Advice on Physical Processes for Small-scale Marine and Coastal Projects

Report No: 624

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Diben yr adroddiad hwn yw rhoi arweiniad ar sut i ystyried prosesau ffisegol morol ac arfordirol wrth ymgymryd â gweithgareddau ar raddfa fach. Bwriedir i'r canllawiau hyn gael eu defnyddio gan ystod o ymarferwyr gan gynnwys:

- Awdurdodau Lleol,
- Gweithredwyr morol ac arfordirol (e.e. porthladdoedd, marinas ac yn y blaen),
- Datblygwyr,
- Perchnogion tir preifat, a
- Swyddogion achos Cyfoeth Naturiol Cymru (CNC).

Mae prosesau ffisegol morol ac arfordirol yn disgrifio'r cyfuniad o hydrodynameg (tonnau, cerrynt a lefelau dŵr), gwaddodion a daeareg, a thopograffeg/morffoleg gwely'r môr. Mae gan brosiectau neu weithgareddau sy'n arwain at ymyriadau ffisegol yn yr amgylchedd morol ac arfordirol y potensial i effeithio ar y prosesau hyn, a all yn ei dro gael effaith ar gynefinoedd a rhywogaethau morol sensitif.

Mae CNC wedi cyhoeddi canllawiau ar ystyried prosesau ffisegol morol ac arfordirol ar gyfer prosiectau ar raddfa fawr (megis Asesiadau o'r Effaith Amgylcheddol (AEA)) (Nodyn Cyfarwyddyd 041 CNC): bwriad y cyngor hwn yw llywio'r gwaith o ddatblygu canllawiau ategol ar gyfer prosiectau a gweithgareddau ar raddfa lai, nad ydynt yn rhai AEA. Gallai'r rhain gynnwys:

- Carthu a gwaredu (gan gynnwys defnydd buddiol o waddodion a garthwyd),
- Gwaith bach ar seilwaith arfordirol,
- Ailbroffilio traethau ac ailgylchu gwaddodion,
- Clirio sianeli draenio a gollyngfeydd,
- Cynaeafu gwymon,
- Trwsio pontydd,
- Clirio ordnans sydd heb ffrwydro (UXO),
- Gwaith ymchwilio tir,
- Tynnu strwythurau o wely'r môr, a
- Gosod seilwaith mewn marinas (angorfeydd, pontynau ac yn y blaen).

Ar gyfer pob un o'r gweithgareddau hyn, cynhyrchwyd 'cerdyn pwnc' sy'n nodi'r wybodaeth sylfaenol sydd ei hangen i lywio'r asesiad o'r math o weithgaredd, cwestiynau cyffredinol sy'n ymwneud â maint a math yr effeithiau a allai godi, canllawiau perthnasol i lywio'r asesiad, a ffynonellau gwybodaeth defnyddiol eraill.

Mae'r canllawiau'n nodi cyfres o gamau gweithredol sy'n eich galluogi i nodi newid posibl mewn modd gwrthrychol. Ceir hefyd gyfres o offer a thechnegau y gellir eu defnyddio i fesur yr ardal lle gallai fod newidiadau (ac effeithiau dilynol ar yr amgylchedd). Gelwir yr ardal hon yn 'barth dylanwad'.

Yn olaf, ar gyfer pob math o brosiect/gweithgaredd, nodwyd ystod o fesurau rheoli posibl a allai leihau neu osgoi effeithiau ar y prosesau ffisegol morol ac arfordirol. Mae'r mesurau hyn wedi'u llywio gan brofiad yr awduron ynghyd â chanllawiau cyhoeddedig.

Executive summary

The purpose of this report is to provide information on how to consider marine and coastal physical processes when undertaking small scale activities. This report is intended for use by a range of practitioners including:

- Local Authorities,
- Marine and coastal operators (e.g. ports, marinas etc),
- Developers,
- Private landowners, and
- Natural Resources Wales (NRW) case officers.

Marine and coastal physical process describe the combination of hydrodynamics (waves, currents and water levels), sediments and geology, and the topography/morphology of the seabed. Projects or activities leading to physical interventions in the marine and coastal environment have the potential to affect these processes, which can in turn have impacts on sensitive marine habitats and species.

NRW has published guidance on consideration of marine and coastal physical processes for large (Environmental Impact Assessment (EIA)) scale projects (NRW Guidance Note 041): this report is intended to inform development of complementary guidance for smaller scale, non EIA projects and activities. These could include:

- Dredging & disposal (including beneficial use of dredged sediments),
- Minor works to coastal infrastructure,
- Beach re-profiling & sediment recycling,
- Clearance of drainage channels & outfalls,
- Seaweed harvesting,
- Bridge repairs,
- Unexploded ordnance (UXO) clearance,
- Ground investigation works,
- Structure removal from seabed, and
- Marina infrastructure installation (moorings, pontoons etc).

For each of these activities, a ‘topic card’ has been produced which sets out the baseline information required to inform the assessment of the activity type, general questions relating to the scale and type of impacts that might arise, relevant guidance to inform the assessment, and other useful sources of information.

The report sets out a series of procedural steps which enable objective determination of potential change along with a series of tools and techniques which may be used to quantify the area across which changes (and subsequent impacts to the environment) may occur. This area is termed the ‘zone of influence’.

Finally, for each project/ activity type a range of potential management measures have been identified which could reduce or avoid impacts on marine and coastal physical processes. These measures have been informed by author experience along with published guidance.

1 Introduction

1.1 Background

Natural Resources Wales (NRW) is frequently required to provide comment on a range of small-scale activities which may have an impact on marine and coastal physical processes. These enquiries may arrive through various consultation routes and be associated with different stages of the activity or project lifecycle. This technical advice aims to explain why some understanding of marine and coastal physical processes matters, what effects might be expected in relation to different projects and activities, what information would be useful to enable NRW provide advice to help inform the project and also where this information might be obtained from.

This report is intended for use by a range of practitioners including:

- Local Authorities,
- Marine and coastal operators (e.g. ports, marinas etc),
- Developers,
- Private landowners, and
- NRW case officers.

It is intended to be used to support consideration of the following project types:

- Dredging & disposal (including beneficial use of dredged sediments),
- Minor works to coastal infrastructure,
- Beach re-profiling & sediment recycling,
- Clearance of drainage channels & outfalls,
- Seaweed harvesting,
- Bridge repairs,
- Unexploded ordnance (UXO) clearance,
- Ground investigation works,
- Structure removal from seabed, and
- Marina infrastructure installation (moorings, pontoons etc).

All of the above projects and activities fall below the threshold for an Environmental Impact Assessment, as set out in The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2017 (legislation.gov.uk). Accordingly, the advice has been tailored to be proportionate to the scale of activity and the levels of impact that can reasonably be expected. Advice on marine and coastal physical processes for projects which require Environmental Impact Assessment is available in NRW's Guidance Note 041. The GN041 guidance includes the design of survey and monitoring strategies, and the application of numerical modelling for marine development projects.

Finally, it is noted that the consideration of contaminated sediments falls out with the remit of this report.

1.2 Aims and objectives

The aim of this report is to set out a series of procedural steps which enable objective determination of the potential changes to marine and coastal physical process associated with the small-scale activities previously listed in Section 1.1.

A series of objectives have been identified which underpin this overarching aim:

- To describe the types of marine and coastal physical process changes which may occur with coastal and marine projects/ activities,
- To outline what information is required to inform assessment of potential change(s),
- To establish how to determine the potential for deleterious environmental effects, arising from the activity or project, and
- To provide examples of how potential adverse impacts can be avoided, reduced or mitigated.

1.3 Report structure

The document is structured as follows:

- **Section 2:** Why is understanding potential changes to marine and coastal physical processes important?
- **Section 3:** What are the types of changes that may occur from my project/ activity?
- **Section 4:** What information is required to inform my project?
- **Section 5:** How can potential adverse impacts be avoided, reduced or mitigated?
- **Section 6:** What other relevant NRW guidance is available?

For each of the projects/ activities covered by this report a ‘topic card’ has been produced (Appendix A) which sets out the baseline information required for each activity type, along with useful information sources. These useful baseline information sources are also summarised in Appendix B.

2 Why is understanding potential changes to marine and coastal physical processes important?

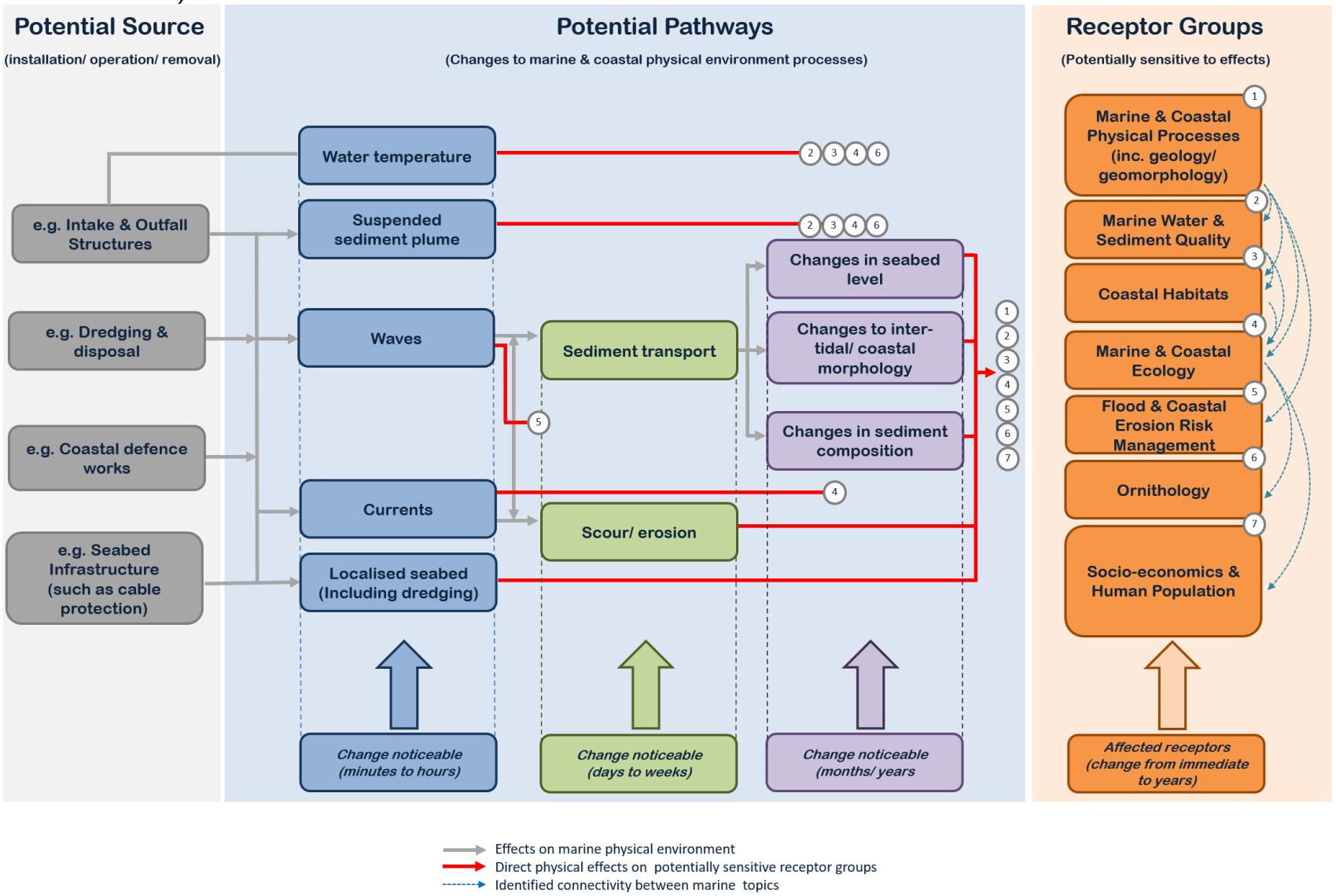
In order to ascertain the potential for a project or activity to impact the marine environment, it is first necessary to understand the potential changes to marine and coastal physical processes. Marine and coastal physical processes is a collective term encompassing the natural cycle of tides, the movement of currents, the wind and wave climate, and the subsequent movement of sediment. Collectively, these processes shape the physical characteristics (or 'morphology') of the seabed and coast and fundamentally influence the marine and coastal environment.

