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Aberaeron Coastal Defence Scheme

Habitat Regulations Assessment – Stage 1 Screening and Stage 2 Appropriate Assessment

Ceredigion County Council

October 2022

Notice

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Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	HRA Screening	RM	AC	KW	RAM	02/11/18
Rev 2.0	HRA Screening and AA for internal review	RM	AC	KW	RAM	22/04/21
Rev 3.0	HRA Screening and AA for client review	RM	AC	KW	RAM	23/04/21
Rev 4.0	For planning/marine licence applications	RM	AC	KW	RAM	09/06/21
Rev 5.0	For planning/marine licence application clarifications	RM	AC	KW	RAM	28/10/22

Client signoff

Client	Ceredigion County Council
Scheme	Aberaeron Coastal Defence Scheme
Job number	5182114
Client signature / date	

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1. Introduction

Atkins has been commissioned by Ceredigion County Council (CCC) to develop proposals for a coastal defence scheme for Aberaeron in order to reduce risks associated with coastal flooding within the town. The scheme is referred to as the Aberaeron Coastal Defence Scheme (herein referred to as 'the Scheme').

Aberaeron is situated on a low plateau. Flooding and storm damage have happened many times in the past and these events continue today. With climate change and the predicted rises in sea levels, storms and flooding will increase in frequency and severity. Low-lying areas of Aberaeron are at risk of flooding generated by extreme tidal waters and wave overtopping in the harbour as well as along South Beach. The layout of the harbour entrance means that waves freely propagate through the entrance channel into the harbour itself. Aberaeron is exposed to a wide range of wave conditions from the north-west and south-west. Storm waves enter the harbour and overtop the harbour walls. During periods of heavy rain, increased volumes of water in the River Aeron also enter the harbour. High tide, heavy rain and storm waves can all combine to make water levels and wave heights even higher.

Engineering works were carried out at North Beach of Aberaeron in 2009 which included the replacement with new timber groynes, a beach nourishment programme, reconstruction of the sea wall and construction of a revetment along the North Beach. The works have since provided improved protection to the northern part of the town from overtopping inundation from the sea, providing 1 in 200 year (1% Annual Exceedance Probability (AEP)) standard of protection against flooding.

Since completion of the works along North Beach, Aberaeron has still experienced a number of flood events. This is primarily due to overtopping along Pen Cei/Quay Parade (north) side of the harbour, adjacent to Pwll Cam and properties opposite the River Aeron A487 road bridge (See Section 1.1 and Figure 1-1).

The Scheme will comprise of five key linked elements (refer to Section 1.1) to provide increased protection to the town of Aberaeron from coastal flooding. An illustrative plan of the Scheme showing the key elements is provided in Figure 1-1. A more detailed description of the 'Site' and its location can be found in Section 1.1.

As construction of the coastal defences will take place both within and in close proximity to European[1] designated conservation sites, an assessment of potential impacts on the designated conservation sites is required and has been requested by Natural Resource Wales (NRW).

This document has been prepared in accordance with the Conservation of Habitats and Species Regulations 2017 ('the Habitats Regulations'). The Habitats Regulations require that a plan or Scheme not directly connected with or necessary to the management of the conservation sites but likely to have a significant effect, either individually or in combination with other plans or Schemes, shall be subject to an assessment of its implications for the site in view of the site's conservation objectives.

This report represents the findings of Stage 1 (Screening) and Stage 2 (Appropriate Assessment) of the Habitats Regulations Assessment (HRA) process and aims to identify the potential impacts and any likely significant effects of the Scheme against the qualifying features of the designated conservation sites and address these impacts.

[1] *Following the changes made to the Conservation of Habitats and Species Regulations 2017 (as amended) by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019, SACs and SPAs in the UK no longer form part of the EU's Natura 2000 ecological network and now form part of a UK national site network. In this document they are still referred to as European Sites.'*

1.1. Proposed Scheme

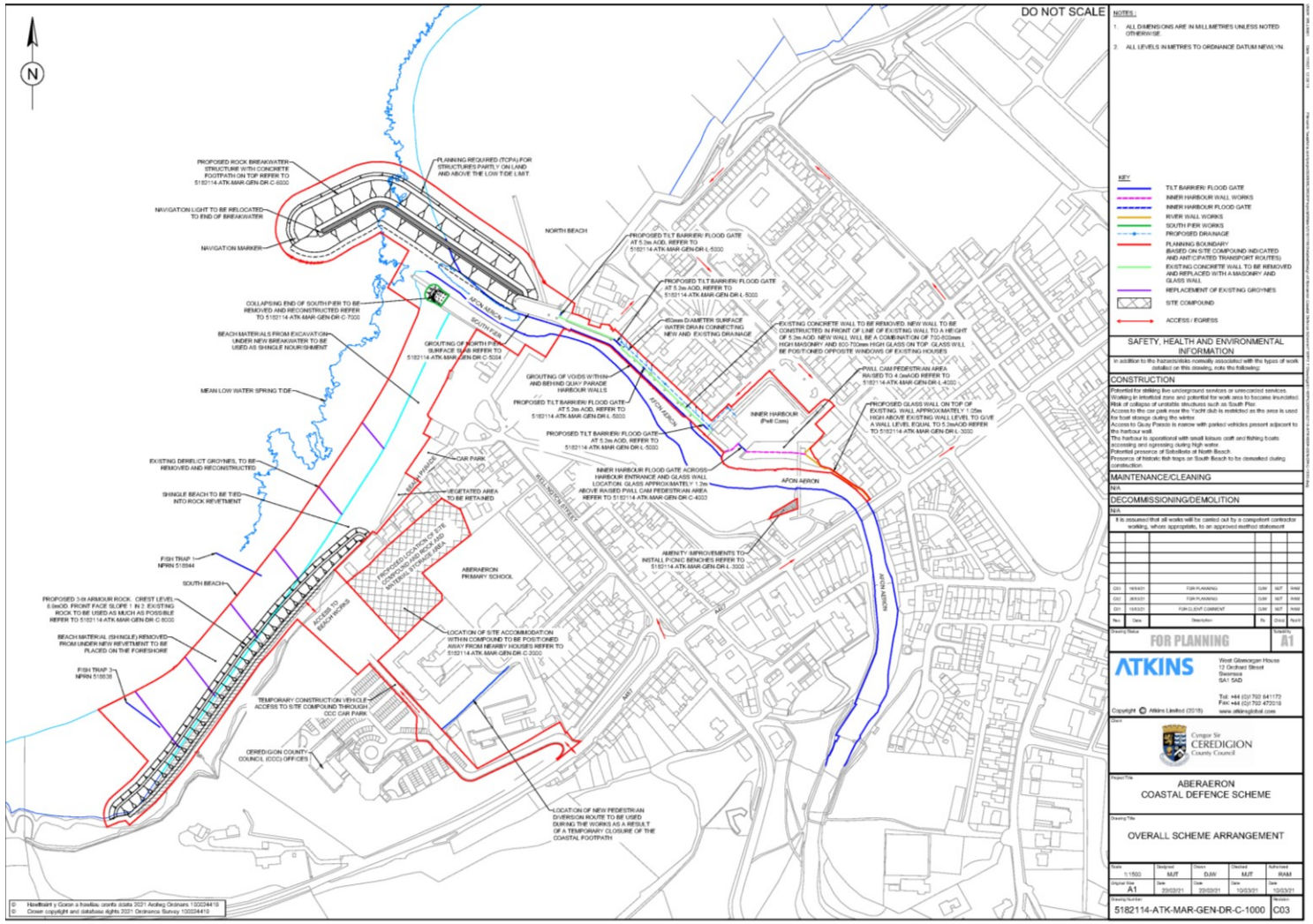
The works are centred around the Harbour, specifically the Inner Harbour of Pwll Cam and Pen Cei/Quay Parade, as well as along South Beach.

The Scheme is made up of five linked elements, described as follows and presented in Figure 1-1.

- Construction of a new rock breakwater extending out from the North Pier
- Refurbishment and re-building of the pier-head of South Pier including grouting repairs of walls
- Flood wall construction at the following locations:
  - Raising of the existing flood wall along Pen Cei/Quay Parade including grouting repairs of the existing quay wall
  - Raising of the existing flood wall between the rear of Monachty Hotel and the A487
  - New flood wall between Pwll Cam and the Monachty Hotel (and connecting with the existing adjacent flood wall between the Monachty Hotel and A487)
- Construction of a flood gate at Pwll Cam inner harbour
- Improvements to the existing defences on South Beach:
  - Replacement of existing timber groynes
  - Replacement of existing rock revetment
  - Beach renourishment

The Scheme has a 1 in 200 year design return period for overtopping within the harbour, with the rock revetment on South Beach having a 1 in 200 year standard of protection. The Scheme also provides a 1 in 1000 year standard of protection against climate change for the design life of the Scheme. The design of the Scheme has been carried out in line with the requirements of the Welsh Government for the development of residential areas in relation to flood risk (TAN15), as well as in line with guidance for flood and coastal erosion risk management and adaptation to climate change (Welsh Government Assembly, 2004 and Welsh Government, 2017).

Figure 1-1 – Scheme Arrangement



1.2. Proposed Access and Construction Method

1.2.1. Site Access and Compound

The site compound will be located on a grass field in between Ysgol Gyrnadd Aberaeron Primary School and South Beach. A temporary gravel access track will be constructed from the car park of the CCC Penmorfa offices to the compound area. Removal of topsoil and grass will also be required for this operation. Both the site compound and gravel track will be removed following construction, and the area re-topsoiled and grassed/seeded, returning it to its existing condition. The site compound will be used to store construction materials, plant and machinery, site offices and basic welfare facilities for the contractors (self-contained kitchen/toilets).

The site compound will also contain a storage area for diesel and fuels and all refuelling of plant will take place in the site compound. All fuels will be stored and handled in accordance with best practice procedures. The contractor will be required to produce a Construction Environmental Management Plan (CEMP) which will set out an emergency response procedure in the event of a chemical leak or spill. The CEMP will also include methods for maintaining a tidy site. All staff on site will be briefed on the contents of the CEMP including the emergency procedures before commencing the works. Upon completion, the site compound will be removed and the area reinstated.

All materials for this Scheme, including the site compound units, will be delivered to site by road. There is a possibility however, that the rock for the breakwater and revetment may come by sea, as well as the Pwll Cam flood gate. The exact details are yet to be finalised and will be determined in conjunction with the appointed contractor. Road access to the site will be by way of the A487, turning onto the unmarked entrance road to CCC Penmorfa offices. Movement of plant to and from the site compound will be carried out between 7am and 7pm.

Should delivery of rock for the breakwater and revetment be by sea, the rock is likely to be sourced from a European quarry. The rock would be transported by barge, which will anchor offshore of Aberaeron for approximately two weeks while it is unloaded by a smaller vessel before returning to the continent for more rock. Approximately 4 return trips will be made.

Rock will be offloaded from the main vessel using an on-board excavator equipped with a hydraulically operated grab onto a shallow draught tipper boat or smaller barge. The rock will be transported to the site of the breakwater or South Beach at high tide and tipping will take place as high up the intertidal zone as possible with rocks tipped onto the seabed. To ensure that the risk of turbidity are managed and to avoid the location of *Sabellaria* reef, a nominated area will be identified for the rock delivery point on the beach which will be provided to the vessel operators. The specified location will minimise the area of beach affected by potential sediment disturbance from this activity. At no time will there be any beaching of boats on the beach.

For the harbour wall raising at Quay Parade, materials will be transported from the site compound, along the A487, into Regent Street and follows the one-way system down Tabernacle Street/Market Street and Cadwgan Place and onto Quay Parade. For the wall raising to the rear of the Monachty Hotel and up to the A487 road bridge, access to this area is via the Market Street car park to the north of Pwll Cam. These activities will not affect the designated conservation sites.

There will be a need to create a temporary sheet pile cofferdam at the entrance of Pwll Cam to construct the new gate. The flood gate for Pwll Cam may be transported by a barge, pulled into the harbour by tug boat. Liaison will be carried out with the CCC Harbourmaster with regards to the need for preparing a Notice to Mariners informing them of this aspect of the works. Alternatively, the gate might be installed from land and the gate brought in by road. For this, a temporary access road formed of crushed stone materials could be constructed from the slipway and along the eastern dock wall within the Pwll Cam harbour on the dock seabed adjacent to the proposed gate location. In addition, a Notice to Mariners is also likely to be needed for the South Pier, South Beach and new breakwater works, due to the proximity of vessels moving in and out of the harbour.

1.2.2. Construction Method

1.2.2.1. North Pier Breakwater

Before the breakwater is constructed, some excavation of the shingle seabed is required to 'toe-in' the outer perimeter of the breakwater below the sea-bed. This will enable the breakwater to be protected from any scour which may arise from large storm waves which might wash out some shingle and undermine the base of the breakwater and to prevent movement from future settlement. The excavation will be carried out using a number of long-reach and 360 degree tracked excavators (see Figure 1-2) positioned on the beach at low tide. Excavation will be carried out at low tide for the sections of breakwater that will be above MLWS. For sections of the breakwater below MLWS, excavation will take place under water. The shingle material removed will be stockpiled above MHWS on South Beach with some of it being re-used in the core of the breakwater and some as shingle recharge on South Beach. The total amount of material excavated is estimated to be 12,916m³ (8,000m^3) is estimated to be used on South Beach as shingle nourishment, and 4,916m^3 in the breakwater core).

Prior to the placement of the breakwater rocks, a geofabric mat will be positioned onto the seabed in the excavated footprint of the breakwater. In addition to helping reduce settlement once the breakwater is constructed, it will also help reduce the washout of bed material beneath the rocks and reduce scour in the future. The mat will be laid on the seabed by a tracked excavator (see Figure 1-3), with rocks placed onto the mat to hold it into position before the rest of the breakwater construction commences.

The rock for the breakwater will sourced from a quarry or number of different quarries, depending on the quantities available and to ensure a constant supply of rock for the scheme. The rock will be transported to site by sea and/or by road. For delivery by road, it is likely the rock would be sourced from a local Welsh quarry, with more than one quarry required due to the volume of rock needed. The rock would be transported to the site compound via the A487. It is estimated that there will be 25 round trips made to site per day over a period of 6 to 9 months using articulated lorries for the larger 6 -10 t rock and tipper lorries for the 0.3 to 1t rock. In between each rock delivery to the site compound, 25t dump trucks (Figure 1-5) will transport the rock from the stockpile in the site compound to the breakwater location, thus maintaining space in the compound for more rock to be delivered. There will be stockpiles of rock temporarily placed on the beach to organise the rock into sizes and due to tidal working.

The rock will be transported from the site compound to South Beach via dump trucks which will use a temporary access ramp formed out of rocks leading from the site compound onto the beach. These dump trucks will then transport the rock along South Beach to the breakwater. The transportation of rock from the site compound to the stockpile areas will continue for approximately 6 - 9 months (movement of approximately 6no. 20t dumpers per day). The dumpers will be required to reduce their footprint on the beach by keeping vehicle movements to the upper beach area and avoiding the intertidal area as much as possible to reduce sediment becoming mobilised into the water and increasing turbidity. Although South Beach forms part of the SSSI and there is a high presence of *Sabellaria alveolata* along the coastline, generally this habitat is absent from the intertidal area at South Beach.

The rocks will be picked up from the stockpile area by a long reach 360 excavator (35-40t) with a grab (see Figure 1-4) attachment to carefully pick up and place the rock. These will be located on the beach for the breakwater construction. For the smaller core rock, dump trucks will be used to tip the rock on top of the geofabric layer and assisted by excavators to spread the rock material. It is likely that the breakwater will be constructed starting from the landward end and progressing seaward. This will allow machinery constructing the parts of the breakwater in the subtidal zone to work from the top of the newly constructed portions of the breakwater.

For delivery by sea, the rock is likely to be sourced from a European quarry. The rock supplied will be transported to the quayside where approximately 25,000t of rock will be loaded onto a barge. The barge vessel will set sail to the site where it will anchor offshore of Aberaeron for around 1 to 2 weeks before setting sail for another load.

A shallow draught tipper boat or smaller barge of capacity 1,000-3,000t will travel with the main vessel and the rock armour will be transferred individually from the main ship onto the tipper boat or barge using an on-board excavator equipped with a hydraulically operated grab. The tipper boat will transport the rock to the site of the breakwater or South Beach at high tide and tip the rock onto the seabed as high up the intertidal zone as possible. At low tide this will be sorted into sizes and placed in the breakwater footprint using the excavator and grab.

At no time will there be any beaching of boats on the beach. The tipper boat or barge will shuttle to and from the main ship transferring rock to the breakwater site. It is estimated that 10-20 journeys to and from the main ship will be required. Once the main ship has been unloaded, it will return to collect more rock from the quarry. A total of up to 4 return trips are estimated to be required to transport the rock.

At the end of the existing North Pier, the existing concrete wave wall will be removed to enable access for construction machinery onto the pier. Demolition of the wall will be carried out using a back-hoe excavator and breaker to break out the concrete, with the material removed off site to a licenced tip. The material is likely to be removed via Quay Parade.

Before completing the breakwater construction, a concrete walkway will be constructed along the full length. Pre-cast concrete 'u'-shaped units will be manufactured in a factory offsite and transported directly to North Pier via Quay Parade, using 8m long trucks with 2 concrete blocks per truck. It is estimated that there will be 4 deliveries to site per day over a period of 1 month, approximately 100 round trips.

The concrete 'u'-shaped units will be positioned on the top of the breakwater with a mobile crane and concrete will be poured into the precast units using a concrete pump and concrete delivery lorries. Rock armour will be placed around the precast units to secure them in place. The surface of the concrete blocks will be left exposed to form a concrete footpath on top of the breakwater. This footpath will provide access for recreation as well as for future maintenance of the structure.

Repair work to the surface slab will be undertaken at the end of the existing North Pier. This will involve vertical drilling and grouting which will take place from the surface of the pier. Holes measuring 35mm will be drilled down into the top surface of the pier to a depth of 5m. The holes will be drilled in a staggered diamond shape pattern at a distance of 1m north to south and 2m east to west. The holes will be injected with a combination of lime and cement grout to stabilise the loose ground beneath the surface slab.

Signage and navigation markers (including electricity cables for navigation lights) will also be installed. Existing life rings are present on North Pier and the need for any additional life rings/buoys will be determined by CCC.

1.2.2.2. South Pier Refurbishment

The seaward end of the South Pier will be demolished using machine mounted breakers, grabs and hand tools. Machinery and equipment will be located on the beach. Sections of concrete, masonry and other arisings will be removed from site by dumpers. There is the potential for some of the masonry to be salvaged and recycled. The demolition work will take place during low tides for ease of access by the contractor. Working at low tide will help to reduce the amount of debris falling into the water. To further reduce this, a geotextile layer, or similar, will be placed on the seabed to help capture falling debris for removal from site before the tide rises. The contractor may also decide to build a level temporary working platform at the base of the pierhead, which is built out of imported rock materials that will be eventually used for the rock breakwater. In this scenario geotextile will be used to ensure separation between imported and indigenous materials so that total removal of the working platform can take place on completion.

Once the collapsing degraded pier head has been removed, concrete or steel piles will be driven into the ground using a piling rig (see Figure 1-7) positioned on the beach. The piles are required to support the weight of the structure for the new pier head. This will be carried out using a combination of pre-augering and driving of piles which will take place intermittently over two months. Precast concrete wall units will be manufactured in a factory and will be transported to South Pier. These will be built up in sections to form the shape of the pier. Once the external precast concrete shell is constructed, concrete pumps will be used to pump wet concrete into the pre-cast shell units to infill the units. Alternatively, to using precast sections, the contractor may decide to make up curved forms (moulds) which are put into the final wall positions into which concrete will be poured directly.

Along the south side of the pier, steel sheet piles over a 10m section will be placed along the base of the wall below the level of the shingle bank to protect the southern side of the pier from the effects of scour and abrasion which result from shingle moved around by strong waves.

Following the piling and installation of the external concrete walls and steel sheet piles, there will be a three-month period of wall grouting and stone masonry repairs. The horizontal and vertical grouting will require hand-held drills being used to drill into the wall face and top of the structure into

any voids present. These holes will then be filled will temporary plastic pipes which will be used to pump lime and cement grout into the voids. Localised masonry repairs and repointing works will be required to the masonry face of the structure. These works will require the use of scaffolding (see Figure 1-8) and negative mobile elevated working platforms (see Figure 1-9) to undertake the repairs.

The relatively small amount of rock required at the end of the pier head will be constructed in a similar method to the breakwater and using the same source with the rock brought to site from either a Welsh or European quarry and transported to site by road or sea respectively. The rock colour will be specified to be grey, to remain consistent with the existing defence structures and the new breakwater construction at North Pier. Please refer to previous section for rock delivery, transport and placement methods.

1.2.2.3. South Beach - Groynes

The timber planks for the groynes will be removed using hand cutting tools and saws. The existing groyne piles will be removed by using an excavator with a grab or chain attachment. This plant will pull the piles out of the ground and place them into the wheeled dumpers for onward disposal. There are existing concrete steps present at the end of the existing timber groynes and these will need to be broken out with an excavator and a breaker. The material will then be placed into dumpers and disposed of at an off-site tip.

The groyne piles and timber planks will be brought onto the beach from the site compound on dump trucks. The timber posts will be inserted into the ground using a piling rig to drive the piles into the ground by a percussion and vibration piling technique. Hand tools will be used to attach the horizontal panels to the timber piles. The groyne works will take approximately two weeks to remove the existing groynes, two weeks to drive in the new piles and a further four weeks to attach the planks. Work will take have to take place at low tide to gain access and this has the benefit of avoiding sediment disturbance.

