fragments
Rossaveel S05	MAR02716.005	Sediment	Brown grey slightly gravelly silty CLAY. Gravel is shell fragments
Rossaveel S06	MAR02716.006	Sediment	Brown grey silty CLAY
Rossaveel S07	MAR02716.007	Sediment	Grey gravelly SAND. Gravel is shell fragments

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR02716
Issue Version	1
Customer Reference	Rossaveel - Marine Institute Analysis

		Units	%	%	%	%	%	Mg/m3
		Method No	ASC/SOP/303	ASC/SOP/303	SUB_01*	SUB_01*	SUB_01*	SUB_02*
		Limit of Detection	0.2	0.2	N/A	N/A	N/A	N/A
		Accreditation	UKAS	UKAS	N	N	N	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Total Moisture @ 120°C**	**Total Solids**	**Gravel (>2mm)**	**Sand (63-2000 µm)**	**Silt (<63 µm)**	**Particle Density**
Rossaveel S01	MAR02716.001	Sediment	47.2	52.8	10.22	63.44	26.33	2.69
Rossaveel S02	MAR02716.002	Sediment	42.3	57.7	12.25	69.18	18.56	2.68
Rossaveel S03	MAR02716.003	Sediment	45.2	54.8	21.71	69.70	8.59	2.75
Rossaveel S04	MAR02716.004	Sediment	53.1	46.9	11.65	31.76	56.59	2.57
Rossaveel S05	MAR02716.005	Sediment	44.7	55.3	7.57	59.94	32.49	2.67
Rossaveel S06	MAR02716.006	Sediment	68.6	31.4	5.50	27.49	67.00	2.54
Rossaveel S07	MAR02716.007	Sediment	39.7	60.3	12.36	65.82	21.82	2.68
Reference Material (% Recovery)			NA	NA	NA	NA	NA	NA
QC Blank			NA	NA	NA	NA	NA	NA

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR02716
Issue Version	1
Customer Reference	Rossaveel - Marine Institute Analysis

		Units	% m/m	%m/m
		Method No	WSLM59*	ANC*
		Limit of Detection	0.02	0.12
		Accreditation	UKAS	No
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**TOC**	**Carbonate Equivalent (%CO3)**
Rossaveel S01	MAR02716.001	Sediment	1.46	40.0
Rossaveel S02	MAR02716.002	Sediment	1.50	41.5
Rossaveel S03	MAR02716.003	Sediment	1.08	41.0
Rossaveel S04	MAR02716.004	Sediment	2.76	32.3
Rossaveel S05	MAR02716.005	Sediment	2.14	31.8
Rossaveel S06	MAR02716.006	Sediment	4.47	22.3
Rossaveel S07	MAR02716.007	Sediment	1.36	42.0
		Reference Material (% Recovery)	75	99
		QC Blank	<0.02	<0.12

* See Report Notes

Certificate of Analysis

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SOCOTEC

Test Report ID	MAR02716
Issue Version	1
Customer Reference	Rossaveel - Marine Institute Analysis

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	ICPMS-MWSED*	ICPMS-MWSED*	ICPMS-MWSED*	ICPMS-MWSED*	ICPMS-MWSED*	ICPMS-MWSED*	ICPMS-MWSED*
		Limit of Detection	0.14	0.03	1	0.7	0.6	0.01	0.4
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic as As**	**Cadmium as Cd**	**Chromium as Cr**	**Copper as Cu**	**Lead as Pb**	**Mercury as Hg**	**Nickel as Ni**
Rossaveel S01	MAR02716.001	Sediment	8.4	0.14	15.4	7.1	18.3	<0.01	7.3
Rossaveel S02	MAR02716.002	Sediment	9.1	0.08	13.8	3.3	11.3	<0.01	5.9
Rossaveel S03	MAR02716.003	Sediment	17.9	0.08	21.7	2.5	30.4	<0.01	4.1
Rossaveel S04	MAR02716.004	Sediment	9.8	0.35	24.3	7.7	15.8	<0.01	12.4
Rossaveel S05	MAR02716.005	Sediment	12.1	0.33	28.2	8.1	19.2	<0.01	13.5
Rossaveel S06	MAR02716.006	Sediment	13.5	0.35	39.2	12.2	25.6	<0.01	18.2
Rossaveel S07	MAR02716.007	Sediment	9.6	0.08	13.2	3.4	10.4	<0.01	5.3
		Certified Reference Material 2702 (Measured Value)	48.46	0.879	292.2	101.9	120.8	0.448	65.37
		Certified Reference Material 2702 (Certified Value)	45.3	0.817	352	117.7	132.8	0.447	75.4
		Certified Reference Material 2702 (% Recovery)	105	76	96	99	99	92	101
		QC Blank	<0.14	<0.03	<1	<0.7	<0.6	<0.01	<0.4