Changes to marine and coastal physical processes have the potential to directly and indirectly impact a wide range of environmental receptor groups (such as coastal habitats (saltmarsh, sand dune, shingle and sea cliff), water quality, intertidal and subtidal benthic ecology, marine mammals, fisheries, recreation and tourism). For instance:

- The creation and dispersion of sediment plumes - a physical process - may lead to settling of material onto benthic habitats, causing smothering or affecting filter feeders, thus impacting sensitive ecological receptors. The plumes themselves may also affect water quality and impact ecological receptors through issues related to light attenuation,
- Scour around marine infrastructure may lead to a loss or modification of a seabed habitat and the requirement for scour protection,
- Coastal defence and beach management works could result in a change to the substrata (sediment type) of the beach, which may impact on its amenity value.

This potential interaction between marine and coastal physical processes and other environmental receptor groups is illustrated in Figure 1. It is noted that for the most part marine and coastal physical processes are not in themselves 'receptors' but are instead 'pathways'.

Figure 1. Examples of relationships between marine and coastal physical processes and other environmental receptor groups (Adapted from Brooks et al. 2018)



3 What are the types of changes that may occur from my project/ activity?

Projects and activities in marine and coastal environments may either temporarily or permanently alter marine and coastal physical processes, potentially leading to change in the form and character of the seabed and water column, with consequential impacts to environmental receptors (Figure 1). These changes may come about directly (such as through the installation of infrastructure onto the seabed) or indirectly as a consequence of a change to a pathway (Figure 1).

Whilst this technical advice note covers a range of activities, for any project it is possible to categorise the range of potential changes which may occur to marine and coastal physical processes into three broad categories, namely:

- 'Sediment disturbance' (by an activity),
- 'Changes to seabed level' (i.e. the formation of pits and mounds), and/or
- 'Blockage' (presented by an obstacle).

Sediment disturbance related changes generally happen when infrastructure is installed or removed from the seabed, or when an activity (such as dredging) is being undertaken. These changes are usually temporary and are typically:

- Elevations in suspended sediment concentrations, and
- Associated (in-direct) changes in seabed level or seabed sediment type due to resettling of the suspended sediment elsewhere.

Changes to seabed level (giving rise to pits and mounds) are generally associated with levelling, excavation (dredging) and associated disposal activities. A decrease in bed level (e.g. dredging) or an increase in bed level (e.g. material disposal) may give rise to secondary effects. These include:

- Changes to the tidal current/ wave regime,
- Changes to the sediment transport regime, and
- Associated (in-direct) changes to seabed morphology resulting from the above processes.

Blockage related changes associated with installed infrastructure will likely be present throughout its operational lifetime but can also occur during installation and removal. The issues typically requiring consideration are:

- Changes to the tidal current/ wave regime,
- Changes to the sediment transport regime,
- Associated (in-direct) changes to seabed morphology resulting from the above processes, and
- Scour development around infrastructure/ plant.

Examples of small-scale activities and the potential changes to marine and coastal physical processes associated with them are set out in Table 1.

Table 1. Examples of small-scale activities and the potential changes to marine and coastal physical processes. ‘x’ indicates potential changes, ‘n/a’ indicated not applicable.

Project type	**Sediment disturbance (by activity)** Increase in Suspended Sediment Concentration	**Sediment disturbance (by activity)** Deposition / Smothering	**Direct changes to seabed level (formation of pits and mounds)** Changes in patterns of currents & waves	**Direct changes to seabed level (formation of pits and mounds)** Changes in patterns of sediment transport	**Direct changes to seabed level (formation of pits and mounds)** In-direct changes to seabed morphology	**Blockage (presented by an obstacle)** Changes in patterns of currents & waves	**Blockage (presented by an obstacle)** Changes in patterns of sediment transport	**Blockage (presented by an obstacle)** In-direct changes to seabed morphology	**Blockage (presented by an obstacle)** Seabed scouring
Dredging & disposal	x	x	x	x	x	n/a	n/a	n/a	n/a
Minor works to coastal infrastructure	x	x	n/a	n/a	n/a	x	x	x	x
Beach re-profiling & sediment recycling	x	x	x	x	x	n/a	n/a	n/a	n/a
Clearance of drainage channels & outfalls	x	x	x	x	x	n/a	n/a	n/a	n/a
Seaweed harvesting	n/a	n/a	n/a	n/a	n/a	x	x	x	n/a
Bridge installation or repairs	x	x	n/a	n/a	n/a	x	x	x	x
UXO clearance	x	x	x	x	x	n/a	n/a	n/a	n/a
Ground investigation works	x	x	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Structure removal from seabed	x	x	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Marina infrastructure installation (moorings, pontoons etc)	x	x	n/a	n/a	n/a	x	x	x	x
Installation/operation of intake / outfall structures	x	x	n/a	n/a	n/a	x	x	x	x

The spatial and temporal scale of the identified changes may differ greatly. Some changes (such as scour) will be highly localised and may be temporary in duration, rather than ongoing. Others (such as changes to the wave or tidal regime) may, (depending upon the scale of the project) extend some distance away from it (tens to hundreds of metres) and persist for its duration.

The spatial extent of these wider changes is highly variable, according to the nature of the activity and the setting it is located within. The concept of ‘zones of influence’ around activities is discussed in more detail in Section 4.1).

Whilst undertaking those identified small scale activities identified in Table 1 has the potential to alter marine and coastal physical process pathways, it does not follow that the larger the change to these marine and coastal physical processes, the greater the environmental impact. For instance: a small amount of maintenance dredging immediately adjacent to a sensitive maerl bed could have a far worse environmental impact than a larger capital dredge located well away from sensitive ecological receptors. As such, it is the sensitivity of the surrounding area and the presence of a pathway connecting the source of the impact to these sensitive areas which will determine the relevance of any changes. This concept is important when determining the appropriateness of/ need for mitigation measures (examples of which are set out in Section 5).

The relevance of any changes to marine and coastal physical process pathways also needs to be considered in the context of baseline conditions and naturally occurring variability within the system. This is discussed further in the next section.

4 What information is required to inform my project?

4.1 Overview

This section sets out the information we need to make an informed judgment as to whether the project has the potential to result in changes to marine and coastal physical processes and subsequent impacts to the environment, and the area across which these changes might occur.

The area which could be affected by changes to marine and coastal physical processes is termed the 'zone of influence' and will be highly variable between projects. It will depend on (amongst other things) the nature of the project (i.e. will it result in sediment disturbance, bed level change and/or blockage), its size (in terms of dimensions of infrastructure, geographic footprint, volume of material displaced etc) and its environmental setting (e.g. open coast/estuarine, sediment availability, strength of tidal currents etc).

Defining the zone of influence will also help understand possible interactions with other projects and, if needed, will inform consideration of in-combination assessments within a Habitats Regulations Assessment.

The information requirements we need to help understand the spatial scale and likely severity of any change are set out in the following series of steps:

- **Step 1:** Define the main components of the project/ activity,
- **Step 2:** Describe the environmental setting in which the project/ activity is situated,
- **Step 3:** Set out what types of changes to marine and coastal physical processes the project or activity may give rise to,
- **Step 4:** Calculate the maximum extent for each change category relevant to the project/ activity,
- **Step 5:** Check each extent to confirm the overall project zone of influence, and
- **Step 6:** Check the zone of influence for any sensitive receptors (which should be detailed in the baseline) and identify potential effects.

These steps are discussed in more detail below.

4.2 Step 1: Project definition

As a minimum, the following should be provided:

- A location map for the project/ activity being proposed. The area where the project/ activity will be installed/ take place should be clearly defined and grid coordinates (lat: long) should be provided, and
- A description of the physical characteristics of the whole project including working methods, time scale of works, likely plant to be used and intended lifetime of installed infrastructure etc.

Further project-specific information requirements are set out on the individual project/ activity topic cards provided in Appendix A.

4.3 Step 2: Description of existing environment

A description of the marine and coastal physical processes within the area of interest is required to help understand the scale of any changes which may occur from the activity and the potential pathways to nearby sensitive receptors.

For example: to inform consideration of a proposal to undertake dredging, we need to understand where any material raised up into suspension in the water column might be transported to and whether this could give rise to any environmental concerns such as smothering of habitats, when the material settles out of suspension. In order to determine this, it is necessary for us to understand the wave and current regime and, hence, the movement and dispersion of suspended sediment within the system. Providing information on baseline turbidity will also help understand whether the area is normally characterised by high levels of suspended sediment concentrations in the water column and, hence, whether any sediment plume from dredging is likely to represent a large change from what is naturally occurring.

This description of the baseline environment is likely to include information on waves, tides, sediment, transport along with patterns of morphological change. However, the type of information and level of detail required will (to some extent) be dependent upon the nature, scale and potential effects of the project and is likely to be an iterative process which is reviewed once the zone of influence has been determined.

For each of the projects/ activities covered by this report a separate topic card has been produced (Appendix A) which sets out the baseline information required for each activity type, along with useful information sources. (These useful baseline information sources are also summarised in Appendix B.) Of particular relevance to coastal projects (such as outfall or channel clearance, beach management, defence maintenance/small scale upgrades) is the baseline information already set out in appendices to Shoreline Management Plans. A Shoreline Management Plan is a strategic plan for the management of coastal erosion and flood risk. It includes a comprehensive description of the marine and coastal physical processes along with a high-level assessment of potential change.