South Beach – Rock Revetment

To construct the new revetment, the existing rock revetment will be removed using an excavator (35t-40t) with a grab and rocks will be loaded onto dump trucks. The existing rocks will be stockpiled for re-use, with the existing 1-4t rocks to be re-used for the making up for low spots in the ground along the location of the proposed defence. Some of the existing shingle around the existing structure will be temporarily removed to construct the new revetment and will then be reinstated around the completed revetment on completion. The intention is to use all reclaimed rock and shingle within the South Beach works. Non-indigenous material which may include hitherto undiscovered concrete, steel or other non-natural debris will be removed to an off-site tip.

An excavator on the beach will excavate the area where the new revetment will be placed. Approximately 8,848m^3 (5,550t) of shingle will be excavated, with all excavated material reused as nourishment. The excavated shingle material will be stockpiled within the beach above MHWS before it is needed for re-use, although this is not critical and shingle can be temporarily located immediately seaward of completed sections of revetment, before being relocated to its final position.

A geofabric separation membrane will then be laid onto the excavated surface prior to the placement of new rock for the revetment. The imported rock for the scheme will be transported to the site compound and stored there initially. The rock will then be transported to the beach by dumpers and tipped onto the beach. At this point the excavator with the grab will sort the rock into stockpiles for temporary storage on the beach before placing into the revetment. Rock will be placed to form the revetment using an excavator with a grab one rock at a time. This work will be undertaken at low tides. The volume of imported rock required for the revetment is estimated to be 14,534m^3.

South Beach - Renourishment

As described in the above sections, the material for the beach nourishment will be stockpiled on the beach following the breakwater and revetment excavation work, ready for re-use on the beach. It is unlikely that shingle material will also need to be imported, but if required, this would be brought from the site compound via dump trucks. A bulldozer (see Figure 1-6) will spread the material to the required slope at low tide.

Flood wall: Quay Parade

The removal of the existing flood wall and construction of the new raised wall will take place in sections to allow the existing flood wall to maintain its current function during the construction phase of the new works. This also allows parking to be maintained alongside the wall where work is not taking place and to maintain access along the road. Residents along Quay Parade have parking at the rear of their properties. It is estimated that approximately 5m length of wall will be removed per day and reconstruction of the same length of wall will take a further 4 days. Approximately 5m of wall will therefore be removed and reconstructed per week.

Work will commence with the removal of street furniture, lighting and signage. This will be carried out using hand tools, with the items set aside for re-instalment following construction. Currently, the lighting is located on the seaward side of the flood wall. Benches will be reinstated to their existing location on the seaward side of the wall with the potential for additional new seating to be provided. Options are also being considered to fix seating directly onto the walls.

The existing inland concrete flood wall will be removed in sections, including its foundation to a depth of 1.5m using an angle grinder, pneumatic breaker, excavator and dumper. Material will be removed from site by loading the material onto small 3 to 5T wheeled dump trucks.

Excavation will be carried out to a depth of 1m into the footway for the wall using disc cutters, pneumatic breakers and excavators to construct the footings for the new wall. The lower concrete and masonry-clad portion of the wall will be constructed by erecting steel reinforcement and pouring concrete into temporary timber formwork (moulds) to form the wall and foundations. The temporary formwork (moulds) is needed to keep the concrete in place while it is setting and is then removed once concrete is set. The concrete wall will be clad with stone masonry to provide a finish that is similar to the existing quay wall.

The glass panels will be manufactured in a factory and transported to Quay Parade. The glass panels will be inserted into pre-determined fixing points cast in the reinforced concrete wall, secured and sealed accordingly. The panels will be supported by steel posts on each side of the glass panel and fixed to the top of the wall.

The tilt barriers will be manufactured off site in a factory. Excavation through disc cutting and breaking will be carried out to a depth of 500mm into the footpath to recess the tilt barrier into the footway and to keep it flush (when closed) with the surrounding walkway. Each tilt barrier should take approximately 1 week to install.

Flood Wall: Pwll Cam to Monachty Hotel

The construction of this section of wall will follow a similar methodology to that at Quay Parade. Excavation will be carried out to a depth of 1m into the quayside for the wall footings using disc cutters, excavators and 3T dumpers. The lower masonry portion of the wall will be constructed by erecting temporary timber formwork (moulds) to form the wall foundation and wall by pouring concrete between the formwork (moulds). Once concrete is set the temporary formwork will be removed leaving the shape of the new wall. The wall will be clad with the same stone masonry as the new wall at Quay Parade, to provide a finish that is similar to existing quay walls, and that will be in keeping with the existing surrounds. The glass panels, will be transported to site from a factory, and will be fixed to the top of the wall by attaching them to steel columns fixed on top on the wall.

To the west of the entrance to Pwll Cam, and adjacent to The Hive, a short 10m long section of wall will also be raised with concrete and masonry cladding to 5.2mOD with glass panels.

A tilt barrier will be constructed at the entrance to the footbridge over the River Aeron. The tilt barriers will be manufactured off site for installation. A recess will be formed within the newly constructed terrace area to a depth of 500mm to house the tilt barrier into the footway. The tilt barriers are spring loaded and will be operated with a key held by CCC. The installation of the barrier should take approximately 1 week.

Flood Wall: Monachty Hotel to A487

To undertake the works from the footbridge to the property adjacent to the Monachty Hotel the existing rock revetment in front of the wall will need to be temporarily moved and placed alongside the river channel to create a working area/access track, so that the existing wall can be removed and the new wall constructed. It will also be necessary to remove part of the existing boundary wall at the rear corner of the Monachty Hotel to create an access route. The rock from the revetment will be shaped to retain a temporary working platform for the works in this area. This will be undertaken using excavators with a grab attachment working in the river when the tide is low. The

excavators will be able to move into the harbour using the slipway at Doc Bach (near Beach Parade).

The new wall construction at Toad Hall will require the base to be constructed of a steel piled foundation driven into the hard ground using a piling rig (see Figure 1-7). Attached landward of the piles will be a (steel) reinforced concrete base for the wall. To construct this, there will be a need for a portable pump to pump out water at the bottom of the excavation (as a result of tidal ingress). On top of the concrete base a new vertical concrete wall will be constructed which will be clad with masonry. The top level of the wall will house glass panels to the same 5.2m AOD crest height as the other flood walls being constructed for this Scheme. On completion of these works the existing rock revetment will be relocated in its original position but placed against the new wall so that it matches its existing appearance and continues to provide scour protection along the river frontage.

The existing wall from the A487 road bridge will be connected to the new wall constructed between Pwll Cam and the Monachty Hotel as described above. Work to raise this stretch of existing wall will involve constructing a reinforced concrete capping beam onto the top of the wall which will be anchored into the existing wall using steel dowels and resin grouting. The small scale of work and limited access will necessitate using hand tools for the most part. The glass panels will be fixed to the top of the new capping beam between the new steel columns on top of the wall.

Construction access to carry out these works is very limited in this location due to the proximity of residential properties behind the wall. It is likely that a temporary scaffolding platform will be erected in the river channel next to the wall. Work to raise the wall would take place from this platform, thus avoiding the need to access the site from property gardens. Materials would be brought onto the working scaffold area via the temporary working area/access track to the rear of the Monachty Hotel. The scaffolding platforms would be screened to enable much of the debris from the works to land on the platform rather than falling into the water.

Pwll Cam Flood gate

There will be a need to create a temporary sheet pile cofferdam at the entrance of Pwll Cam to construct the new gate. Following the cofferdam construction, the working area along with Pwll Cam will be dry and pumps may be required to remove any groundwater or rainwater inflows. Prior to constructing the cofferdam, a fish rescue will be undertaken in the dock. The cofferdam will be constructed at low tide.

To ensure that the walls supporting the gate have sufficient strength, a precast or formed concrete wall will be constructed to create the concrete abutments upon which the flood gate will be attached. Due to the access limitations at Pwll Cam, consideration of options for this aspect of the construction will be a key part of the contractor procurement process. If the wall is precast, the units would arrive to site from the factory by road. If a formed wall is proposed by the contractor, formwork (moulds) would be erected to form the shape of the wall, with concrete then poured into the formwork before setting and then the formwork removed. The wall will be clad with stone masonry to provide a finish that is similar to the existing quay wall.

Drilling and grouting of walls will also take place to consolidate existing masonry and repair cracks and holes in the entrance channel walls alongside the Hive. The existing sill at the entrance to Pwll Cam will be removed by excavation using a saw cutter and excavator to remove existing concrete. A new concrete sill would then be cast onto the prepared ground.

For all of the wall grouting, drilling and lowering of the cill, this work would be done behind the cofferdam in the dry.

Piling (see Figure 1-7) will be required below the abutment walls and cill to provide the foundations for the wall abutments to resist the force of the water at high tide and during storm events. A total of 12 concrete or steel piles will be inserted into the harbour bed across the channel entrance underneath the footprint of the new gate. The piling will take place of a period of approximately 20 days. Piling is likely to be pre- augured and driven but will depend on the contractor's method statement and the results of the ground investigation. Two steel tension anchor bars for each abutment measuring 20mm in diameter, will also be drilled into the ground below the seabed to provide further resistance against the resultant forces of on the gate and abutments. Further anchor bars will be drilled into adjacent wall to provide additional structural restraint.

The flood gate will be manufactured off-site and is likely to be brought to site via a barge due to its size and the limited quayside access. A tug-boat will guide the barge (see Figure 1-12) into the harbour, with a crane positioned (Figure 1-13) on the barge used to lift the gate into position. Depending on the time taken to offload the gate from the barge, the barge may need to rest on the

harbour bed until it can leave on the next high tide. There will be a smaller crane located either in the car park (Figure 1-12) or adjacent to the slipway which will be used for ancillary activities.

There is a possibility that the gate might be installed from land and the gate brought in by road. An alternative option is that a temporary access road formed of crushed stone materials could be constructed from the slipway and along the eastern dock wall on the dock seabed to the gate location. This temporary structure would be installed after construction of the cofferdam and would provide a working platform to access the gate area including a location for a heavy-duty crane to position itself for lifting the gate.

Installation of the gate is the only aspect of the Scheme that may require some night-time working. This is because the installation is a continuous operation likely to take more than 12 hours to complete. The contractor would follow best practice procedures for work at night, including measures to minimise noise and directional lighting.

The construction of the gate will also require some digging of service trenches using saw cutters and excavators or similar to bury electrical cables for the gate operation which will connect to mains services in Market Street. A control kiosk to house the gate operating equipment will be constructed in close proximity to the gate. It is likely to be located to the east of the entrance to Pwll Cam adjacent to the gate. The design of this structure is not yet confirmed but could be housed within a small compound comprised of masonry walls to blend with the existing abutment and flood defence walls.

Figure 1-2 - Tracked Excavator with Bucket for Excavation

Figure 1-3 - Tracked Excavator Placing Geotextile

Figure 1-4 - Tracked Excavator with Grab to Pick Up and Place Rock

Figure 1-5 - Wheeled Dumper Transporting Rock

Figure 1-6 - Dozer to Spread out the Imported Shingle

Figure 1-7 - Piling Rig

Figure 1-8 - Scaffolding for South Pier and Wall Repairs

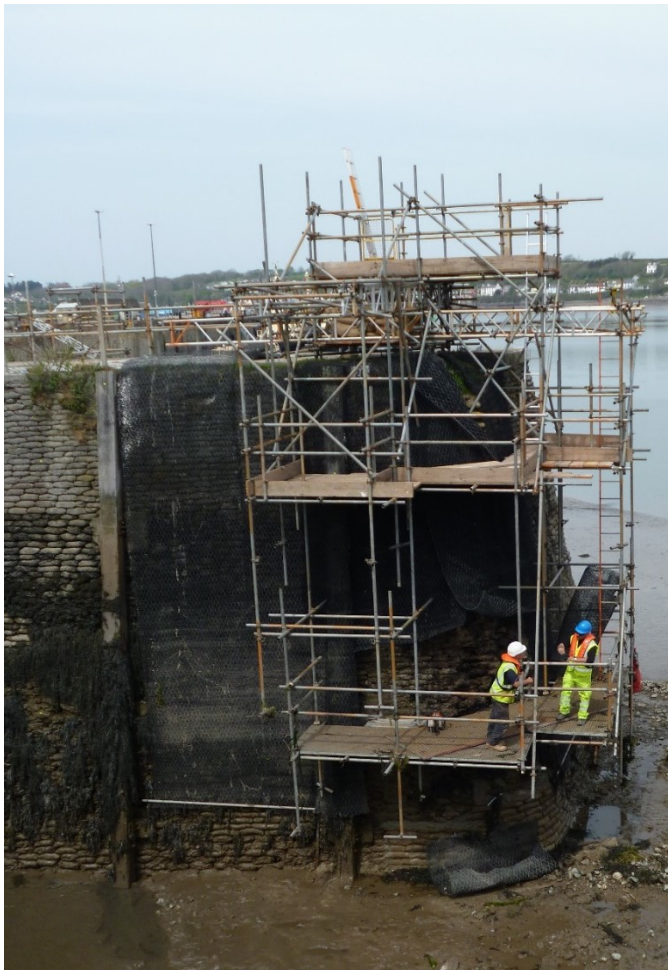


Figure 1-9 - Negative Mobile Elevated Working Platforms (MEWP's) to Repair Walls from Above High Water

Figure 1-10 - Crane and Basket to Carry Operatives for Wall Repairs

Figure 1-11 - Repointing and Wall Repairs by Rope Access

Figure 1-12 - Barge, Tug, Crane and Gate at Milford Marina

Figure 1-13 Barge, Crane and Gate at Milford Marina

1.2.3. Outline construction programme

The works are scheduled to commence in winter 2021 and be completed by winter 2022, a duration of approximately 12 months. Construction will commence with the new breakwater with the other

Scheme elements overlapping over the 12 month period. It is estimated that the construction timescale for each phase of the works will be as follows:

Activity	Programme
New breakwater	12 months
Restoration of South Pier	6 months
Flood Walls	6 months
Pwll Cam flood gate	9 months
South Beach improvement works	9 months

It should be noted that these durations are weather dependent and will rely on the contractor appointed and their detailed method statement.

In order for the Scheme to be completed in the shortest time possible, construction will be carried out Monday to Sunday from 7am to 7pm. Within these working hours, significant elements of work will be restricted to periods of low tide only. Work that can take place at all tide states will include work to all three flood walls and the grouting repairs of quay walls.

1.3. Operation

Following construction, the Scheme will provide protection from erosion and flooding for a 1 in 200 year standard of protection from flooding through wave overtopping of the harbour walls. The Scheme has been designed to account for current predictions of sea level rise over the next 100 years.

Conceptual understanding of the coastal processes combined with numerical modelling suggests that that sediment accretion may occur at the seaward end of the breakwater and in the harbour channel. CCC will be responsible for the regular maintenance of the Scheme and will monitor seabed levels following construction. Annual maintenance dredging of the harbour is undertaken by CCC under a marine licence from NRW. This is expected to continue to be required with the Scheme in place. Any change in dredging requirements will require an amended / new marine licence, for which CCC will apply if necessary. Any future marine licence application will need to be accompanied by its own HRA.

In the UK there is a network of conservation sites for rare and threatened species of birds and habitats. The network is comprised of Special Areas of Conservation (SAC) and Special Protection Areas (SPA). These sites are protected by the Conservation of Habitats and Species Regulations 2017 as amended (known as the Habitats Regulations). Following the UK's exit from the European Union (EU), the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 made changes to the 2017 Habitats Regulations so that the European sites no longer form part of the EU's ecological network but now form part of a UK national site network. They continue, however, to be referred to as 'European Sites' as they are part of the UK's international commitments to conservation conventions. The list of habitat types and species for which existing sites were designated, however, remain listed in Annexes I and II for the EU Habitats Directive (92/43/EEC) and the EU Birds Directive (79/409/EEC).

In addition to the UK network of SACs and SPAs, many of the SPA sites are also designated as Ramsar sites. The Ramsar Convention on Wetlands of International Importance is an international mechanism which aims to protect internationally important wetlands, of particular importance to migratory bird species. In the UK, Ramsar sites are extended the same protection as SACs and SPAs and are therefore also considered in this HRA assessment.

The Habitats Regulations require 'competent authorities' to undertake an 'appropriate assessment' of plans, Schemes and strategies that are not connected to the management of the site and are likely to have a significant effect on the site. There is a similar requirement in relation to sites designated under the Ramsar Convention (Ramsar sites).

There are four distinct stages in the HRA process:

- **Stage 1**: Screening – the process which initially identifies the likely potential impacts on a European site, either alone or in combination with other plans or Schemes and considers

whether these potential impacts are likely to be significant. This is often called a Test of Likely Significant Effect (TLSE).

- **Stage 2**: Appropriate Assessment (or HRA) – the detailed consideration of the impact on the integrity of a European site of the plan or Scheme, with respect to the site's conservation objectives and its structure and function. This is to determine whether there will be adverse effects on the integrity of the site.

- **Stage 3**: Assessment of alternative solutions – the process which examines alternative ways of achieving the objectives of the plans or Schemes that avoid adverse potential impacts on the integrity of the European site.

- **Stage 4**: Assessment where no alternative solutions exist and where adverse potential impacts remain – an assessment of whether the development is necessary for imperative reasons of overriding public interest (IROPI) and, if so, of the compensatory measures needed to maintain the overall coherence of the site network.

On the basis of the above, this document presents the findings of Stage 1 (Screening) and Stage 2 (Appropriate Assessment) to support the Competent Authority making an AA of the Scheme.

2. Baseline

2.1. Statutory Designated Sites

Information on European designated sites[2] located within 10 km of Aberaeron harbour was obtained from the MAGIC[3], Joint Nature Conservation Committee (JNCC) websites and Natural Resources Wales (NRW) websites in April 2021. The search was also extended to include European designated sites where qualifying species are migratory or transient and have the potential to occur in the area of the Scheme.

Aberaeron is located in the north-east corner of the Cardigan Bay / Bae Ceredigion SAC, and immediately adjacent to the boundary of the West Wales Marine SAC. There are no Ramsar sites or SPAs within 10km of Aberaeron Harbour.

There are several statutory designated sites located outside of the 10km radius of the proposed Scheme, which have migratory or transient qualifying species with the potential to occur within the area of the Scheme. These sites include:

- Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC,
- Northern Cardigan Bay / Gogledd Bae Ceredigion SPA, and the
- Cors Fochno and Dyfi Estuary Ramsar and SPA site.

The qualifying features of these sites are discussed in Section 3.

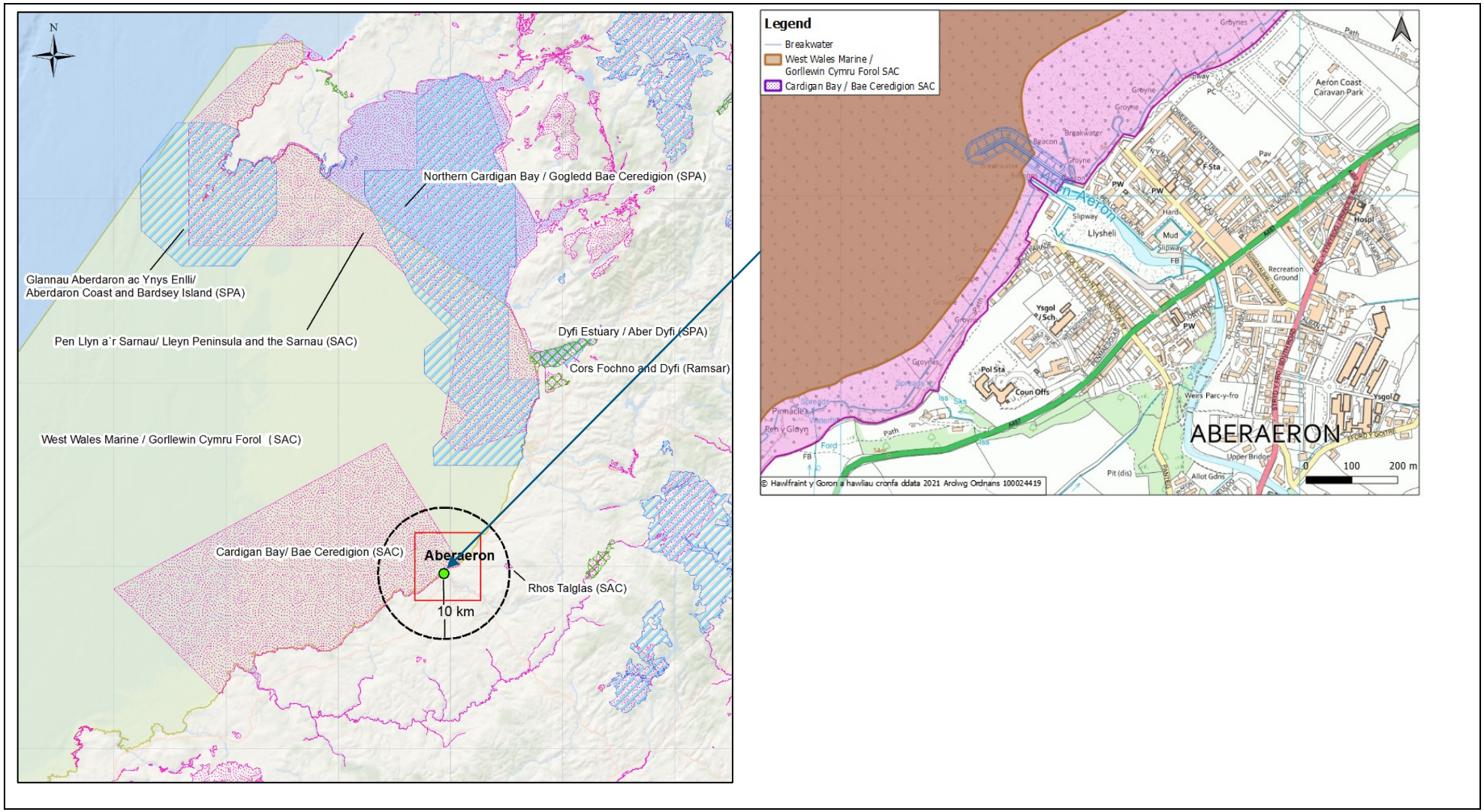
An overview of the statutory designated sites located in the search area are provided in Figure 2-1 below and locations are presented in Table 2-1.