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR02716
Issue Version 1
Customer Reference Rossaveel - Marine Institute Analysis

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	ICPMS-MWSED*	ICPOES-MWSED*	ICPOES-MWSED*
		Limit of Detection	3.5	1750	2
		Accreditation	UKAS	UKAS	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Zinc as Zn**	**Aluminium as Al**	**Lithium as Li**
Rossaveel S01	MAR02716.001	Sediment	29.6	15900	20.8
Rossaveel S02	MAR02716.002	Sediment	23.2	12500	17.4
Rossaveel S03	MAR02716.003	Sediment	28.1	16700	16.4
Rossaveel S04	MAR02716.004	Sediment	52.9	19300	28.3
Rossaveel S05	MAR02716.005	Sediment	48.4	19800	22.2
Rossaveel S06	MAR02716.006	Sediment	59.1	28500	43.4
Rossaveel S07	MAR02716.007	Sediment	21.8	14600	15.8
Certified Reference Material 2702 (Measured Value)			441.3	73746	114.7
Certified Reference Material 2702 (Certified Value)			485.3	84000	78.2
Certified Reference Material 2702 (% Recovery)			101	96	92
QC Blank			<3.5	<1750	<2

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID MAR02716
Issue Version 1
Customer Reference Rossaveel - Marine Institute Analysis

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
Rossaveel S01	MAR02716.001	Sediment	<5	<5
Rossaveel S02	MAR02716.002	Sediment	<5	<5
Rossaveel S03	MAR02716.003	Sediment	<5	<5
Rossaveel S04	MAR02716.004	Sediment	<5	<5
Rossaveel S05	MAR02716.005	Sediment	<5	<5
Rossaveel S06	MAR02716.006	Sediment	<5	<5
Rossaveel S07	MAR02716.007	Sediment	<5	<5
Certified Reference Material BCR-646 (Measured Value)			522	333
Certified Reference Material BCR-646 (Certified Value)			770	480
Certified Reference Material BCR-646 (% Recovery)			68	69
QC Blank			<1	<1

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR02716
Issue Version	1
Customer Reference	Rossaveel - Marine Institute Analysis

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	N*	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
Rossaveel S01	MAR02716.001	Sediment	<5	<5	<5	25.8	18.2	15.7
Rossaveel S02	MAR02716.002	Sediment	<5	<5	<5	<5	<5	<5
Rossaveel S03	MAR02716.003	Sediment	<5	<5	<5	<5	<5	<5
Rossaveel S04	MAR02716.004	Sediment	<5	<5	<5	<5	<5	11.1
Rossaveel S05	MAR02716.005	Sediment	<5	<5	<5	<5	<5	<5
Rossaveel S06	MAR02716.006	Sediment	<5	<5	<5	<5	<5	<5
Rossaveel S07	MAR02716.007	Sediment	<5	<5	<5	<5	<5	<5
Certified Reference Material Nist 1941b (Measured Value)			62.4	63.2	123	202	197	377
Certified Reference Material Nist 1941b (Certified Value)			38.4	53.3	184	335	358	453
Certified Reference Material Nist 1941b (% Recovery)			163	119	67	60	55	83
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries
~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.
As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.
* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR02716
Issue Version	1
Customer Reference	Rossaveel - Marine Institute Analysis