The rationale behind the main baseline information questions listed in Appendix A is summarised below:

1. Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
   a. [Helps inform understanding of likely key processes e.g. wave driven sediment transport, transport of fine-grained material in suspension etc.]

2. What is the approximate tidal range (spring and neap)?
   a. [Helps inform understanding of expected distribution of wave energy in inter-tidal areas. Water depth in sub-tidal areas is a key influence on (amongst other things) the degree to which waves will mobilise sediments at the bed.]

3. What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides?

a. [Influences a very wide range of processes including the degree to which wave stirring of the bed might occur and the inundation frequency of inter-tidal areas and the variation of speed and direction of tidal flows, particularly in estuaries.]

4. What are the average and peak current speeds?
   a. [Key factor in determining the potential spatial extent of sediment disturbance related impacts.]

5. What is the spring tidal excursion distance at the site?
   a. [Helps define how far suspended sediment plumes might reasonably be expected to be transported.]

6. What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)?
   a. [Helps inform understanding of (amongst other things) the likely persistence of any changes to seabed character, the potential for scour development as well as the extent/ duration of any sediment plumes during the activity.]

7. Is the project/ activity in a high or low turbidity environment?
   a. [Helps inform whether any sediment plumes are likely to be inside or outside the likely range of natural variability.]

8. What is the shoreline management policy (e.g. Advance the line, Hold the line, Managed realignment, No active intervention)?
   a. [Helps inform judgement regarding the potential sensitivity of the coast to change.]

9. Is the nearby coast eroding?
   a. [Helps inform whether the coast is currently in a natural state of equilibrium etc and allows any likely project/ activity change to be placed in the context of already occurring trends.]

10. What is the direction (and ideally rate) of longshore/ seabed sediment transport?
    a. [Helps determine where any blockage related impacts are more likely to be experienced in relation to the position of the project/ activity.]

4.4 Step 3: Defining the types of change which the project/ activity may give rise to

As set out in Section 3, potential changes which may occur to marine and coastal physical processes fall into one of three broad categories, namely:

- Sediment disturbance (by an activity),
- Changes to seabed level (i.e. the formation of pits and mounds), and/or
- Blockage (presented by an obstacle).

Table 1 should be used to define which of the three change categories the project may give rise to, noting that a single project or activity could lead to more than one of these changes and all will need to be considered to inform the zone of influence.

4.5 Step 4: Calculating the potential spatial extent of change associated with the project/ activity

The sections above outline what information we need to understand the nature of the project and the environmental setting in which it is located. But we also need to understand the potential spatial scale of change to marine and coastal physical processes which may arise from the project/ activity in question. In this step, we outline some techniques which can be used to provide this information for the three categories of potential change outlined earlier (namely sediment disturbance, bed level related changes and blockage).

Larger (Environmental Impact Assessment scale) marine and coastal developments are supported by assessments that are typically informed by a range of technical analyses (including numerical modelling) which describe process relationships and quantify the potential impact. For smaller scale projects, this level of in-depth analysis is rarely warranted. Instead, more appropriate desk-based approaches are available which are proportionate to the typical scale of project and level of potential impact. These assessment techniques are based on the application of some simplistic rules to identify the maximum extent to which any changes could reasonably be seen in the marine environment.

It should be noted that observational evidence from other similar projects or activities completed in the same area has the potential to provide highly useful supporting material. So if (for instance), understanding is required with regards to potential impacts associated with clearance of a drainage channel & outfall, the provision of information relating to previous nearby works (including where, when, what and how much material was removed) is likely to be very helpful. We recommend, therefore, that a check is undertaken to determine whether other similar projects or activities have been completed in the same area.

The following sections provide example approaches and should not be considered to be comprehensive. Depending upon the project and its location, more detailed analysis may be required.

Determining the potential maximum extent of sediment disturbance related changes

Activities such as dredging disturb sediment, resulting in suspended sediment plumes. These plumes transport sediment away by currents before settling back on the seabed. The distance this material may travel depends on:

- The type of material being disturbed:
  - [coarser material such as sand and gravel will settle out of suspension much more quickly than finer material such as muds (Table 2)],
- How fast the current speeds are in the vicinity of the project:
  - [higher current speeds have the potential to transport material further away from the point of release into the water column], and
- Water depth at the point of sediment release:
  - [the greater the water depth into which material is released, the longer it will take to settle to the bed and therefore the further the material could be transported by currents].

Table 2. Indicative settling velocities for a range of different sized sediment particles (based on Soulsby, 1997)

Sediment type	Fall velocity (m/s)
Gravels	0.5
Coarse sands	0.1
Medium sands	0.05
Fine sands	0.01
Mud (Silts & clays)	0.001

The following are simple guides for identifying likely plume extent resulting from sediment transport via tidal currents (noting there will be uncertainty associated with this approach).

For sands and gravels:

- Material will settle out of suspension and back to the seabed very quickly (order of seconds to minutes in water depths of up to ~30 m), and
- In general, the footprint in which change may occur (either in the water column or to the seabed) will be limited to a distance of tens to hundreds of metres from the project/activity,

Table 3 provides indicative distances that coarse material (sands and gravels) may reasonably be transported away from the release location based on a range of peak current speeds and water depths.

Table 3. Indicative distances (in metres) that sand/gravel sized material may be transported in suspension, based on settling velocities set out in Soulsby (1997). Results provided for a range of maximum peak current speeds (m/s) and water depths into which material may be released, and are based on a settling velocity of 0.05 m/s.

	Representative maximum current speed (m/s)									
Depth at release (m)	**0.25**	**0.5**	**0.75**	**1**	**1.25**	**1.5**	**1.75**	**2**	**2.25**	**2.5**
0	0	0	0	0	0	0	0	0	0	0
2	10	20	30	40	50	60	70	80	90	100
4	20	40	60	80	100	120	140	160	180	200
6	30	60	90	120	150	180	210	240	270	300
8	40	80	120	160	200	240	280	320	360	400
10	50	100	150	200	250	300	350	400	450	500
12	60	120	180	240	300	360	420	480	540	600
14	70	140	210	280	350	420	490	560	630	700
16	80	160	240	320	400	480	560	640	720	800
18	90	180	270	360	450	540	630	720	810	900
20	100	200	300	400	500	600	700	800	900	1000
22	110	220	330	440	550	660	770	880	990	1100
24	120	240	360	480	600	720	840	960	1080	1200
26	130	260	390	520	650	780	910	1040	1170	1300
28	140	280	420	560	700	840	980	1120	1260	1400
30	150	300	450	600	750	900	1050	1200	1350	1500

For plumes that are expected to comprise fine grained muddy material (i.e. silts and clays):

- Material will remain in suspension for much longer (order of hours to days, depending on water depth),
- Figure 2 shows indicative plume travel distances where released sediment has greater than ~5% of fine-grained muds,
- The area across which the plume may propagate can be very roughly approximated by assuming a plume spreading/ dispersion ratio of 1 unit increase in width for every 10 units in length travelled. This is illustrated in Figure 3 (Note that the concentration of the plume will greatly reduce with distance from release, as the action of waves and tides will mechanically disperse material), and
- The above information can be used to identify how far a plume may travel and therefore help determine which potentially sensitive receptors (such as designated nature conservation sites) should be considered within the wider assessment of possible environmental impacts.

Figure 2. Indicative distances (in km) that silt/ clay sized material may be transported in suspension, based on settling velocities set out in Soulsby (1997). (Results provided for a range of representative maximum peak current speeds)

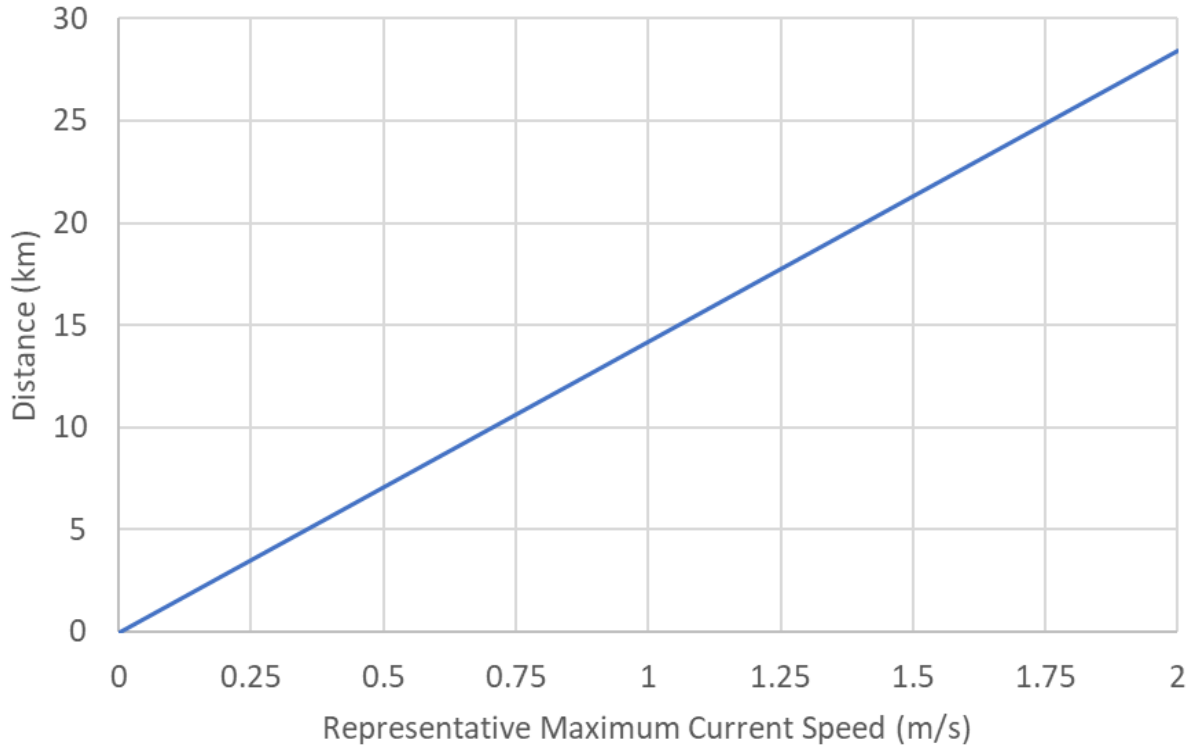
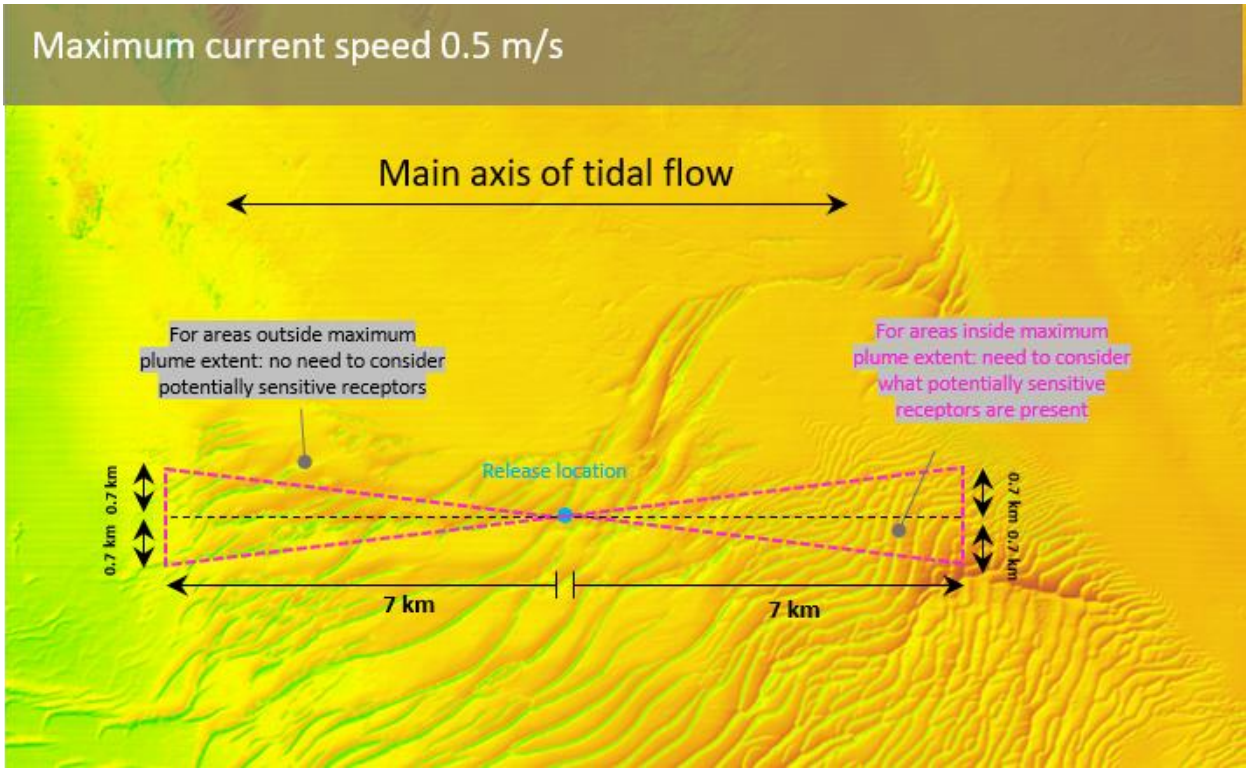