Table 2-1: Statutory Designated Sites in the Area of the Scheme

Statutory designated site	Distance/direction from study area
Cardigan Bay / Bae Ceredigion SAC	The proposed works will be conducted inside the SAC which extends to MHWS but not into the harbour
West Wales Marine / Gorllewin Cymru Forol SAC	The proposed works will be conducted inside the boundary of the SAC which extends to MLWS
Rhos Talglas SAC	9.2km East
Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC	18km North
Northern Cardigan Bay / Gogledd Bae Ceredigion SPA	16km North
Cors Fochno and Dyfi Estuary Ramsar and SPA	33km North

[2] Including: Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Ramsar sites.
[3] www.magic.defra.gov.uk

Figure 2-1 - Location of Designated Sites in Relation to the Scheme



3. Site Interest Features

3.1. Cardigan Bay / Bae Ceredigion SAC

The Annex I and Annex II habitat and species qualifying features of the Cardigan Bay / Bae Ceredigion SAC are presented in Table 3-1 below. Due to the proximity of the Scheme to the SAC, all features will be assessed as part of this HRA.

Table 3-1: Cardigan Bay / Bae Ceredigion SAC

Feature	Quality and Importance
Cardigan Bay / Bay Ceredigion SAC Selection (JNCC, 2015)	
Annex I Habitats that are a primary reason for selection	
Not applicable	Not applicable
Annex I Habitats present as a qualifying feature (but not a primary reason for selection)	
Sandbanks which are slightly covered by sea water all the time	Nationally significant
Reefs	Nationally significant
Submerged or partially submerged sea caves	Considered to be of significant conservation value
Annex II species that are a primary reason for selection	
Bottlenose dolphin (*Tursiops truncatus*)	Nationally significant
Annex II species present as a qualifying feature (but not a primary reason for selection)	
Sea lamprey (*Petromyzon marinus*)	Considered to support a significant presence
River lamprey (*Lampetra fluviatilis*)	Considered to support a significant presence
Grey seal (*Halichoerus grypus*)	Considered to support a significant presence

3.2. West Wales Marine / Gorllewin Cymru Forol SAC

The Annex I and Annex II habitat and species qualifying features of the West Wales Marine / Gorllewin Cymru Forol SAC are presented in Table 3-2 below. Due to the proximity of the Scheme to the SAC, all features will be assessed as part of this HRA.

Table 3-2: West Wales Marine / Gorllewin Cymru Forol SAC

Feature	Quality and Importance
West Wales Marine / Gorllewin Cymru Forol MPA candidate SAC (JNCC, 2017)	
Annex I Habitats that are a primary reason for selection	
Not applicable	Not applicable
Annex I Habitats present as a qualifying feature (but not a primary reason for selection)	
Not applicable	Not applicable
Annex II species that are a primary reason for selection	
Harbour porpoise (*Phocoena phocoena*)	Nationally significant
Annex II species present as a qualifying feature (but not a primary reason for selection)	
Not applicable	Not applicable

3.3. Rhos Talglas SAC

The Annex I and Annex II habitat and species qualifying features of the Rhos Talglas SAC are presented in Table 3-3 below.

Table 3-3: Rhos Talglas SAC

Feature	Quality and Importance
Rhos Talglas SAC selection (JNCC, 2015a)	
Annex I Habitats that are a primary reason for selection	
Not applicable	Not applicable
Annex I Habitats present as a qualifying feature (but not a primary reason for selection)	
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)	Considered to be of significant conservation value
Annex II species that are a primary reason for selection	
Marsh fritillary butterfly. *Euphydryas (Eurodryas, Hypodryas) aurinia*	Nationally significant
Annex II species present as a qualifying feature (but not a primary reason for selection)	
Not applicable	Not applicable

Due to the distance of the SAC from the Scheme (9.2km) only highly mobile species with the potential to occur in the area of the Scheme will be assessed as part of this HRA. Therefore, the following features have been **excluded** from the next stage of assessment:

- Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)
- Marsh fritillary butterfly. *Euphydryas (Eurodryas, Hypodryas) aurinia*

It is therefore considered unlikely that the Scheme will impact upon the functioning of the designated features of the Rhos Talglas SAC. The Rhos Talglas SAC is not assessed further as part of this HRA.

3.4. Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC

The Annex I and Annex II habitat and species qualifying features of the Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC are presented in Table 3-4 below.

Table 3-4: Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC

Feature	Quality and Importance
Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC selection (JNCC, 2016)	
Annex I Habitats that are a primary reason for selection	
Sandbanks which are slightly covered by sea water all the time	Considered to support significant biodiversity
Estuaries	Nationally significant
Coastal lagoons	Nationally significant, one of four of these unique habitats in the UK
Large shallow inlets and bays	Considered to support significant biodiversity
Reefs	Nationally significant
Annex I Habitats present as a qualifying feature (but not a primary reason for selection)	

Mudflats and sandflats not covered by seawater at low tide	Considered to support significant biodiversity
Salicornia and other annuals colonizing mud and sand	Considered to play an important role in stabilising the intertidal zone
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	Nationally significant
Submerged or partially submerged sea caves	Considered to be of significant conservation value
Annex II species that are a primary reason for selection	
Not applicable	Not applicable
Annex II species present as a qualifying feature (but not a primary reason for selection)	
Bottlenose dolphin (*Tursiops truncatus*)	Nationally significant
Otter (*Lutra lutra*)	Considered to support a significant presence
Grey seal (*Halichoerus grypus*)	Nationally significant

Due to the distance of the SAC from the Scheme (18km) only highly mobile species with the potential to occur in the area of the Scheme will be assessed as part of this HRA. Therefore, the following features have been **excluded** from the next stage of assessment:

- Sandbanks which are slightly covered by sea water all the time;
- Estuaries;
- Coastal lagoons;
- Large shallow inlets and bays;
- Reefs;
- Mudflats and sandflats not covered by seawater at low tide;
- Salicornia and other annuals colonizing mud and sand;
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*);
- Submerged or partially submerged sea caves; and

3.5. Northern Cardigan Bay / Gogledd Bae Ceredigion SPA

The qualifying feature of the Northern Cardigan Bay / Gogledd Bae Ceredigion SPA is presented in Table 3-5 below. Although the SPA is at a distance of 16 km from the site, the Red-throated diver is a highly mobile species with the potential to occur in the area of the Scheme, and therefore has been assessed as part of this HRA.

Table 3-5: Northern Cardigan Bay / Gogledd Bae Ceredigion proposed SPA

Feature	Quality and Importance
Departmental Brief, Advice to the Welsh Government (NRW, 2015)	
Red-throated diver (*Gavia stellata*)	Nationally significant

3.6. Cors Fochno and Dyfi Estuary Ramsar and SPA

The qualifying features of the Cors Foncho and Dyfi Estuary Ramsar and SPA are presented in Table 3-6 below.

Table 3-6: Cors Fochno and Dyfi Estuary Ramsar and SPA

Feature	Quality and Importance

Dyfi Estuary / Aber Dyfi SPA Core Management Plan (CCW, 2008) and Information sheet on Ramsar Wetlands (JNCC, 1976)	
Active raised bogs	Considered to support significant biodiversity
Degraded raised bogs still capable of natural regeneration	Considered to support significant biodiversity
Depressions on peat substrates of the *Rhynchosporion*	Considered to support significant/unique biodiversity
Petalwort (*Petalophyllum ralfsii*)	Considered to support a significant presence
Greenland white-fronted goose (*Anser albifrons flavirostris*)	Internationally significant
Common greenshank (*Tringa nebularia*)	Nationally significant
Otter (*Lutra lutra*)	Considered to support a significant presence

Due to the distance of the Ramsar and SPA from the Scheme (33km) only highly mobile species with the potential to occur in the area of the Scheme will be assessed as part of this HRA. Therefore, the following features have been **excluded** from the next stage of assessment:

- Active raised bogs;
- Degraded raised bogs still capable of natural regeneration;
- Depressions on peat substrates of the Rhynchosporion;
- Petalwort (*Petalophyllum ralfsii*)
- Common greenshank (*Tringa nebularia*); and
- Otters (*Lutra lutra*) have been included within in Lleyn Peninsula and the Sarnau SAC.

4. Conservation Objectives

The conservation objectives for a European protected site are intended to represent the aims of the Habitats and Birds Directives in relation to that site. NRW provide advice on the conservation objectives and operations that may cause deterioration of the habitats or species, or disturbance of the species for which sites have been designated. This advice is in the form of 'Regulation 35 advice' for marine SACs (i.e. SACs with a marine component) or 'management plans' for other sites.

Measures taken under the Habitats Directive should be designed to maintain or restore habitats and species of European Community importance at / to "favourable conservation status" (FCS). The conservation objectives for a site set the standards which must be met if the features of the site (habitats and species) are to be at FCS.

FCS is defined in Article 1 of the Habitats Directive as:

Conservation status of a natural habitat means the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory referred to in Article 2.

The conservative [sic] status of a natural habitat will be taken as 'favourable' when:

- Its natural range and the areas it covers within that range are stable or increasing;
- The specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; and
- Conservation status of typical species is favourable as defined in [Article] 1(i).

The conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term natural distribution and abundance of its populations within the territory referred to in Article 2.

The conservation status of a species will be taken as 'favourable' when:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The conservation objectives recognise and acknowledge that the features are part of a complex, dynamic and multi-dimensional environment which human activity has already modified and continues to modify to varying degrees and at varying spatial and temporal scales, either acutely or chronically.

The conservation objectives seek to prevent further negative modification of the extent, structure and function of natural habitats and species' populations by human activity and to ensure that degradation and damage to the features that is attributable to human activities or actions is prevented.

The conservation objectives, therefore, seek to:

- Encompass inherent dynamism rather than to work against it;
- Safeguard features and natural processes from those impacts of human activity that cause damage to the features through the degradation of their range, extent, structure, function or typical species; and

- Facilitate, where necessary, restoration of features or components of features that are currently damaged or degraded and in unfavourable condition.

The conservation objectives for the European protected sites and their features within a 10 km radius or potential area of the Scheme are set out below.

4.1. Site Conservation Objectives

The Site Conservation Objectives have been drawn directly from the NRW documents listed in Chapter 8.

4.1.1. Cardigan Bay / Bae Ceredigion SAC

The habitat features designated as part of the Cardigan Bay / Bae Ceredigion SAC are as follows:

- Sandbanks which are slightly covered by sea water all the time;
- Reefs; and
- Submerged or partially submerged sea caves.

The species features designated as part of the Cardigan Bay / Bae Ceredigion SAC are as follows:

- Bottlenose dolphin (*Tursiops truncatus*);
- Sea lamprey (*Petromyzon marinus*);
- River lamprey (*Lampetra fluviatilis*); and
- Grey seal (*Halichoerus grypus*).

Table 4-1: Cardigan Bay / Bae Ceredigion Conservation Objectives for SAC Special Features

To achieve favourable conservation status all the following, subject to natural processes, need to be fulfilled and maintained in the long-term. If these objectives are not met restoration measures will be needed to achieve favourable conservation status.
Cardigan Bay / Bae Ceredigion Special Area of Conservation (NRW, 2017)
Habitat Features
Range
The overall distribution and extent of the habitat features within the site, and each of their main component parts is stable or increasing. For the reef feature these include: • Intertidal bedrock reefs; • Intertidal cobble, pebble with *Sabellaria alveolata* (biogenic) reefs; • Subtidal bedrock reefs; • Subtidal pebble, cobble and boulder reefs; and • Sea caves.
Structure and function
The physical biological and chemical structure and functions necessary for the long-term maintenance and quality of the habitat are not degraded. Important elements include: • Geology; • Sedimentology; • Geomorphology; • Hydrography and meteorology; • Water and sediment chemistry; and • Biological interactions. This includes a need for nutrient levels in the water column and sediments to be:

- At or below existing statutory guideline concentrations; and
- Within ranges that are not potentially detrimental to the long-term maintenance of the features species populations, their abundance and range.

Contaminant levels in the water column and sediments derived from human activity to be:

- At or below existing statutory guideline concentrations;
- Below levels that would potentially result in increase in contaminant concentrations within sediments or biota; and
- Below levels potentially detrimental to the long-term maintenance of the feature species populations, their abundance or range taking into account bioaccumulation and biomagnification.

Typical Species

The presence, abundance, condition and diversity of typical species is such that habitat quality is not degraded. Important elements include:

- Species richness;
- Population structure and dynamics;
- Physiological health;
- Reproductive capacity.
- Recruitment;
- Mobility; and
- Range.

As part of this objective it should be noted that:

- Populations of typical species subject to existing commercial fisheries need to be at an abundance equal to or greater than that required to achieve maximum sustainable yield and secure in the long term; and
- The management and control of activities or operations likely to adversely affect the habitat feature is appropriate for maintaining it in favourable condition and is secure in the long term.

Species Features

Populations

The population is maintaining itself on a long-term basis as a viable component of its natural habitat. Key parameters are: population size, structure, production, and condition of the species within the site.

As a part of this objective for **bottlenose dolphin** and **grey seal**, it should be noted that contaminants derived from human activity are below levels capable of causing physiological damage or reproductive or immune suppressions.

Grey seal populations should not be reduced as a result of human activity.

Range

The natural species populations within the SAC are not being reduced, or likely to be reduced within the foreseeable future.

As part of this objective for **bottlenose dolphin** and **grey seal**, it should be noted that:

- Their range within the SAC and adjacent areas is not constrained or hindered;
- There are appropriate and sufficient food resources for the species within the SAC and beyond; and
- The sites and amount of supporting habitat used by these species are accessible and their extent and quality is stable or increasing.

Supporting habitats and species

The presence, condition, abundance and diversity of habitats and species required to support the qualifying feature species is such that the abundance, distribution and population dynamics of these species are stable or increasing, both within the site and beyond. Key considerations include: • Distribution • Extent. • Structure; • Function and quality of habitat; and • Prey availability and quality. As part of this objective it should be noted that: • The abundance of prey species subject to existing commercial fisheries needs to be equal to or greater than that required to achieve maximum sustainable yield and secure in the long term; • The management and control of activities or operations likely to adversely affect the species feature is appropriate for maintaining it in favourable condition and is secure in the long term; • Contamination of potential prey species should be below concentrations potentially harmful to their physiological health; and • Disturbance by human activity is below levels that suppress reproductive success, physiological health or long-term behaviour.
Restoration and recovery
As part of this objective it should be noted that for the **bottlenose dolphin** populations should be increasing.

4.1.2. West Wales Marine / Gorllewin Cymru Forol SAC

The species features designated as part of the West Wales Marine / Gorllewin Cymru Forol candidate SAC are as follows:

- Harbour porpoise (*Phocoena phocoena*)

Table 4-2: West Wales Marine / Gorllewin Cymru Forol Draft Conservation Objectives

To achieve favourable conservation status all the following, subject to natural processes, need to be fulfilled and maintained in the long-term. If these objectives are not met restoration measures will be needed to achieve favourable conservation status.
West Wales Marine / Gorllewin Cymru Forol Draft Conservation Objectives and Advice on Activities (NRW, 2016)
Harbour porpoise (*Phocoena phocoena*)
To ensure that the integrity of the site is maintained and that it makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for harbour porpoise in UK waters. In the context of natural change, this will be achieved by ensuring that: • **Harbour porpoise** is a viable component of the site; • There is no significant disturbance of the species; and • The condition of supporting habitats and processes, and the availability of prey is maintained.

4.1.3. Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC

The species features designated as part of the Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC which are highly mobile and therefore assessed as part of this HRA are as follows:

- Bottlenose dolphin (*Tursiops truncatus*); and
- Grey seal (*Halichoerus grypus*).

Table 4-3: Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau Conservation Objectives

To achieve favourable conservation status all the following, subject to natural processes, need to be fulfilled and maintained in the long-term. If these objectives are not met restoration measures will be needed to achieve favourable conservation status.
Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau Special Area of Conservation (CCW, 2009)
Populations
The population is maintaining itself on a long-term basis as a viable component of its natural habitat. Key parameters are: population size, structure, production, and condition of the species within the sits. As a part of this objective for **bottlenose dolphin** and **grey seal**, it should be noted that contaminant burdens derived from human activity are below levels that may cause physiological damage, or immune or reproductive suppression. For **grey seal** populations should not be reduced as a consequence of human activity.
Range
The natural species populations within the SAC are not being reduced, or likely to be reduced within the foreseeable future. As part of this objective for **bottlenose dolphin, grey seal and otters**, it should be noted that: • Their range within the SAC and adjacent areas is not constrained or hindered; • There are appropriate and sufficient food resources for the species within the SAC and beyond; and • The sites and amount of supporting habitat used by these species are accessible and their extent and quality is stable or increasing.
Supporting Habitats and Species
The presence, condition, abundance and diversity of habitats and species required to support the qualifying feature species is such that the abundance, distribution and population dynamics of these species are stable or increasing, both within the site and beyond. Key considerations include: • Distribution • Extent. • Structure; • Function and quality of habitat; and • Prey availability and quality. As part of this objective it should be noted that: • The abundance of prey species subject to existing commercial fisheries needs to be equal to or greater than that required to achieve maximum sustainable yield and secure in the long term; • The management and control of activities or operations likely to adversely affect the species feature is appropriate for maintaining it in favourable condition and is secure in the long term; • Contamination of potential prey species should be below concentrations potentially harmful to their physiological health; and • Disturbance by human activity is below levels that suppress reproductive success, physiological health or long-term behaviour.
Restoration and recovery
As part of this objective it should be noted that for the **bottlenose dolphin** populations should be increasing.

4.1.4. Northern Cardigan Bay / Gogledd Bae Ceredigion SPA

The species feature designated as part of the Northern Cardigan Bay / Gogledd Bae Ceredigion SPA which are highly mobile and therefore assessed as part of this HRA are as follows:

- Red-throated diver (*Gavia stellata*)

Table 4-4: Northern Cardigan Bay / Gogledd Bae Ceredigion Conservation Objectives

To achieve favourable conservation status all the following, subject to natural processes, need to be fulfilled and maintained in the long-term. If these objectives are not met restoration measures will be needed to achieve favourable conservation status.
Northern Cardigan Bay / Gogledd Bae Ceredigion Draft Conservation Objectives (NRW, 2015a)
Red-throated diver (*Gavia stellata*)
• The size of the population should be stable or increasing, allowing for natural variability, and sustainability in the long term; • There should be sufficient habitat, of sufficient quality to support the species long term population; and • The foraging habitat of this species should remain unaffected by anthropogenic factors and should not decrease significantly in area.

4.1.5. Cors Fochno and Dyfi Estuary Ramsar and SPA

The species feature designated as part of the Cors Fochno and Dyfi Estuary Ramsar and SPA which are highly mobile and therefore assessed as part of this HRA are as follows:

- Greenland white-fronted goose (*Anser albifrons flavirostris*)

Table 4-5: Cors Fochno and Dyfi Estuary Conservation Objectives for Ramsar and SPA

To achieve favourable conservation status all the following, subject to natural processes, need to be fulfilled and maintained in the long-term. If these objectives are not met restoration measures will be needed to achieve favourable conservation status.
Dyfi Estuary / Aber Dyfi SPA Core Management Plan (CCW, 2008)
Greenland white-fronted goose (*Anser albifrons flavirostris*)
• Maintaining the extent and quality of grazing areas; • Ensuring minimum disturbance of roosting and feeding areas; • The Dyfi wintering populations of Greenland white-fronted goose reaches levels of national importance (i.e. 1% or greater of the national (UK) population annually); • Winter mortality levels are <1% annually; • Juvenile birds comprise >5% of the wintering population annually; and • All site-specific factors affecting the achievement of these objectives are controlled.

5. Stage 1 - Screening

5.1. Likely Significant Effects – Alone

The Aberaeron Coastal Defence Scheme will take place in the Cardigan Bay / Bae Ceredigion SAC, and adjacent to the boundary of the West Wales Marine / Gorllewin Cymru Forol SAC. Further designated sites have been included where transient/migratory protected features have the potential to occur in the area of the Scheme.

Table 5-1 sets out the features of the European Designated sites, the potential impacts and the potential mechanism of impact and the screening result.