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	N*	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BKF***	**CHRYSENE***	**DBENZAH**	**FLUORANT**	**FLUORENE**
Rossaveel S01	MAR02716.001	Sediment	<5	19.2	25.8	<5	38.8	<5
Rossaveel S02	MAR02716.002	Sediment	<5	<5	<5	<5	<5	<5
Rossaveel S03	MAR02716.003	Sediment	<5	<5	<5	<5	<5	<5
Rossaveel S04	MAR02716.004	Sediment	<5	<5	<5	<5	17.0	<5
Rossaveel S05	MAR02716.005	Sediment	<5	<5	<5	<5	<5	<5
Rossaveel S06	MAR02716.006	Sediment	<5	20.3	16.5	<5	29.4	<5
Rossaveel S07	MAR02716.007	Sediment	<5	<5	<5	<5	<5	<5
Certified Reference Material Nist 1941b (Measured Value)			242	315	340	64.5	502	48.7
Certified Reference Material Nist 1941b (Certified Value)			307	225	399	53.0	651	85.0
Certified Reference Material Nist 1941b (% Recovery)			79	140	85	122	77	57
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries
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* See Report Notes

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SOCOTEC

Test Report ID	MAR02716
Issue Version	1
Customer Reference	Rossaveel - Marine Institute Analysis

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/306
		Limit of Detection	1	1	1	1	100
		Accreditation	UKAS	UKAS	UKAS	UKAS	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**INDPYR**	**NAPTH**	**PHENANT**	**PYRENE**	**THC**
Rossaveel S01	MAR02716.001	Sediment	9.47	<5	<5	35.1	46300
Rossaveel S02	MAR02716.002	Sediment	<5	<5	<5	<5	31500
Rossaveel S03	MAR02716.003	Sediment	<5	<5	<5	<5	23100
Rossaveel S04	MAR02716.004	Sediment	<5	11.8	14.0	14.2	62600
Rossaveel S05	MAR02716.005	Sediment	<5	<5	<5	<5	59400
Rossaveel S06	MAR02716.006	Sediment	<5	<5	<5	23.3	178000
Rossaveel S07	MAR02716.007	Sediment	<5	<5	<5	<5	36800
Certified Reference Material Nist 1941b (Measured Value)			301	470	323	395	1455
Certified Reference Material Nist 1941b (Certified Value)			341	848	406	581	1400
Certified Reference Material Nist 1941b (% Recovery)			88	55	79	68	104~
QC Blank			<1	<1	<1	<1	<100

For full analyte name see method summaries

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Test Report ID MAR02716
Issue Version 1
Customer Reference Rossaveel - Marine Institute Analysis

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB28**	**PCB52**	**PCB101**	**PCB118**	**PCB138**	**PCB153**	**PCB180**
Rossaveel S01	MAR02716.001	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Rossaveel S02	MAR02716.002	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Rossaveel S03	MAR02716.003	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Rossaveel S04	MAR02716.004	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Rossaveel S05	MAR02716.005	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Rossaveel S06	MAR02716.006	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	0.09	<0.08
Rossaveel S07	MAR02716.007	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Certified Reference Material Nist 1941b (Measured Value)			3.32	4.90	4.72	4.02	3.60	5.30	2.96
Certified Reference Material Nist 1941b (Certified Value)			4.52	5.24	5.11	4.23	3.60	5.47	3.24
Certified Reference Material Nist 1941b (% Recovery)			73	93	92	95	100	97	91
QC Blank			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

For full analyte name see method summaries

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Test Report ID MAR02716
Issue Version 1
Customer Reference Rossaveel - Marine Institute Analysis

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	N*	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**AHCH**	**BHCH**	**GHCH**	**DIELDRIN**	**HCB**	**DDE**	**DDT**	**DDD**
Rossaveel S01	MAR02716.001	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Rossaveel S02	MAR02716.002	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Rossaveel S03	MAR02716.003	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Rossaveel S04	MAR02716.004	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Rossaveel S05	MAR02716.005	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Rossaveel S06	MAR02716.006	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Rossaveel S07	MAR02716.007	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Certified Reference Material Nist 1941b (Measured Value)			48.2	33.1	42.1	45.0	7.55	3.17	0.44	48.1
Certified Reference Material Nist 1941b (Certified Value)			40	40	40	40	5.83	3.22	1.12	40
Certified Reference Material Nist 1941b (% Recovery)			121~	83~	105~	113~	129	98	39	120~
QC Blank			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