Figure 3. Illustrative diagram showing the theoretical footprint in which change may occur to the water column and/or seabed from the release of fine-grained material, based on settling velocities set out in Soulsby (1997). (Example shown is for release in a location with maximum current speeds of ~0.5 m/s).



Determining the potential maximum extent of bed level related changes

As for the changes described above, the environmental setting (baseline) will define the maximum extent which changing the bed level could affect the wave, tide and sediment transport processes. Water depth and topography are particularly key parameters here.

For identification of the potential maximum extent of small-scale changes associated with modification of bed levels, the following can be used as a guide (noting there will be uncertainty associated with this approach):

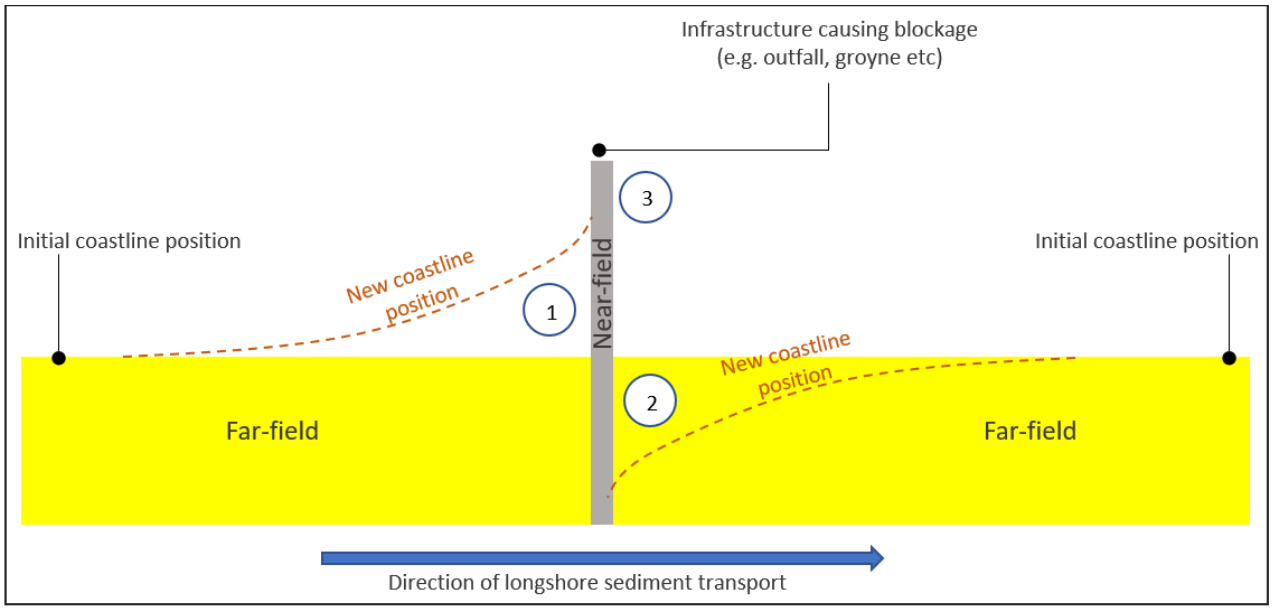
- Where a bed level increase or reduction is less than ~5% of total water depth, measurable change to marine and coastal physical process parameters is unlikely, and
- Where the elevation of the bed is modified by greater than 5% of total water depth, it is expected that change to marine and coastal physical processes could occur over a distance of (up to) approximately 5x the maximum dimension of the dredging or disposal area. (For instance, if dredging occurred within a box measuring 50 m x 20 m, change could theoretically occur within a distance of 250 m from the dredged area).

Determining the potential maximum extent of blockage related changes (including localised scour)

If structures are to be installed at the coast or on the seabed, we will want to know the likely extent of any blockage related changes which could occur to waves, tides and sediment transport and if there are sensitive receptors in this area (Figure 4). Here, we describe the potential for blockage at two scales:

- Far-field – potentially resulting in modest changes to waves/tides, sediment transport processes and morphology within an area that extends outside of the activity or project footprint, and
- Near-field – potentially resulting in flow turbulence and causing scour of the seabed within a highly localised area immediately adjacent to a structure.

Figure 4. Schematic overview illustrating the potential for blockage related changes in bed levels around installed infrastructure



1: Sediment blockage updrift of infrastructure, leading to net bed level increase and seaward migration of coastline

2: Reduction in sediment supply downdrift of infrastructure, leading to net bed level decrease and landward migration of coastline

3: Potential for localised scour (bed level decrease) due to turbulence around infrastructure

Far-field

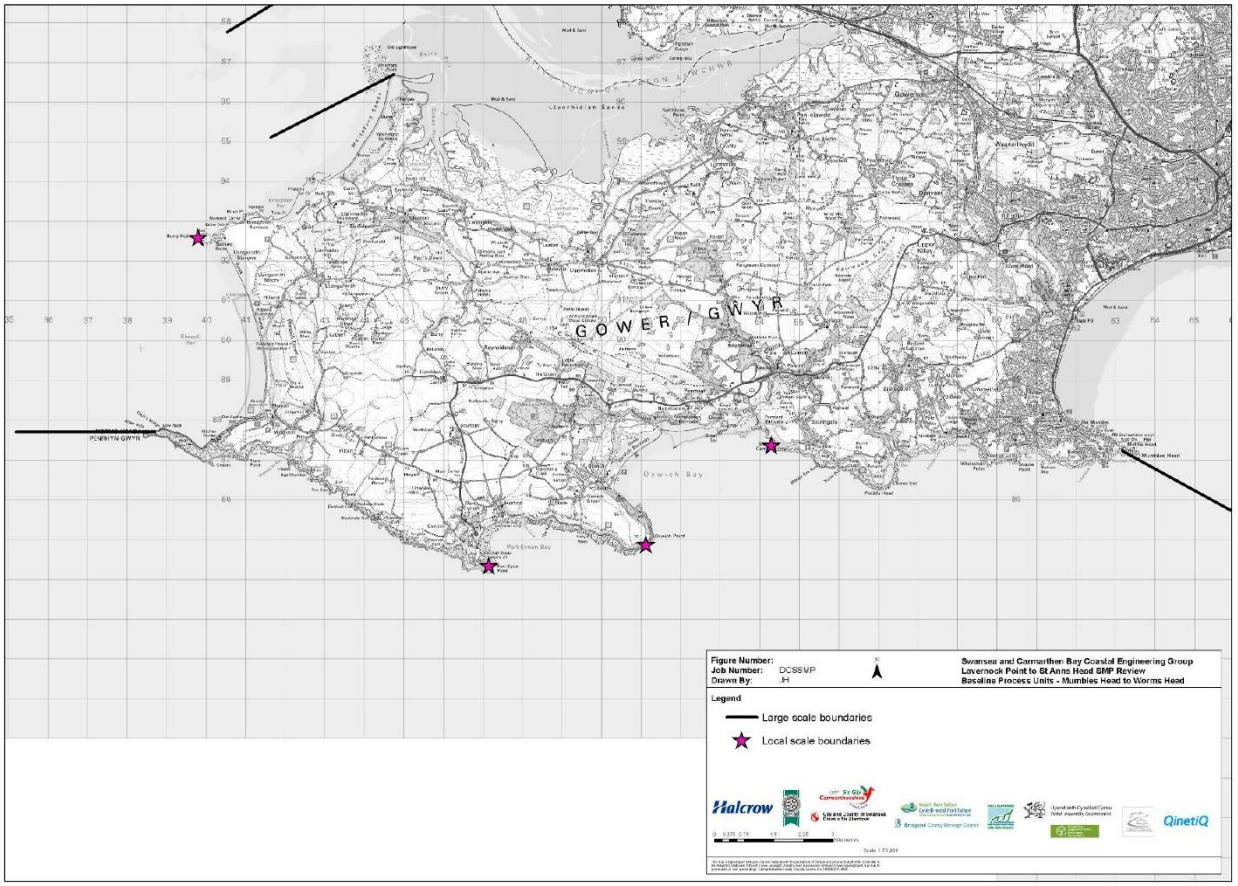
The potential extent of changes from a structure will be particularly sensitive to its design. For instance, two jetty structures may be of comparable size and in similar locations, but a sheet piled structure would have far greater potential to cause blockage related change than one supported by narrow cylindrical piles (which flow can pass between). It is also likely to be sensitive to coastal setting, especially whether the project is in an open coastal setting or within a (likely more sheltered) estuarine environment. For these reasons alone, it is extremely challenging to determine potential footprints of change using simplistic relationships.

