Nova Innovation Ltd

Construction Method Statement

Shetland Tidal Array (as extended)

45 Timber Bush
Edinburgh
EH6 6QH

Tel: +44 (0)131 241 2000

www.novainnovation.com

Author:	Tom Wills
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Confidential

Prepared for:	Marine Scotland, Shetland Islands Council
Contacts:	Sophia Irvine (Marine Scotland) Ryan Leask (Shetland Islands Council)
Report Distribution:	
Marine Scotland	Sophia Irvine Giulia Agnisola
Shetland Islands Council	Ryan Leask
Nova Innovation Ltd	Operations Team (hard copy kept on site at Cullivoe Pier office)
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	Name	Job Title
Prepared by:	Tom Wills	Offshore Manager
Reviewed by:	Kate Smith	Environmental Manager
Authorised by:	Gary Connor	Engineering Director
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1.0-1.4	20/12/2019	First issues, revised based on MS-LOT feedback.	To discharge pre-commencement of works licence conditions
2.0	24/04/2020	Revised based on consultee feedback (SNH/MCA).	

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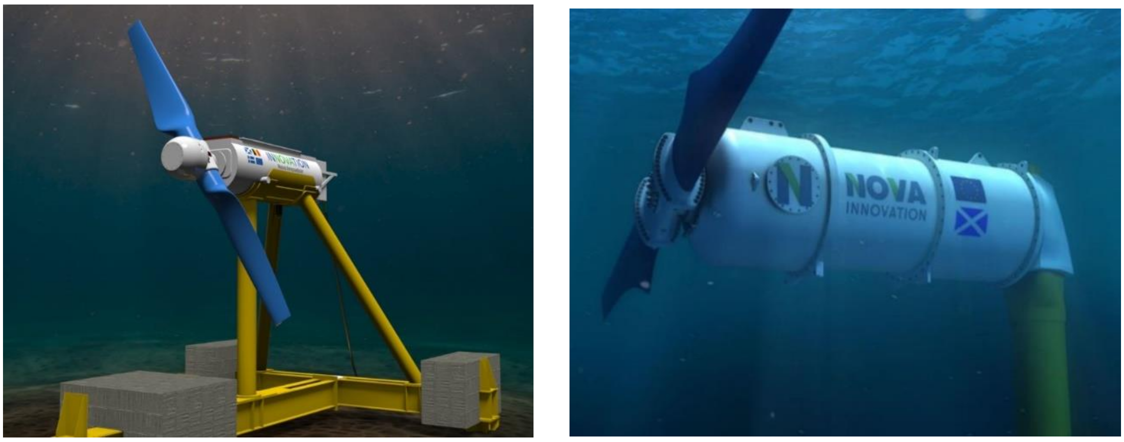
1 Introduction

Nova Innovation has produced this Construction Method Statement to describe the methods and techniques that will be employed to install, operate, reconfigure and decommission the 600 kW array of Nova M100 tidal turbines, including cables and offshore infrastructure, in the Bluemull Sound near Cullivoe in Shetland.

An existing offshore tidal array of three M100 turbines (T1, T2 and T3), known as the Shetland Tidal Array, will be expanded with the addition of three new M100D direct drive turbines (T4, T5 and T6), taking the total to six bottom-mounted, gravity-anchored, non-yawing horizontal axis turbines of 100 kW capacity. Each of the six tidal turbines comprises a cylindrical nacelle unit, rotor and tripod gravity base to secure it to the seabed. The design of the newest three turbines has evolved (see Figure 1 and details in 2.2). Associated infrastructure includes a subsea cable hub, inter-array cabling and export cables connecting the array to Cullivoe Pier.

Figure 1: Nova Innovation M100 turbine models: original M100 (left) and updated M100D (right)



Source: Copyright © Nova Innovation 2019

Each turbine has a rotor diameter of 8.5 m, and a hub height of 8.9 m, making the total height from the bottom of feet to the tip of the blades less than 14 m. The devices will operate in a maximum sustained tidal speed of 2.6 m/s and are located at depths that ensure that during operation all parts of the turbine are at least 15 m below lowest astronomical tide, to allow ample draught clearance for shipping.

As part of the research work associated with the EU Horizon 2020 project, Enabling Future Arrays in Tidal (EnFAIT), Nova will monitor the operation of the expanded tidal array for around a year to evaluate an optimised array layout using Array Interaction Modelling. The three newest turbines (T4, T5 and T6) will then be repositioned to maximise learning and power production from the array.

This work will be carried out under, and in accordance with, the conditions of:

- Shetland Islands Council (SIC) Works Licence 2018/021/WL, issued under the Zetland County Council Act 1974
- Marine Scotland Marine Licence 06642/18/0, issued under the Marine (Scotland) Act 2020, part 4

Nova Innovation maintains a Marine License Conditions Status Register for the Shetland Tidal Array, which is regularly shared with the Marine Scotland Licensing Operations Team (MS-LOT) and Shetland Islands Council (SIC), to ensure that all relevant consent conditions are being complied with. Table 1 below lists the consent plans and other relevant documentation.

Table 1: Reference Documentation

Documentation	Doc. No.	Notes
CES Lease	n/a	
SIC Works License	2018/021/WL	
MS-LOT Marine Licence	06642/18/0 (replaces ML 04859 15 1)	
Nova Innovation STA Licence Conditions Status Register	n/a – refer license number	Comprehensive register of all conditions and compliance status for Marine Licence and Works Licence
STA Project Environmental Monitoring Plan (PEMP)	EnFAIT-0362	
STA Vantage Point Monitoring Report	EnFAIT-0363	
STA Subsea Video Footage Report	EnFAIT-0364	
STA Cable Plan	EnFAIT-0234	
Emergency Response & Cooperation Plan (ERCOP)	EnFAIT-0365	

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2 The Construction Works

2.1 Location

The Shetland Tidal Array is located in Bluemull Sound, near Cullivoe Harbour, within the area bounded by joining the following points:

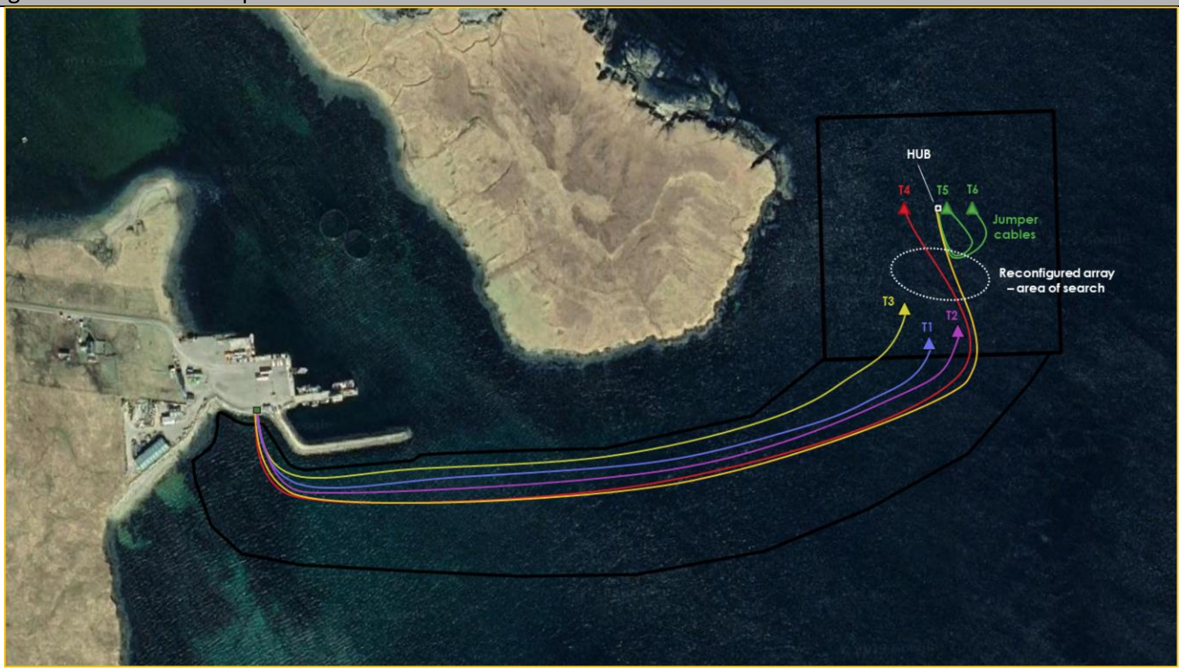
60° 41.900’ N 000° 59.150’ W	60° 41.900’ N 000° 58.847’ W
60° 42.052’ N 000° 58.847’ W	60° 42.052’ N 000° 59.150’ W

Cable landing point:

60° 41.883’ N 000° 59.933’ W

Bluemull Sound is situated between the Shetland Islands of Yell and Unst. At the time of writing, three M100 (geared) turbines (T1, T2 and T3) are deployed just east of the Ness of Cullivoe. Figure 2 shows the planned array layout once the three new M100D (direct drive) turbines have been installed: T4, T5 and T6. The area of search that will be considered for a subsequent reconfiguration of the array is also shown.