For full analyte name see method summaries

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REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
WSLM59*	MAR02716.001-007	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ANC*	MAR02716.001-007	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ICPMS-MWSED*	MAR02716.001-007	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ICPOES-MWSED*	MAR02716.001-007	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
SUB_01*	MAR02716.001-007	Analysis was conducted by an approved subcontracted laboratory.
SUB_02*	MAR02716.001-007	Analysis was conducted by an approved subcontracted laboratory.
ASC/SOP/301	MAR02716.001-007	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/302	MAR02716.001-007	The Primary process control data associated with this Test has not wholly met the requirements of the Laboratory Quality Management System QMS with one or more target analytes falling outside acceptable limits. The remaining data gives the Laboratory confidence that the test has performed satisfactorily and that the validity of the data may not have been significantly affected.However in line with our QMS policy we have removed accreditation, where applicable, from the affected analytes (DDT) . These circumstances should be taken into consideration when utilising the data.
ASC/SOP/303/304	MAR02716.001-007	The Primary process control data associated with this Test has not wholly met the requirements of the Laboratory Quality Management System QMS with one or more target analytes falling outside acceptable limits. The remaining data gives the Laboratory confidence that the test has performed satisfactorily and that the validity of the data may not have been significantly affected.However in line with our QMS policy we have removed accreditation, where applicable, from the affected analytes (ACENAPTH, BKF) . These circumstances should be taken into consideration when utilising the data.
ASC/SOP/303/304	MAR02716.001-007	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/303/304	MAR02716.001-007	Benzo[k]fluoranthene is known to coelute with Benzo[j]fluoranthene and these peaks can not be resolved. It is believed Benzo[j]fluoranthene is present in these samples therefore it is suggested that the Benzo[k]fluoranthene results should be taken as a Benzo[k]fluoranthene (inc. Benzo[j]fluoranthene). Benzo[j]fluoranthene is not UKAS accredited. This should be taken into consideration when utilising the data.
ASC/SOP/303/304	MAR02716.001-007	Chrysene is known to coelute with Triphenylene and these peaks can not be resolved. It is believed Triphenylene is present in these samples therefore it is suggested that the Chrysene results should be taken as a Chrysene (inc. Triphenylene).This should be taken into consideration when utilising the data.

DEVIATING SAMPLE STATEMENT

Deviation Code	Deviation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Sample Contaminated through Damaged Packaging	N/A	N/A
D3	Sample Contaminated through Sampling	N/A	N/A
D4	Inappropriate Container/Packaging	N/A	N/A
D5	Damaged in Transit	N/A	N/A
D6	Insufficient Quantity of Sample	N/A	N/A
D7	Inappropriate Headspace	N/A	N/A
D8	Retained at Incorrect Temperature	N/A	N/A
D9	Lack of Date & Time of Sampling	N/A	N/A
D10	Insufficient Sample Details	N/A	N/A
D11	Sample integrity compromised or not suitable for analysis	N/A	N/A

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Method	Sample and Fraction Size	Method Summary
Total Solids	Wet Sediment	Calculation (100%-Moisture Content).Moisture content determined by drying a portion of the sample at 120°C to constant weight.
Particle Size Analysis	Wet Sediment	Wet and dry sieving followed by laser diffraction analysis.
Total Organic Carbon (TOC)	Air dried and seived to <2mm	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Carbonate	Air dried and seived to <2mm	Quantitative digestion with Hydrochloric Acid back titration with 1M Sodium Hydroxide to pH 7
Metals	Air dried and seived to <2mm	Microwave assisted HF/Boric extraction followed by ICP analysis.
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis.
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-MS analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Solvent extraction and clean up followed by GC-FID analysis.
Polychlorinated Biphenyls (PCBs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.
Organochlorine Pesticides (OCPs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.