Table 5-1: HRA Screening Table of Likely Significant Effects

Site	Potential Impact	Potential Cause of Impact	LSE? (Y/N)
Cardigan Bay / Bae Ceredigion SAC Habitat features: • Sandbanks which are slightly covered by sea water all the time • Reefs • Submerged or partially submerged sea caves	Habitat loss / Physical damage	**Footprint losses** Construction of the North Pier breakwater will result in direct removal and loss of intertidal and subtidal habitat in the footprint of the breakwater, including intertidal bedrock reefs; and intertidal cobble, pebble with *Sabellaria* (biogenic reefs), which are Reef features of the SAC. This area also includes blue mussels. The footprint of the breakwater is 10,820m^2. This will result in 2,942m^2 of Blue mussel bed loss (SLR.MX.MytX) and 7,878^2 of intertidal area. There is no *Sabellaria* in the footprint of the new breakwater. The seabed in the area of the new breakwater *not* on the intertidal reef feature (as shown by the SAC feature mapping) is a mixture of Biotope A1.3131 (LR.LLR.F.Fves) - '*Fucus vesiculosus* on moderately exposed to sheltered mid eulittoral rock' and a mosaic of biotope A2.2 (LS.Lsa) - 'Littoral Sand' and biotope A2.821 (LR.FLR.Eph.EphX) - 'Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata', shown in transects 3 and 5 of the drop down video survey results. This coincides reasonably well with interpreted sidescan sonar that shows the area to be gravelly sand with occasional boulders, and sand (ranging from fine sand to gravelly sand) suggesting a mixed sand and rock area. It is unlikely that the whole area could be classed as geogenic reef, as there is clearly a much more predominantly sandy area in the inshore area around the area of the new breakwater. The sidescan sonar interpretation shows the area beyond the breakwater to be 'gravel with cobbles and occasional boulders' and more likely to correspond to geogenic reef. This is the very low intertidal into the subtidal area. This also corresponds with the findings of the drop down video survey of the area. Appendix A sets out more information on the detail of the intertidal and subtidal area. The breakwater will be created from rock such that it is likely to provide a similar rock / cobble substrate to those areas lost, potentially creating at least the same area of geogenic intertidal reef as will be lost and enabling blue mussels and other species to recolonise. There is approximately 62,709m^2 blue mussel habitat between Aberaeron harbour and the edge of the SAC boundary to the north (54778+758+530+6643 from DataMapWales). Should the whole area of the blue mussels be lost, this would	N

		amount to 4.7% of reef feature between Aberaeron and the edge of the SAC to the north which itself is only about 1% of the total SAC reef feature (of 22,948,000m^2). The losses would account for 0.01% of the total SAC reef feature. The mussels are part of the intertidal reef feature but do not form part of the biogenic reef - the Regulation 37 advice notes that "*In Cardigan Bay SAC the only biogenic reefs present are formed by the ross worm Sabellaria spp*". Overall, *Mytilus* spp. populations are considered to have a strong ability to recover from environmental disturbance (Holt *et al*., 1998; Seed & Suchaneck, 1992). Littoral and sublittoral beds are considered to have 'Medium' resilience (2 -10 years) to represent the potential for recovery within a few years where a proportion of the bed remains ('Medium' or 'Low' resistance). Discussions with NRW Technical Advisory indicate that they do not believe the footprint losses would be significant. **Indirect losses as a result of changes to coastal processes** The presence of the breakwater has the potential to change sediment and coastal processes, affecting wave climate, fluvial and tidal flows through the river / harbour mouth, scour, suspended sediment, etc. These changes may have indirect impacts to the reef features, both biogenic and geogenic, by changing the movement of water, scour and changing turbidity, either increasing or decreasing sediment in the water column. The substrates at Aberaeron were dominated by bedrock, boulders and mixed sediments though occasional large patches of fine sand were present. The nature of the sediment type was patchy across the site though sand was largely restricted to the south western portion and a gradient from sand to coarser sediment was evident from shore to sea. The sediment with the harbour, navigation channel and harbour mouth is dominated by gravel and cobbles, with relatively small proportions of sand. The amount of sand increases in the harbour entrance and around the area where the new breakwater would be situated, which is currently outside of the harbour. There is very little sand in the navigation channel.	

		A conceptual understanding of the sediment transport processes has been developed and discussed / agreed with NRW (Atkins 2022).[4] The offshore area contains mixed sand, gravel, cobbles, pebbles and occasional boulders and can be considered to be geogenic reef. Sand is transported to this offshore reservoir from the south (from outside the bay) by offshore processes. There is also some loss of sand from this area northwards further along the coast. There is some on / offshore sand transportation from South Beach, but as has been indicated, there is limited onshore sand transportation and this beach is gradually eroding, with northwards inshore transportation of sediment toward South Pier. There is transportation of sediment from the River Aeron to the offshore area. The general northwards direction of the offshore sediment transportation plus the on / offshore flows between North Beach and the offshore area suggest that some of this may feed the *Sabellaria* on North Beach. This is not the only source of sediment for North Beach / the *Sabellaria* reef, as the updrift transportation also feeds the offshore area. NRW water quality data shows that the River Aeron is low in suspended sediment. Looking at the coast overall, it can be seen that Sabellaria extend north beyond the extent of the SAC boundary as Sabellaria is mapped in Article 17 habitat data as Aberystwyth and beyond. Along this area of coast there are a few small fluvial outfalls but these could not provide a sufficient supply of sediment needed to support such widespread *Sabellaria* growth. It is much more likely that the majority of sediment utilised by *Sabellaria* along the whole coast and on North Beach is marine in nature. Sediment from the River Aeron is not likely to naturally be deposited on South Beach given its offshore to northwards direction of travel. However, the placement of sediment from CCC's annual dredging of the harbour on South Beach adds to the South Beach 'source' of sediment, before on / offshore movement and then movement further northwards. Discussions with NRW Advisory indicate that they have concerns regarding the possible changes that the new breakwater could have on coastal processes. These focus on the possible decrease in sediment supply to the *Sabellaria* reef on North Beach. They do not have concerns regarding any Sabellaria on South Beach as this is considered to be more ephemeral and not creating 'reef' structures (as are defined in NRW, 2019). They also do not have concerns regarding an increase in sedimentation or smothering of North Beach.	

[4] Atkins, 2022, Detailed Design of Aberaeron Coastal Defence Scheme, Conceptual Understanding of Baseline Geomorphology, 5182114-ATK-MAR-GEN-RP-C-1048

		Models have been created for bed shear stress, flows and current speed for baseline conditions (now) and to model the potential changes the new breakwater could have on these parameters. Changes in current speed show that the area affected is geographically limited within 500m of the new breakwater. The reef feature extends approximately 2.5km (2,500m) north from Aberaeron to the edge of the SAC. In total there is almost 22,948 Ha (229,480,000m^2) of reef feature within the SAC. The area of *Sabellaria* from the mouth of Aberaeron harbour to the edge of the SAC is 96,333m^2 [5]. The area of total intertidal reef feature in the same location is 257,413m^2. Not all of the area affected by a change is either Sabellaria or reef feature (the upper area of the shore accounts for approximately half of the area of impact, which is not part of the SAC feature). The area of SAC feature affected is therefore approximately a maximum of 20% of the SAC feature between Aberaeron and the edge of the designation, which itself is only about 1% of the total SAC reef feature (of 22,948,000m^2). The area affected is a maximum of approximately 0.08% of the SAC reef feature. This area is calculated based on the area affected by any change >1%. Comparisons between the absolute range of speeds in the baseline compared to the absolute range of speeds with the breakwater show that the absolute change in speeds are very small i.e. even large relative changes (much greater than 1%) are very small in absolute terms. The changes are too small to significantly alter the overall coastal processes or change the conceptual model of and transport process for sediment in the area. They are too small to affect the exposure climate of the area – it will remain an exposed coast with the same coastal processes. Changes in bed shear stress show a similar pattern to those for current speed. The size of area affected by relative changes in bed shear stress are greater than those for changes in current speed, but still restricted to approximately 600m from the breakwater. Similarly, a comparison between the absolute range of bed shear stress in the baseline compared to the absolute range of bed shear stress with the breakwater show that the absolute changes in bed shear stress are very small i.e. even large relative changes (much greater than 1%) are very small in absolute terms. The changes are too small to significantly alter the overall coastal processes or change the conceptual model of and transport process for sediment in the area.	

[5] 51397 + 10749+9631 + 24556) + (54778 + 74641 + 1996 + +758 + 6323 + +2003 + 2756 + 530 + 10654 + 6643) polygon areas, DataMapWales

		They are too small to alter the size of sediment particle transported by coastal processes. The maximum area over which any changes occur are spatially limited around the new breakwater and that this area of influence is within 500m – 600m of the structure. The spatial extent of these changes are insufficient to materially alter the wider coastal processes impacting the supply of sediment to the area or the degree of exposure to which the coast is subject (except in the harbour and harbour entrance, which is the purpose of the new breakwater). Furthermore, the absolute changes are very small such that they will not change the volume or grain size of sediment mobilised in the area sufficiently to alter the among or type of sediment available for *Sabellaria*. Given the very high likelihood that the main source of sediment for *Sabellaria* is marine, the lack of impact to coastal processes, the geographically limited area over which any changes will take place and the very small magnitude of those changes, along with the very large area of *Sabellaria* and intertidal reef in the SAC, any changes to the current speed will be too small and too localised to significantly impact the subtidal reef feature of the SAC. The changes are very small and very localised such that changes to the geology, sedimentology, geomorphology, hydrography and meteorology, water and sediment chemistry and biological interactions that take place along the coast, as these are driven by much larger processes which will not be interrupted or affected by the presence of the breakwater. The physical biological and chemical structure and functions necessary for the long-term maintenance and quality of the structure and function of habitat will not be affected. Appendix A sets out more information on the detail of the intertidal and subtidal area and model outputs. Additional supporting technical reports provide the detail of model set up, calibration, model runs and outputs, as well as the sediment processes and conceptual understanding of the coastal processes at Aberaeron.	
	Disturbance (e.g. physical)	The movement of construction vehicles and rock delivery barges within the intertidal area has the potential to have disturbance impacts in the intertidal area and has the potential to lead to disturbance to reef habitat. Excavation of the foundations of the North Pier breakwater and placement of rock armour has the potential to lead to disturbance impacts to adjacent reef habitat. Without mitigation in place, LSE upon reef habitat due to disturbance cannot be ruled out.	Y

	Accidental pollution during construction, maintenance and repair works	There is potential for accidental pollution releases during construction, maintenance and repair works of the Scheme. In accordance with habitat mapping, the '*Sandbanks which are slightly covered by sea water all the time'* are located approximately 5km offshore from the Scheme (Cardigan Bay SAC, 2018). Due to the distance of the sandbanks from the Scheme, it is unlikely that any accidental pollution will impact on the habitat feature. In accordance with habitat mapping, *Reefs* (including both rocky and biogenic reef) are located in the subtidal area of the proposed development footprint (Cardigan Bay SAC, 2018). Whilst the majority of works in intertidal areas will be carried out at low tide to limit pathways for pollution into the water column, the construction of the eastern extent of the North Pier breakwater will be undertaken below MHWS and will involve working directly in the water column. Works below MHWS include excavation of the foundations of the structure and rock armour placement. Therefore without mitigation in place LSE due to accidental pollution cannot be ruled out. Refuelling will take place within the site compound area in bunded areas in accordance with good practice to avoid pollution incidents. Measures will also be in place for grouting and pointing materials to catch materials which may drop onto the foreshore and to allow removal before the returning tide. There are no recorded '*Submerged or partially submerged sea caves*' in the area of the Scheme. Whilst there has been no dedicated mapping of the habitat feature, the closest known seacave in the SAC is located approximately 2km from the Scheme (Cardigan Bay SAC, 2018b). Due to the distance of the seacaves from the Scheme, it is unlikely that any accidental pollution will impact on the habitat feature.	Y
	Increased turbidity	The replenishing/redistribution of shingle on the beach could lead to increases in turbidity in the water column. Further excavation of the foundations for the North Pier breakwater and rock armour placement undertaken directly in the water column has the potential to lead to increases in turbidity. It is estimated that 10 occurrences of rock placement by boat will take place. The impact of rock placement will be short term, and temporary. It is likely that any suspended sediments due to rock placement will be washed out with each tidal cycle. During excavation of the breakwater foundations, the quantity of fine suspended sediment added to the system will be much lower than the volume of sediment usually in suspension as a result of normal tides and currents. Modelling carried out	N

		indicates that the sediment transport pattern would lead to deposition in areas which already receive accretion. Therefore LSE from increases in turbidity during construction is unlikely.	
Cardigan Bay / Bae Ceredigion SAC Species features: • Bottlenose dolphin (*Tursiops truncatus*); • Sea lamprey (*Petromyzon marinus*); • River lamprey (*Lampetra fluviatilis*); and • Grey seal (*Halichoerus grypus*).	Habitat loss / Physical damage	River lamprey and sea lamprey lay their eggs in clean river gravels and when hatched the larvae spend several years buried in sandy sediments feeding on organic matter before metamorphosing after 3-4 years (Maitland, 2003). Juveniles of both species migrate to estuaries and inshore waters where they feed parasitically on a range of fish species. Adult river lamprey are predominantly an estuarine and inshore species, whereas adult sea lamprey have a more oceanic distribution (Maitland, 2003). Adult river lamprey migrate through the SAC to reach the River Aeron on their spawning migration between October and December. Adult sea lamprey migrate through the site between March and June to reach the River Aeron. Juvenile sea lamprey migrate downstream during the site between December and June (NRW, 2017). The River Aeron is outside of the designated Cardigan Bay SAC. The River Aeron is unlikely to be suitable for egg laying, such that there will be no damage or habitat loss for larvae in the sediments. In the SAC, works below MHWS is limited to construction of the eastern extent of the North Pier breakwater. Due to the small area of the works, any potential damage or habitat loss caused by the Scheme is unlikely to have a significant effect on the overall functioning of the feature and therefore conservation objectives of the SAC. Bottlenose dolphin and Grey seals are highly mobile and transient species. The construction works of the Scheme are unlikely to cause physical damage or habitat loss but noise created may change the behaviour and use of the area by the Bottlenose dolphin or Grey seal. However, it is known for seals to pup on Aberaeron beaches during quiet periods.	N
	Disturbance (e.g. physical & noise)	The River Aeron is an important breeding, feeding and nursery grounds for River and Sea lamprey. The inshore coastal areas of the River Aeron are used as feeding grounds by juvenile River and Sea lamprey, as well as adult River lamprey and migrating River and Sea lamprey. The proposed works in the SAC have the potential to disturb River and Sea lamprey within coastal inshore waters, whether physically or through noise impacts. Construction works outside of the SAC, within the River Aeron further have the potential to lead to noise and vibration disturbance impacts to lamprey. This includes	Y

		transportation by tug and installation of the barge in the harbour, and installation of a temporary scaffolding platform within the river channel. There is a risk that noise from construction activities such as the addition of rock armour, placement of scour protection and removal of existing beach groynes may disturb Bottlenose dolphins and Grey Seal. Piling operations will produce percussive noise with the potential to disturb marine mammals. The works are predicted to be temporary and small scale. However, given the numbers of Bottlenose dolphin and Grey seal in the SAC, as well as the transient nature of the species and their sensitivity to underwater noise, disturbance impacts cannot be ruled out. Therefore, without mitigation in place, LSE from disturbance impacts to species features of the SAC cannot be ruled out.	
	Accidental pollution during construction, maintenance and repair works	There is potential for accidental pollution releases during construction, maintenance and repair works which have the potential impact the species features of the SAC. Whilst the majority of works in intertidal areas will be carried out at low tide to limit pathways for pollution into the water column, the construction of the eastern extent of the North Pier breakwater will be undertaken below MHWS and will involve working directly in the water column. Works below MHWS include excavation of the foundations of the structure and rock armour placement. Therefore, without mitigation in place LSE to species features of the SAC due to accidental pollution cannot be ruled out.	Y
	Increased turbidity	The replenishing/redistribution of shingle on the beach could lead to increases in turbidity in the water column. Further excavation of the foundations for the North Pier breakwater and rock armour placement undertaken directly in the water column has the potential to lead to increases in turbidity. It is estimated that 10 occurrences of rock placement by boat will take place. The impact of rock placement will be short term, and temporary. It is likely that any suspended sediments due to rock placement will be washed out with each tidal cycle. During excavation of the breakwater foundations, the quantity of fine suspended sediment added to the system will be much lower than the volume of sediment usually in suspension as a result of normal tides and currents. Modelling carried out indicates that the sediment transport pattern would lead to deposition in areas which already receive accretion. Therefore, LSE from increases in turbidity during construction is unlikely.	N

West Wales Marine / Gorllewin Cymru Forol SAC Harbour Porpoise *Phocoena phoconea*) and comparision	Disturbance (e.g. physical & noise)	There is a risk that noise from construction activities such as excavation for the breakwater foundations, rock dumping of the rock armour within the water column may disturb Harbour porpoise. Piling operations will produce percussive noise with the potential to disturb Harbour porpoise. The works are predicted to be temporary and small scale. However, given the numbers of Harbour porpoise in the SAC, as well as the transient nature of the species, and their sensitivity to underwater noise, without mitigation in place disturbance impacts cannot be ruled out.	Y
	Accidental pollution during construction, maintenance and repair works	There is potential for accidental pollution releases during construction, maintenance and repair works. Excavation within the water column has the potential to lead to increases in turbidity and accidental pollution releases. Works within the intertidal area further has the potential to lead to contamination releases. Without mitigation in place impacts from accidental pollution cannot be ruled out.	Y
Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC • Bottlenose dolphin (*Tursiops truncatus)* • Grey seal (*Halichoerus grypus)* • *Otter (Lutra lutra)*	Disturbance (e.g. physical & noise)	There is a risk that noise from construction activities such as excavation for the breakwater foundations, rock dumping of the rock armour within the water column may disturb Bottlenose dolphin and Grey seal. Piling operations will produce percussive noise with the potential to disturb marine mammals. There is a risk that ability for otters to move between freshwater and marine habitats is constrained by the construction works. The works are predicted to be temporary and small scale. However, given the transient nature of the species, disturbance impacts without mitigation in place cannot be ruled out.	Y
	Accidental pollution during construction, maintenance and repair works	There is potential for accidental pollution releases during construction, maintenance and repair works. Excavation within the water column has the potential to lead to increases in turbidity and accidental pollution releases. Works within the intertidal area further has the potential to lead to contamination releases. Without mitigation in place impacts from accidental pollution cannot be ruled out.	Y
Northern Cardigan Bay / Gogledd Bae Ceredigion SPA	Disturbance (e.g. physical & noise)	There is potential that noise from construction activities could disturb birds in the immediate vicinity of the works. The Northern Cardigan Bay / Gogledd Bae Ceredigion SPA hosts 7% of the UK wintering population of red throated divers (JNCC, 2017a). Red throated divers have	Y

Red throated divers (*Gavia stellata*)		a wide distribution and have been recorded in the Cardigan Bay / Bae Ceredigion Spa (JNCC, 2015). Due to the transient nature of the species, there is potential for red throated divers to occur within the area of the construction works. Therefore, disturbance impacts without mitigation in place cannot be ruled out.	
	Accidental Pollution during construction, maintenance and repair works	Due to the distance of the Northern Cardigan Bay / Gogledd Bae Ceredigion SPA from the Scheme (16km North), it is unlikely that any accidental pollution during construction, maintenance and repair works will impact the features of the SPA.	N
Cors Fochno and Dyfi Estuary Ramsar and SPA Greenland white-fronted goose (*Anser albifrons flavirostris*) Common greenshank (*Tringa nebularia*)	Disturbance (e.g. physical & noise)	The Greenland white-fronted goose is a highly migratory species with the potential to occur in the area of the Scheme. The Cors Foncho and Dyfi Estuary hosts the most southerly wintering population of the Greenland white-fronted goose species in the UK. The geese use the saltmarsh and grasslands in the SPA for feeding and roost on the sandbanks and mud-flats (JNCC, 2001). Due to a lack of these available habitats in the area of the Scheme, as well as the distance of their preferred habitat from the Scheme (33km further south from their most southerly location) it is considered unlikely that the Scheme will cause disturbance to Greenland white-fronted geese. The greenshank is confined to the north and west of Scotland in summer but has potential to occur in the area of the scheme during migration or wintering. The greenshank can be found across the coast of the UK during migratory passage or overwintering. The greenshank have been recorded at Cors Foncho and Dyfi Estuary representing 1.3% of the UK population. (JNCC, 1976). Greenshank favour boggy moorland and peatland. Due to a lack of these available habitats in the area of the Scheme, it is considered unlikely that the Scheme will cause disturbance to greenshank.	N
	Accidental Pollution during construction, maintenance and repair works	Due to the distance of the Cors Foncho and Dyfi Estuary Ramsar and SPA from the Scheme (33km North), it is unlikely that any accidental pollution during construction, maintenance and repair works will impact the features of the Ramsar and SPA.	N

5.2. Likely Significant Effects – In-combination

Ceredigion County Council planning portal was reviewed for information of any Schemes that may have been assessed for potential impacts upon the European sites identified within this assessment and, therefore, may have an in-combination effect with the Scheme. Further, a search of the NRW public register identified no marine licence applications of relevance to the Scheme.

Planning applications within the area of the Scheme are presented in Table 5-2 below and are both minor developments. Both planning applications are undertaken outside of the footprint of the European sites. Therefore, there is no pathway for interaction with habitat features of European sites.

Both developments will take place outside of the River Aeron and therefore impacts to river and sea lamprey are unlikely. Potential flood resilience measures incorporated into the Monachty Hotel extension may lead to minor disturbance impacts from noise or vibration, however significant impacts are unlikely.

Red throated divers (*Gavia stellata*) are transient in nature and have the potential to occur within the area of the proposed developments. Disturbance through visual, noise and vibration impacts have the potential to impact red throated divers, however Aberaeron is a working harbour and popular tourism destination. Any birds using the area of developments are loafing and foraging habitat are likely habituated to some level of disturbance. No operations such as percussive piling are proposed for either developments. Therefore, in combination impacts on Red throated divers are not anticipated.

Therefore, this Stage 1 screening has not identified any in-combination LSE with proposed developments in the area of the Scheme.

Table 5-2: Proposed Developments Within the Area of the Scheme

Development	Summary of relevant aspects	Potential Interactions
Ceredigion County Council Full planning application – (A210065) and Listed building consent (A210257) The Hive – proposed roof deck above existing fishmonger to include removal of existing flat roof. Status – In Progress (planning application submitted Jan 2021 and listed building consent in March 2021)	The work would take place within The Hive's property boundary, with the proposed roof deck a replacement of the existing. A heritage impact assessment was carried out for the listed building consent due to the listed status of the quay wall. The new roof deck would be on raised stainless steel stilts with a glass balcony wall and is of modern appearance. View would be across the harbour from the deck.	None envisaged
Full planning application (A200805) and amendment (A210048) Monachty Hotel – extension and alteration to existing hotel to be used in conjunction with the Cellar restaurant to include demolition of balcony terrace and erection of bar and WC building. Status – Approved Nov 2020	The work would take place on the seaward side of the hotel, which faces into the harbour and is backed by a flood wall along the River Aeron. Although the application has been approved, the applicant was advised in the decision notice to incorporate flood resilience measures into the design given the location of the site in a flood risk area.	None envisaged

5.3. TLSE Matrix

The LSE of the Scheme on European sites has been assessed within Table 5-1 and has been summarised in Table 5-3 below.