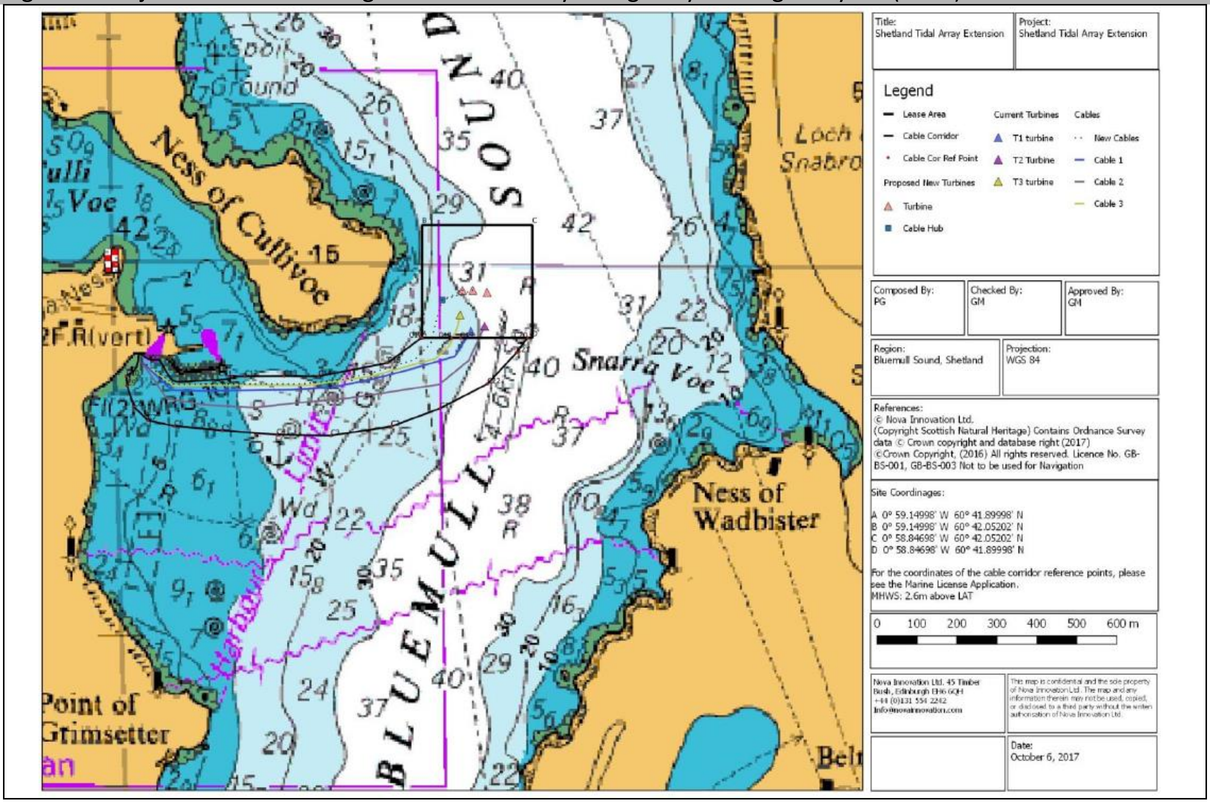
Figure 2: STA build-out plan



Source: Nova Innovation 2014

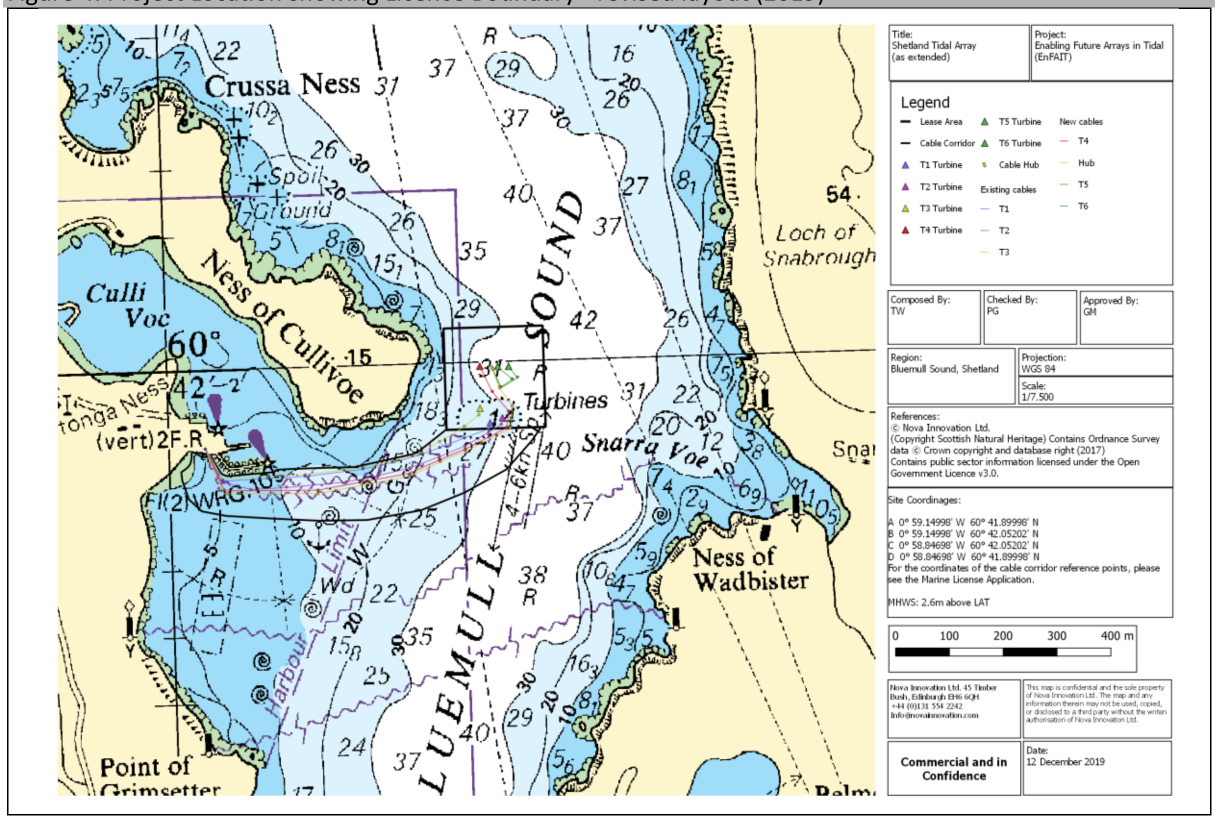
The existing turbines each have their own export cable to shore. In 2017, it was envisaged that the three new turbines would be connected to shore via a subsea hub with a single export cable led to the north of the existing three cables (Figure 3). This has now been revised so that T4 will be installed with its own export cable, and T5 and T6 will be connected via jumper cables to a subsea hub, with its own export cable (Figure 4). See Section 2.2 for details.

Figure 3: Project Location showing Licence Boundary – originally envisaged layout (2017)



Source: Nova Innovation 2014

Figure 4: Project Location showing Licence Boundary - revised layout (2019)

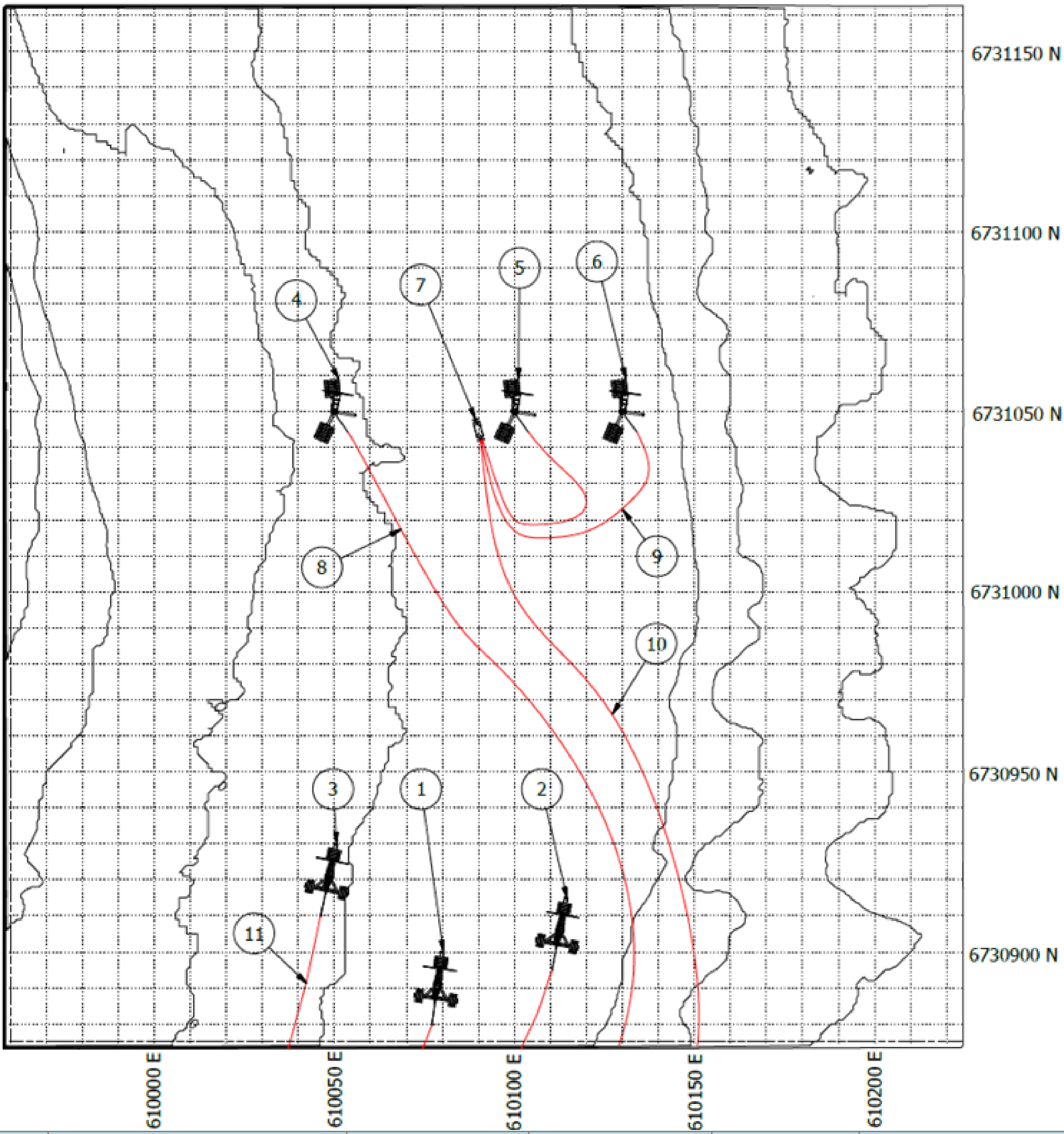


Source: Nova Innovation 2019

2.2 Array layout and headings

Figure 5 shows a more detailed view of the array.

Figure 5: Shetland Tidal Array site layout – approximately to scale (10m grid squares)



Ref	Item	UTM30 (N)	UTM30 (E)	Heading	Notes
1	M100 T1 TURBINE	6730893	610079	008	AS-BUILT
2	M100 T2 TURBINE	6730908	610113	011	AS-BUILT
3	M100 T3 TURBINE	6730923	610049	012	AS-BUILT
4	M100D T4 TURBINE	6731050	610050	010	PHASE 1 (2020)
5	M100D T5 TURBINE	6731050	610100	009	PHASE 2 (2020/21)
6	M100D T6 TURBINE	6731050	610130	008	PHASE 2 (2020/21)
7	SUBSEA CABLE HUB	6731045	610090	-	PHASE 2 (2020/21)
8	T4 EXPORT CABLE	-	-	-	PHASE 1 (2020)
9	T5/6 JUMPER CABLE	-	-	-	PHASE 2 (2020/21)
10	T5/6 EXPORT CABLE	-	-	-	PHASE 2 (2020/21)
11	M100 EXPORT CABLES	-	-	-	AS-BUILT

Source: Copyright © Nova Innovation 2020

2.3 Turbine coordinates (Lat/Long)

Table 2: Turbine coordinates

	UTM V30 N/E		WGS84 GPS Lat/Long (decimal)	
	Northing	Easting	Latitude	Longitude
T1 Turbine	6730893	610079	60.69848	-0.98360
T2 Turbine	6730908	610113	60.69861	-0.98297
T3 Turbine	6730923	610049	60.69876	-0.98413
T4 Turbine	6731050	610050	60.69990	-0.98404
T5 Turbine	6731050	610100	60.69988	-0.98313
T6 Turbine	6731050	610130	60.69988	-0.98258
T5/6 Hub	6731045	610090	60.69984	- 0.98331

2.4 Cable route coordinates

Table 3: Subsea cable routes

	UTM V30		WGS84 GPS Lat/Long (decimal)	
	Northing	Easting	Latitude	Longitude
T1 Cable				
Turbine T1	6730893	610079	60.69848	- 0.98360
WP01	6730876	610075	60.69833	- 0.98369
WP02	6730851	610007	60.69812	- 0.98494
WP03	6730824	609939	60.69790	- 0.98621
WP04	6730806	609889	60.69775	- 0.98713
WP05	6730784	609807	60.69758	- 0.98864
WP06	6730765	609725	60.69743	- 0.99015
WP07	6730745	609564	60.69729	- 0.99311
WP08	6730739	609461	60.69727	- 0.99500
WP09	6730731	609335	60.69723	- 0.99730
SHORE	6730819	609287	60.69803	- 0.99814
T2 Cable				
Turbine T2	6730908	610113	60.69861	- 0.98297
WP01	6730889	610110	60.69844	- 0.98304
WP02	6730828	610009	60.69792	- 0.98492
WP03	6730798	609938	60.69767	- 0.98624
WP04	6730767	609856	60.69741	- 0.98776
WP05	6730741	609740	60.69721	- 0.98990
WP06	6730726	609677	60.69709	- 0.99106
WP07	6730714	609513	60.69703	- 0.99407
WP08	6730707	609414	60.69700	- 0.99589
WP09	6730710	609325	60.69705	- 0.99751
SHORE	6730819	609287	60.69803	- 0.99814

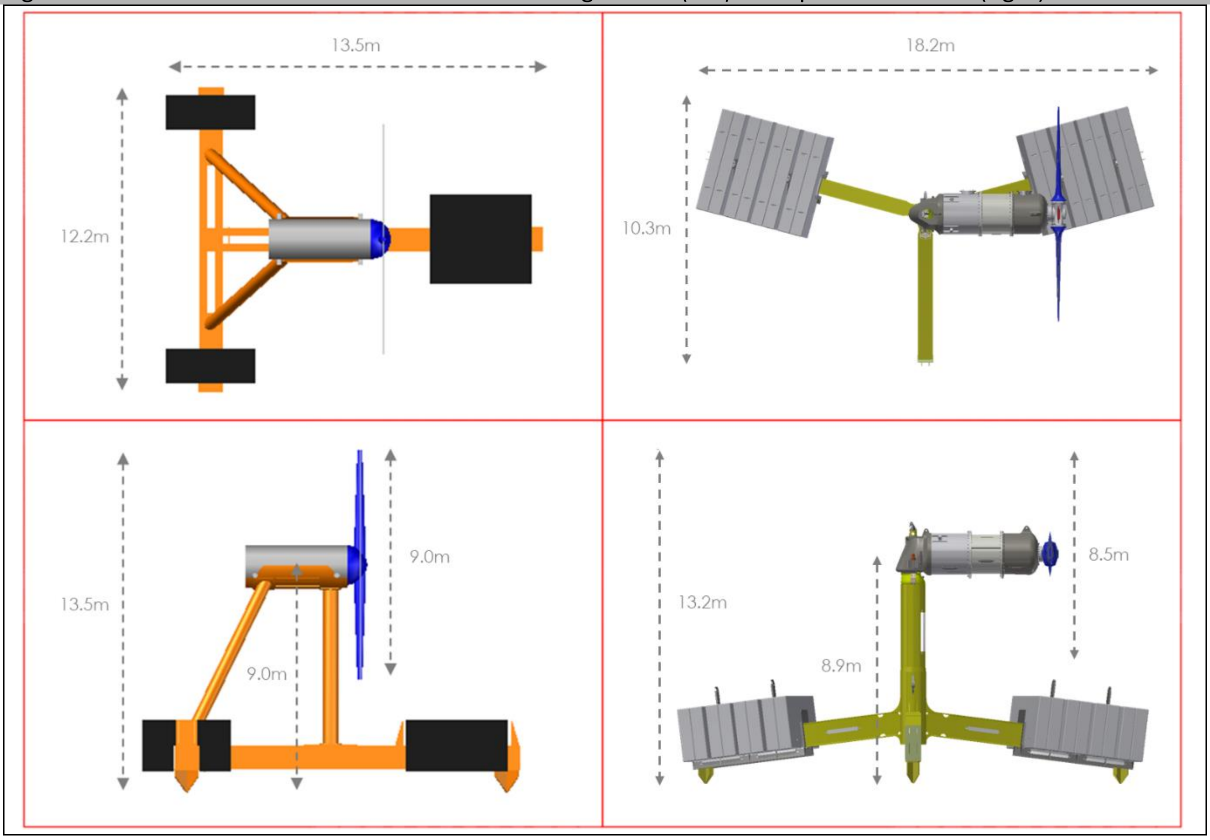
(continued on next page)