Analyte Definitions					
Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name
ACENAPTH	Acenaphthene	C2N	C2-naphthalenes	THC	Total Hydrocarbon Content
ACENAPHY	Acenaphthylene	C3N	C3-naphthalenes	AHCH	alpha-Hexachlorcyclohexane
ANTHRACN	Anthracene	CHRYSENE	Chrysene	BHCH	beta-Hexachlorcyclohexane
BAA	Benzo[a]anthracene	DBENZAH	Dibenzo[ah]anthracene	GHCH	gamma-Hexachlorcyclohexane
BAP	Benzo[a]pyrene	FLUORANT	Fluoranthene	DIELDRIN	Dieldrin
BBF	Benzo[b]fluoranthene	FLUORENE	Fluorene	HCB	Hexachlorobenzene
BEP	Benzo[e]pyrene	INDPYR	Indeno[1,2,3-cd]pyrene	DDD	p,p'-Dichlorodiphenyldichloroethane
BENZGHIP	Benzo[ghi]perylene	NAPTH	Naphthalene	DDE	p,p'-Dichlorodiphenyldichloroethylene
BKF	Benzo[k]fluoranthene	PERYLENE	Perylene	DDT	p,p'-Dichlorodiphenyltrichloroethane
C1N	C1-naphthalenes	PHENANT	Phenanthrene		
C1PHEN	C1-phenanthrene	PYRENE	Pyrene		

APPENDIX 4: Radiological Analysis EPA Lab Report (26th September 2025)

Laboratory Test Report

Report Date: 26th September 2025

Samples Tested on Behalf of: Aquafact International Services Ltd

Laboratory Analysis: High Resolution Gamma Spectrometry with appropriate density correction

Sample Type: Marine Sediment

Date of Receipt: 02 July 2025

Date of Analysis July - September 2025

Results:

ORM Reference	Client Reference	Coordinates	Nuclide	Activity Concentration (Bq/kg, dry)[1]
CT25000350	ST_01	n/a	K-40 I-131 Cs-134 Cs-137 Am-241 Ra-226 Pb-210 Ra-228 U-235 U-238	183 ± 3 Nd Nd 0.38 ± 0.01 0.41 ± 0.04 5.6 ± 0.1 27.0 ± 2.1 5.4 ± 0.1 0.49 ± 0.02 17.1 ± 0.6
CT2500351	ST_02	n/a	K-40 I-131 Cs-134 Cs-137 Am-241 Ra-226 Pb-210 Ra-228 U-235 U-238	249 ± 3 Nd Nd 1.19 ± 0.02 < 0.25 9.5 ± 0.2 70.5 ± 3.0 9.5 ± 0.2 0.79 ± 0.03 24.4 ± 0.8

Note:

1. Quoted uncertainties are ±1 SD counting statistics
2. Nd = not detected

The Office of Radiation Protection and Environmental Monitoring received two sediment samples from Rossaveel Harbour collected on 30th June 2025 for analysis.

The samples were prepared by placing an aliquot in a well-defined counting geometry and then measured on a high-resolution gamma spectrometer. Appropriate density corrections were applied to the resultant spectra to take account of the differences in sample density. Dry to wet weight ratio was determined for the sample. Results are quoted on a dry weight basis.

The results indicate that dumping of these materials at sea will not result in a radiological hazard.

Simon O'Toole 26/09/2025

Veronica Smith
Laboratory Manager

Notes:

- This report relates only to the samples tested.
- This report shall not be reproduced except in full, without the approval of the Agency
- The following scientific officers may sign test reports on behalf of the lab manager: Mr Simon O'Toole, Ms Olwyn Hanley.
- Where applicable, the number following the symbol ± is the combined standard uncertainty and not a confidence interval.

8. List Endnotes

[1] Method 610: Polynuclear Aromatic hydrocarbons. Available from: https://www.epa.gov/sites/default/files/2015-10/documents/method_610_1984.pdf.

[2] The Marine Life Information Network Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel - MarLIN - The Marine Life Information Network

[3] The Marine Life Information Network Melinna palmata with Magelona spp. and Thyasira spp. in infralittoral sandy mud - MarLIN - The Marine Life Information Network

[4] The Marine Life Information Network Spirobranchus triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles - MarLIN - The Marine Life Information Network

[5] The Marine Life Information Network Flustra foliacea, small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders - MarLIN - The Marine Life Information Network

[6] The Marine Life Information Network Flustra foliacea and Hydrallmania falcata on tide-swept circalittoral mixed sediment - MarLIN - The Marine Life Information Network

[7] The Marine Life Information Network Zostera (Zostera) marina beds on lower shore or infralittoral clean or muddy sand - MarLIN - The Marine Life Information Network