Table 5-3: TLSE Impact Matrix

European Designated Site / Feature LSE? (Yes/No)	Distance from Scheme (km)	Sandbanks which are slightly covered by sea water all the time	Reefs	Submerged or partially submerged sea caves	Bottlenose dolphin	Sea lamprey	River lamprey	Grey seal	Harbour porpoise	Red-throated diver	Greenland white-fronted goose	Greenshank	Otter
Cardigan Bay / Bae Ceredigion SAC	0	No	Yes	No	Yes	Yes	Yes	Yes	N/A	N/A	N/A	N/A	N/A
West Wales Marine / Gorllewin Cymru Forol SAC	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A
Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC	18	N/A	N/A	N/A	Yes	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
Northern Cardigan Bay / Gogledd Bae Ceredigion SPA	16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A
Cors Fochno and Dyfi Estuary Ramsar and SPA	33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	No	N/A

Key:

N/A	The species or habitat type is not an interest feature of that site.
	The potential for the Scheme to have a likely significant effect on these interest features cannot be ruled out and will therefore have to be considered further as part of the Scheme level HRA assessment.
	The proposed Scheme will have no likely significant effects on the feature.

5.4. Stage 1 Screening Conclusion

There is potential for the Scheme to have a likely significant effect on species and habitat features within the Cardigan Bay / Bae Ceredigion SAC, West Wales Marine / Gorllewin Cymru Forol SAC, Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC and the Northern Cardigan Bay / Gogledd Bae Ceredigion SPA. These species and habitat features include:

- Reefs;
- Bottlenose dolphin (*Tursiops truncatus*);
- Sea lamprey (*Petromyzon marinus*);
- River lamprey (*Lampetra fluviatilis*);
- Grey seal (*Halichoerus grypus*);
- Harbour Porpoise (*Phocoena phocoena*);
- Otter *(Lutra lutra;* and
- Red-throated diver (*Gavia stellata*).

These species are all transient in nature and there is potential for these species to occur within the area of the Scheme. Therefore, without mitigation in place it is not possible to screen out potential impacts to these features at this stage.

In-combination effects have been considered as part of this assessment (see Table 5-3 above) and it has been concluded that there is no potential for any LSE in-combination with other plans and Schemes.

6. Stage 2 Appropriate Assessment

6.1. Introduction

Following completion of the HRA Stage 1 Screening assessment it was concluded that the Scheme, without mitigation, could have an LSE in respect to disturbance and accidental pollution. The following European sites and designated features have been assessed in this Stage 2 AA:

Cardigan Bay / Bae Ceredigion SAC:

- Reefs;
- Bottlenose dolphin (*Tursiops truncatus*);
- Sea lamprey (*Petromyzon marinus*);
- River lamprey (*Lampetra fluviatilis*); and
- Grey seal (*Halichoerus grypus*).

West Wales Marine / Gorllewin Cymru Forol SAC

- Harbour Porpoise (*Phocoena phocoena*)

Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC

- Bottlenose dolphin (*Tursiops truncatus*);
- Grey seal (*Halichoerus grypus*); and
- Otter *(Lutra lutra*.

Northern Cardigan Bay / Gogledd Bae Ceredigion SPA

- Red-throated diver (*Gavia stellata*).

6.2. Stage 2 Appropriate Assessment of the Plan Alone

A Stage 2 Appropriate Assessment (AA) is required, as it was not possible to rule out LSE that the Scheme could have on the Cardigan Bay / Bae Ceredigion SAC, West Wales Marine / Gorllewin Cymru Forol SAC, Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC and the Northern Cardigan Bay / Gogledd Bae Ceredigion SPA.

At Stage 2, the potential effects are examined in more detail to see if they could have an adverse impact on the integrity of the European Sites. Where necessary, mitigation measures have been put forward to address any potential adverse effects on integrity. If it cannot be shown that there will be no adverse effects on the integrity of the designated sites, then the aspects of the Scheme that could have an adverse effect will need to be avoided or amended, alternatively the Scheme progresses to the next stage of HRA assessment i.e. Stages 3 and 4.

6.2.1. Construction Impacts

The proposed construction phase of the Scheme, without mitigation, could result in noise, vibration, visual, and physical disturbance to the following qualifying features of European sites:

- Reefs;
- Bottlenose dolphin (*Tursiops truncatus*);
- Sea lamprey (*Petromyzon marinus*);
- River lamprey (*Lampetra fluviatilis*);
- Grey seal (*Halichoerus grypus*);
- Harbour Porpoise (*Phocoena phocoena*);
- *Otter (Lutra lutra*; and
- Red-throated diver (*Gavia stellata*).

6.2.1.1. Mitigation Measures

Reefs

Mitigation measures to minimise and limit physical disturbance impacts to reef habitat features during construction are presented below:

- To prevent nuisance/disturbance and direct damage, rock delivery by sea will avoid tipping rock on the reef features. Anchoring will only take place offshore away from the reef. A rock delivery location for where rock tipping will be permitted will be provided agreed between CCC and the contractor and provided to the vessel operators. This location can be agreed with NRW as part of the consent conditions.

- In order to protect the *Sabellaria* reefs and mussel bed habitats along North Beach, it is proposed that vehicles and plants will track across the South Beach.

- To reduce turbidity, excavation will be carried out at low tide for the sections of breakwater that will be above MLWS. For sections of the breakwater below MLWS, excavation will need to take place under water. A geofabric mat will also be positioned onto the seabed in the excavated footprint of the breakwater, which will help reduce the washout of bed material beneath the rocks both during construction and in the future. Construction vehicles will utilise the upper beach as much as possible, to avoid beach materials being washed out into the sea. The tipping of rock from the barge and rock stockpiling on the beach will take place as high up the intertidal zone as possible to reduce wash out of fines into the sea.

- An Environmental site supervisor will be appointed to oversee construction work for the Scheme to ensure that work within the intertidal area and industry standard practices for pollution control are implemented.

- A pre-construction walkover survey of the working corridor and construction area will be undertaken by a suitable trained ecologist to determine *Sabellaria* presence and working corridors / practices will be amended as necessary, in consultation with NRW.

With the implementation of the mitigation measures, it is considered that the risk of physical disturbance impacts to reef habitat features will be minimal and the Scheme is unlikely to have any effect upon the integrity of the Cardigan Bay / Bae Ceredigion SAC in regard to reefs.

Marine Mammals (Bottlenose dolphin, Harbour porpoise and Grey seal)

Mitigation measures to minimise and limit disturbance impacts to Grey seal, Harbour porpoise and Bottlenose dolphin during construction are presented below:

- All vessel operators working on the Scheme will be given a briefing, alerting them to the possible presence of marine mammals in the area, and the guidelines (including the Ceredigion Marine Code of Conduct) for safe vessel operation in the presence of cetaceans. With implementation of this measure, the chance of boat strike resulting in physical injury or mortality of marine mammals will be extremely unlikely. Similarly, by observing the guidelines, vessels will be operated in an appropriate manner so that marine mammals will not be subjected to undue disturbance or harassed.

- Vessel operators will be required to use predefined and regular routes, as these will become known to marine mammals using these waters. This measure will further serve to minimise disturbance to marine mammals due to vessel movements.

- Periodic re-assessment of mitigation measures for marine mammals and their effectiveness will be undertaken by the environmental site supervisor.

- The use of competent observer(s) to spot marine mammals along the Aberaeron frontage during high noise and vibration activities, in particular rock placement and piling operations. If cetaceans are observed, works will be delayed until they have left the area. This measure will ensure the area in the vicinity of works is clear of marine mammals prior to the commencement of works and will serve to reduce any disturbance to marine mammals. The need for marine mammal observers should be agreed with CCC and NRW.

- The generation of underwater sounds at night are to be avoided. The construction working hours are 7am to 7pm and therefore underwater night time sound will not be generated.

- The majority of the marine works will take place at low tide, to avoid working in the water column. Piling operations will be undertaken at low tide to avoid generation of percussive noise in the water column and a soft start approach will be used.

- Prior to construction start, an assessment of seal pup situation on the beaches should be assessed with continuing surveillance during August – November. Works are anticipated to start during winter which is in advance of the pupping season. As a result of the ongoing work in the following 12 months it is anticipated that the beaches will not be sufficiently quiet to create a suitable location for pupping. In the event of seal pups being present on the beaches at Aberaeron, there will be a need to wait for seal pups to mature and to have gone to sea.

With the implementation of the mitigation measures, it is considered that the risk of disturbance impacts to marine mammal features will be minimal and the Scheme is unlikely to have any effect upon the integrity of the Cardigan Bay / Bae Ceredigion SAC, West Wales Marine / Gorllewin Cymru Forol SAC and Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC in regards to marine mammals.

River lamprey and Sea lamprey

Mitigation measures to minimise and limit disturbance impacts to River lamprey and Sea lamprey both within the marine environment, and within the River Aeron are as follows:

- All works, with the exception of installing the Pwll Cam flood gate and excavation and rock dumping of the northern extent of the breakwater, will be carried out at low tide and during daylight hours. This will avoid any noise transmission within the water column and avoid the need for artificial lighting that may disturb migratory fish.
- All works, with the exception of installing the barge and temporary scaffolding platform, will be undertaken outside of the river channel in the River Aeron.
- The scaffolding platforms will be screened to prevent the debris from the works from falling into the water.
- No in-channel works scheduled between 15 April to 15 October, as per the closed season for the River Aeron, to avoid impacts to migratory fish.
- Rock delivery by sea will avoid tipping rock below MLWS. A rock delivery location for where rock tipping will be permitted will be provided agreed between CCC and the contractor and provided to the vessel operators.

With the implementation of the mitigation measures, it is considered that the risk of disturbance impacts to River lamprey and Sea lamprey features will be minimal and the Scheme is unlikely to have any effect upon the integrity of the Cardigan Bay / Bae Ceredigion SAC in regard to River and Sea lamprey.

Otter

Mitigation measures to reduce / limit impacts to otter will include the following:

- A suitably experienced ecologist will carry out a daily pre work survey when working in the River Aeron for otter resting places immediately prior to site works.
- Measures to reduce the risk of harm to commuting and foraging otter will include covering open trenches at night or providing a means of escape (such as a plank of wood) at night to prevent mammals becoming trapped, and safe overnight storage of plant, materials and equipment.
- Any lighting of the site during the hours of darkness will also seek to avoid suitable habitats for this species, such as the banks of the River Aeron and adjacent intertidal habitat.
- The Scheme will enhance otter migration by improving connectivity between the River Aeron and the sea, the latter of which provides an important foraging area for otters. This will be done by extending the existing wall ledge on the northern bank of the river further downstream. Provision of a ledge will enable otters to better migrate back upstream during periods of high water and reduce them being forced onto dry land and towards busy roads.

With the implementation of the mitigation measures, it is considered that the risk of disturbance impacts to otters will be minimal and the Scheme is unlikely to have any effect upon the integrity of the Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC in regards to otters.

Red-throated diver

Mitigation measures to reduce / limit disturbance impacts to Red throated diver include:

- The pre-construction walkover undertaken by the environmental site supervisor will undertake a check for nesting birds within the construction footprint and advise on any necessary action to avoid disturbance.

- All works, with the exception of installing the Pwll Cam flood gate, will be carried out at low tide and during daylight hours. For the single occurrence for gate installation expected for night-time working, the contractor will follow best practice procedures for working at night, including measures to minimise noise and directional lighting.

- Periodic re-assessment of mitigation measures for birds and their effectiveness will be undertaken by the environmental site supervisor.

With the implementation of the mitigation measures, it is considered that the risk of disturbance impacts to Red throated diver features will be minimal and the Scheme is unlikely to have any effect upon the integrity of the Northern Cardigan Bay / Gogledd Bae Ceredigion SPA.

6.2.2. Accidental pollution

The proposed construction phase of the Scheme, without mitigation, could result in the discharge of pollutants from accidental spills during construction. This may affect the following qualifying features of European sites:

- Reefs;
- Bottlenose dolphin (*Tursiops truncatus*);
- Sea lamprey (*Petromyzon marinus*);
- River lamprey (*Lampetra fluviatilis*);
- Grey seal (*Halichoerus grypus*);
- Harbour Porpoise (*Phocoena phocoena*); and
- *Otter (Lutra lutra*.

6.2.2.1. Mitigation Measures

Potential construction effects will be minimised by following construction best practice and adherence to the Environment Agency's Guidance on Pollution Prevention (GPPs) [6]and the Construction Industry Research and Information Association (CIRIA) C715 Environmental good practice on site handbook[7].

Specific control measures that will be employed throughout the works include:

- The Scheme will utilise a circular waste system within the Site;
- Site compounds, materials and equipment will be appropriately secured and fenced off, away from the Site if necessary;
- The Scheme will make use of well-maintained equipment and plant to minimise potential for fuel/oil and chemical leaks. Plant and machinery will be switched off when not in use; and

[6] https://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/

[7] The CIRIA documents are a series of publications developed by the Construction Industry Research and Information Association. Each document is targeted at a particular type of business or activity and covers environmental good practice to minimise pollution.

- To address biosecurity risks, vessels, equipment and materials used will be in a clean condition prior to their arrival on site, and on removal from site. NRW's Biosecurity Plan template can will be used in order to minimise the risks posed by marine invasive non-native species (INNS).

With the implementation of the mitigation measures outlined above, it is considered that the risk of accidental pollution is minimal and unlikely to have an adverse effect upon the site integrity of the Cardigan Bay / Bae Ceredigion SAC and West Wales Marine / Gorllewin Cymru Forol SAC.

6.2.3. Operational Impacts

Operation of the Scheme will be passive apart from the operation of Pwll Cam gate in time of flood. Post construction, there will be a long duration in excess of 50 years to carry out any repair or maintenance works. There are no planned maintenance works and operation of the Scheme does not require any intervention once construction has finished.

There will however be monitoring of sediment deposition which may require the need for dredging within the navigation channel in order to maintain navigable depth. Alternatively, there may be a need to move or set navigation marks or buoys in locations of shallow depth.

In operation the Scheme, without mitigation, could result in physical disturbance to the following qualifying features of European sites:

- Reefs; and
- *Otter (Lutra lutra*.

Reefs

Mitigation measures to minimise and limit physical disturbance impacts to reef habitat features during operation are presented below:

- Monitoring of bed levels will be carried out following construction, with maintenance dredging taking place to remove excess sediment build up, if necessary. Monitoring of sediment build up in the 'V' shaped notch between the North Pier and the groyne will also take place, with excess sediment removed and recycled if required. Arisings from existing harbour dredging operations are deposited on South Beach and this method would continue with post-construction maintenance dredging. The large majority of this material is placed at the northern end of the South Beach in the vicinity of the Yacht Club, at the top of the shingle bank, to build up the width of the shingle berm and improve the level of protection against wave overtopping. The material also provides protection against erosion. This has the advantage of retaining materials within the beach rather than removing surplus materials for disposal.
- If the build up of sediment occurs, it may also be suitable to move navigation marks of buoys in locations deemed to be too shallow for navigation. This would be decided in conjunction with the harbour authority.

With the implementation of the mitigation measures, it is considered that the risk of physical disturbance impacts to reef habitat features will be minimal and the Scheme is unlikely to have any effect upon the integrity of the Cardigan Bay / Bae Ceredigion SAC in regard to reefs.

Otter

Mitigation measures to reduce / limit impacts to otter during operation will include the following:

- Maintain enhancements provided for The Scheme for otter migration which are provided to improve connectivity between the River Aeron and the sea, the latter of which provides an important foraging area for otters. Maintain the enhancements provided i.e. any ledges to enable otters to better migrate back upstream during periods of high water.

With the implementation of the mitigation measures, it is considered that the risk of disturbance impacts to otters will be minimal and the Scheme is unlikely to have any effect upon the integrity of the Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC in regards to otters.

6.3. In-combination Effects

The schemes detailed above in section 5.2 once complete will have no operational impact on the European sites.

6.4. Stage 2 Appropriate Assessment Conclusion

Following the Stage 2 Appropriate Assessment (AA) mitigation measures have been identified to ensure that the risks to the European sites is minimal and unlikely to have an adverse impact on the site integrity of the Cardigan Bay / Bae Ceredigion SAC, West Wales Marine / Gorllewin Cymru Forol SAC, Lleyn Peninsula and the Sarnau / Pen Llyn a`r Sarnau SAC and the Northern Cardigan Bay / Gogledd Bae Ceredigion SPA.

In-combination effects have been considered as part of this assessment (see section 6.3) and it has been concluded that there is no potential for any LSE in-combination with other plans and Schemes.

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9. Abbreviations

AOD	Above Ordnance Datum
CCC	Ceredigion County Council
FCS	Favourable Conservation Status
HRA	Habitats Regulations Assessment
IROPI	Imperative Reasons of Overriding Public Interest
JNCC	Joint Nature Conservation Committee
LSE	Likely Significant Effect
MAGIC	Multi-Agency Geographical Information for the Countryside
MHWS	Mean High Water Springs
NRW	Natural Resource Wales
OBC	Outline Business Case
SPA	Special Protection Areas
SAC	Special Area of Conservation
TLSE	Test of Likely Significant Effect

Appendix A. Intertidal Ecology

A.1. Intertidal ecology and habitats

The intertidal zone of Aberaeron South Beach is gently sloping, composed of shingle on the upper beach, and sand on the lower beach, which makes it popular with tourists, locals and visitors alike.

Ground investigations undertaken by Quantum Geotech[8] provide information on the seabed characteristics of the area, identifying superficial materials using sidescan sonar. The seabed features identified in the survey are shown in Figure A1. This shows that the seabed exhibits wide spatial variations in sediment features, ranging from fine sands to gravel with cobbles and occasional boulders.

This corresponds to the Regulation 37 Advice, which describes the Range of the rocky reef feature as such: "*Cardigan Bay SAC supports both rocky and biogenic reef types. Its rocky reefs are widespread and in the subtidal form a mosaic with areas of sand and gravel. Reefs in the bay consist largely of boulder, cobble and pebble, but along the beaches and just offshore there are occasional areas of bedrock*." Table A1 shows the areas of the different habitat feature in the Cardigan Bay SAC.

Table A1 - Habitat features in the Cardigan Bay SAC

			Site assessment			
			A B C D	**A B C**	**A B C**	**A B C**
Habitat code	Habitat	Area (Ha)	Habitat Representativity	Relative surface	Degree of conservation	Global assessment
1110	Sandbanks which are slightly covered by sea water all the time	15298.79	C (Significant representatively)	C ≤ 2%	B Good conservation	C Significant value
1140	Mudflats and sandflats not covered by seawater at low tide	153.37	D (Non-significant presence representatively)			
1170	Reefs	22948.18	C (Significant representatively)	B > 2%-15%	B Good conservation	C Significant value
8330	Partially submerged / submerged sea caves	95.86	B (Good representatively)	C ≤ 2%	B Good conservation	C Significant value

[8] Quantum Geotech, "Aberaeron Coastal Defence, Ground Investigation - Ground Investigation Factual Report, Report No. Q0377/FR.01," Quantum Geotech, February 2021.

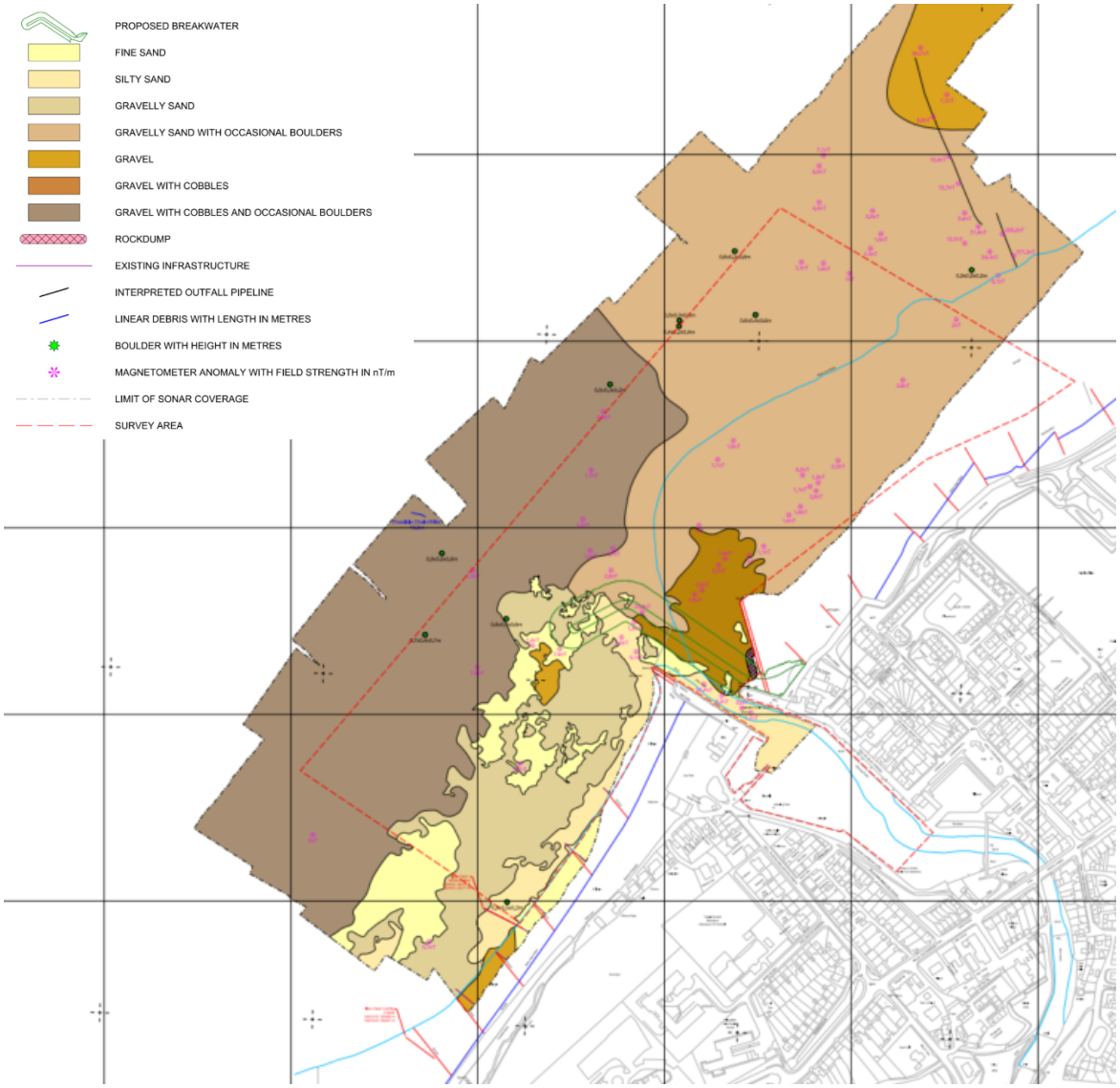

Figure A1 - Interpreted seabed substrate, from sidescan sonar

The Countryside Council for Wales (CCW, now Natural Resources Wales (NRW)) undertook habitat surveys around the whole of the Welsh coast between 2007 and 2010 known as the HABMAP Scheme. Data from this survey Scheme has been downloaded and the intertidal biotopes in the area of the Scheme are presented in

Table A2 (https://naturalresources.wales/about-us/our-Schemes/marine-Schemes/habmap).