	UTM V30		WGS84 GPS Lat/Long (decimal)	
	Northing	**Easting**	**Latitude**	**Longitude**
T3 Cable				
Turbine T3	6730923	610049	60.69876	- 0.98413
WP01	6730915	610048	60.69869	- 0.98417
WP02	6730883	610007	60.69841	- 0.98492
WP03	6730840	609939	60.69804	- 0.98620
WP04	6730809	609889	60.69778	- 0.98713
WP05	6730785	609813	60.69759	- 0.98852
WP06	6730768	609725	60.69746	- 0.99015
WP07	6730748	609564	60.69732	- 0.99310
WP08	6730742	609461	60.69730	- 0.99499
WP09	6730734	609335	60.69726	- 0.99730
SHORE	6730819	609287	60.69803	- 0.99814
T4 Cable				
Turbine	6731050	610050	60.69990	- 0.98404
WP01	6730980	610085	60.69926	- 0.98344
WP02	6730925	610130	60.69875	- 0.98265
WP03	6730880	610125	60.69835	- 0.98277
WP04	6730820	610010	60.69785	- 0.98490
WP05	6730790	609940	60.69760	- 0.98620
WP06	6730750	609855	60.69726	- 0.98778
WP07	6730705	609600	60.69693	- 0.99247
WP08	6730705	609340	60.69700	- 0.99723
SHORE	6730819	609287	60.69803	- 0.99814
T5/6 Cable				
T5/6 Hub	6731045	610090	60.69984	- 0.98331
WP01	6730990	610105	60.69934	- 0.98307
WP02	6730940	610140	60.69889	- 0.98246
WP03	6730880	610135	60.69835	- 0.98258
WP04	6730815	610010	60.69780	- 0.98491
WP05	6730785	609940	60.69755	- 0.98621
WP06	6730745	609855	60.69721	- 0.98778
WP07	6730695	609600	60.69684	- 0.99248
WP08	6730695	609350	60.69690	- 0.99706
SHORE	6730819	609287	60.69803	- 0.99814

2.5 Deposits

There are some minor differences between the existing three M100 turbines and the three new M100D turbines that are to be deployed. The newer turbines are heavier, with slightly reduced rotor diameter and blade tip height. The tripod substructure for the new turbines is now “Y” shaped rather than “T” shaped, but the total contact area with the seabed is unchanged. See Figure 6 and Table 4 for details.

Figure 6: Nova Innovation turbine dimensions: existing M100s (left) and updated M100Ds (right)



Source: Copyright © Nova Innovation 2019

Table 4: Comparison of key dimensions and dry/wet weights between M100 and M100D turbine models

Parameter	Original (M100)	Updated (M100D)
Nacelle weight	13.5t / 1.0t	21.7t / 10.1t
Steel substructure weight (inc. cable attachment)	32.0t / 28.0t	25.6t / 22.4t
Concrete ballast blocks (each)	7.2t / 4.6t (14 individual blocks)	9.1t / 5.7t (16 blocks in 4 cages)
Steel ballast cage (holds 4 concrete blocks)	n/a	3.0t/2.6t
Weight of ballast units (total)	101.0t / 63.7t	157.6t / 101.7t
Total weight	146.3t / 93.4t	206.8t / 138.5t
Hub height	9.0m	8.9m
Rotor diameter	9.0m	8.5m
Blade tip height	13.5m	13.2m
Substructure plan view footprint	13.5 x 12.2 m	10.3 x 18.2m
Points of contact with seabed	Three single point contacts per turbine (>0.4m^2 each point)	

Source: Copyright © Nova Innovation 2019

Both types of turbine substructure are ballasted using concrete blocks. For the M100s, 14 individual blocks are used. The M100Ds are ballasted with 16 individual blocks, loaded in sets of 4 into 4 steel ballast cages. See Figure 7 and dry/wet weights in Table 4 above.

Figure 7: Individual ballast block; 4-block ballast cage and two ballast cages as installed on substructure

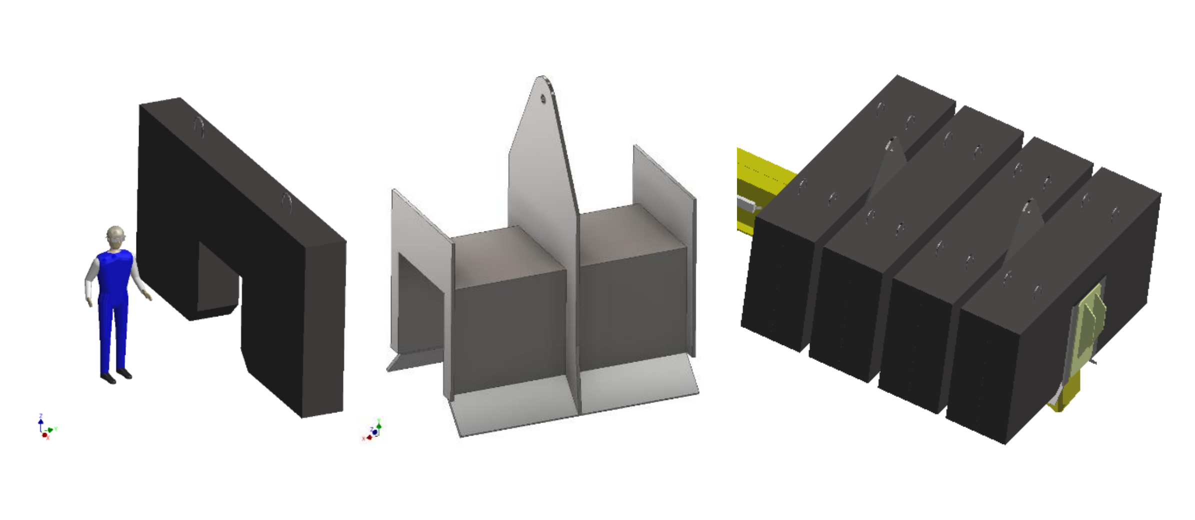


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Table 5 outlines the total deposits associated with the updated deployment plan, compared to the amounts detailed in Nova Innovation's marine license.

Table 5 Comparison of licensed deposits and approximate totals from updated deployment plan

Marine License 06642/18/0					Current deployment plan
Deposit	**Units**	**Amount**	**QTY**	**Totals**	**Totals**
Steel/iron	tonnes	50	6	**300**	**<300**
Plastic/synthetic	m^2	30	6	**180**	**<180**
Concrete	m^3	50	6	**300**	**<300**
Subsea cables	m	1,200 x 4 600 x 3	7	**6,600**	**<6,600**
Subsea sensor frames	kg	500	4	**2,000**	**<2,000**
Nortek Signature 500 ADCPs	kg	n/a	4	**4**	**4**

Source: Copyright © Nova Innovation 2019

As discussed in 2.1, turbines T1, T2, T3 and T4 have their own dedicated cables to shore, whereas T5 and T6 will be connected via jumper cables to a subsea hub (a steel tube of approximately 1m diameter and 2m length), to which a single export cable is connected. No additional deposits are required to secure the cables. Approximate cable lengths are as shown below (maximum totals in Table 5):

- T1 = 1,007m
- T2 = 1,085m
- T3 = 971m
- T4 = 1,341m
- T5/6 hub = 1,351m
- T5 and T6 jumper cables = 110m (each cable, 2 in total)
- Total length = 5,931m

From time to time, seabed sensor frames will be deployed on site with Acoustic Doppler Current Profilers/Velocimeters, as covered by the existing marine license.

2.6 Construction schedule

Table 6 sets out the construction schedule for the initial deployments of turbines T4, T5 and T6. The first site surveys were first carried out in 2014 and subsequent surveys have been carried out in parallel with maintenance works on the existing three turbines. A final pre-installation video survey of the precise set-down locations is planned for February 2019. The construction works to install the T4 machine are scheduled to commence in April. The installation of the T5 and T6 machines is scheduled for September 2020.

Table 6: T4-6 deployments in 2020

Turbine		Jan	Feb	Mar		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T4	Deploy substructure													
	Lay T4 export cable													
	Deploy nacelle													
	Normal operations													
T5+6	Deploy 2 x substructures													
	Lay hub and export cable													
	Deploy 2 x jumper cables													
	Deploy 2 x nacelles													
	Normal operations													

Source: Copyright © Nova Innovation 2019

Following a year of turbine operations and related site resource measurements and numerical modelling work, the turbines T4, T5 and T6 are to be relocated as part of an investigation into tidal turbine wakes and array interaction modelling under the EnFAIT (Enabling Future Arrays in Tidal) project.

Table 7 sets out the construction schedule for the reconfigured deployments of turbines T4, T5 and T6.

Table 7: Array reconfiguration in 2021

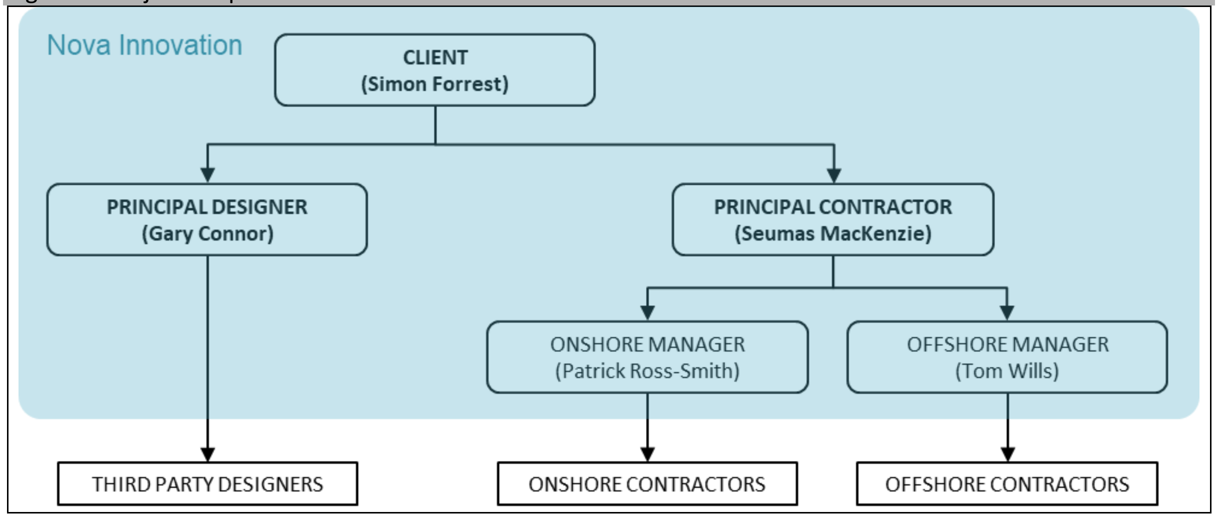
Turbine		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T4-6	Normal operations												
	Recover 3 x nacelles												
	Recover T4 cable												
	Recover 2 x jumper cables												
	Relocate 3 x substructures												
	Lay T4 cable												
	Deploy 2 x jumper cables												
	Deploy 3 x nacelles												
	Normal operations												

Source: Copyright © Nova Innovation 2019

2.7 Responsibilities

Nova Innovation has primary responsibility for implementing the CMS and in line with the UK Construction (Design and Management) Regulations 2015, the company is acting as client, principal designer and principal contractor for the development. To ensure accountability, named individuals within Nova Innovation are appointed to these different roles (Figure 8).

Figure 8: Project Responsibilities



Source: Nova Innovation 2020

Contact details for these individuals are as follows:

Simon Forrest, Client/CEO	simon.forrest@novainnovation.com
	0131 241 2010
Seumas Mackenzie, Principal Contractor/Project Manager	Seumas.mackenzie@novainnovation.com
	[Redacted]
Gary Connor, Principal Designer/Engineering Director	gary.connor@novainnovation.com
	[Redacted]
Patrick Ross-Smith, Onshore Manager	patrick.ross-smith@novainnovation.com
	[Redacted]
Tom Wills, Offshore Manager	tom.wills@novainnovation.com
	[Redacted]

Contact details for nominated offshore contractors are detailed in Nova's Marine Licence (available here: http://marine.gov.scot/ml/marine-licence-deposits-tidal-array-bluemull-sound-shetland-04859), while contact details for onshore contractors are detailed in Nova's Construction Phase Plan.

In addition to the above Nova personnel, Kate Smith, Nova's Environmental Manager is responsible for overseeing delivery of the environmental monitoring programme for the Shetland Tidal Array and associated licence conditions. Contact details are as follows: kate.smith@novainnovation.com, 01286 239 710.

2.8 CMS compliance and review

As mentioned in Section 1, Nova regularly updates a Marine License Conditions Status Register and sends this to MS-LOT for review.

2.9 Good practice and mitigation

Table 8 outlines the environmental mitigation and good practice measures which Nova will follow in order to ensure compliance with the appropriate license conditions. This table will also be included in the operational documentation provided to the offshore contractor.