For large coastal structures (such as those which are the focus of NRW Guidance Note GN041), coastal sediment cell information contained with the Shoreline Management Plans can initially be used as the basis for defining an absolute maximum limit for the extent of potential change arising from structures installed within inter-tidal areas. A coastal sediment cell is a largely self-contained stretch of coastline which can broadly be regarded as closed system into/ from which sediment is not usually transferred.

Shoreline Management Plans divide the coast into a series of cells and sub cells defined by coastal type and processes such as the movement of beach and seabed sediment (sand, shingle, etc) within and between them by tide and wave driven currents. The movement of material within these units is largely self-contained and therefore can be considered as a closed coastal sub-system as far as sediment is concerned.

An example of this concept is shown in Figure 5, which sets out the large scale and local scale boundaries along the southern Gower coastline, identified during development of the Lavernock Point to St Ann's Head Shoreline Management Plan (SCBCEG, 2011). In reality, even these sub-cells can be divided further, since natural features (such as small headlands and promontories) and manmade structures (such as groynes and piers) are likely to further restrict sediment movement within the local sub-cell.

Figure 5. Large scale and local scale sediment boundaries between Mumbles Head and Worms Head. (Source: SCBCEG, 2011).



However, for small-scale inter-tidal or shallow sub-tidal structures that fall within the range of activities covered by this report, the use of sediment sub-cell information is less helpful as the spatial extent of change will be considerably smaller than the footprint of the sub-cell. Instead, based on expert judgment (informed by experience gained from involvement across a wide range of coastal projects and supported by relevant literature (e.g. Mangor et al. 2017)), it is expected that the maximum potential extent of change to marine and coastal physical processes will be limited to a radial distance of (up to) approximately 10x the maximum dimension of the structure. But it is emphasised again here that this assumption is extremely crude and will be highly dependent upon the setting and project/ activity: in the vast majority of cases, it is expected that measurable change would be considerably more limited in extent.

Near-field

Scour has the potential to develop in the immediate vicinity of a structure installed on the seabed. Scour is the result of net sediment removal over time (typically in the order of hours to days from installation in mobile sediments) due to the complex three-dimensional interaction between the foundation and ambient flows (currents and/or waves). Such interactions result in locally accelerated flow and locally elevated turbulence levels that enhance sediment transport potential in the area of influence.

A guide for identifying the potential extent of localised scour from a structure (such as piles) is as follows:

- Scour of the seabed around piles will be dependent upon the structure diameter, the nature of the seabed sediments as well as ambient tide and wave conditions,
- Figure 6 illustrates the approximate relationship between structure diameter and the maximum potential extent of scour (in metres) away from the structure for (i) mud and (ii) sandy/gravel beds, based on relationships set out in Whitehouse (1998), and
- Figure 7 illustrates the overall maximum potential extent of scour (in m^2), including the structure itself.

Figure 6. Potential extent of scour from piles (in metres), for structures on a sand/gravel bed (blue) and muddy bed (orange), based on Whitehouse (1998)

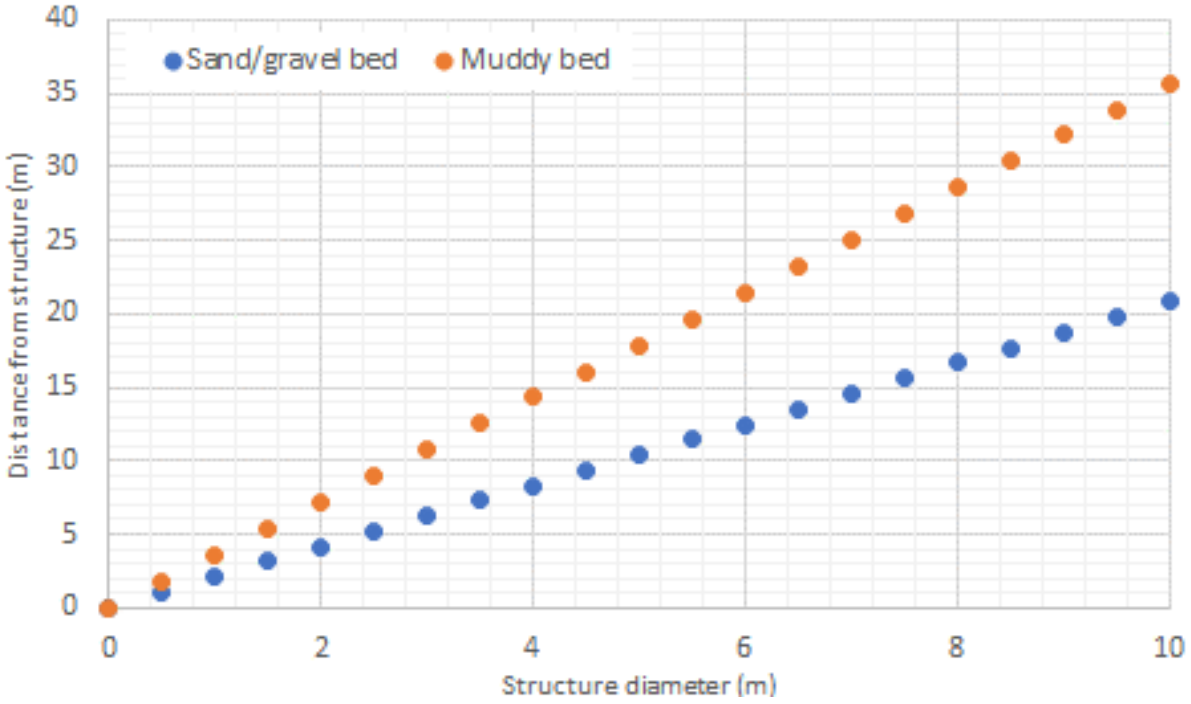
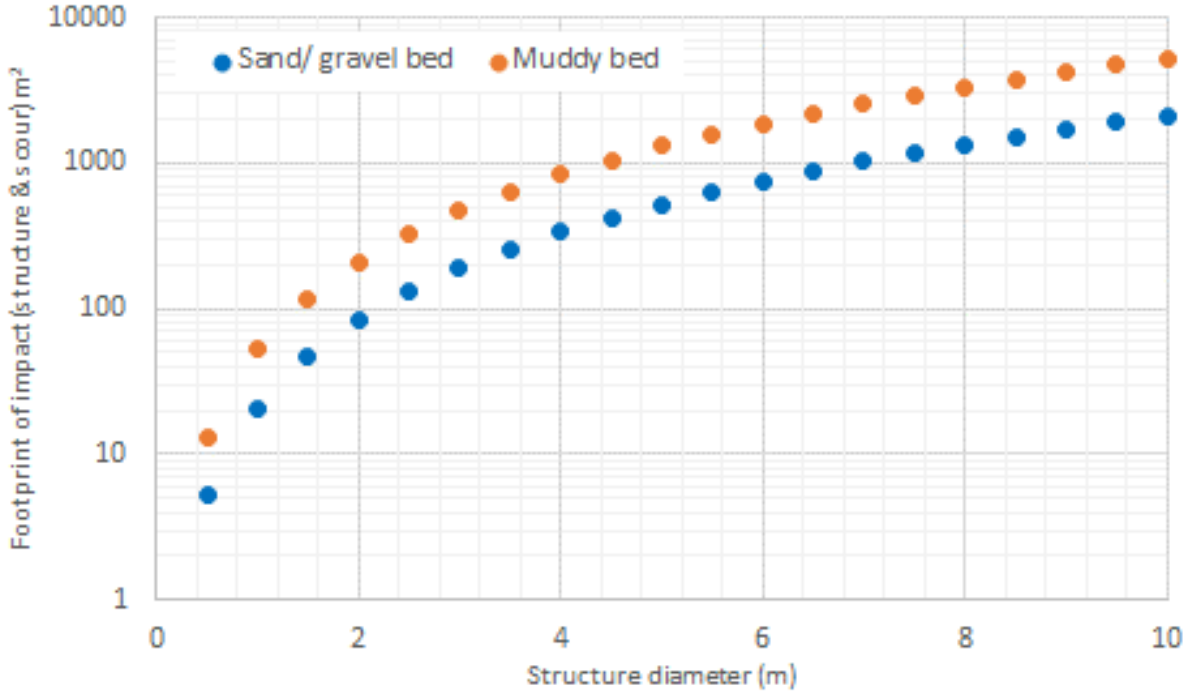


Figure 7. Potential footprint of scour around piles (in m^2), for structures on a sand/gravel bed (blue) and muddy bed (orange), based on Whitehouse (1998)



4.6 Step 5: Defining the overall zone of influence

The section above sets out example approaches to identifying the maximum extent of any change associated with sediment disturbance, blockage and bed level related changes. As set out in Table 1, a single project or activity could lead to more than one of these changes. Accordingly, **all** will need to be overlaid and considered to inform the **overall** zone of influence. Once this has been completed the overall project/ activity Zone of Influence can be determined.

4.7 Step 6: Understanding the sensitivity of the project setting

The sensitivity of the area (in terms of the presence of designated environmental receptors) is of particular importance in determining the potential resulting severity arising from any changes to marine and coastal physical processes.

It should be clearly stated if the proposed activity (or its zone of influence) overlaps with or has the potential to overlap with a designated site or sensitive habitat. These include (but are not limited to):

- Designated nature conservation sites (see NRW Environmental webGIS and DataMapWales),
  - Special Area of Conservation (SAC)
  - Special Protection Area (SPA)
  - Ramsar
  - Marine Conservation Zone (MCZ)
  - Site of Scientific Interest (SSSI)
- Sensitive habitats outside of designated sites,
  - Section 7 habitat protected under the Environment Wales (Act) 2016 and OSPAR habitat under the OSPAR Convention
  - Annex I habitats (inside and) outside Special Areas of Conservation
- Bathing waters (see NRW 'Find a bathing water' webGIS),
- Waterbodies designated by the Water Framework Directive (WFD) (see NRW Water Watch Wales webGIS), and
- Shellfish Waters.

5 How can potential adverse impacts be avoided, reduced or mitigated?

This section briefly sets out a range of potential management measures which may be considered, should the change in marine and coastal physical processes give rise to impacts which could be avoided or reduced.

These potential management measures are set out in Table 4. They have been informed by experience gathered from involvement in a range of marine and coastal projects and activities, as well as from existing published guidance, including:

- Dredging Management Practices for the Environment – A Structured Selection Approach (PIANC, 2009),
- The Coastal Handbook: A Guide for all Those Working on the Coast (Environment Agency, 2010),
- Beach management manual (CIRIA, 2010), and
- The Drainage Channel Biodiversity Manual: Integrating Wildlife and Flood Risk Management (Buisson et al. 2008).