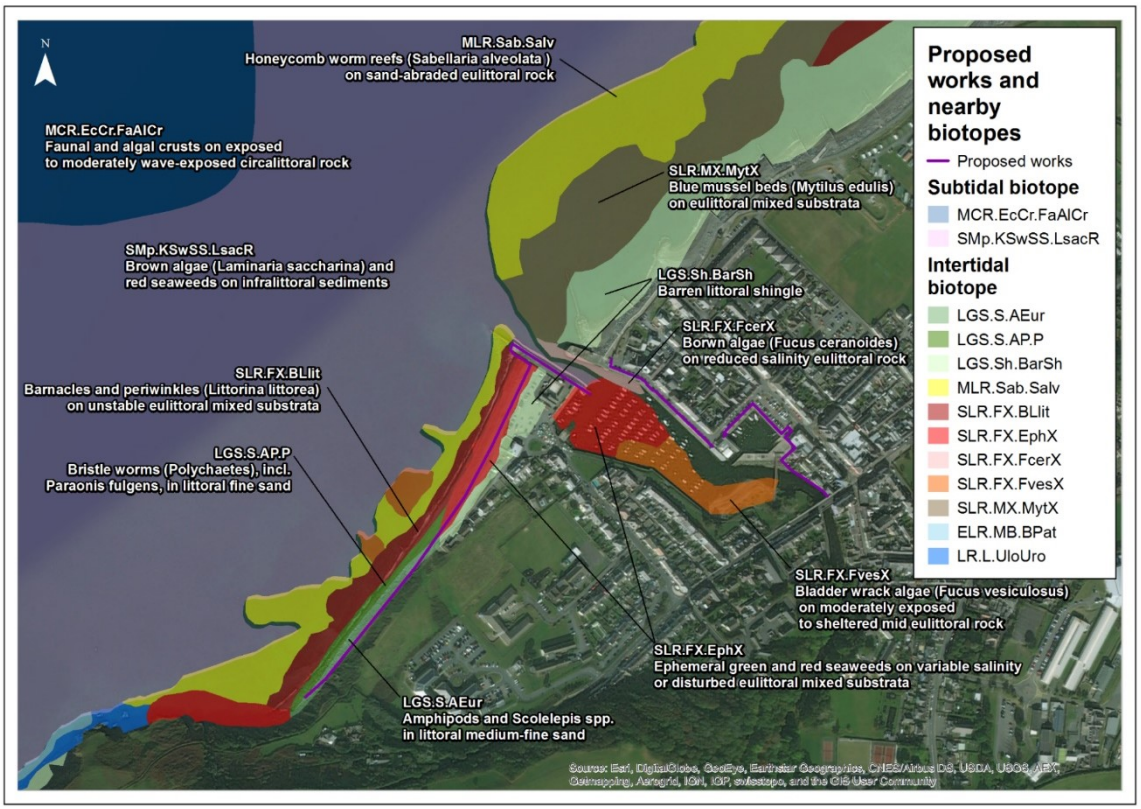

Figure A2 - Intertidal and Subtidal Habitat Map

The descriptions provided of the biotopes have been taken from the corresponding Marine Nature Conservation Review (MNCR) Marine Habitat Classification on the JNCC website[9]. As these surveys were undertaken using previous MNCR classification systems, the biotopes have been converted to the most recent EUNIS (2007) classifications. The biotopes in the area of the Scheme are shown in

[9] http://www.jncc.gov.uk/marine/biotopes/hierarchy.aspx

Table A2.

Table A2 - Intertidal Biotopes in the Scheme Area

Biotope (MNCR)	EUNIS classification 2007	Description
LGS.S.AEur	A2.223	Amphipods and *Scolelepis spp*. in littoral medium-fine sand
LGS.S.AP.P	A2.2311	Polychaetes, including *Paraonis fulgens*, in littoral fine sand
LGS.Sh.BarSh	A2.111	Barren littoral shingle
MLR.Sab.Salv	A2.711	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock
SLR.FX.BLit	A2.431	Barnacles and *Littorina littorea* on unstable eulittoral mixed substrata
SLR.FX.EphX	A2.821	Ephemeral green and red seaweeds on variable salinity or disturbed eulittoral mixed substrata
SLR.FX.FcerX	A1.327	*Fucus ceranoides* on reduced salinity eulittoral rock
SLR.FX.Fves	A1.313	*Fucus vesiculosus* on moderately exposed to sheltered mid eulittoral rock
SLR.MX.MytX	A2.721	*Mytilus edulis* beds on eulittoral mixed substrata
ELR.MB.BPat	A1.1121	*Chthamalus montagui* and *Chthamalus stellatus* on exposed upper eulittoral rock
LR.L.UloUro	B3.115	*Ulothrix flacca* and *Urospora* spp. on freshwater-influenced vertical littoral fringe soft rock

Intertidal habitat types of conservation importance identified within the area of the Scheme include *Sabellaria alveolata* (Honeycomb worm) reefs on sand-abraded eulittoral rock in the area next to South Pier and along South Beach and extending into the subtidal zone.

The Honeycomb worm (*Sabellaria alveolata*) form littoral biogenic reefs (reefs made of living creatures, in the lower intertidal area and shallow subtidal), which help to stabilise the boulders and cobbles. Other species found in this habitat include barnacles *Elminius modestus* and *Semibalanus balanoides*, mussel *Mytilus edulis*, and whelk *Nucella lapillus*. The crab *Carcinus maenas* and the anemone *Actinia equina* can be present in cracks and crevices of the reef.

Despite *Sabellaria* being identified as present in the HABMAP survey, an ecological walkover survey carried out in summer 2019 by a member of the Scheme team, found no *Sabellaria* reefs or encrustations in the intertidal area along South Beach or around the piers. Discussion with NRW Technical Advisory suggests that the intertidal *Sabellaria* beds on South Beach are more ephemeral and do not form such persistent and long term reef structures as those on North Beach (and elsewhere in the SAC).

Mussel beds on North Beach were visible at low tide. Species observed on the wooden groynes and piers included limpets, barnacles and seaweed species.

Mussel (*Mytilis edulis*) beds on eulittoral (lower intertidal area) mixed substrates are located along the North Beach of Aberaeron, and whilst not a habitat feature of the designated sites listed in Table 9.1, mussel beds provide an important food source for wintering wader birds, and 'mussel mud' formed by blue mussel waste is an important source of nutrients for animals living within the seabed (JNCC, 2015).

Within the harbour, the southern shoreline is exposed at low tide, with **Figure A2** showing a habitat type of ephemeral green and red seaweeds as well as bladder wrack algae. The northern shore remains submerged at low tide and comprises a mix of fine river sediment, sand and shingles. The harbour mouth and channel is dredged annually to maintain a navigable depth. The dredged material is recycled onto South Beach.

A drop down video survey was carried out in the area of the proposed Scheme in 2019 to identify habitats across the intertidal and subtidal area (see Figure A3 and Table A3).

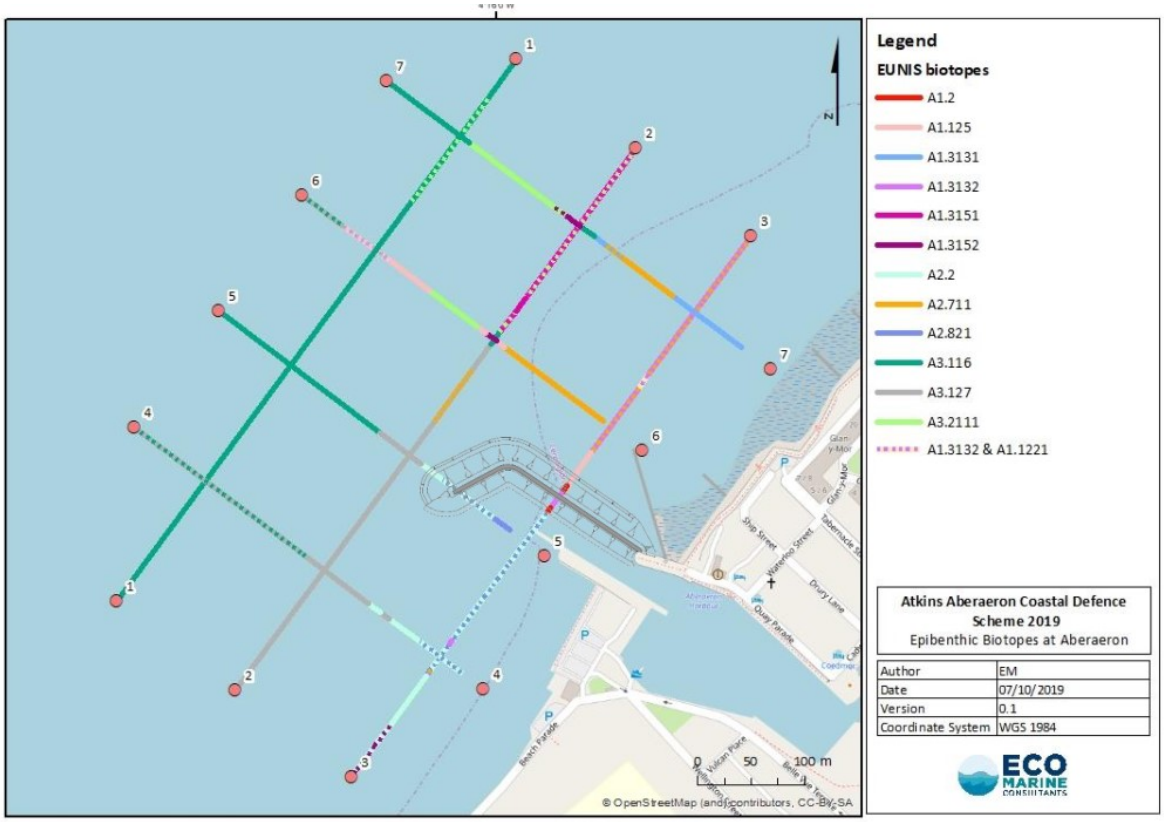

Figure A3 – Drop down video survey transects

Table A3 - Biotopes identified in the drop down video survey

EUNIS Biotope Complex	Habitat Description	Distance Coverage (m)	% Coverage
A1.125 (Level 5)	*Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock (LR.HLR.FR.Mas)	101.93	3.03
A1.2 (Level 3)	Moderate energy littoral rock (LR.M.LR)	14.11	0.42
A1.3131 (Level 5)	*Fucus vesiculosus* on moderately exposed to sheltered mid eulittoral rock (LR.LLR.F.Fves)	92.11	2.74
A1.3131 (Level 5) & A2.711 (Level 5)	*Fucus vesiculosus* on moderately exposed to sheltered mid eulittoral rock (LR.LLR.F.Fves) and *Sabellaria alveolata* reefs on sand-abraded eulittoral rock (LS.LBR.Sab.Salv) mosaic	22.77	0.68
A1.3132 (Level 6)	*Fucus vesiculosus* on mid eulittoral mixed substrata (LR.LLR.F.Fves.X)	22.60	0.67
A1.3132 (Level 6) & A1.1221 (Level 6)	*Fucus vesiculosus* on mid eulittoral mixed substrata (LR.LLR.F.Fves.X) (Level 6) and *Corallina officinalis* and *Mastocarpus stellatus* on exposed to moderately exposed lower eulittoral rock (LR.HLR.FR.Coff.Coff)	14.99	0.45
A1.3151 (Level 5)	*Fucus serratus* on full salinity sheltered lower eulittoral rock (LR.LLR.F.Fserr.FS)	13.85	0.41
A1.3152 (Level 6)	*Fucus serratus* on full salinity lower eulittoral mixed substrata (LR.LLR.F.Fserr.X)	28.39	0.84
A1.3152 (Level 6) & A2.2 (Level 6)	*Fucus serratus* on full salinity lower eulittoral mixed substrata (LR.LLR.F.Fserr.X) and Littoral sand (LS.Lsa)	60.38	1.80

EUNIS Biotope Complex	Habitat Description	Distance Coverage (m)	% Coverage
A1.3152 (Level 6) & A3.2111 (Level 6)	Fucus serratus on full salinity lower eulittoral mixed substrata (LR.LLR.F.Fserr.X) and *Laminaria digitata* on moderately exposed sublittoral fringe bedrock (IR.MIR.KR.Ldig.Ldig) mosaic	13.35	0.40
A2.2 (Level 3)	Littoral sand (LS.Lsa)	127.07	3.78
A2.711 (Level 5)	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock (LS.LBR.Sab.Salv)	171.70	5.11
A2.711 (Level 5) & A1.3132 (Level 6)	*Sabellaria alveolata reefs* on sand-abraded eulittoral rock (LS.LBR.Sab.Salv) and *Fucus vesiculosus* on mid eulittoral mixed substrata (LR.LLR.F.Fves.X)	234.84	6.98
A2.711 (Level 5) & A2.821 (Level 5)	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock (LS.LBR.Sab.Salv) and Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata (LR.FLR.Eph.EphX)	7.57	0.23
A2.821 (Level 5)	Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata (LR.FLR.Eph.EphX)	18.52	0.55
A2.821 (Level 5) & A2.2 (Level 3)	Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata (LR.FLR.Eph.EphX) and Littoral sand (LS.Lsa) (Level 3)	290.66	8.64
A3.116 (Level 5)	Foliose red seaweeds on exposed lower infralittoral rock (IR.HIR.KFaR.FoR)	818.54	24.34
A3.116 (Level 5) & A3.127 (Level 5)	Foliose red seaweeds on exposed lower infralittoral rock (IR.HIR.KFaR.FoR) and *Polyides rotundus, Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock (IR.HIR.KSed.ProtAhn)	251.92	7.49
A3.127 (Level 5)	*Polyides rotundus, Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock (IR.HIR.KSed.ProtAhn)	463.02	13.77
A3.127 (Level 5) & A1.125 (Level 5)	*Polyides rotundus, Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock (IR.HIR.KSed.ProtAhn) and *Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock (LR.HLR.FR.Mas)	55.56	1.65
A3.127 (Level 5) & A2.711 (Level 5)	*Polyides rotundus, Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock (IR.HIR.KSed.ProtAhn) & *Sabellaria alveolata* reefs on sand-abraded eulittoral rock (LS.LBR.Sab.Salv)	62.39	1.86
A3.2111 (Level 6)	*Laminaria digitata* on moderately exposed sublittoral fringe bedrock (IR.MIR.KR.Ldig.Ldig)	155.29	4.62
A3.2111 (Level 6) & A1.3151 (Level 6)	*Laminaria digitata* on moderately exposed sublittoral fringe bedrock (IR.MIR.KR.Ldig.Ldig) and *Fucus serratus* on full salinity sheltered lower eulittoral rock (LR.LLR.F.Fserr.FS)	198.40	5.90
A3.2111 (Level 6) & A3.116 (Level 5)	*Laminaria digitata* on moderately exposed sublittoral fringe bedrock (IR.MIR.KR.Ldig.Ldig) and Foliose red seaweeds on exposed lower infralittoral rock (IR.HIR.KFaR.FoR)	123.16	3.66

The survey report noted that the substrates at Aberaeron were dominated by bedrock, boulders and mixed sediments though occasional large patches of fine sand were present. The nature of the sediment type was patchy across the site though sand was largely restricted to the south western portion and a gradient from sand to coarser sediment was evident from shore to sea. This also corresponds well with the general description of the Range of the reef feature in the Regulation 37 Advice.

These types of habitat appear to fall within two of the three reef geomorphological categories as set out in the R37 advice for the Cardigan Bay SAC[10]:

- Raised areas of hard ground consisting of pebbles, cobbles and boulders. Present both subtidally and intertidally. They cover wide areas and appear to form a patchwork with more mobile patches of sediment.
- Biogenic reefs of the polychaete worm Sabellaria alveolata. Present predominantly in the intertidal, but extending into the subtidal. They grow on top of bedrock and hard ground where wave action suspends the sediment particles required by the worm for reef creation.

A.2. Sabellaria alveolata

Sabellaria alveolata is a polychaete able to build bioconstructions of different thickness, size and patchiness, in intertidal and subtidal environments. The worm reefs are formed by millions of tubes built by sand and shells (whole or in fragments) bonded together with a strong glue produced by the worm.

S. alveolata is found intertidally (although occasionally subtidally, capable of surviving down to 10m) in exposed areas – from exposed, to moderately exposed to very exposed. It can be found across lower eulittoral, mid eulittoral, sublittoral fringe and the upper infralittoral areas of the coast on a range of substrate - bedrock, cobbles, large to very large boulders, pebbles and small boulders. Its salinity preferences are 30 – 40 psu. *Sabellaria* can tolerate local salinity increases but are moderately sensitive to local decreases in salinity (Armstrong et al, 2021), [11] although there is no information relating to its sensitivity to a decrease in salinity on the MarLIN website.

Spawning occurs each July in the UK but actual recruitment levels vary considerably from year to year. Larvae spend between 6 weeks and 6 months in the plankton (MarLIN website) and are concentrated close to the coast (Dubois et al.2007 cited in Lisco et al 2020). It is extremely difficult to model where *Sabellaria* is / isn't going to settle as it is dependent on factors including on sediment supply, a relatively high tidal regime and food sources, but there is currently an incomplete understanding of the circumstances for *Sabellaria* colonisation (Callaway, pers comm 2022). There needs to be both as adult stock and larval supply for *Sabellaria* settlement as *Sabellaria* has a strong settlement preference for adult tubes or sites currently or previously used by *Sabellaria*. Artificial structures and materials seem to be readily colonised by *S. alveolata* when located near existing reefs (Armstrong et al, 2021).

NRW (2019) note that overall, the extent and distribution of *S. alveolata* reefs in Wales 'are thought to be increasing' and that this may be related to factors such as increasing sea water temperature due to climate change, improvements to water quality, periods of good recruitment, and increases in the availability of habitats such as those provided by coastal defence structures.

Individual worms have a life span of 2-5 years although there are records for 7 - 9 year old individuals (MarLIN website[12]), although other sources cite different periods: 4–5 years (Gruet1984, cited in Lisco et al 2020); 1 – 3 years (Callaway pers. comm, 2022).

A reef as a whole is a really fluid system with lots of turnover of individuals (Callaway pers. comm, 2022). *Sabellaria* reefs undergo cycles of development and decay over a period of a few years. Although individual reefs come and go - areas that are good for *Sabellaria* alveolate tend to remain so (MarLIN website).

From an ecological point of view, the role of *Sabellaria* reefs seems to be very important, because they provide a massive increase in the available space for other species; they also accumulate organic deposits that can be important sources of food for other organisms, thus promoting the

[10] NRW, 2018, Cardigan Bay/ Bae Ceredigion Special Area of Conservation Advice provided by Natural Resources Wales in fulfilment of Regulation 37 of the Conservation of Habitats and Species Regulations 2017, https://cdn.cyfoethnaturiol.cymru/media/687993/eng-cardigan-bay-reg-37-report-2018.pdf

[11] Armstrong, S., Pearson, Z., Williamson, D., Frost, N., Scott, C. 2021. Restoring marine and coastal habitats in Wales: identifying spatial opportunities and benefits. NRW Evidence Report No: 554, 96pp, NRW, Cardiff, https://cdn.cyfoethnaturiol.cymru/media/693866/nrw-restoration-opportunities_final-report_word_9july21-002.pdf

[12] MarLIN - The Marine Life Information Network - Honeycomb worm (Sabellaria alveolata) https://www.marlin.ac.uk/species/detail/1129

increase of local biodiversity (Lisco et al 2020). Although the communities associated with these reefs are not necessarily particularly rich, the reefs provide attachment for a variety of macrophytes and epifaunal species, as well as a multi-faceted matrix of cavities for various faunal species (NRW 2019).