Table 8: Environmental mitigation and good practice measures

Mitigation or good practice measure	Responsible person(s)	Corresponding licence condition
Minimising disturbance to wildlife during site operations		
All personnel to adhere to the Scottish Marine Wildlife Watching Code during all installation, operation and maintenance activities. Copies of the code kept in site files at Cullivoe, and Nova offices and onboard all vessels engaged in Works. Included in all site briefings.	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 8
Avoidance of damage to seabed habitats and species		
Benthic survey to identify benthic habitats or species on the recommended Priority Marine Features list will be carried out prior to commencement of works to identify micro-siting of device foundations and final turbine layout/location of all infrastructure.	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 4; 7
Siting of turbines and cables undertaken utilising visual feedback system such as a camera or ROV, to prevent placing in or on maerl or horse mussel beds.	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 4; 7
All lifting equipment appropriately certified and all lifts and offshore operations appropriately risk assessed to minimis the risk of dropped objects during deployment and retrieval. MS-LOT to be notified within 24 hours in the event of a dropped object event.	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 3
Managing collision risk for marine wildlife with operational turbines		
Use of land-based bird and mammal surveys of the Project area to understand potential spatial overlap and collision risk factors.	Kate Smith	Marine Licence condition 3.1.10 Works Licence conditions 3 & 11
Use of subsea video monitoring to understand interactions of marine wildlife with turbines and collision risk factors.	Kate Smith	Marine Licence condition 3.1.10 Works Licence conditions 3 & 11
Any collision events observed in subsea video footage to be reported immediately to Marine Scotland and Shetland Islands Council (noting analysis of footage is *post hoc* and not in real time).	Kate Smith	Marine Licence condition 3.1.10
Waste and pollution		
All debris or waste material (including that below MHWS) will be removed from the site at Cullivoe and disposed of responsibly (recycled where possible).	Patrick Ross Smith	Marine Licence condition 3.1.10 Works Licence condition 3

Only contractors with ISO 14001:2015 environmental management systems accreditation to be used in marine operations	Tom Wills	Marine Licence condition 3.1.10
All turbine and substructure fabrication takes place with appropriate storage and pollution prevention facilities and procedures.	Alex Boswell (Edinburgh). Patrick Ross Smith (Shetland)	Marine Licence condition 3.1.10
No chemicals or fuel storage on site. If situation changes, materials will be stored appropriately including use of bunding if necessary.	Patrick Ross Smith	Marine Licence condition 3.1.8; 3.1.10; 3.2.1.3
No drilling or piling to be carried out, avoiding significant underwater noise and associated impacts	Tom Wills	Marine Licence condition 3.1.10
Unexpected pollution or breaches of environmental obligations		
Any accidental pollution or breaches to be reported to Marine Scotland within 24 hours.	Tom Wills	Marine Licence condition 3.2.1.2
Copy of Shetland Contingency Plan kept on site at Cullivoe and onboard all vessels engaged in Works. Measures in the Plan to be followed as appropriate.	Tom Wills	Marine Licence condition 3.1.10; 3.2.1.2 Works Licence condition 3
Decommissioning		
All reasonable, appropriate, and practicable steps will be taken to restore the Site to its original condition before the Works were undertaken, or to as close to its original condition as is reasonably practicable. To be detailed in Decommissioning Programme	Tom Wills	Marine Licence condition 3.2.1.4
Biosecurity and Invasive Non Natives Species (INNS)		
Turbines and substructures will be shipped to Shetland by road rather than sea to minimise potential for transfer of INNS	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 9
Northern Isles-based vessels used for marine operations, to minimise potential for transfer of INNS	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 9
Operator used for marine operations follows its own biosecurity good practice and has ISO 14001:2015 environmental management systems accreditation	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 9
Turbines, substructures, cables and hub will not be deployed subsea elsewhere before deployment in Bluemull Sound.	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 9
Temporary moorings (e.g. chains) used during deployment will be sourced from Shetland or pressure washed / air dried prior to use in Bluemull Sound.	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 9
Turbines and substructures will undergo visual inspections when removed from the water. INNS ID cards to be used during inspections. Biological material is removed as standard (on Cullivoe or Belmont Pier), to avoid dangerous handling conditions. If inspections identify INNS species, care will be taken to avoid contaminated material entering the marine environment. Any INNS identified will be reported to Shetland Islands Council, Marine Scotland and Scottish Natural Heritage.	Tom Wills	Marine Licence condition 3.1.10 Works Licence condition 9

3 Construction method statement

This chapter covers the offshore operations associated with the Shetland Tidal Array – surveying, installation, maintenance and decommissioning – including the nature of the mooring and the type of vessels to be used. All operations will be managed and overseen locally by Nova Innovation personnel who will be resident in Shetland for the duration of the operations. Details of the vessels and operators Nova intends to use to assist with operations have been provided separately to MS-LOT.

3.1 Vessels to be used

The scale of Nova's tidal devices allows small, readily available multicat workboats to be used for all installation, maintenance and recovery operations. An example of a suitable vessel is shown in Figure 9.

Figure 9: Representative turbine deployment and retrieval vessel (Leask Marine C-Odyssey)

Source: Delta Marine

These types of vessel have proven capability of operating in the conditions commonly experienced in and around the Bluemull Sound, particularly during the installation and maintenance of the existing three M100 turbines since 2016. They have sufficient margin of additional operational safety capacity to comfortably deal with the size and weight of equipment for this project. Any additional surveying operations will be conducted using a smaller, local vessel. Nova do not intend to ever have more than one vessel on site at any time. As with previous STA operations, a 4-point mooring will be used as required.

3.2 Communications Strategy

Nova will communicate with all relevant parties to ensure that they have the information they require in order to ensure the works are carried out safely and without risk to marine navigation.

Direct notifications will be issued to MS-LOT, SIC, CES and the UKHO one month in advance of the construction phase and following the completion of the construction works.

We will notify the following organisations of the start of site works via a Notices to Mariners (NtMs) issued at least one month prior to commencement of these works:

- Maritime and Coastguard Agency
- Crown Estate Scotland
- Marine Scotland Licensing Operations Team (MS-LOT)
- SIC (Works License Team)

- SIC Ports and Harbours
- SIC Ferries
- Northern Lighthouse Board
- Shetland Fisherman's Association (SFA)
- Shetland Shellfish Management Organisation (SSMO)
- Royal Yachting Association (RYA) – admin@ryascotland.org.uk
- Lerwick Boating Club
- Clyde Cruising Club
- Royal National Lifeboat Institution (RNLI) – Lerwick Lifeboat Station
- Shetland Maritime Rescue Coordination Centre (MRCC)
- UK Hydrographic Office
- Local Recreational Angling Associations/Operators

If necessary, additional NtMs will be issued to update the relevant parties on the progression of the works.

A Transportation Audit Sheet (TAS) will be submitted within 14 days of the end of any calendar month where construction work is actively undertaken.

In addition, we will provide information for the Kingfisher fortnightly maritime safety bulletins.

Table 9 provides an overview of the communications strategy for these works.

Table 9: STA Communications Strategy Overview (Construction Works)

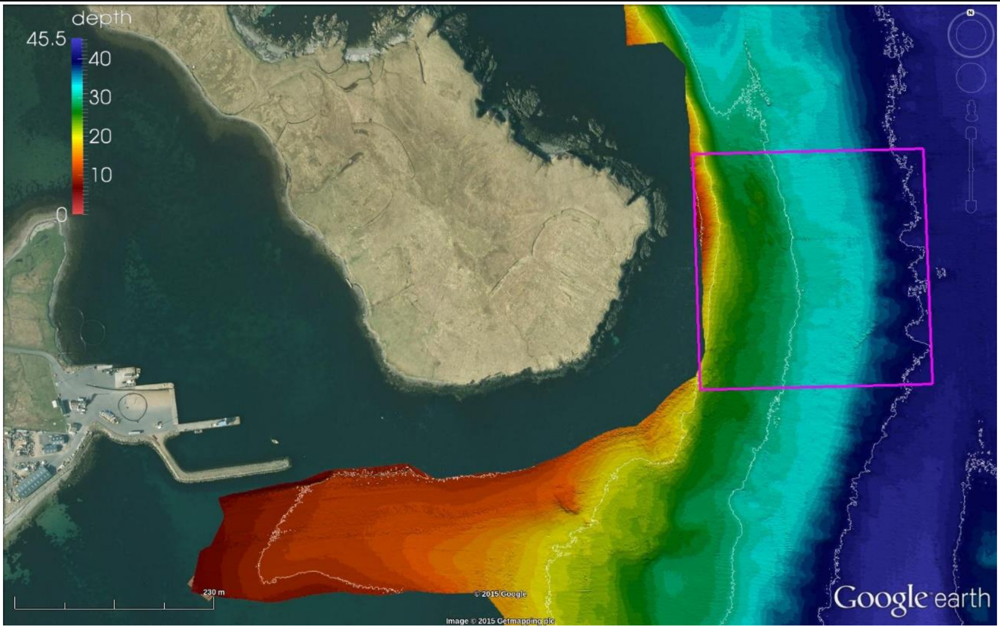
<table>
<tr><th rowspan="2">Organisation</th><th rowspan="2">1 month prior to commencement</th><th colspan="2">During active construction work</th><th rowspan="2">Within 1 month of completion</th></tr>
<tr><th>Weekly</th><th>Monthly (within 14 days of end of month)</th></tr>
<tr><td>UKHO</td><td rowspan="4">Direct notification in writing (by email)</td><td rowspan="6">Ensure NtM live and accurate</td><td>n/a</td><td>Notify in writing, confirm detail and coordinates of deployed equipment.</td></tr>
<tr><td>MS-LOT</td><td>Transportation Audit Reports</td><td>Confirm completion date in writing, submit audit report.</td></tr>
<tr><td>CES</td><td rowspan="4">n/a</td><td rowspan="2">Notify in writing.</td></tr>
<tr><td>SIC</td></tr>
<tr><td>NtM list</td><td>Issue NtM</td><td rowspan="2">De-activate notifications</td></tr>
<tr><td>Kingfisher Bulletin</td><td>Provide information for Bulletin</td></tr>
</table>

Source: Nova Innovation, 2020

3.3 Site surveys

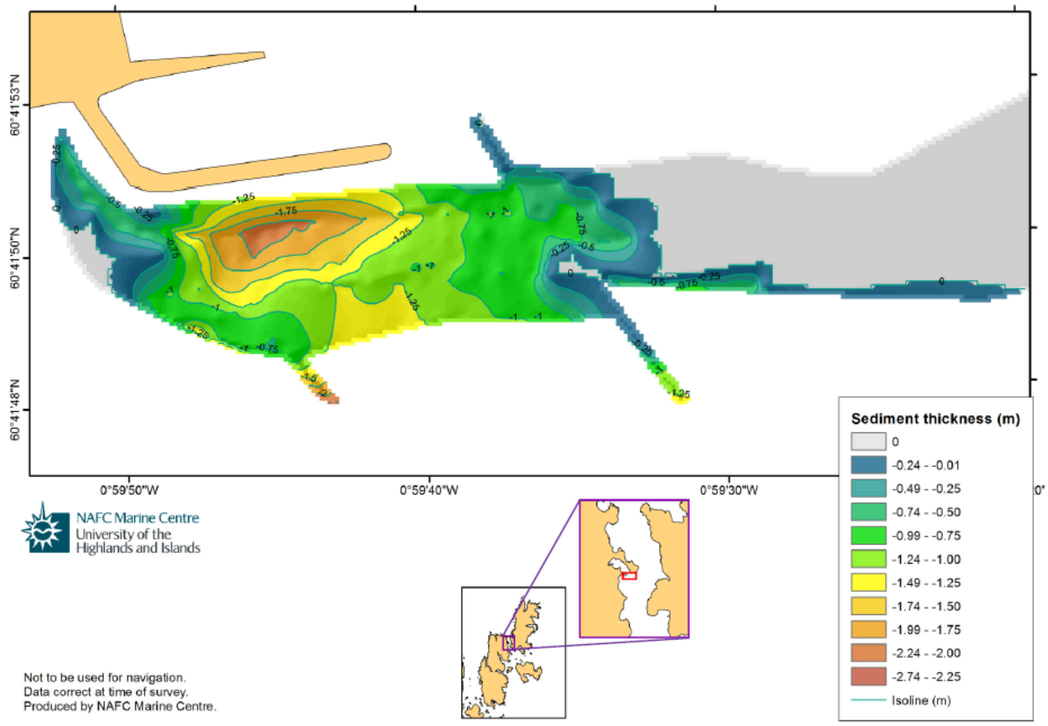
Nova Innovation already has a very detailed knowledge of the site and lease area from five years of operations, including bathymetry data (Figure 10) and sediment thickness data (Figure 11) as well as hundreds of hours of video footage from drop camera and diver operations.

Figure 10: Existing site bathymetry data



Source: Copyright © Nova Innovation 2017

Figure 11: Total sediment thickness, drawn at 250 cm intervals with overlaying isolines. No sediment was identified in the rest of the cable route and array area to the East of the location shown.