Table 4. Examples of potential management measures which may be considered to limit change to marine and coastal physical processes

Project/ activity	Potential change	Potential management measure
Dredging & disposal (inc. beneficial use of dredged sediment)	Loss of material from sediment system	Can a beneficial environmental use be found for the dredged material within the sediment cell containing the dredging? Particularly in estuaries, use a disposal site in close proximity to the dredge location
Dredging & disposal (inc. beneficial use of dredged sediment)	High suspended sediment concentrations and sediment deposition on or near sensitive receptors	Restrict dredging and disposal to certain states of the tide (only flood or ebb etc) to minimise likelihood of plumes interacting with sensitive receptor Restrict the overflow of dredgers and barges, particularly for silt and mud sediments in areas of low background suspended sediment concentrations If mechanical dredging use as large a dredger and buck/grab as is feasible For cutter suction dredgers reduce cutter speed to minimum to maintain optimum production Discharge sediment from overflow through the hull of dredger Do not use Water Injection Dredging up flow of sensitive bed areas Marinas/coastal dredging/infrastructure dredging: installation of silt screens

Project/ activity	Potential change	Potential management measure
Dredging & disposal (inc. beneficial use of dredged sediment)	Loss of material once deposited at site (unless beneficial use is designed as sacrificial)	[Beneficial use] Deposit sediment at highest density feasible. This may require prior de-watering of sediment. [Beneficial use] Construction of various retaining structures, e.g. brush fencing, gravel bunds, filling holes in marsh or seabed, use of geotextile bunds
Minor works to coastal infrastructure	Redistribution of sediment/ reduction in sediment transport to downdrift locations	Carefully consider placement location for sediment to enable downdrift transport Design intervention to ensure that interruptions to sediment transport downdrift are minimised Use of soft coastal defence measures as an alternative to hard structures. Included here is potential use of beach nourishment. Seek to bury cables/pipes to an appropriate depth. Where required, can cable/pipe protection with a lower profile above the seabed be used (e.g. mattressing rather than rock armouring?)
Beach re-profiling & sediment recycling	Loss of material from sediment system during recycling Compaction of beach from plant movement	Consider vehicle type to restrict number of movements? Agree routes to help minimise compaction? Use of tracks on the beach
Clearance of drainage channels & outfalls	Loss of material from sediment system	Aim to retain material within the same sediment system/in an appropriately determined marine setting
Seaweed harvesting	n/a	n/a
Bridge repairs	Blockage of flow, narrowing cross-section increasing flows causing potential for bed erosion and bank erosion	Use plant with smallest underwater blockage, minimising time on site
Unexploded ordnance clearance	Disturbance of seabed	Detonate in areas away from sensitive areas with features sensitive to shock waves
Ground investigation works	[Minimal disturbance of seabed]	n/a
Structure removal from seabed	Disturbance of seabed creating sediment (plumes)	Undertake at times of low flow speeds in as shallow water as possible
Marina infrastructure installation (moorings, pontoons etc)	Disturbance of seabed from piling	Undertake at times of low flow. Other considerations for example noise will outweigh such considerations
Installation/operation of intake / outfall structures	Interruption of sediment transport pathways/ modification of the nearshore wave regime	Minimise profile of structure relative to seabed

6 What other relevant NRW guidance is available?

General guidance on environmental considerations for marine development is available via the Guidance and advice section of the NRW website.

NRW has produced a specific marine and coastal physical processes Guidance Note to inform Environmental Impact Assessment baseline survey, monitoring and numerical modelling requirements for major (i.e. Band 3) development projects with respect to marine, coastal and estuarine environments (Guidance reference GN041). The Guidance Note is based on two NRW evidence reports:

- Evidence Report No: 243 Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform Environmental Impact Assessment of Major Development Projects, and
- Evidence Report No: 208 Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments.

Both of the above evidence reports provide useful background information on marine and coastal physical processes and may have some applicability for Band 2 projects which fall just below the threshold for Environmental Impact Assessment. However, for the most part the recommendations put forward are specific to much larger development projects than those which are the focus of this report.

NRW has produced guidance for undertaking benthic marine habitat survey and monitoring (Guidance note: GN030). This guidance comprises a series of chapters covering specific habitats and will be of relevance if a seabed habitat characterisation survey is required. Of most relevance is the guide to subtidal habitat characterisation surveys (GN030g) and the guide to characterising and monitoring subtidal sediments (GN030h).

Finally, NRW is currently developing a position statement on the ‘Sustainable Management of Marine and Coastal Sediment’, as well as guidance on the ‘Assessment of Coastal Squeeze’. These documents may be of wider interest when considering some of the small-scale activities discussed within this report, including works to coastal infrastructure and the clearance of drainage channels & outfalls.

7 References

Brooks, AJ., Whitehead, PA., Lambkin, DO. (2018). Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects. NRW Report No: 243, 119 pp, Natural Resources Wales, Cardiff.

Buisson R.S., Wade P.M., Cathcart R.L., Hemmings S.M., Manning C.J., & Mayer L. (2008) The Drainage Channel Biodiversity Manual: Integrating Wildlife and Flood Risk Management. Association of Drainage Authorities and Natural England, Peterborough.

CIRIA (2010). Beach Management Manual (second Edition). 962pp.

Environment Agency (2010). The Coastal Handbook: A Guide for all Those Working on the Coast.

Mangor, K., Drønen, N. K., Kaergaard, K.H. and Kristensen, N.E. 2017. Shoreline management guidelines. DHI https://www.dhigroup.com/marine-water/ebook-shoreline-management-guidelines. Accessed 26/01/2022

PIANC (2009). Dredging Management Practices for the Environment – A Structured Selection Approach. PIANC Report No. 100 – 2009.

Soulsby, R. (1997). Dynamics of Marine Sands. Thomas Telford, London. pp249.

Swansea and Carmarthen Bay Coastal Engineering Group (SCBCEG) (2011). Lavernock Point to St Ann's Head SMP https://www.southwalescoastalgroup.cymru/en/shoreline-management-plan-smp2/. Accessed on 17/11/2021

Whitehouse, R.J.S., (1998). Scour at marine structures: A manual for practical applications. Thomas Telford, London, 198 pp.

8 Appendices

A. Project/ activity specific topic cards

A1 Dredging & disposal (inc. beneficial use)

Project Definition:

- Where are the dredge and disposal locations (Map and grid coordinates)?
- What is the material type that is being dredged?
- How will the material be dredged (Back hoe, Trailing Suction Hopper Dredger etc)?
- How will the sediment be deposited at the site (e.g. vessel bottom placement, pipe etc.)?
- [For beneficial use] What (if any) methods will be used to promote de-watering if fine grained material is being used?

Description of existing environment

- Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
- What is the approximate tidal range (spring and neap)? (Reference: 1)
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 2,3,4,5,6,7)
- What are the average and peak current speeds? (Reference: 1)
- What is the spring tidal excursion distance at the site? (Reference: 1)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 2,3,5,7,8,9)
- Is the project/ activity in a high or low turbidity environment? (Reference: 10)
- What is the shoreline management policy (e.g. Advance the line, Hold the line, Managed realignment, No active intervention)? (Reference: 11)
- Is the nearby coast eroding? (Reference: 2,11)
- What is the direction (and ideally rate) of longshore/ seabed sediment transport? (Reference: 11)

Impact assessment

- What is the likely extent, duration and concentration of sediment plume(s) associated with dredging and disposal?
- What is the potential extent and thickness of bed level change associated with material settling out of suspension from sediment plumes?
- What is the likely change to hydrodynamics and the height of waves passing over dredged areas and any associated implications for coastal erosion?
- What are the implications for local water circulation resulting from the removal or creation of topographical features on the seabed?
- What is the likely effect on the seabed of removing material? In particular the nature of the sediment to be left once dredging ceases, and the likely nature and scale of the resulting topography?
- [For beneficial use] What existing issues could be addressed by the addition of dredged material (e.g. salt-marsh loss due to sea level rise, enhanced coastal protection)? Can these be demonstrated using observational evidence?
- [For beneficial use] Will the deposited material be retained *in situ* long term? Are any containment devices to be used (e.g. brush fences, geotextile tubes, bunds etc.)?
- [For beneficial use] If the material is sacrificial, where is it likely to disperse and what is the likely timescale?
- [For beneficial use] Are there other environmental benefits (e.g. reduction in emissions, fuel saving, increased carbon capture etc.)?

Relevant guidance

- Dredging Management Practices for the Environment – A Structured Selection Approach (Reference: 12)
- The Coastal Handbook: A Guide for all Those Working on the Coast (Reference: 13)
- Restoring Estuarine and Coastal Habitats with Dredged Sediment - CaBA (Reference: 14)

References

1: UK Renewables Atlas
2: Welsh Coastal Monitoring Centre
3: DataMapWales
4: UKHO
5: EMODnet
6: IMARDIS
7: Strategic Environmental Assessment (SEA) data portal
8: BGS Offshore Geoportal
9: UKSeamap 2018 (JNCC 2019)
10: Cefas (2016)
11: Shoreline Management 2 Plans
12: PIANC (2009). Dredging Management Practices for the Environment – A Structured Selection Approach. PIANC Report No. 100 – 2009.
13: Environment Agency (2010). The Coastal Handbook: A Guide for all Those Working on the Coast.
14: Restoring Estuarine and Coastal Habitats with Dredged Sediment - CaBA (catchmentbasedapproach.org)

A2 Minor works to coastal infrastructure

Project Definition:

- Where is the project/activity location (Map and grid coordinates)?
- Where will any disturbed sediment be placed (Map and grid coordinates)?
- What are the working methods (inc. likely plant)?
- When will the work be carried out and how long will it last?
- How will construction materials be stored (e.g. rock armour on the foreshore)?

Description of existing environment

- Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
- What is the approximate tidal range (spring and neap)? (Reference: 1)
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 2,3,4,5,6,7)
- What are the average and peak current speeds? (Reference: 1)
- What is the spring tidal excursion distance at the site? (Reference: 1)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 2,3,5,7,8,9)
- Is the project/ activity in a high or low turbidity environment? (Reference: 10)
- What is the shoreline management policy (e.g. Advance the line, Hold the line, Managed realignment, No active intervention)? (Reference: 11)
- Is the nearby coast eroding? (Reference: 2,11)
- What is the direction (and ideally rate) of longshore/ seabed sediment transport? (Reference: 11)

Impact assessment

- What is the footprint of the scheme, the direct impacts and then any subsequential indirect impacts due to scour etc?
- To what extent could the works impact coastal morphology, both adjacent to the defence and downdrift, because of an interruption to sediment supply and change to wave characteristics?
- What is the likely extent, duration and concentration of any sediment plume(s) associated with installation of infrastructure?
- To what extent could any new coastal defences contribute to coastal squeeze related to sea level rise?
- To what extent/ how has the potential for climate change (especially sea level rise and larger/ more frequent storms) been taken into consideration in the design of infrastructure?
- Is there a smaller scheme that could be less intrusive to the environment?