The reef at Aberaeron is classed as being a 'platform' by NRW guidance (2019) [13]. Platforms are colonies comprised of newly settled, live, dead or a combination of *Sabellaria*, with an elevation >2cm. Platforms are continuous relatively flat colonies formed by numerous fully coalesced hummocks commonly 50 cm+ in thickness. These colonies are often found on rugose rock or stable consolidated cobbles and/or boulders on which they completely outcompete other sessile fauna. A platform qualifies as 'reef' if the continuous area is >25 m^2.

As the supply of sediment is known to be important for *Sabellaria*, several papers have looked at the particle size range of sands used to build the tubes and reefs.

Lisco et al 2020 looked at a range of factors contributing to the structure of a Sabellaria reef in Ostea, central Italy. Looking at the tube structure shows the grains closest to the void (tube) appear to be placed around it in a regular order, while those outside the tube and between other tubes (intertube), are arranged in a more chaotic way. Figure A4 shows three main sections of the structure - the circular void of the worm; the tube that is built by the worm capturing sand grains; and the sediments that are deposited between adjacent tubes. The top image in Figure A4 was taken under a microscope; the bottom image highlights the three main sectors in different colours. The circular void of the tube is clearly visible in the centre of both images. The tube that is built by the worm capturing sand grains is shown in white in the top image and in red in the bottom. The intertube deposits are shown in grey in in the top image and in yellow in the bottom. The sands located between adjacent tubes (intertube) seem to be less sorted in grain size than the sands directly trapped by the worm (tube). Nevertheless, the fiftieth percentile of the grain-size distribution (D50) has the same dimension in the two sectors, being D50 = 207 ± 48 µm (159 – 255 µm) in the tubes and D50 = 204 ± 37 µm (167 – 241 µm) in the intertube sectors.

[13] Natural Resources Wales (NRW). 2019. Benthic habitat assessment guidance for marine developments and activities A guide to characterising and monitoring Sabellaria reefs. Cardiff: NRW. 63p. https://cdn.cyfoethnaturiol.cymru/media/695526/gn030d-sabellaria-final-accessible.pdf

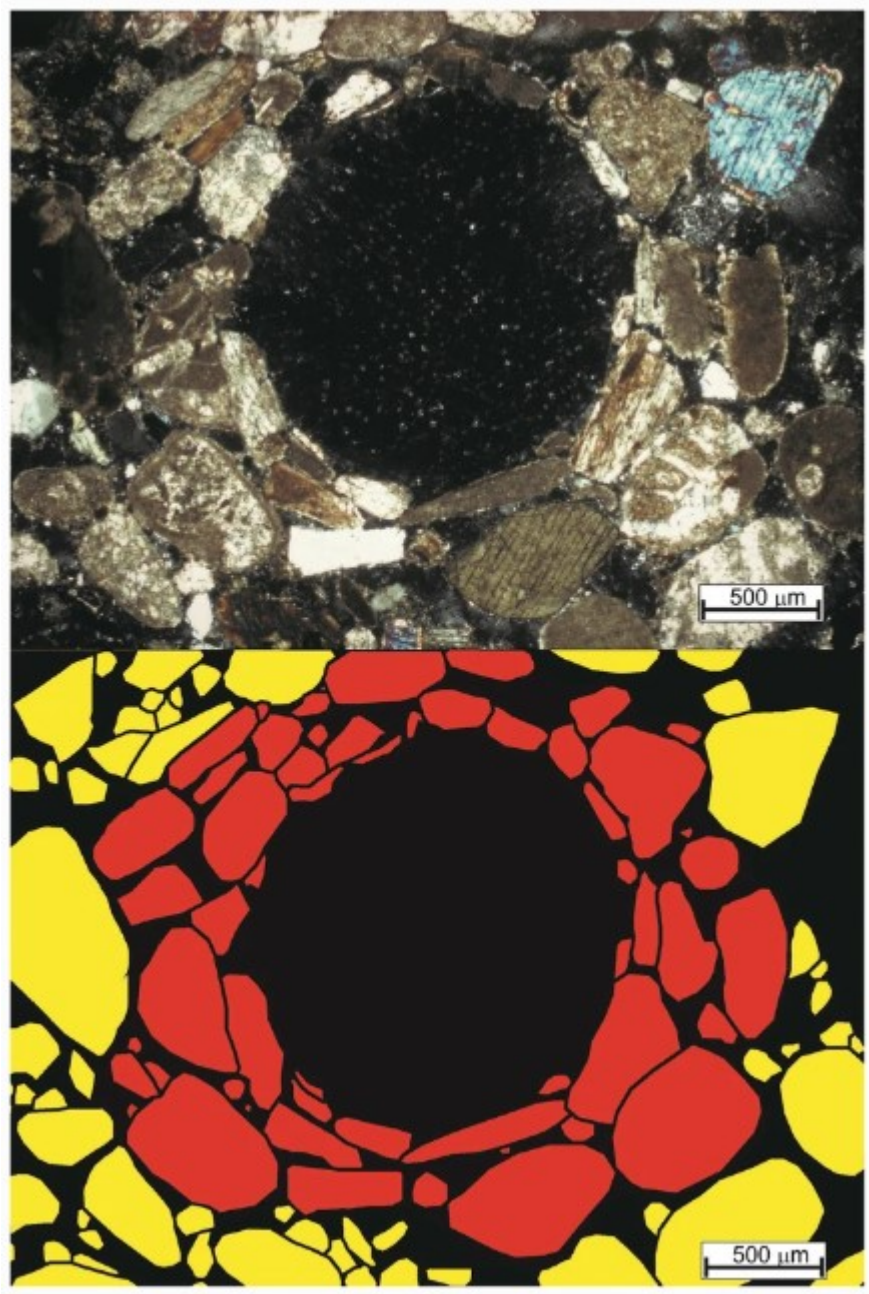

Figure A4 – Example showing the microstructure of Sabellaria congregation, showing the three main sections of the structure

Key - the tube that is built by the worm capturing sand grains (above: in white; below: in red); the intertube deposits (in grey in above; in yellow below).

Grain-size analysis was also carried out by physically sieving sand samples collected from different water depths (0.0 m, − 1.5 m, − 3.5 m, and − 5.0 m). This shows the D50 is variable between 311 µm and 499 µm (Lisco et al 2020). However, if sieving analyses are carried out on disaggregated fragments of the bioconstruction, the results will record both the granulometric distribution of tube and intertube sediments. Carefully isolating single tubes before sieving analyses possibly helps to obtain more representative data for the actual grain size of sediments that the worm traps (Naylor and Viles 2000, cited in Lisco et al 2020). Lisco et al, 2020 present a collation of grain size results from *Sabellaria* reefs from around the world, which show a range of 150µm – 700µm (see Figure A5). This corresponds to sediment types ranging from fine sand (125µm) through to very coarse sand (500µm) and slightly larger, although not as large as very fine gravel (2,000µm) or as small as coarse silt (37µm) or very fine sand (62µm).[14]

[14] The Engineering Toolbox website, Particle Size (engineeringtoolbox.com)

Authors	Taxa (bioconstruction location)	Sample preparation	Grain-size range
Taramelli Rivosecchi (1961)	*Sabellaria alveolata* (Lazio, Italy)	Disaggregation of bioconstruction with a not-specified method	200 µm
Multer and Milliman (1967)	*Phragmatopoma lapidosa* (Florida, America)	Disaggregation of bioconstruction in a sodium hypochlorite solution	125–500 µm
Gruet (1984)	*Sabellaria alveolata* (France)	Single tubes were individually disaggregated with hydrogen peroxide on a hotplate	150–600 µm
Naylor and Viles (2000)	*Sabellaria alveolata* (Great Britain)	Manually separated individual tubes and disaggregation	290–420 µm
Nicoletti et al. (2001)	*Sabellaria alveolata* (Lazio, Italy)	Disaggregation of bioconstruction	250–700 µm
Delbono et al. (2003)	*Sabellaria alveolata* (Liguria, Italy)	Disaggregation of bioconstruction with deionized water washing, automatic dry sieving	400–700 µm

Figure A5 – Literature data on granulometric distribution of reef worm (Lisco et al, 2020)

A.3. Sediment and coastal processes

Sediment analysis was carried out at several locations in Aberaeron Harbour and the area of the proposed new breakwater. Figure A6 shows the location of trial pits (TP) and boreholes (BH) sampled during 2021. Table A4 shows the sediment analysis results of the trial pits. Borehole data is considered to be less relevant as a source of sediment for *Sabellaria*, as it focusses on the underlying sediment, rather than the surficial sediment that would be mobilised and potentially available for reef building.

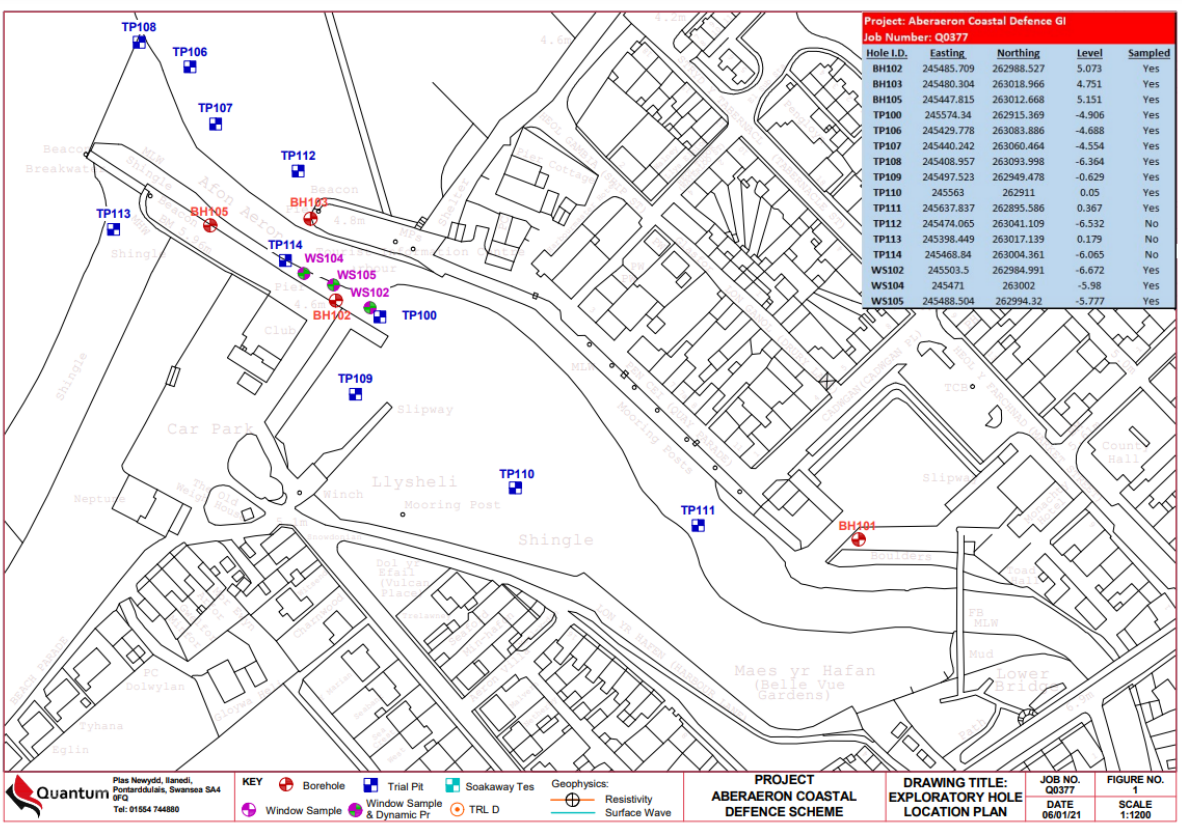

Figure A6 – Location of trial pit (TP) and borehole (BH) samples

Table A4 – Trial pit analysis results

			% dry mass			
Trial Pit	Location description	Sample no.	Cobbles	Gravel	Sand	Silt and Clay
TP100	Harbour entrance – landward end South Pier (not navigation channel)	2	10	79	9	2
TP100	Harbour entrance – landward end South Pier (not navigation channel)	4	12	76	10	2
TP106	New breakwater footprint	2	22	73	4	1
TP107	New breakwater footprint	1	0	37	25	38
TP107	New breakwater footprint	4	0	84	12	4
TP108	New breakwater footprint – seaward end	2	6	82	10	2
TP109	Cei Bach	2	23	60	9	8
TP109	Cei Bach	5	10	79	6	5
TP110	Harbour mooring area	2	0	67	27	6
TP110	Harbour mooring area	4	0	76	18	6
TP111	Harbour navigation channel (opposite Cadwgan Place)	1	32	67	1	0
TP111	Harbour navigation channel (opposite Cadwgan Place)	3	7	84	2	7
TP112	New breakwater footprint	0-0.25m - Brown gravelly fine to medium SAND. Gravel is fine to coarse angular to sub-rounded siltstone sandstone limestone 0.25 – 0.70m - Soft to locally stiff dark grey silty slightly sandy gravelly CLAY with high sub-rounded siltstone sandstone cobble/ boulder content. Sand is fine to medium. Gravel is fine to coarse sub-angular to well-rounded siltstone sandstone 0.70 – 2.8m - Pale brown slightly clayey sandy fine to coarse angular to well-rounded siltstone sandstone quartz GRAVEL with high sub-angular high angular cobble/ boulder content. Sand is fine to coarse.				
TP113	End of South Pier	0.0 – 1.3m - Shingle over brown grey very sandy fine to coarse sub-rounded to well-rounded limestone sandstone GRAVEL with high sub-rounded limestone cobble/ boulder content. Sand is fine to coarse				
TP114	Navigation channel – end of North Pier	0 – 1.2m - Pale brown slightly clayey sandy fine to coarse angular to well-rounded siltstone sandstone quartz GRAVEL with high sub-angular high angular cobble/ boulder content. Sand is fine to coarse.				

TP112, TP113, TP114 – visual inspection only; no sediment analysis

The sediment with the harbour, navigation channel and harbour mouth is dominated by gravel and cobbles, with relatively small proportions of sand. The amount of sand increases in the harbour entrance and around the area where the new breakwater would be situated, which is currently outside of the harbour. There is very little sand in the navigation channel. There is a reasonable proportion of sand in the harbour mooring area – this can be seen from satellite imagery of the harbour, which show the area between Harbour Lane and the navigation channel where the moorings are located to be sandy. The mid harbour bank and the 'beach' at the landward end of Harbour Lane are much more cobbly.

Data from NRW's water quality monitoring station on the River Aeron shows that it contains low levels of suspended sediments. The navigation channel does not silt up and although Ceredigion County Council (CCC) do undertake annual dredging of the harbour, this is confined to the Cei Bach area and is a relatively small volume. This material is placed on South Beach, in accordance with CCC's marine licence and the agreement of NRW.

A conceptual understanding of the sediment transport processes has been developed and discussed / agreed with NRW (Atkins 2022).[15] The coastline is subject to more slope driven processes rather than alongshore sediment drift. Without current coastal management measures, continued landward retreat would be expected. Increased sea level rise will tend to narrow the intertidal area, and allow larger waves to attack the cliffs, accelerating the recession. Some erosion of the clay cliffs at Aberaeron South Beach is occurring and this could over time allow a breach into a lower-lying area behind, adjacent to the southern flank of the harbour. In the long term, the Shoreline Management Plan (SMP) policy for this area closest to South Pier is Managed Realignment.

Sources of beach sediment are limited along this stretch of coastline, predominantly due to the presence of headlands reducing the longshore sediment transport to adjacent bays, as well as the more-resistant hard rock cliff outcrops which are less susceptible to erosion. Erosion of the clay cliffs at Aberaeron South Beach contain little beach supply material and do not have a significant impact on sediment supply. Even at present, there is little sediment transport along the upper shoreline and retaining sediment to the south of the pier is not seen as being critical to management of Aberaeron North Beach (Royal Haskoning, 2011)[16].

Figure A7 shows the baseline conceptual model at Aberaeron. This splits the processes into those affecting the sand (yellow arrows) and the shingle fractions (orange arrows). The key coastal geomorphological features are shown in oval boxes. The associated yellow and orange arrows indicate the direction/s of sediment transport. Anthropogenic influences are shown in black boxes with white text, with their associated dashed arrows indicating the features that they influence. The relative significance of each process is illustrated by the size of the connecting lines/arrows. The dashed red lines indicate the extent of each policy unit.

[15] Atkins, 2022, Detailed Design of Aberaeron Coastal Defence Scheme, Conceptual Understanding of Baseline Geomorphology, 5182114-ATK-MAR-GEN-RP-C-1048

[16] Royal Haskoning 2011, West of Wales Shoreline Management Plan, Microsoft Word - 14 - Section 4 Coastal Area C PDZ8 (grwparfordirolgorllewincymru.cymru), https://www.grwparfordirolgorllewincymru.cymru/sites/default/files/2019-06/4c3%20-%20Section%204%20Coastal%20Area%20C%20PDZ8.pdf

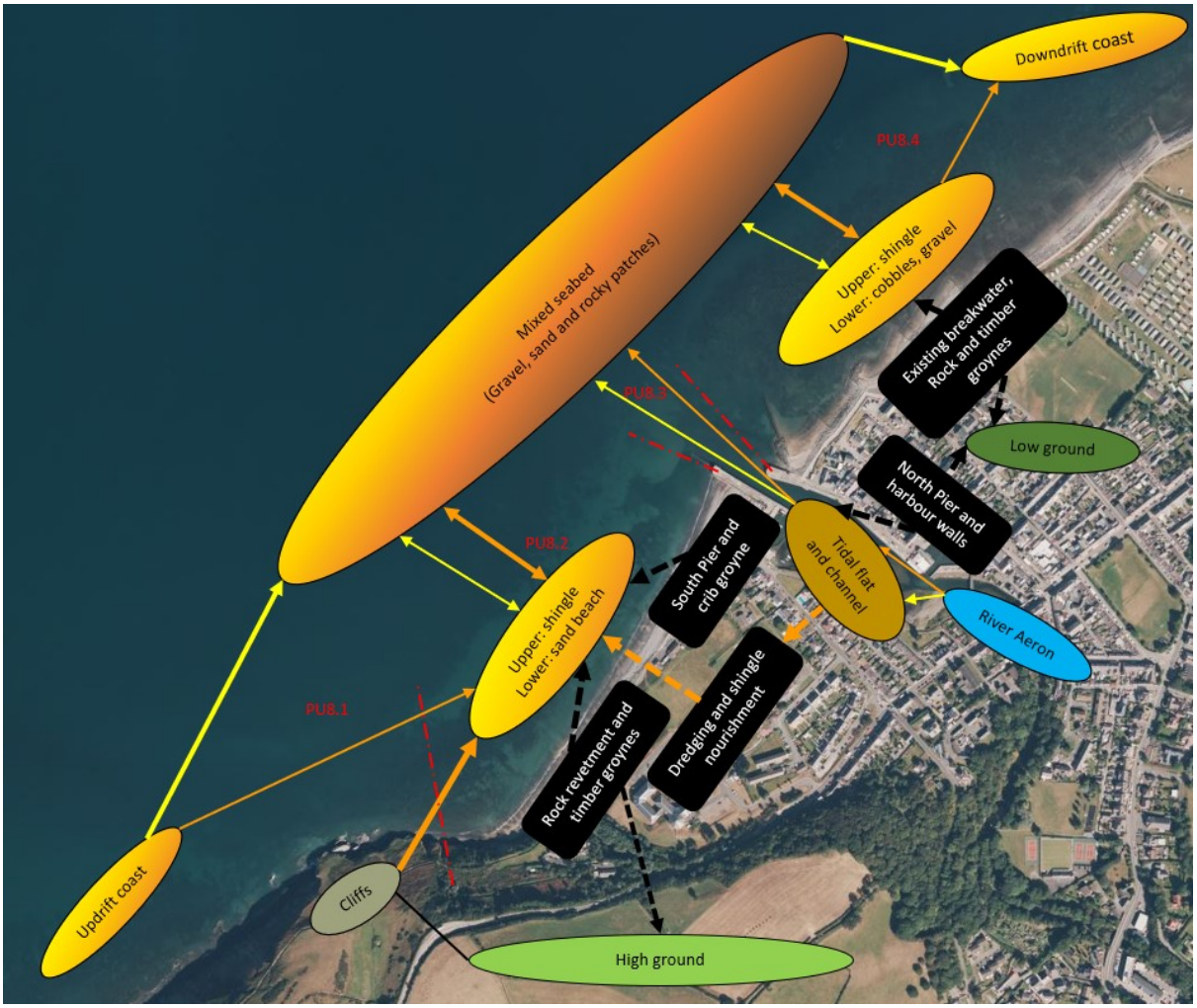

Figure A7 - Conceptual model of baseline coastal geomorphology at Aberaeron

As *Sabellaria* is not reliant on shingle, it is the yellow arrows in the model that are of particular relevance. North beach is a repository of shingle and gravelly sand (from side scan sonar). There is some on / offshore sand transportation between North Beach and the offshore area.

The offshore area contains mixed sand, gravel, cobbles, pebbles and occasional boulders and can be considered to be geogenic reef. Sand is transported to this offshore reservoir from the south (from outside the bay) by offshore processes. There is also some loss of sand from this area northwards further along the coast.

There is some on / offshore sand transportation from South Beach, but as has been indicated, there is limited onshore sand transportation and this beach is gradually eroding, with northwards inshore transportation of sediment toward South Pier.

There is transportation of sediment from the River Aeron to the offshore area. The general northwards direction of the offshore sediment transportation plus the on / offshore flows between North Beach and the offshore area suggest that some of this may feed the *Sabellaria* on North Beach. This is not the only source of sediment for North Beach / the *Sabellaria* reef, as the updrift transportation also feeds the offshore area. NRW water quality data shows that the River Aeron does not contain a large quantity of suspended sediment. Looking at the coast overall, it can be seen that Sabellaria extend north beyond the extent of the SAC boundary as Sabellaria is mapped in Article 17 habitat data as Aberystwyth and beyond. Along this area of coast there are a few small fluvial outfalls but these could not provide a sufficient supply of sediment needed to support such widespread *Sabellaria* growth. It is much more likely that the majority of sediment utilised by *Sabellaria* along the whole coast and on North Beach is marine in nature.