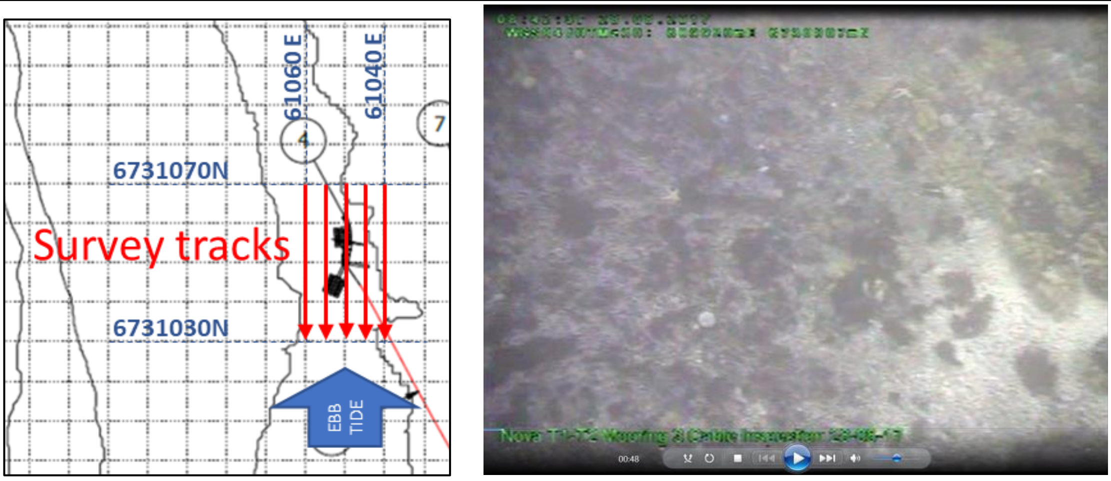
Source: Copyright © Nova Innovation 2017

Detailed video surveys were conducted of the deployment site and cable route in 2010 and 2014. No evidence of species on the marine priority list (in particular Horse Mussels and Maerl) was observed. See Appendix B.

3.3.1 Pre-deployment surveys

To confirm that the target area of seabed is clear of obstructions and any particularly sensitive species, including benthic habitats or species on the recommended Priority Marine Features list, pre-deployment surveys of the turbine installation locations will be carried out prior to construction works commencing. These surveys will use a drop video camera. Using a high water slack (when the building ebb tide will be running to the north - away from the existing machines), a series of survey transects will be carried out as shown in Figure 12. Initial survey tracks will be separated by 5-10m: closer or additional tracks may be used if required.

Figure 12: Example pre-deployment survey tracks and drop camera image



Ref	Item	UTM30 (E)	UTM30 (N)	Heading
4	M100D T4 TURBINE	610050	6731050	010

Source: Copyright © Nova Innovation 2020

A final pre-deployment survey of each turbine installation will also be carried out on the day of deployment operations, using the same Spyball drop video camera deployed from the multicat vessel, which will maintain accurate position keeping using a four-point mooring (Figure 13). The same methodology will be used to carry out seabed surveys prior to cable and cable hub installation. Flashcards will be used (see Appendix A) to inform *in situ* interpretation of video footage by on-board personnel, but all video will also be recorded for *post-hoc* examination.

Deployment of the substructure will be carried out using a lift beam fitted with a Gyrocompass, ensuring that accurate reading of the heading and tilt of turbine foundations are recorded.

3.3.2 Post-deployment surveys

To confirm the locations and surrounding environment of all deployed equipment, surveys of the deployed turbines, cable routes and other infrastructure will be conducted using a drop camera deployed from a suitable vessel. Geolocation will be provided by the vessel GPS. The confirmed positions of the deployed devices and cable will be communicated to UKHO to be marked on hydrographic charts.

The position of the deployed devices and cables will also be communicated to MS-LOT, along with GIS shapefiles detailing the locations of the turbines and associated infrastructure following initial deployment, redeployment and final deployment.

Figure 13: Multicat drop camera deployment and sample image from cable survey

Source: Copyright © Nova Innovation 2020

All pre- and post-deployment surveys will be carried out with due consideration of sensitive habitats and species: the survey team will carry species ID cards in order that species of interest can be identified - see Section 3.8 and Appendix A.

3.3.3 Survey reporting

Pre- and post-deployment video survey data will be verified by a suitably experienced expert able to confirm species and habitat identifications to the appropriate biotope or species level. Information from these surveys will be reported in monitoring reports submitted as part of the environmental monitoring strategy set out in the PEMP. If sensitive benthic habitats or species are identified from the footage, micro-siting will be used to avoid any physical impacts. It should be noted that no such habitats or species have been observed in previous video surveys of the Shetland Tidal Array Project area. For details of previous surveys, see Appendix B.

3.4 T4-6 device installations

The T4 turbine will be deployed in the following stages:

1) **Load-out substructure**: the Substructure will be assembled and have the Cable Backpack and Nacelle trial-fitted onto it at Belmont Pier in Unst. A mobile land-based crane will then transfer the steel substructure from its storage location on Belmont Pier, Unst to the Multicat deployment vessel.

2) **Deploy substructure:** The substructure will be transported from Belmont Pier to the installation location, where it will be lowered to the correct position on the seabed.

3) **Ballast substructure:** The Multicat will pick up the concrete ballast units at Cullivoe Pier, Yell, before transporting them to site and lowering them onto the relevant locations on the turbine substructure.

4) **Deploy cable:** The reeled cable will be carried by the Multicat from Cullivoe Pier to the installation location. The cable will be laid from the Multicat as a single length from the turbine location to the pier at Cullivoe. At the offshore end, the subsea cable attaches to the substructure. At the shore end, the cable is led up the beach and terminated inside an onshore GRP housing. No additional deposits are required to secure the cables.

5) **Deploy nacelle:** The Multicat will collect the turbine nacelle from Cullivoe Pier and carry it to the installation location. The nacelle will be lowered from the vessel to the substructure, to which it will be mechanically locked. The electrical connection is made by a remotely actuated wet-mate connector.

The process for installing the T5 and T6 machines will be as outlined above, with the difference that these two turbines will be connected via jumper cables to a subsea hub with a single cable to shore. The subsea hub will be lowered to the seabed by the Multicat installation vessel and the cable laid back to shore and terminated. The jumper cables will then be installed to connect the turbines to the cable hub. As with previous STA operations to date, a 4-point mooring will be used for positioning when required.

Operations are designed to be diverless, but a dive team will be on standby should they be required. Nova do not plan to use any ROVs. Equipment deployment and recoveries will be carried out using a combination of the main vessel winch and the vessel Hi-Ab crane, plus vertically lowered and surface-actuated recovery tools.

3.5 T4-6 device redeployments (array reconfiguration)

Following an initial period of turbine operations, site measurements and related numerical modelling work, the T4-6 devices will be relocated closer to the T1-3 devices, as part of Nova's work to validate and optimise tidal array operations through the EU-funded EnFAIT (Enabling Future Arrays in Tidal) project.

Pre-deployment site surveys will first be carried out of the T4-6 redeployment locations that have been identified, to confirm these areas are free of obstructions and any particularly sensitive species.

The T4 turbine will be repositioned in the following stages:

1) **Recover turbine:** The Multicat will moor up over the turbine, lower a recovery tool onto the turbine, release the mechanical lock and disengage the wet-mate connector so that the turbine can be recovered to Cullivoe Pier.

2) **Recover cable:** Once the subsea cable has been disconnected at the shore end, the Multicat will load this end of the cable. Then, using a powered cable reeler, the vessel will begin pulling the cable aboard onto a reel, moving towards the offshore location. At the offshore end, the vessel will moor up and recover the offshore end of the cable from the substructure onto the vessel deck, using a weighted grab tool lowered vertically.

3) **Deballast, reposition and reballast substructure:** The Multicat will then recover an appropriate number of concrete ballast units from the substructure, so that the wet weight of the partially deballasted substructure can be taken by the main vessel winch and the substructure can be repositioned in the appropriate location, before the ballast units that have been removed are reinstated. The turbine cable and nacelle can then be reinstated as outlined below.

4) **Redeploy cable:** The reeled cable will be carried by the Multicat from Cullivoe Pier to the installation location. The cable will be laid from the Multicat as a single length from the turbine location to the pier at Cullivoe. At the offshore end, the subsea cable attaches to the substructure. At the shore end, the cable is led up the beach and terminated inside an onshore GRP housing.

5) **Redeploy turbine:** The Multicat will collect the turbine nacelle from Cullivoe Pier and carry it back to the installation location. The nacelle will be lowered from the vessel to the substructure, to which it will be mechanically locked. The electrical connection is made by a remotely actuated wet-mate connector.

The process for recovering and redeploying the T5 and T6 machines will be as outlined above, with the difference that these two turbines are connected via jumper cables to a subsea hub with a single cable to shore, so only the jumper cables need to be recovered and redeployed: the subsea hub can be left offshore.

Depending on the precise T4-6 locations that the EnFAIT research work defines, the hub may however need to be repositioned. The finalised locations for the redeployment of T4, T5, T6, the subsea hub and all related cable routes will be communicated to MS-LOT, CES, SIC and UKHO in advance of the reconfiguration works.

Post-deployment site surveys will be carried out of all the deployed equipment, to confirm their exact locations and proximity to any obstructions or particularly sensitive species.

As-deployed coordinates will be formally submitted to MS-LOT, CES, SIC and UKHO on completion of these reconfiguration works.

3.6 Management of installation

Offshore operations will be carried out during appropriately slack tides with suitable wave and weather conditions. The installation will be managed by Nova Innovation staff who will be resident in Shetland for the project. Following successful commissioning, monitoring of the devices will be undertaken remotely via a fibre optic cable. This will allow the devices to be monitored either from the shore or remotely via a secure internet connection.

3.7 Site marking / buoys

Given the depth of the turbine and the advice of marine navigation stakeholders to keep the area clear of potential hazards, the site will not be marked with any buoys or markers during normal operation. Temporary marker buoys required during vessel operations will be deployed in compliance with COLREGS and removed on completion of deployment.

3.8 Health, Safety and the Environment

The work will be conducted in compliance with Nova Innovation's HSE policy. All staff and personnel involved in the project will be fully briefed and trained and will exercise good health and safety and environmental work practices. This document should be read in conjunction with the Project Environmental Monitoring Plan (PEMP). Hard copies of all relevant Health and Safety and environmental protocols and codes of practice, along with project licences and associated documents are located at Nova's Cullivoe Pier office and shared with all personnel involved in operations.

<u>Pollution prevention measures</u>
There are no hazardous substances contained in the turbines. All exposed steel surfaces are painted with standard marine-grade paint. There will only be less than twenty litres of hydraulic fluid in each device, contained within a sealed unit which itself is contained within the watertight nacelle.

<u>Measures to avoid the introduction of marine non-native species (NNS)</u>
Nova has produced a biosecurity plan for the project, detailing measures to avoid contributing to the spread of invasive marine non-native species within the Shetland area. None of the new array equipment to be deployed in Bluemull Sound will have been deployed subsea previously. Temporary moorings (e.g. chains) will either be sourced from Shetland or will be pressure washed or air dried prior to deployment in the Bluemull Sound. Attempts will be made to use locally based boats for offshore operations where it is practical to do so. Additional measures to avoid introduction of NNS during the project lifetime are outlined in the PEMP, following recommendations in *A Biosecurity Plan for the Shetland Islands* (NAFC 2015).

<u>Measures to avoid environmental harm during operations</u>
Details of the environmental monitoring that will be carried out to monitor the effects of the operating turbines on marine wildlife are provided in the PEMP. Monitoring will continue to focus on the potential for marine wildlife to interact and collide with the operating turbines. In the event that monitoring detects collisions or other unacceptable environmental harm then devices can be shut down, if required. This can be done remotely from Nova Innovation's offices in Edinburgh or manually on-site. Details for determining an appropriate management response to any unacceptable environmental harm are set out in the PEMP. It is worth noting that to date Nova have recorded more than 10,000 hours of operational video footage, with no observed instances of any collisions or negative interactions between the devices and marine wildlife.

See also Table 8, section 2.9 for full details of all environmental good practice and mitigation measures that will be implemented during the Works.

3.9 Operations and maintenance

Each marine turbine comprises a cylindrical nacelle unit, rotor and a supporting gravity-based frame. The turbine blades are bidirectional, operating in both directions of tidal flow without the need for the nacelle to yaw. The turbine blades rotate in the tidal stream and power a generator that is housed within the nacelle. The electricity produced by the generator is exported to the grid by a subsea cable from the turbines to the shore (T1 to T4) or via a small subsea hub (T5 and T6). All electrical power conditioning and control is based onshore at the grid connection point on Cullivoe Pier.

Communication to the machines is via a fibre optic cable embedded in the power cable, which can be accessed by a secure ISDN/broadband communications link, allowing each individual turbine to be accessed remotely over the internet. It is also therefore possible to control and monitor the turbines locally and remotely from Nova's Edinburgh office.

Nova may need to carry out unplanned maintenance activities on any of the existing or new turbines: this work would be accompanied by the relevant marine notifications – see Table 10.

Table 10: STA Communications Approach for Maintenance Works

Organisation	1 month prior to commencement (or as soon as possible if unscheduled)	During active maintenance work	Within 1 month of completion
MS-LOT	Direct notification in writing (by email)	Ensure NtM and Kingfisher Bulletin live and accurate	Notify in writing of any significant changes to deployed equipment.
CES			
SIC			
UKHO	Issue NtM		
NtM list			De-activate notifications
Kingfisher Bulletin	Provide information for Bulletin		

Source: Nova Innovation, 2020

Each turbine nacelle will be periodically removed from its base and taken back to Cullivoe Pier for servicing on land, following which it will be returned to its base. The stages involved in this process are set out below.

Retrieval: A release mechanism is activated by the service vessel using a recovery tool lowered vertically. This releases the nacelle from the base from where it is lifted to the surface, secured to the vessel and removed to Cullivoe Pier for servicing. Temporary marker buoys may be used.

Redeployment: On completion of servicing, the nacelle is returned to the site; the device is lowered onto the base and the structural connection is completed. The deployment tool is then recovered.