Relevant guidance

- The Coastal Handbook: A Guide for all Those Working on the Coast (Reference: 12)
- [NRW is currently developing guidance on the assessment of coastal squeeze]

References

1: UK Renewables Atlas
2: Welsh Coastal Monitoring Centre
3: DataMapWales
4: UKHO
5: EMODnet
6: IMARDIS
7: Strategic Environmental Assessment (SEA) data portal
8: BGS Offshore Geoportal
9: UKSeamap 2018 (JNCC 2019)
10: Cefas (2016)
11: Shoreline Management 2 Plans
12: Environment Agency (2010). The Coastal Handbook: A Guide for all Those Working on the Coast.

A3 Beach re-profiling & sediment recycling

Project Definition:

- Where is the project/activity location (Map and grid coordinates)?
- Where is the applicant wanting to place the sediment and the reasoning behind this – top of beach off the back of a dumper or down at low tide (Map and grid coordinates)?
- What are the working methods?
- When will the work be carried out and how long will it last?
- Can plant access the beach without impacting existing defence structures?

Description of existing environment

- What is the shoreline management policy (e.g. Advance the line, Hold the line, Managed realignment, No active intervention)? (Reference: 1)
- Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
- How has the beach profile naturally varied over time (i.e. months to years)? (Reference: 2,3)
- What is the net rate/direction of sediment transport on the beach? (Information on the direction (and sometimes rate) of sediment transport is typically set out in Shoreline Management Plans) (Reference: 1)
- What is the net change in beach volume in the location where sediment recycling is proposed? (Reference: 2,3)
- Are patterns of sediment transport/ circulation broadly understood within the coastal cell in which the works will be undertaken? (Reference: 1)
- What is the approximate tidal range (spring and neap)? (Reference: 4)
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 2,3,5,6,7,8)
- What are the average and peak current speeds? (Reference: 4)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 2,3,6,7,8,9)
- Is the nearby coast eroding? (Reference: 2,3)
- What is the direction (and ideally rate) of longshore/ seabed sediment transport? (Reference: 1)

Impact assessment

- In the case of sediment recycling, what are the potential impacts on downdrift areas where material is being extracted?
- Could the re-distribution of material result in an increase in local flood risk?

Relevant guidance

- The Coastal Handbook: A Guide for all Those Working on the Coast (Environment Agency, 2010) (Reference: 12)
- The Beach Management Manual (Reference: 13)

References

1: Shoreline Management 2 Plans
2: Welsh Coastal Monitoring Centre
3: DataMapWales
4: UK Renewables Atlas
5: UKHO
6: EMODnet
7: IMARDIS
8: Strategic Environmental Assessment (SEA) data portal
9: BGS Offshore Geoportal
10: UKSeamap 2018 (JNCC 2019)
11: Cefas (2016)
12: Environment Agency (2010). The Coastal Handbook: A Guide for all Those Working on the Coast.
13: CIRIA (2010). Beach Management Manual (second Edition). 962pp.

A4 Clearance of drainage channels & outfalls

Project Definition:

- Where is the project/activity location? (Map and grid coordinates)?
- Where is the applicant placing the cleared sediment and what is the rationale for this? (Map and grid coordinates)?
- What is the volume and type of material being removed?
- What are the working methods?
- When will the work be carried out and how long will it last?
- If beach access is required, can plant access without impacting existing defence structures?

Description of existing environment

- How quickly is the channel infilling and have rates being changing over time? [If they have been increasing rapidly, for instance, it may be necessary to consider causal factors – such as landuse – rather than just addressing the symptom of it.]
- What are the local sediment pathways? (Reference: 1)
- What is the approximate tidal range (spring and neap)? (Reference: 2)
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 3,4,5,6,7,8)
- What are the average and peak current speeds where material is being deposited? (Reference: 2)
- What is the spring tidal excursion distance where material is being deposited? (Reference: 2)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 3,4,6,8,9,10)
- Is the disposal location in a high or low turbidity environment? (Reference: 11)
- What is the shoreline management policy (e.g. Advance the line, Hold the line, Managed realignment, No active intervention)? (Reference: 1)

Impact assessment

- To what extent could localised drainage channel/ outfall clearance result in elevated levels of suspended sediment concentrations in the coastal receiving waters?
- How long might any sediment plume persist and at what elevation above background levels?

Relevant guidance

- The Drainage Channel Biodiversity Manual: Integrating Wildlife and Flood Risk Management (Reference: 12)

References

1: Shoreline Management 2 Plans
2: UK Renewables Atlas
3: Welsh Coastal Monitoring Centre
4: DataMapWales
5: UKHO
6: EMODnet
7: IMARDIS
8: Strategic Environmental Assessment (SEA) data portal
9: BGS Offshore Geoportal
10: UKSeamap 2018 (JNCC 2019)
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12: Buisson R.S., Wade P.M., Cathcart R.L., Hemmings S.M., Manning C.J., & Mayer L. (2008) The Drainage Channel Biodiversity Manual: Integrating Wildlife and Flood Risk Management. Association of Drainage Authorities and Natural England, Peterborough.

A5 Seaweed harvesting

Project Definition:

- Where is the project/activity location (Map and grid coordinates)?
- What are the working methods for seaweed removal?

Description of existing environment

- What is the nature of the seabed/ coast in the vicinity of the seaweed harvesting area and to what extent might it be sensitive to an increase in wave energy? (Reference: 1,2,3,4,5,6,7)
- Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
- For the location of interest, to what extent does the presence of seaweed attenuate wave energy?
- What is the approximate tidal range (spring and neap)? (Reference: 8)
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 2,3,4,5,9,10)
- What are the average and peak current speeds? (Reference: 8)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 2,3,4,5,6,7)
- Is the nearby coast eroding? (Reference: 1)
- What is the direction (and ideally rate) of longshore/ seabed sediment transport? (Reference: 1)

Impact assessment

- How might currents be modified through removal of seaweed and could this change the sediment characteristics of the seabed in nearby areas, through modification of sedimentation rates?

Relevant guidance

- Seaweed aquaculture and mechanical harvesting: an evidence review to support sustainable management. (Reference: 11)
- Wild Seaweed Harvesting: Strategic Environmental Assessment (Reference: 12)

References

1: Shoreline Management 2 Plans
2: Welsh Coastal Monitoring Centre
3: DataMapWales
4: EMODnet
5: Strategic Environmental Assessment (SEA) data portal
6: BGS Offshore Geoportal
7: UKSeamap 2018 (JNCC 2019)
8: UK Renewables Atlas
9: UKHO
10: IMARDIS
11: Natural England (2021). Seaweed aquaculture and mechanical harvesting: an evidence review to support sustainable management (NECR378).
12: ABPmer (2016). Wild Seaweed Harvesting Strategic Environmental Assessment Environmental Report for Scottish Government. November 2016.

A6 Bridge repairs

Project Definition:

- Where is the project/activity location (Map and grid coordinates)?
- What are the working methods (inc. likely plant)?
- When will the work be carried out and how long will it last?

Description of existing environment

- Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
- What is the approximate tidal range (spring and neap)? (Reference: 1)
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 2,3,4,5,6,7)
- What are the average and peak current speeds? (Reference: 1)
- What is the spring tidal excursion distance at the site? (Reference: 1)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 2,3,5,7,8,9)
- Is the project/ activity in a high or low turbidity environment? (Reference: 10)

Impact assessment

- To what extent might construction plant impact the seabed, either directly (due to physical disturbance) or indirectly (due to scour (from flow turbulence)/ temporary blockage of flow)?
- What is the potential for scour around any new bridge piers (footprint/ depth)?

Relevant guidance

- The Coastal Handbook: A Guide for all Those Working on the Coast (Reference: 11)

References

1: UK Renewables Atlas
2: Welsh Coastal Monitoring Centre
3: DataMapWales
4: UKHO
5: EMODnet
6: IMARDIS
7: Strategic Environmental Assessment (SEA) data portal
8: BGS Offshore Geoportal
9: UKSeamap 2018 (JNCC 2019)
10: Cefas (2016)
11: Environment Agency (2010). The Coastal Handbook: A Guide for all Those Working on the Coast.

A7 Unexploded ordnance clearance

Project Definition:

- Is removal of overlying sediment required to access the ordnance? (Is there a possible requirement for 'light touch' methods e.g. Water Injection Dredging, hence sediment dispersal impacts?)
- What is the potential impact footprint (diameter/ depth) associated with any detonation operations?

Description of existing environment

- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 1,2,3,4,5,6)
- What are the average and peak current speeds? (Reference: 7)
- What is the spring tidal excursion distance at the site? (Reference: 7)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 1,2,4,6,8,9)
- Is the project/ activity in a high or low turbidity environment? (Reference: 10)
- What is the direction (and ideally rate) of seabed sediment transport? (Reference: 11,12)

Impact assessment

- Are pits expected to fill in overtime and if yes, what are the approximate timescales envisaged?

Relevant guidance

- [None identified]

References

1: Welsh Coastal Monitoring Centre
2: DataMapWales
3: UKHO
4: EMODnet
5: IMARDIS
6: Strategic Environmental Assessment (SEA) data portal
7: UK Renewables Atlas
8: BGS Offshore Geoportal
9: UKSeamap 2018 (JNCC 2019)
10: Cefas (2016)
11: Shoreline Management 2 Plans
12: Kenyon & Cooper (2005)

A8 Ground investigation works

Project Definition:

- Where is the project/activity location (Map and grid coordinates)?
- What are the working methods (inc. likely plant such as jack-up barges)?
- When will the work be carried out and how long will it last?

Description of existing environment

- Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 1,2,3,4,5,6)
- What are the average and peak current speeds? (Reference: 7)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 1,2,4,6,8,9)
- What is the direction (and ideally rate) of longshore/ seabed sediment transport? (Reference: 10)

Impact assessment

- What is the potential impact footprint (diameter/ depth) on the seabed associated with jack-up platform/ vessel legs (either directly from the leg pressure and/or indirectly from potential scour if in place for a significant length of time)?
- How long might any resultant seabed depressions persist for?

Relevant guidance

- [None identified]

References

1: Welsh Coastal Monitoring Centre
2: DataMapWales
3: UKHO
4: EMODnet
5: IMARDIS
6: Strategic Environmental Assessment (SEA) data portal
7: UK Renewables Atlas
8: BGS Offshore Geoportal
9: UKSeamap 2018 (JNCC 2019)
10: Shoreline Management 2 Plans

A9 Structure removal activities

Project Definition:

- Where is the project/activity location (Map and grid coordinates)?
- What are the working methods (inc. likely plant)?
- When will the work be carried out and how long will it last?
- If beach access is required, can plant access without impacting existing defence structures?