Sediment from the River Aeron is not likely to naturally be deposited on South Beach given its offshore to northwards direction of travel. However, the placement of sediment from CCC's annual dredging

of the harbour on South Beach adds to the South Beach 'source' of sediment, before on / offshore movement and then movement further northwards.

A.4. Changes to sediment and coastal processes

Discussions with NRW Advisory indicate that they have concerns regarding the possible changes that the new breakwater could have on coastal processes. These focus on the possible decrease in sediment supply to the *Sabellaria* reef on North Beach. They do not have concerns regarding any Sabellaria on South Beach as this is considered to be more ephemeral and not creating 'reef' structures (as are defined in NRW, 2019). They also do not have concerns regarding an increase in sedimentation or smothering of North Beach.

Models have been created for bed shear stress, flows and current speed for baseline conditions (now) and to model the potential changes the new breakwater could have on these parameters. Information regarding the models are contained in separate reports. Specific outputs are reproduced in this report.

Four different scenarios were modelled to produce outputs showing the influence of both tidal currents and wave-induced currents. The model scenarios were carried out for a baseline condition and for the inclusion of the breakwater:

- Tide only
- Tide and typical Afon Aeron flows
- 1 in 1 year wave condition and typical Afon Aeron flow
- 1 in 75 year wave condition and Afon Aeron storm flow

The following sections show the run outputs for tide and typical Afon Aeron flows, as these represent 'day to day' conditions that would be experienced following the construction of the breakwater. They therefore represent the conditions that would exert the most influence over the environment in which the *Sabellaria* / reef feature exists.

Changes in current speed

The following figure shows the total areas with at least a 1% relative difference in current speeds from the baseline runs with the presence of the breakwater. It also shows in outline the area of Sabellaria reef monitored by NRW annually. The reef feature of the SAC extends much beyond this outline (as shown in Figure A2)

The plots show areas with mean increases in current speed due to the presence of the breakwater in red, and areas with mean decreases in blue. The reason the plots are not expressed in magnitudes of relative difference (%) is because in some areas, small deviations from the baseline output show large relative differences in the breakwater runs. For example, a current speed output from the baseline run: 0.0002 m/s, and breakwater run: 0.0006 m/s results in a 200% relative increase but would only be a very small actual chance in current speed (and one that would not change the physical conditions of the area to a degree such that it would affect *Sabellaria*, which is highly tolerant of high energy environments – being found in exposed to very exposed areas). The MarLIN sensitivity assessment indicates that *Sabellaria* has low sensitivity to increases in flow rates (MarLIN website)[17]

[17] MarLIN - The Marine Life Information Network - Honeycomb worm (Sabellaria alveolata) https://www.marlin.ac.uk/species/detail/1129

Table A5 - Approximate areas affected by change in current speed >1%.

Model run scenario	Area of increased current speed (m^2)	Area of decreased current speed (m^2)	Total area affected (m^2)
Tide Only	149,900	329,870	479,770
Tide with typical Afon Aeron flow	150,310	332,290	482,600
1 in 1 year wave condition & typical Afon Aeron flow	340,180	249,600	589,780
1 in 75 year wave condition & Afon Aeron storm flow	357,180	156,810	513,990

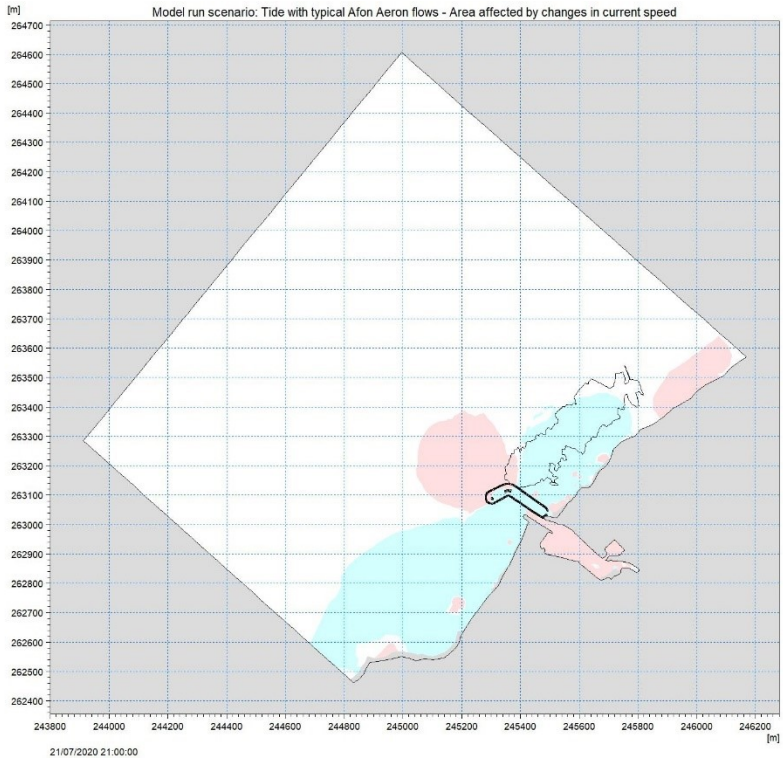

Figure A8 - Run scenario: Tide with typical Afon Aeron flows - Area affected by relative changes in current speed.

Decreases in current speed to the south of the breakwater are to be expected. This may slightly slow the rate of erosion of sand from South Beach, however, it is not expected to affect the overall pattern of sediment movement shown in the conceptual model. Sediment will continue to be lost to the offshore area and move inshore along South Beach towards South Pier.

The decrease in currents on North Beach will similarly not reduce the sediment supply to the *Sabellaria* – reduced flows may retain sediment in the area slightly longer. The MarLIN sensitivity assessment indicates that *Sabellaria* has very low sensitivity to increases in suspended sediment (MarLIN website). Any reductions in currents are not expected to change the overall exposure of the area, such that it would no longer be an exposed shore, thereby impacting the conditions required for *Sabellaria* presence. This area of influence does not extend much beyond the offshore extent of the monitored *Sabellaria* reef area and only along the shore a maximum of approximately 500m, some of which is on 'barren littoral shingle' (LGS.Sh.Bar.Sh). There is a slight area of increase in current speed on the upper shore further north, also on 'barren littoral shingle' (LGS.Sh.Bar.Sh). This habitat is not expected to change as a result of either increases or decreases in current speed, so there will be no impact to the intertidal reef feature in this area.

Some increases in flow are shown in a localised area off the end of the new breakwater. The breakwater is 220m long and this area of influence is approximately the same length again, extending ~250m offshore. This is in an area of infralittoral rock with the biotopes IR.HIR.KSed.ProtAhn '*Polyides rotundus, Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock' and IR.HIR.KFaR.FoR 'Foliose red seaweeds on exposed lower infralittoral rock'. While there is clearly some sand in this area, it is not across the whole area and the changes are very limited to the immediate area of the breakwater (within 250m). A slight increase in flow may increase the mobilisation of sediment in this area, but as it does not extend beyond 250m, it will not affect overall sediment processes or impact on the source of sediment for *Sabellaria*. The MarLIN sensitivity assessment indicates that *Sabellaria* has low sensitivity to increases in flow rates (MarLIN website).

The total area that might be affected by any change in current speed >1% is therefore that area on North Beach affected by a decrease in current speed plus the area at the end of the new breakwater affected by an increase in current speed. While it can be seen that much of the *Sabellaria* on North Beach within 500m of the new breakwater is affected by a change in flow, this needs to be considered in the context of what those changes mean to the biology of the *Sabellaria* in this area, as well as in the context of the feature of the SAC.

The area affected near Aberaeron is within 500m of the new breakwater. The reef feature extends approximately 2.5km (2,500m) north from Aberaeron to the edge of the SAC. In total there is almost 22,948 Ha (229,480,000m^2) of reef feature within the SAC.

Table A8 - Approximate areas affected by change in current speed >1% for tide with typical Afon Aeron flow

	Location of change	Area (m2)
1	South Beach area of decrease	228,789
2	South Beach area of increase	2,274
3	Aberaeron Harbour / mouth	27,690
4	Seaward of the new breakwater	85,611
5	North Beach area of decrease	101,075
6	North Beach area of increase	34,326

The area of *Sabellaria* from the mouth of Aberaeron harbour to the edge of the SAC is 96,333m^2 [18]. The area of total intertidal reef feature in the same location is 257,413m^2. Not all of the area affected by a change is either Sabellaria or reef feature (as Figure A9 shows, the upper area of the shore accounts for approximately half of the area of impact, which is not part of the SAC feature). The area of SAC feature affected is therefore approximately a maximum of 20% of the SAC feature between Aberaeron and the edge of the designation, which itself is only about 1% of the total SAC reef feature (of 22,948,000m^2). The area affected is a maximum of approximately 0.08% of the SAC reef feature.

The plots show all relative changes in current speed >1% between the baseline and breakwater models. The range of actual current speed in the baseline and breakwater models is shown in Table A9. This shows that the absolute change in the range of current speed of the baseline compared to the breakwater models are very small. This means that even large relative changes (much greater than 1%) are very small in absolute terms. The changes are too small to significantly alter the overall coastal processes or change the conceptual model of and transport process for sediment in the area. They are too small to affect the exposure climate of the area – it will remain an exposed coast with the same coastal processes as shown in Figure A7. As such, these very small changes are not expected to impact the *Sabellaria* reef, or the wider intertidal reef feature. They are also too small to significantly impact the subtidal reef feature of the SAC.

[18] 51397 + 10749+9631 + 24556) + (54778 + 74641 + 1996 + +758 + 6323 + +2003 + 2756 + 530 + 10654 + 6643) polygon areas, DataMapWales

Table A9 – Absolute change in the range of current speeds between baseline and breakwater models for Tide with typical Afon Aeron flows

	Over whole model		Over Sabellaria Reef on North Beach	
	BASELINE CURRENT SPEED [M/S]	WITH BREAKWATER CURRENT SPEED [M/S]	BASELINE CURRENT SPEED [M/S]E	WITH BREAKWATER CURRENT SPEED [M/S]
MAX	0.65	0.65	0.25	0.25
MIN	0.00	0.00	0.08	0.08
RANGE	0.65	0.65	0.17	0.17
MEAN	0.21	0.20	0.19	0.19

The maximum area over which any change in current speeds occur are spatially limited around the new breakwater and that this area of influence is within 500m – 1km of the structure. The spatial extent of these changes are insufficient to materially alter the wider coastal processes impacting the supply of sediment to the area.

Furthermore, the absolute changes in current are very small such that they will not change the volume or grain size of sediment mobilised in the area sufficiently to alter the among or type of sediment available for *Sabellaria*.

Given the very high likelihood that the main source of sediment for *Sabellaria* is marine, the lack of impact to coastal processes, the geographically limited area over which any changes will take place and the very small magnitude of those changes, along with the very large area of *Sabellaria* and intertidal reef in the SAC, any changes to the current speed will be too small and too localised to significantly impact the subtidal reef feature of the SAC.

The changes are very small and very localised such that changes to the geology, sedimentology, geomorphology, hydrography and meteorology, water and sediment chemistry and biological interactions that take place along the coast, as these are driven by much larger processes which will not be interrupted or affected by the presence of the breakwater. The physical biological and chemical structure and functions necessary for the long-term maintenance and quality of the structure and function of habitat will not be affected.

Changes in bed shear stress

The following figures express the total areas with at least a 1% relative difference in current speeds from the baseline runs with the presence of the breakwater. The plots show areas with mean increases in bed shear-stress due to the presence of the breakwater in red, and areas with mean decreases in blue. The reason the plots are not expressed in magnitudes of relative difference (%) is because in some areas, small deviations from the baseline output show large relative differences in the breakwater runs. For example, a bed shear-stress output from the baseline run: 0.001 N/m^2, and breakwater run: 0.002 N/m^2 results in a 100% relative increase but would only be a very small actual chance in bed shear stress (and one that would not materially change the size of sediment that would be mobilised, either increasing or decreasing the amount of type of sediment available to *Sabellaria*, which can utilise a range of sand particle sizes and is highly tolerant of high energy environments – being found in exposed to very exposed areas).

Table A10 - Approximate areas affected by change in bed shear-stress.

Model run scenario	Area of increased bed shear-stress (m^2)	Area of decreased bed shear-stress (m^2)	Total area affected (m^2)
Tide Only	278090	437590	715680
Tide with typical Afon Aeron flow	285040	445160	730200
1 in 1 year wave condition & typical Afon Aeron flow	558410	291800	850210
1 in 75 year wave condition & Afon Aeron storm flow	645560	163490	809050

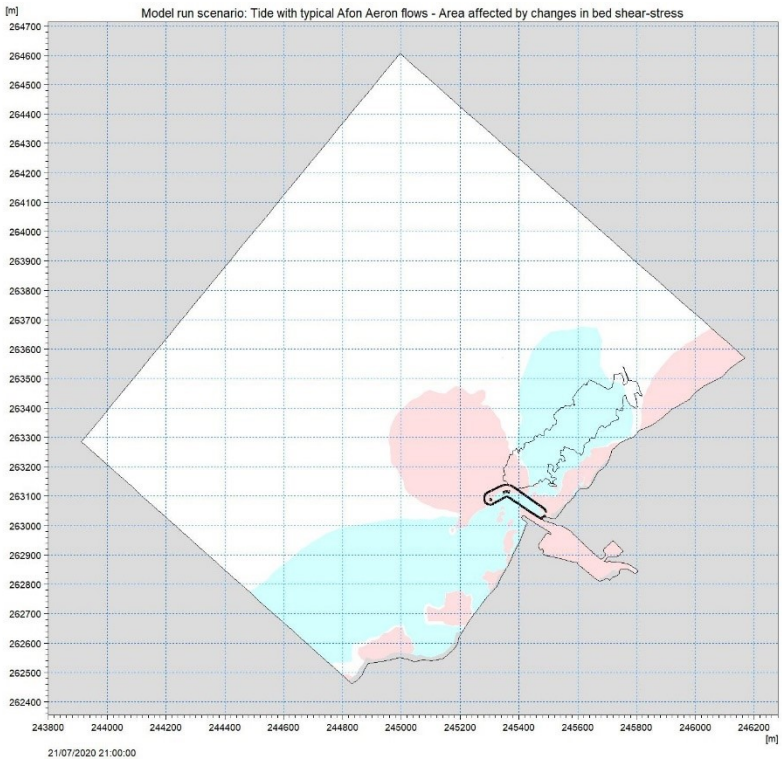

Figure A9 - Run scenario: Tide with typical Afon Aeron flows – Area affected by relative changes in bed shear-stress.

Similar patterns in the changes to bed shear stress can be seen as to those in the current model outputs – the same general areas experience a relative increase or decrease in bed shear stress. The size of area affected by relative changes in bed shear stress are greater than those for changes in current speed, but still restricted to approximately 600m from the breakwater. This may mobilise slightly larger particles of sediment in this area. The general on / offshore and northerly sediment processes are not expected to change as a result of this change.

A reduction in bed shear stress on South Beach corresponds to a decrease in current speed in this area and may also help retain sediment in the area, slightly reducing the rate of beach lowering / erosion in this area.

The change in bed shear stress in the harbour may mobilise more / larger sediment particles in the harbour area, which may slightly increase sediment transport. The reduction immediately in the

'shadow' to the south of the new breakwater could then cause this to reduce with sediment not being transported as far from the harbour mouth. This may increase the rate of sedimentation in the approach to the harbour, which may result in a need for dredging. As the intent would be to continue the practice of adding any dredged sediment to South Beach, the overall transportation of sediment from the river to the coastal area is unlikely to be affected significantly.

The decrease in bed shear stress on North Beach will similarly not reduce the sediment supply to the *Sabellaria* and may retain sediment in the area slightly longer. The MarLIN sensitivity assessment indicates that *Sabellaria* has very low sensitivity to increases in suspended sediment (MarLIN website). Any reductions in bed shear stress are not expected to change the overall exposure of the area, such that it would no longer be an exposed shore, thereby impacting the conditions required for *Sabellaria* presence. This area of influence extends into the subtidal area beyond the offshore extent of the monitored *Sabellaria* reef area by no more than about 300m and only along the shore a maximum of approximately 500m, some of which is on 'barren littoral shingle' (LGS.Sh.Bar.Sh). There is also an area of increase in bed shear on the upper shore further north, also on 'barren littoral shingle' (LGS.Sh.Bar.Sh). This habitat is not expected to change as a result of either increases or decreases in current speed, so there will be no impact to the intertidal reef feature in this area (these areas are also outside of the SAC feature).

Some increases in bed shear are shown in a localised area off the end of the new breakwater. The breakwater is 220m long and this area of influence is approximately twice the length again, extending no more than ~600m offshore. This is in an area of infralittoral rock with the biotopes IR.HIR.KSed.ProtAhn '*Polyides rotundus, Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock' and IR.HIR.KFaR.FoR 'Foliose red seaweeds on exposed lower infralittoral rock'. While there is clearly some sand in this area, it is not across the whole area and the changes are limited to the immediate area of the breakwater (within 600m). A slight increase in bed shear stress may increase the mobilisation of sediment in this area, but as it does not extend beyond 600m, it will not affect overall sediment processes or impact on the source of sediment for *Sabellaria*.

The total area that might be affected by any change in bed shear stress >1% is therefore that area on North Beach affected by a decrease in current speed plus the area at the end of the new breakwater affected by an increase in current speed. While it can be seen that much of the Sabellaria on North Beach within 500m of the new breakwater is affected by a change in flow, this needs to be considered in the context of what those changes mean to the biology of the *Sabellaria* in this area, as well as in the context of the feature of the SAC.

The area affected near Aberaeron is within 500m - 600m of the new breakwater. This feature extends approximately 2.5km (2,500m) north from Aberaeron to the edge of the SAC. In total there is almost 22,948 Ha (229,480,000m^2) of reef feature within the SAC.

Table A11 - Approximate areas affected by change in bed shear stress >1% for tide with typical Afon Aeron flow

	Location of change	Area (m2)
1	South Beach area of decrease	288,749
2	South Beach area of increase	2,274
3	Aberaron Harbour / mouth	27,690
4	Seaward of the new breakwater	85,611
5	North Beach area of decrease	101,075
6	North Beach area of increase	34,326

The area of *Sabellaria* from the mouth of Aberaeron harbour to the edge of the SAC is 96,333m^2 [19]. The area of total intertidal reef feature in the same location is 257,413m^2. Not all of the area affected by a change is either *Sabellaria* or reef feature (as Figure A9 shows, the intertidal area below the edge of the reef accounts for approximately half of the area of impact, which is not part of the SAC feature). The area of SAC feature affected is therefore a maximum of 20% of the SAC feature between Aberaeron and the edge of the designation, which itself is only about 1% of the total SAC reef feature (of 22,948,000m^2). The area affected is a maximum of approximately 0.08% of the SAC reef feature.

[19] 51397m2 + 10749m2+9631m2 + 24556 m2) + (54778 + 74641 + 1996 + +758 + 6323 + +2003 + 2756 + 530 + 10654 + 6643) polygon areas, DataMapWales

The plots show all relative changes in bed shear stress >1% between the baseline and breakwater models. The range of actual bed shear stresses in the baseline and breakwater models is shown in Table A12. This shows that the absolute change in the range of bed shear stresses of the baseline compared to the breakwater models are very small. This means that even large relative changes (much greater than 1%) are very small in absolute terms. The changes are too small to significantly alter the overall coastal processes or change the conceptual model of and transport process for sediment in the area. They are too small to affect the exposure climate of the area – it will remain an exposed coast with the same coastal processes as shown in Figure A7. As such, these very small changes are not expected to impact the Sabellaria reef, or the wider intertidal reef feature. They are also too small to significantly impact the subtidal reef feature of the SAC.

Table A12 – Absolute change in the range of bed shear stress between baseline and breakwater models for Tide with typical Afon Aeron flows

	Over whole model		Over Sabellaria Reef on North Beach	
	BASELINE BED SHEAR STRESS [N/m^2]	WITH BREAKWATER BED SHEAR STRESS [N/m^2]	BASELINE BED SHEAR STRESS [N/m^2]	WITH BREAKWATER BED SHEAR STRESS [N/m^2]
MAX	16.95	16.93	1.29	1.27
MIN	0.00	0.00	0.22	0.11
RANGE	16.95	16.93	1.07	1.16
MEAN	1.00	0.96	0.86	0.71

The maximum area over which any change in bed shear stress occurs are spatially limited around the new breakwater and that this area of influence is within 500m – 1km of the structure. The spatial extent of these changes are insufficient to materially alter the wider coastal processes impacting the supply of sediment to the area.

Furthermore, the absolute changes in bed shear stress are very small such that they will not change the volume or grain size of sediment mobilised in the area sufficiently to alter the among or type of sediment available for *Sabellaria*.

Given the very high likelihood that the main source of sediment for *Sabellaria* is marine, the lack of impact to coastal processes, the geographically limited area over which any changes will take place and the very small magnitude of those changes, along with the very large area of *Sabellaria* and intertidal reef in the SAC, any changes to bed shear stress will be too small and too localised to significantly impact the subtidal reef feature of the SAC.

The changes are very small and very localised such that changes to the geology, sedimentology, geomorphology, hydrography and meteorology, water and sediment chemistry and biological interactions that take place along the coast, as these are driven by much larger processes which will not be interrupted or affected by the presence of the breakwater. The physical biological and chemical structure and functions necessary for the long-term maintenance and quality of the structure and function of habitat will not be affected.

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