3.10 Operational environmental monitoring

Each device will be monitored manually and automatically for a period following deployment. If no harm is observed to the environment, then the device will continue to be monitored automatically during its operating lifetime. Details of the environmental monitoring that will be carried out are set out in the PEMP.

3.11 Contingency Plans for Loss of Device

In the highly unlikely event that any of the devices (or a part thereof) should become detached from their substructure, an alarm is immediately sent to the operator on duty who will co-ordinate retrieval operations.

The device is negatively buoyant, so will remain on the seabed in the event of failure. As discussed above, the amount of hydraulic fluid is minimal and all such fluids are housed within sealed units inside a watertight nacelle – i.e. are doubly contained.

3.12 Decommissioning

Removal of the devices at any time is relatively straightforward due to their relatively small scale. Means for the removal from site of the major sub-components are listed below:

1) **Turbine nacelle** removal follows the maintenance procedure described above. The nacelle will be dismantled onshore for re-use or recycling.

2) **Turbine base** is recovered by a lifting tool and raised from the seabed to the surface by a service vessel. The base is secured to the vessel and taken to shore, where it can be re-used or dismantled for recycling.

3) The **cable** is retrieved by drawing it on to a spool on a work boat, reversing the deployment process. Any protection associated with the cable (e.g. rock bags) is recovered at the same time.

4) **Switchgear and control** is housed in a stand-alone, ingress-protected GRP container on the pier at Cullivoe; it can easily be removed from the same.

Once the devices and associated structures are removed, the seabed and surrounding locality will return to their natural state with no permanent impact from the devices.

The full decommissioning programme will be agreed with MS-LOT.

3.13 Change Management

Significant changes to the schedule or methods outlined in this CMS (including those resulting from the COVID-19 outbreak) will be communicated to MS-LOT and the project team with this CMS being updated as appropriate. Nova's internal quality and change management procedures will be adhered to at all times.

4 Vessel Management Plan

The vessels to be used for offshore operations will be determined in advance of the operation depending on availability. The size and operational capability of vessels will be as follows:

1) Surveying: small local boat or Multicat vessel

2) Deployment and retrieval: Multicat vessel (see Figure 9)

Only one of these project vessels will be on site at any given time. The equipment deployment and recovery tasks to be carried out are of the same sort that Nova has been carrying out routinely in this area since 2014. The local harbour master and other users of Cullivoe and Belmont Pier are familiar with these operations, as are the identified vessel providers. No special vessel management arrangements are required.

The harbour master, Shetland Ports and Harbours and Shetland CGOC will be advised in advance of all operations (see 3.2). All quayside and harbour works will be undertaken in compliance with the direction of the harbour master.

All vessels involved in the installation, maintenance and decommissioning of the device will comply with all aspects of the International Regulations for Preventing Collisions at Sea (COLREGS)[1]. All vessels used will carry all equipment as required under the vessels' registration, e.g. the Code of practice for the safety of small workboats and pilot boats[2].

Notices to Mariners will be used to inform stakeholders of offshore operations. During all offshore operations we will adhere to the good practice guidelines associated with the Scottish Marine Wildlife Watching Code, hard copies of which are kept in Nova's office at Cullivoe Pier and onboard all vessels engaged in operations.

[1] Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) (as amended)

[2] https://www.gov.uk/government/publications/small-craft-codes

5 Glossary

CPP	Construction Phase Plan
CES	Crown Estate Scotland
CMS	Construction Method Statement
EnFAIT	Enabling Future Arrays in Tidal
ERCOP	Emergency Response and Cooperation Plan, a copy of which is stored in the Nova site office, with another brought aboard the vessel by the Nova Offshore Rep
M100	The existing (gearbox-driven) 100kW Nova turbines (T1, T2 and T3)
M100D	The new (direct drive) 100kW Nova turbines (T4, T5 and T6)
MS-LOT	Marine Scotland Licensing Operations Team
RAMS	Risk Assessment and Method Statement(s)
SIC	Shetland Islands Council
STA	Shetland Tidal Array

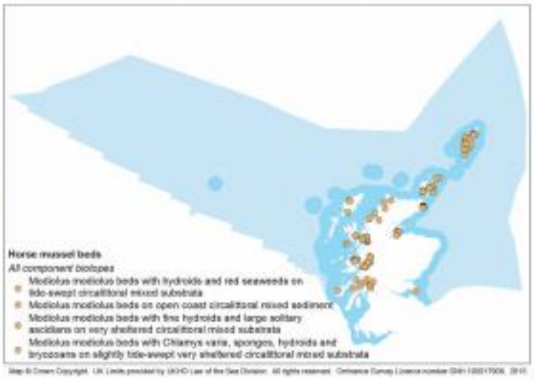
Appendix A Habitat ID flashcards

Ref: https://www.nature.scot/snh-commissioned-report-406-descriptions-scottish-priority-marine-features-pmfs

TERRITORIAL WATERS

Broad habitat

HORSE MUSSEL BEDS

Image	Distribution
	

Feature description

Characteristics - The horse mussel *Modiolus modiolus* occurs in scattered clumps, thin layers or dense raised beds, which can extend up to several hectares in size. Raised beds are formed of horse mussels bound together by a matrix of byssus threads. Silt, organically rich faeces and shells accumulate within the structure and further increase the bed height. Horse mussel beds significantly modify sedimentary habitats and provide hard substratum, refuge and ecological niches for a wide variety of organisms. The beds increase local biodiversity and may provide settling grounds for commercially important bivalves, such as queen scallops.

Environmental preferences - Weak to strong water movement on a variety of mixed substrata. Found at depths of 5-220m.

Scottish distribution - Recorded from sea lochs, embayments and open coast in Shetland, Orkney, off Caithness and down the west coast with scattered records from the Outer Hebrides and Moray Firth. Relatively small, dense beds of horse mussels can also occur on steep rocky surfaces within sea lochs.

Wider distribution - Recorded from the Ards Peninsula, Strangford Lough, off both ends of the Isle of Man, off north-west Anglesey and north of the Llŷn Peninsula, Wales.

Feature status - Scottish waters support 85% of all horse mussel beds in the British Isles which themselves represent most of the habitat within Europe. They are sensitive to physical disturbance and mobile fishing gears may damage and/or remove beds. The extent and quality of habitat has declined since the 1950s with formerly extensive beds in Strangford Lough (N. Ireland) lost as recently as 2007 due to scallop trawling and dredging. The condition of beds in Loch Creran and Loch Duich on the west coast of Scotland has also deteriorated but the cause is currently unknown.

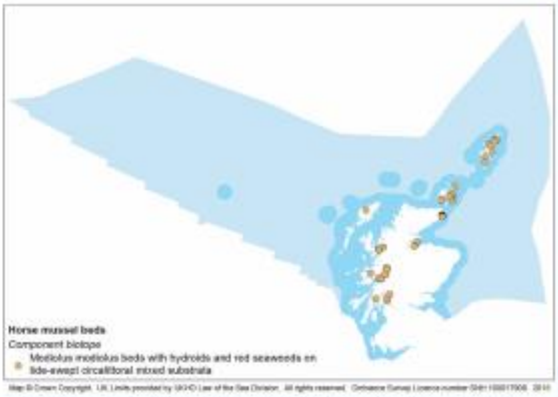
Natural heritage importance	Information sources
EC Habitats Directive Annex I	MarLIN
OSPAR T&D	OSPAR Case Report
Scottish Biodiversity List	UK BAP Habitat Definitions
UK BAP	UK Marine SACs Overview

Component biotopes in Scottish waters

Modiolus modiolus beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata - **SS.SBR.SMus.ModT**.
Modiolus modiolus beds on open coast circalittoral mixed sediment - **SS.SBR.SMus.ModMx**.
Modiolus modiolus beds with fine hydroids and large solitary ascidians on very sheltered circalittoral mixed substrata - **SS.SBR.SMus.ModHAs**.
Modiolus modiolus beds with *Chlamys varia*, sponges, hydroids and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata - **SS.SBR.SMus.ModCvar**.

Component biotope name

MODIOLUS MODIOLUS **BEDS WITH HYDROIDS AND RED SEAWEEDS ON TIDE-SWEPT CIRCALITTORAL MIXED SUBSTRATA (SS.SBR.SMus.ModT)**

Image	**Distribution**
 Image: Keith Hiscock / JNCC	

Feature description

Characteristics - In strong currents or tide-swept conditions, the horse mussel (*Modiolus modiolus*) forms raised beds on mixed muddy substrates. The beds are made up of living and dead mussels, bound together with byssus threads, and an accumulation of silt and mussel faeces. In some cases they can be several metres high and many metres long providing refuge for a variety of other organisms. Red seaweeds and sea firs grow on or amongst the horse mussels. Brittlestars are often common in this habitat, along with tube worms, whelks, clams and sea anemones.

Environmental preferences - Typically found on the open coast but also in the tide-swept channels of marine inlets on mixed, muddy substrata (cobbles and pebbles) from 5-50m.

Scottish distribution - Recorded from Shetland (e.g. Basta Voe and Yell Sound), Orkney (Shapinsay Sound), the Caithness coast (Noss Head), the Moray Firth, the Outer Hebrides (Loch Roag) and within sea lochs of the west coast of Scotland (e.g. Loch Carron, Loch Linnhe and Loch Long).

Wider distribution - There are very few records of this biotope outside of Scotland but it has been recorded in the Irish Sea off the north-west Llŷn Peninsula (North Wales) and off Co. Down (Northern Ireland).

Feature status - Supporting the majority of horse mussel beds in the British Isles, Scottish waters are nationally important for this habitat which is sensitive to physical disturbance. Mobile fishing gears may damage or completely remove horse mussel beds.

Natural heritage importance	**Information sources**
EC Habitats Directive Annex I (Reefs, typical of Large shallow inlets and bays) OSPAR T&D Scottish Biodiversity List UK BAP	JNCC Marine Habitat Classification MarLIN OSPAR Case Report UK BAP Habitat Definitions

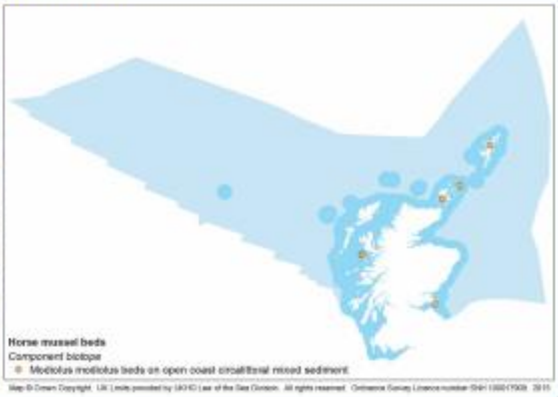
Sub-component biotopes in Scottish waters

No sub-component biotopes

TERRITORIAL WATERS

Component biotope name

***MODIOLUS MODIOLUS* BEDS ON OPEN COAST CIRCALITTORAL MIXED SEDIMENT (SS.SBR.SMus.ModMx)**

Image	Distribution
	

Feature description

Characteristics - Beds of horse mussels (*Modiolus modiolus*) on or within mixed muddy and gravel sediments in deep water. Clumps of live and dead shells are bound together by byssal threads providing a stabilising effect on the sea bed. The accumulation of silt and mussel faeces upon and around the beds provides a habitat that attracts a rich diversity of organisms, in particular polychaete worms. Venerid bivalves and brittlestars are also commonly present.

Environmental preferences - Typically occurs on current swept, moderately sheltered circalittoral mixed sediment (muddy sand and gravel, with shells and stones) at depths of 40-100m.

Scottish distribution - Recorded from the Northern Isles (Sullom Voe, Shetland and Hoy Sound, Orkney) as well as from the Small Isles on the west coast, and Isle of May on the east.

Wider distribution - There are a number of records in the Irish Sea, with scattered records on the east coast of Ireland, Northern Ireland and England. Records of *M. modiolus* off Norway, in the Kattegat Sea and off the west coast of France may represent examples of this biotope.

Feature status - *M. modiolus* is a long lived species with poor recruitment. Horse mussel beds are sensitive to physical disturbance which can adversely affect bed integrity. Mobile fishing gears may damage or completely remove beds.

Natural heritage importance	Information sources
EC Habitats Directive Annex I (Reefs) OSPAR T&D Scottish Biodiversity List UK BAP	JNCC Marine Habitat Classification MarLIN OSPAR Case Report UK BAP Habitat Definitions

Sub-component biotopes in Scottish waters

No sub-component biotopes

Component biotope name

MODIOLUS MODIOLUS **BEDS WITH FINE HYDROIDS AND LARGE SOLITARY ASCIDIANS ON VERY SHELTERED CIRCALITTORAL MIXED SUBSTRATA (SS.SBR.SMus.ModHAs)**

Image	Distribution
 Image: Sue Scott / JNCC	

Feature description

Characteristics - In wave sheltered areas, the horse mussel (*Modiolus modiolus*) forms beds or scattered clumps on mixed muddy substrates. The beds or clumps consist of living and dead mussels bound together by byssus threads. They provide refuges and substratum for sea firs, solitary sea squirts and fish species. The beds also support a variety of brittlestars, together with commercially important shellfish (e.g. queen scallops), hermit crabs, spider crabs and whelks.

Environmental preferences - This biotope typically forms on mixed, muddy substrata (cobbles and pebbles) in sheltered conditions with slight tidal movement at depths of 5-30m.