Description of existing environment

- Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
- What is the approximate tidal range (spring and neap)? (Reference: 1)
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 2,3,4,5,6,7)
- What are the average and peak current speeds? (Reference: 1)
- What is the spring tidal excursion distance at the site? (Reference: 1)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 2,3,5,7,8,9)
- Is the project/ activity in a high or low turbidity environment? (Reference: 10)
- What is the shoreline management policy (e.g. Advance the line, Hold the line, Managed realignment, No active intervention)? (Reference: 11)
- Is the nearby coast eroding? (Reference: 2,11)
- What is the direction (and ideally rate) of longshore/ seabed sediment transport? (Reference: 11)
- Do the structure(s) that require removing have any role in determining/ stabilising the morphology of the adjacent coast? (For instance, a large outfall pipe which has been in place for many decades may control the form of the adjacent coast for several tens/ hundreds of metres either side of it.) (Reference: 11)

Impact assessment

- Could any changes in coastal morphology influence flood risk, through lowering of protection to storm surge events?
- To what extent could localised disturbance of the seabed result in elevated levels of suspended sediment concentrations in the coastal receiving waters?

Relevant guidance

- The Coastal Handbook: A Guide for all Those Working on the Coast (Reference: 12)

References

1: UK Renewables Atlas
2: Welsh Coastal Monitoring Centre
3: DataMapWales
4: UKHO
5: EMODnet
6: IMARDIS
7: Strategic Environmental Assessment (SEA) data portal
8: BGS Offshore Geoportal
9: UKSeamap 2018 (JNCC 2019)
10: Cefas (2016)
11: Shoreline Management 2 Plans
12: Environment Agency (2010). The Coastal Handbook: A Guide for all Those Working on the Coast.

A10 Installation of marina infrastructure (e.g. pontoons and moorings)

Project Definition:

- [See dredge and disposal section should any dredging activities be required]
- Where is the project/activity location (Map and grid coordinates)?
- What is the footprint of the structure and is it 'open' or 'closed'?
- What is the expected lifetime of the new infrastructure?
- Where will any disturbed sediment be placed (Map and grid coordinates)?
- What are the working methods (inc. likely plant)?
- When will the work be carried out and how long will it last?

Description of existing environment

- [See dredge and disposal section should any dredging activities be required]
- Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
- What is the approximate tidal range (spring and neap)? (Reference: 1)
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 2,3,4,5,6,7)
- What are the average and peak current speeds? (Reference: 1)
- What is the spring tidal excursion distance at the site? (Reference: 1)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 2,3,5,7,8,9)
- Is the project/ activity in a high or low turbidity environment? (Reference: 10)
- What is the shoreline management policy (e.g. Advance the line, Hold the line, Managed realignment, No active intervention)? (Reference: 11)
- Is the nearby coast eroding? (Reference: 2,11)
- What is the direction (and ideally rate) of longshore/ seabed sediment transport? (Reference: 11)

Impact assessment

- [See dredge and disposal section should any dredging activities be required]
- Will the installed structures encourage short, medium or long-term scour or accretion of the adjacent seabed?
- Could installed structures interfere with the transport of sediment, either at the bed and/or suspended in the water column?
- How will the wave climate be affected by changes in bathymetry/ presence of new infrastructure and what will the effect be on adjacent inter-tidal areas and shorelines?
- What are the anticipated maintenance dredging requirements expected to be?

Relevant guidance

- The Coastal Handbook: A Guide for all Those Working on the Coast (Reference: 12)

References

1: UK Renewables Atlas
2: Welsh Coastal Monitoring Centre
3: DataMapWales
4: UKHO
5: EMODnet
6: IMARDIS
7: Strategic Environmental Assessment (SEA) data portal
8: BGS Offshore Geoportal
9: UKSeamap 2018 (JNCC 2019)
10: Cefas (2016)
11: Shoreline Management 2 Plans
12: Environment Agency (2010). The Coastal Handbook: A Guide for all Those Working on the Coast.

A11 Installation/operation of intake / outfall structures

Project Definition:

- [See dredge and disposal section should any dredging activities be required]
- Where is the project/activity location (Map and grid coordinates)?
- Where will any disturbed sediment be placed (Map and grid coordinates)?
- What are the working methods (inc. likely plant)?
- When will the work be carried out and how long will it last?
- How will construction materials be stored (e.g. rock armour on the foreshore)?
- If beach access is required, can plant access without impacting existing defence structures?
- What is the expected lifetime of the new infrastructure?

Description of existing environment

- [See dredge and disposal section should any dredging activities be required]
- Is the setting exposed to wind/ wave activity (e.g. open coast) or sheltered (e.g. up-estuary)?
- What is the approximate tidal range (spring and neap)? (Reference: 1)
- What is the elevation of the seabed/ inter-tidal in the area of the activity, relative to Mean High Water of Spring Tides? (Reference: 2,3,4,5,6,7)
- What are the average and peak current speeds? (Reference: 1)
- What is the spring tidal excursion distance at the site? (Reference: 1)
- What are the characteristics of the seabed/ inter-tidal sediments at the site which may be disturbed (including shallow geology)? (Reference: 2,3,5,7,8,9)
- Is the project/ activity in a high or low turbidity environment? (Reference: 10)
- What is the shoreline management policy (e.g. Advance the line, Hold the line, Managed realignment, No active intervention)? (Reference: 11)
- Is the nearby coast eroding? (Reference: 2,11)
- What is the direction (and ideally rate) of longshore/ seabed sediment transport? (Reference: 11)

Impact assessment

- [See dredge and disposal section should any dredging activities be required]
- To what extent might the presence of the outfall structure interrupt the movement of bedload/longshore sediment transport?
- Is scour or accretion expected to occur in the immediate vicinity of the structure?
- How might the passage of waves be modified by the presence of the intake/ outfall structures and could such changes result in the modification of the adjacent coast?

Relevant guidance

- The Coastal Handbook: A Guide for all Those Working on the Coast (Reference: 12)

References

1: UK Renewables Atlas
2: Welsh Coastal Monitoring Centre
3: DataMapWales
4: UKHO
5: EMODnet
6: IMARDIS
7: Strategic Environmental Assessment (SEA) data portal
8: BGS Offshore Geoportal
9: UKSeamap 2018 (JNCC 2019)
10: Cefas (2016)
11: Shoreline Management 2 Plans
12: Environment Agency (2010). The Coastal Handbook: A Guide for all Those Working on the Coast.

B. Where can I find information to inform assessment?

Source	Reference Type	Designations	Habitats	Hydrodynamics	Winds & waves	Seabed sediments	Suspended sediments	Sediment transport	Geology	Seabed morphology	Coastal morphology	Climate Change	Notes
NRW Natural Environment Map	Website (data portal)	Y	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Nature conservation designations
Welsh Coastal Monitoring Centre	Website (data portal)	n/a	Y	Y	Y	Y	n/a	n/a	n/a	Y	Y	n/a	Coastal monintoring data available for download
DataMapWales	Website (data portal)	n/a	Y	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Y	n/a	GIS layers available showing (amongst other things) intertidal Phase 1 Habitat Surveys and LiDAR (showing intern/atidal elevations)
UK Renewables Atlas	Website (data portal)	n/a	n/a	Y	Y	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Range of modelled data available, including tidal range, current speed, spring tidal excursion ellipse, winds and waves.
SEASTATES	Website (data portal)	n/a	n/a	n/a	Y	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Modelled wind and wave statistics available for download (as roses)
UKHO	Website (data portal)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Y	n/a	n/a	Bathymetry data available for download
EMODnet	Website (data portal)	n/a	Y	Y	Y	Y	n/a	n/a	Y	Y	n/a	n/a	Very wide range of regional scale data available for download
BGS Offshore Geoportal	Website (data portal)	n/a	n/a	n/a	n/a	Y	n/a	n/a	Y	n/a	n/a	n/a	Seabed sediments and borehole records available to view/ download
IMARDIS	Website (data portal)	n/a	n/a	Y	Y	n/a	n/a	n/a	n/a	Y	n/a	n/a	Hydrodynamic/Wave (ADCP) and bathymetric data available for download

Source	Reference Type	Designations	Habitats	Hydrodynamics	Winds & waves	Seabed sediments	Suspended sediments	Sediment transport	Geology	Seabed morphology	Coastal morphology	Climate Change	Notes
Strategic Environmental Assessment (SEA) data portal	Website (data portal)	n/a	n/a	n/a	n/a	Y	n/a	n/a	Y	Y	n/a	n/a	Offshore bathymetry and seabed characterisation data available for download
Shoreline Management 2 Plans	Reports	n/a	n/a	n/a	n/a	n/a	n/a	Y	n/a	n/a	Y	Y	Policies for coastal management up to 2105
Cefas (2016)	Reports(s)	n/a	n/a	n/a	n/a	Y	n/a	n/a	n/a	n/a	n/a	n/a	GIS layers available on request from Cefas
The Estuary Guide	Website & reports	n/a	n/a	Y	n/a	n/a	n/a	n/a	n/a	n/a	Y	n/a	Key source of information on estuary characteristics around Wales
UKSeamap 2018 (JNCC 2019)	Reports	n/a	Y	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	EUNIS broadn/ascale habitat map, building on UKSeaMap 2016 with updates to substrate. GIS download available
The National Tidal and Sea Level Facility (NTSLF)	Website (data portal)	n/a	n/a	Y	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Sea level monitoring data, including the analysis of sea level extremes
UKCP18	Website (data portal)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Y	Climate change predictions
MCCIP	Reports(s)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Y	Marine Climate Change Impact Partnership

B1. References

JNCC (2019). Marine habitat data product: UKSeaMap 2018 v1 - EUNIS broad-scale habitat map, building on UKSeaMap 2016 with updates to substrate.

B2. Websites

EMODnet [https://emodnet.ec.europa.eu/en]

UKCP18 [https://ukclimateprojections-ui.metoffice.gov.uk/ui/home]

DataMapWales [https://datamap.gov.wales/]

The Estuary Guide [http://www.estuary-guide.net/]

Marine Climate Change Impacts Partnership (MCCIP) [https://www.mccip.org.uk/]

UK Renewables Atlas [https://www.renewables-atlas.info/]

IMARDIS [https://portal.imardis.org/]

Welsh Coastal Monitoring Centre [https://www.wcmc.wales/data]

Strategic Environmental Assessment (SEA) data portal [https://www.bgs.ac.uk/data/sea/app/search]

National Tide and Sea Level Facility [https://ntslf.org/]

NRW Natural Environment Map https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer210/Inde.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/External_Map_Browser/viewers/EMB_Address/virtualdirectory/Resources/Config/Default&locale=en-gb

C. Data Archive Appendix

No data outputs were produced as part of this project.

Further copies of this report are available from library@cyfoethnaturiolcymru.gov.uk