Scottish distribution - Found in sea lochs and voes in Shetland (e.g. Sullom Voe), Orkney (e.g. North Sanday and Shapinsay Sound), the Outer Hebrides (e.g. Loch Roag and Loch Tarbert) and the west coast (e.g. Loch Sunart and Loch Duich).

Wider distribution - This biotope is only recorded in Scotland.

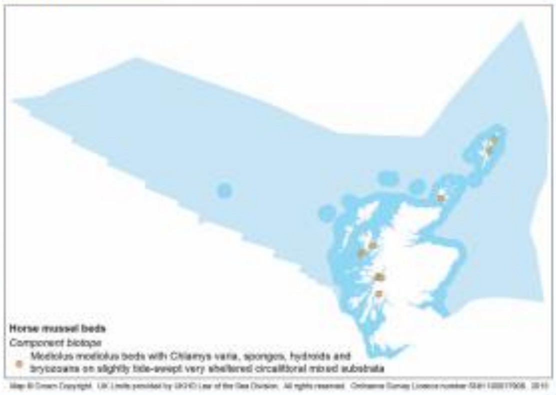
Feature status - This biotope is unique to Scottish waters and, like the other horse mussel bed biotopes, is sensitive to physical disturbance which can adversely affect bed integrity. Mobile fishing gears may damage or completely remove *M. modiolus* beds.

Natural heritage importance	Information sources
EC Habitats Directive Annex I (Reefs, typical of Large shallow inlets and bays) OSPAR T&D Scottish Biodiversity List UK BAP	JNCC Marine Habitat Classification MarLIN OSPAR Case Report UK BAP Habitat Definitions

Sub-component biotopes in Scottish waters

No sub-component biotopes

TERRITORIAL WATERS	
Component biotope name	
***MODIOLUS MODIOLUS* BEDS WITH *CHLAMYS VARIA*, SPONGES, HYDROIDS AND BRYOZOANS ON SLIGHTLY TIDE-SWEPT VERY SHELTERED CIRCALITTORAL MIXED SUBSTRATA (SS.SBR.SMus.ModCvar)**	
Image	**Distribution**



Feature description

Characteristics - Beds of horse mussels (*Modiolus modiolus*) on or in gravelly mud sediments. Beds are made up of living and dead mussels, bound together with byssus threads, and an accumulation of silt and mussel faeces. The beds provide refuge and substratum for a variety of other organisms. The variable scallop (*Chlamys varia*) is characteristically present amongst the horse mussels. Brittlestars, feather stars, hermit crabs, spider crabs and whelks are also found in this biotope. Sponges, sea firs, sea mats and sea squirts grow on the mussels.

Environmental preferences - This biotope forms beds on slightly tide-swept, very sheltered circalittoral mixed sediment (pebbles and shells on sandy mud) at depths of 5-220m.

Scottish distribution - Restricted to a small number of sea lochs on the west coast (Loch Fyne, Loch Creran and on Skye), as well as from Orkney and within Bluemull Sound in Shetland. An atypical deep water variant of this biotope has recently been recorded within the Sound of Canna.

Wider distribution - There are only a few records of this biotope outside of Scottish waters, these are primarily in the Irish Sea (Northern Ireland and north-west Wales).

Feature status - This is a rare horse mussel bed biotope and like all biogenic reefs is sensitive to physical disturbance which can adversely affect bed integrity. Mobile fishing gears may damage or completely remove *M. modiolus* beds.

Natural heritage importance	Information sources
EC Habitats Directive Annex I (Reefs, typical of Large shallow inlets and bays) OSPAR T&D Scottish Biodiversity List UK BAP	JNCC Marine Habitat Classification MarLIN OSPAR Case Report UK BAP Habitat Definitions

Sub-component biotopes in Scottish waters

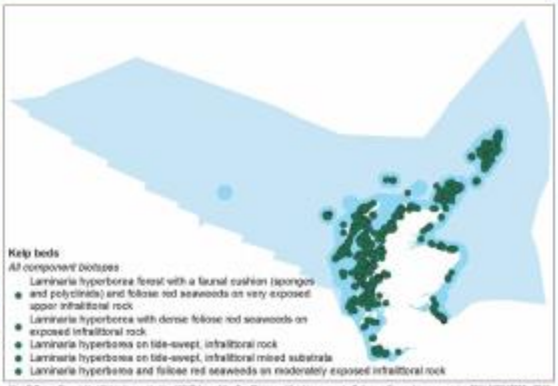
No sub-component biotopes

NOVA INNOVATION

Territorial waters

Broad habitat

Kelp beds

Image	Distribution
	

Feature description

Characteristics – Beds of the kelp *Laminaria hyperborea* form as forests and parks in rocky coastal areas, under a variety of wave and tidal conditions. The kelp provides a canopy under which a wide range of animals and other seaweeds thrive. A rich diversity of red seaweeds grow among the kelp and on the kelp stipes, while depending on conditions, sea mats and sea firs may colonise the fronds. The rocks below the kelp are often encrusted with coralline algae or support cushion forming fauna, such as sea anemones, sponges and sea squirts. Small crustaceans and worms live among the kelp holdfasts, while sea urchins and sea snails graze on the seaweeds, and fish find shelter from predators among the fronds.

Environmental preferences - Kelp beds occur in shallow waters (to a maximum of 20-30m), on bedrock and boulders in a range of wave exposure regimes and tidal conditions.

Scottish distribution - Widely recorded around all coasts of the Scottish mainland and islands. The more exposed biotopes are particularly recorded from Atlantic coasts in the west and the north.

Wider distribution - Widely recorded around the coasts of the UK and Ireland, although more exposed biotopes are only found on the west coast of Ireland, off Cornwall and south-west Wales.

Feature status - Scotland holds a significant proportion of the UK records of kelp beds and therefore the habitat is considered to be nationally important. The kelp component may be a target for seaweed harvesting, with potential effects on habitat structure and species diversity. Activities which cause changes in wave exposure or tidal flow could also have effects on this habitat.

Natural heritage importance	Information sources
EC Habitats Directive Annex I (Reefs) Scottish Biodiversity List (IR.MIR.KR.LhypT & IR.MIR.KR.LhypTX only) UK BAP (IR.MIR.KR.LhypT & IR.MIR.KR.LhypTX only)	JNCC Marine Habitat Classification MarLIN

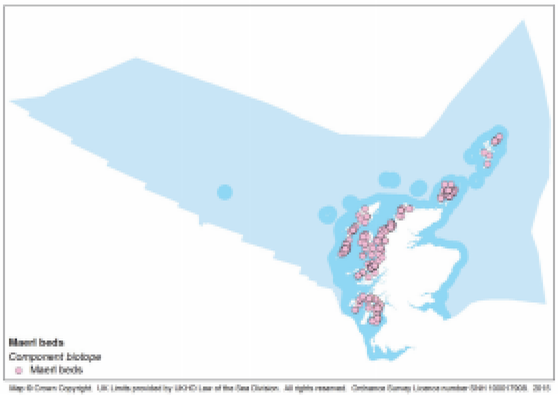
Component biotopes in Scottish waters

Laminaria hyperborea forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock - **IR.HIR.KFaR.LhypFa**.
Laminaria hyperborea with dense foliose red seaweeds on exposed infralittoral rock - **IR.HIR.KFaR.LhypR**, including: **IR.HIR.KFaR.LhypR.Ft** & **IR.HIR.KFaR.LhypR.Pk**.
Laminaria hyperborea on tide-swept, infralittoral rock - **IR.MIR.KR.LhypT**, including: **IR.MIR.KR.LhypT.Ft** & **IR.MIR.KR.LhypT.Pk**.
Laminaria hyperborea on tide-swept infralittoral mixed substrata - **IR.MIR.KR.LhypTX**, including: **IR.MIR.KR.LhypTX.Ft** & **IR.MIR.KR.LhypTX.Pk**.
Laminaria hyperborea and foliose red seaweeds on moderately exposed infralittoral rock - **IR.MIR.KR.Lhyp**, including: **IR.MIR.KR.Lhyp.Ft**; **IR.MIR.KR.Lhyp.Pk**; **IR.MIR.KR.Lhyp;GzFt** & **IR.MIR.KR.Lhyp:GzPk**.

TERRITORIAL WATERS

Broad habitat

MAERL BEDS

Image	Distribution
 Image: Marine Scotland	

Feature description

Characteristics - Maerl beds are formed by an unusual red seaweed with a hard chalky skeleton that grows as small rounded nodules or short branched twig-like shapes. In high abundance, maerl can form loosely interlocking beds through which water is able to circulate, providing the perfect conditions for the development of diverse communities of plants and animals (on, within or under the beds). Red seaweeds, sea firs, sea urchins, brittlestars, starfish, sea anemones and scallops may colonise the surface. Maerl needs light to grow, so living maerl is restricted to the surface of the beds overlying the chalky skeletons of dead maerl. Three maerl species exist in the British Isles and the relative composition of these within a bed, and the proportion of living / dead maerl within and between beds, varies with factors such as salinity and wave exposure. Maerls are extremely slow growing and extensive beds may be 1000s of years old.

Environmental preferences - Coarse clean sands and gravels either on the open coast or in tide-swept channels to a depth of about 20m. Occasional records from muddier sediments e.g. Loch Torridon.

Scottish distribution - Widespread on the west coast (e.g. Arran, Loch Sween, Sound of Arisaig and Loch Laxford), the Outer Hebrides (e.g. Sound of Barra and Loch nam Madadh) and in tide-swept areas of Orkney (e.g. Wyre and Hoy Sound) and Shetland (e.g. Bluemull Sound).

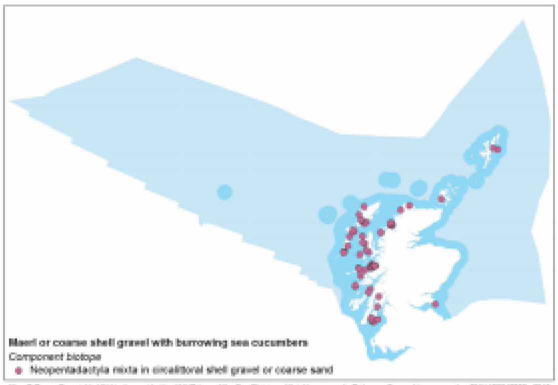
Wider distribution - Recorded on the south English coast, in Wales, Ireland and Northern Ireland, NW Iceland, NW France, NW Spain and the Canaries. Also known to occur in Sweden and Norway.

Feature status - Scotland has approximately 30% of the maerl beds in north-west Europe and most of the beds in the UK. They are sensitive to physical disturbance, smothering, increased suspended sediment and changes in water flow. Pressures are known to include mobile demersal fishing activity, aquaculture, pollution and extraction (for soil conditioner).

Natural heritage importance	Information sources
EC Habitats Directive Annex I (Subtidal sandbanks)	JNCC Marine Habitat Classification
OSPAR T&D	OSPAR Case Report
Scottish Biodiversity List	UK BAP Habitat Definitions
UK BAP	UK MarineSACs Overview

Component biotopes in Scottish waters

Maerl beds - **SS.SMp.Mrl**, including:**SS.SMp.Mrl.Pcal** (inc. **Pcal.R** & **Pcal.Nmix**); **SS.SMp.Mrl.Lgla**; & **SS.SMp.Mrl.Lcor**.

TERRITORIAL WATERS	
Broad habitat	
MAERL OR COARSE SHELL GRAVEL WITH BURROWING SEA CUCUMBERS	
Image	**Distribution**
	

Feature description

Characteristics - Gravel, maerl gravel (dead maerl) or coarse sands with high densities of the gravel sea cucumber, *Neopentadactyla mixta*. Scallops, brittlestars, crabs and dragonets live on the surface of the sediment (some seaweeds may also be present) with widespread species such as tube dwelling sea anemones, sand mason worms and parchment worms living within the coarse substrates. This biotope may occur adjacent to maerl beds. During winter months, the gravel sea cucumbers bury deep in the sediment and become dormant.

Environmental preferences - Found in sublittoral clean, gravel, maerl gravel (dead maerl) and / or coarse sands in moderately wave-exposed, fully saline conditions at 10-50m.

Scottish distribution - Found primarily along the west coast and the Outer Hebrides, with occasional records from Orkney (Scapa Flow), Shetland (Lunna Ness and Out Skerries) and the Isle of May (outer Firth of Forth).

Wider distribution - This habitat is not recorded outside of the British Isles. The gravel sea cucumber itself has a wider recorded distribution, from northern Norway to the Bay of Biscay.

Feature status - This habitat is highly sensitive to physical disturbance and pressures are known to include mobile demersal fishing (including scallop dredging) and the extraction of maerl (for soil conditioner).

Natural heritage importance	Information sources
EC Habitats Directive Annex I (Subtidal sandbanks) Scottish Biodiversity List UK BAP	JNCC Marine Habitat Classification MarLIN

Component biotopes in Scottish waters

Neopentadactyla mixta in circalittoral shell gravel or coarse sand - **SS.SCS.CCS.Nmix**.

Figure 14: Maerl (Lithothamnion glaciale)

Figure 15: Maerl (Phymatolithon calcareum)

Figure 16: Horse mussels (modiolus modiolus)

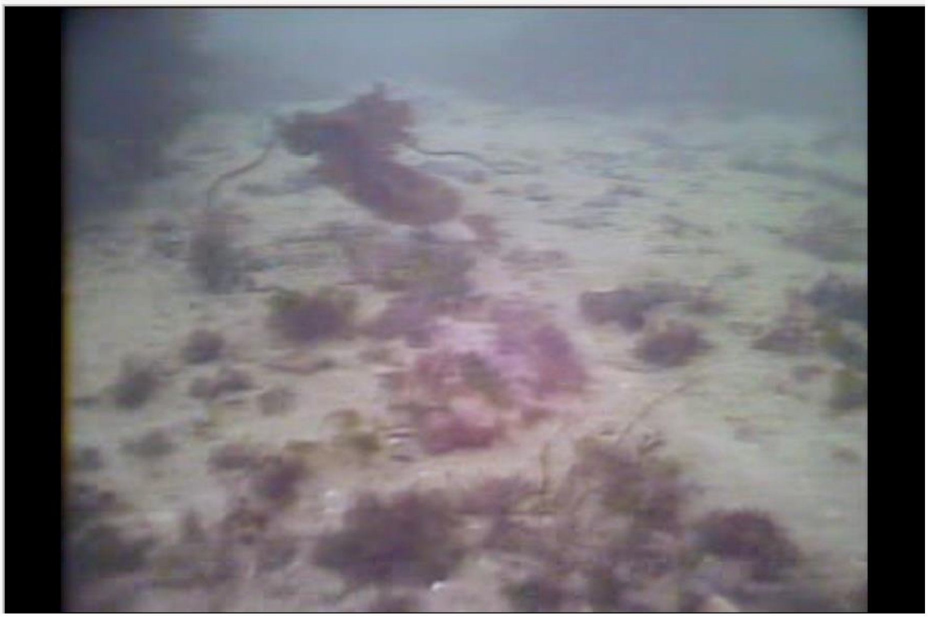
Figure 17: Horse mussel bed with hydroids and red seaweed, Linga Sound, Shetland.

Appendix B Results from previous site surveys

Representative stills are shown below from the surveys undertaken on November 2010 and May 2014.

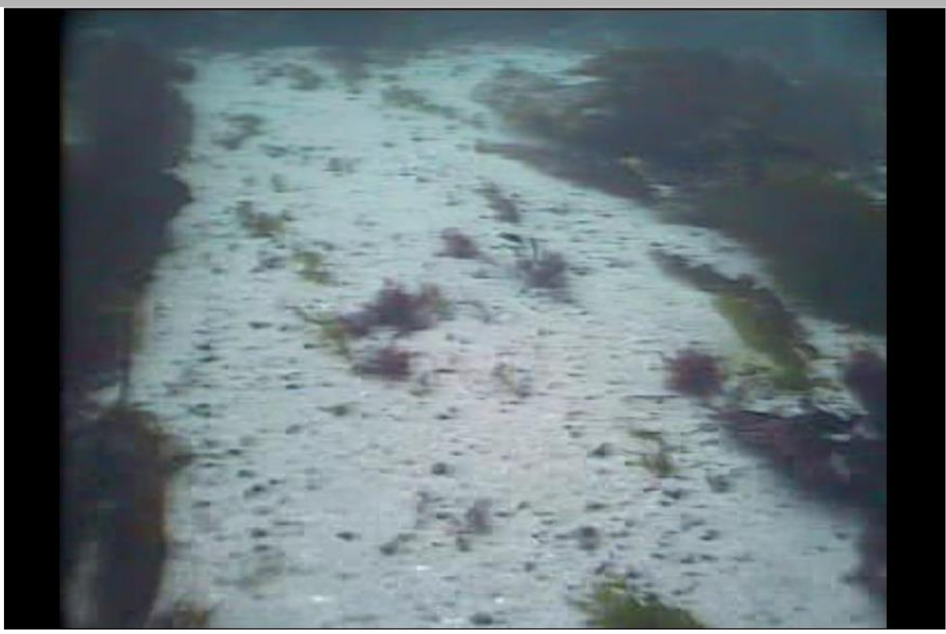
Near the shore the surveys cover the sublittoral zone. The sublittoral zone progresses from a coarse sandy seabed to boulder and cobble plains with little sediment in the sound. As the tidal flow becomes more severe the sea-bed becomes progressively rockier with rapidly reducing levels of flora and fauna. The sublittoral fringe is dominated by the kelp Laminaria digitata but little Laminaria hyperborean as has been reported elsewhere in Bluemull Sound. The species most observed were common sea urchins or Skaddiman's Head and colonies of Alcyonium digitatum. No survey observed any BAP species such as maerl or horse mussel.

Figure 18 Plate 1: Fine and Coarse Sand



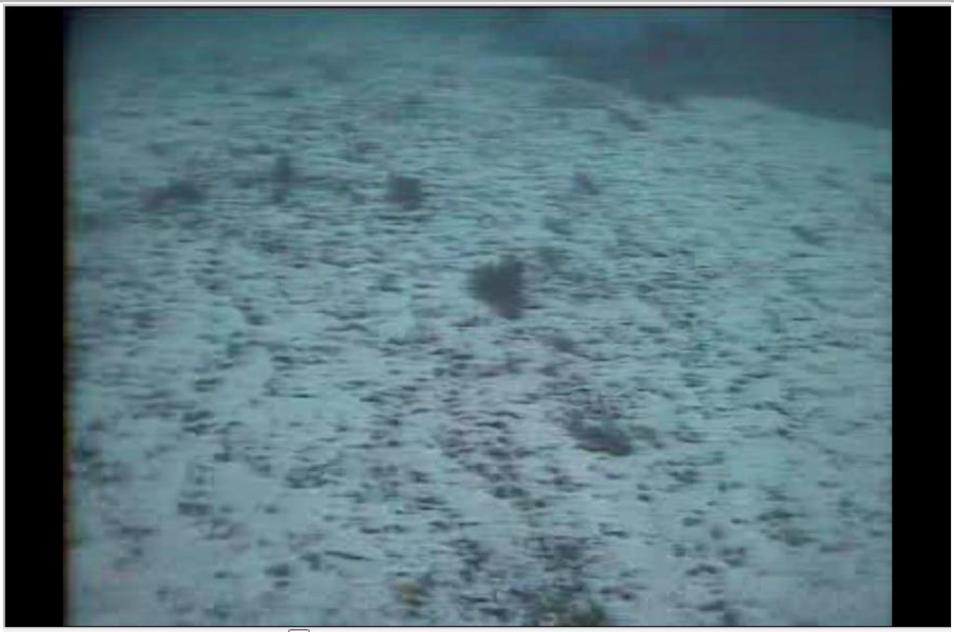
Source: Copyright © Nova Innovation 2015

Figure 19 Plate 2: Fine and Coarse Sand



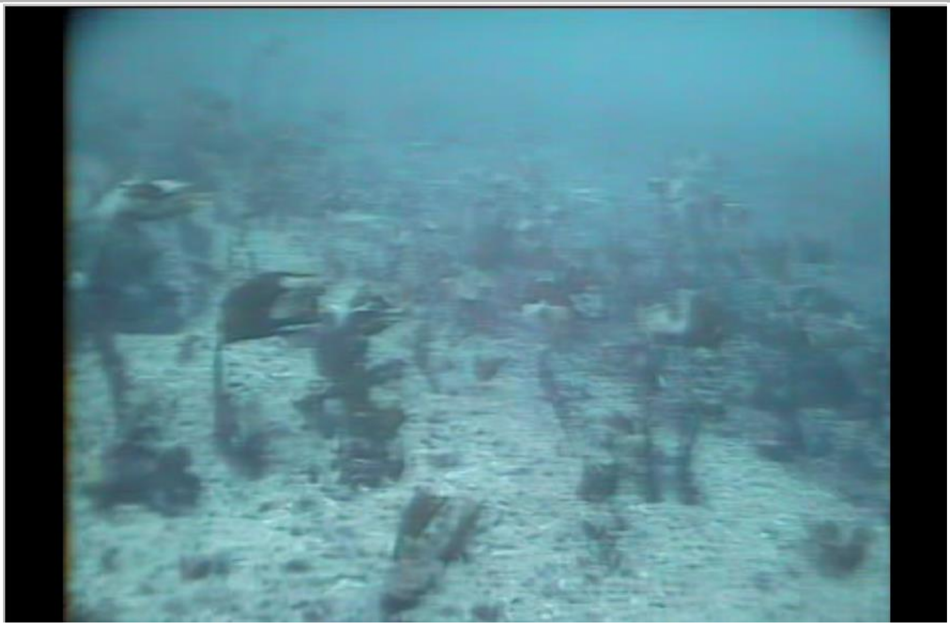
Source: Copyright © Nova Innovation 2015

Figure 20 Plate 3: Coarse Sand



Source: Copyright © Nova Innovation 2015

Figure 21 Plate 4: Coarse Sand and Fine Gravel

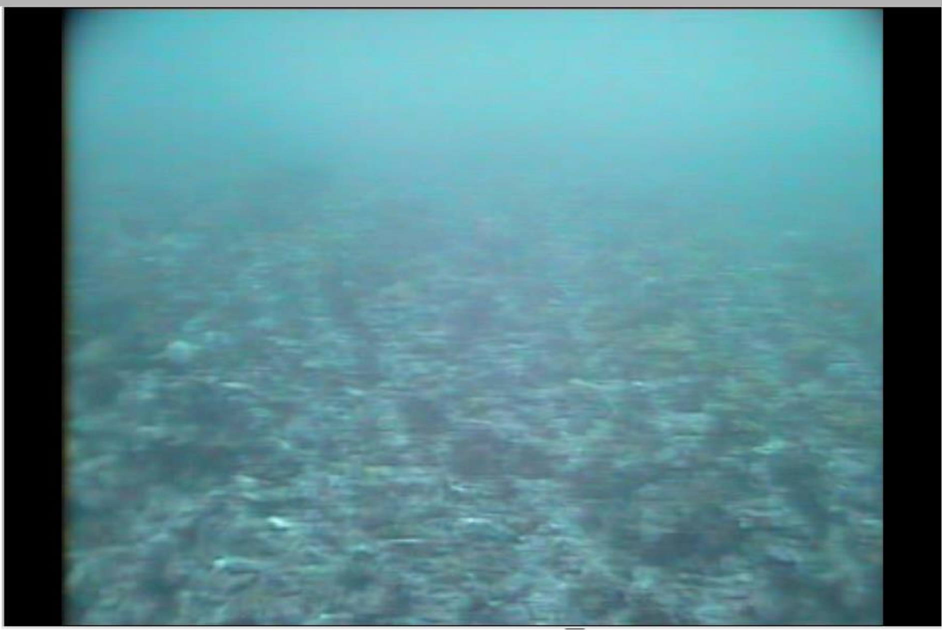


Source: Copyright © Nova Innovation 2015

Figure 22 Plate 5: Gravel and small stones

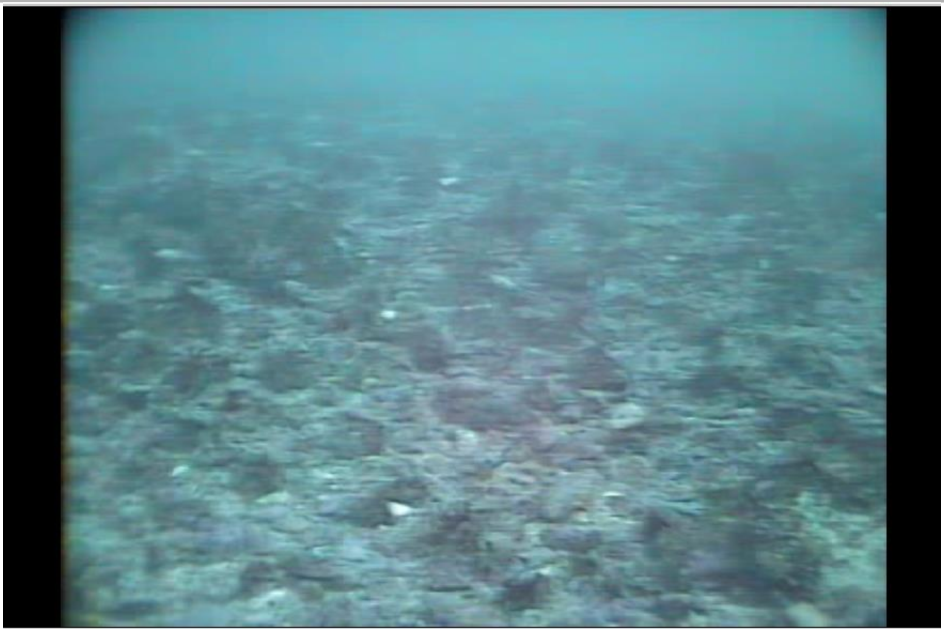
Source: Copyright © Nova Innovation 2015

Figure 23 Plate 6: Gravel and shattered rock



Source: Copyright © Nova Innovation 2015

Figure 24 Plate 7: Shattered rock and small boulders



Source: Copyright © Nova Innovation 2015

Figure 25 Plate 8: Shattered rock, small and large boulders

Source: Copyright © Nova Innovation 2015

Figure 26 Plate A: Shattered rock, small boulders and Alcyonium digitatum (Dead Man's Fingers)

Source: Copyright © Nova Innovation 2015

Figure 27 Plate B: Large boulders, shattered rock and Alcyonium digitatum

Source: Copyright © Nova Innovation 2015