Cyfoeth Naturiol Cymru
Natural Resources Wales

Guidance Note

# Marine Physical Processes Guidance to inform Environmental Impact Assessment (EIA)

## Physical processes guidance to inform EIA baseline survey, monitoring and numerical modelling requirements for major development projects with respect to marine, coastal and estuarine environments.

**Reference number:** GN041

**Document Owner:** Marine Programming Planning and Delivery Group

### What is this document about?

The purpose of this guidance note is to provide advice to developers to inform Environmental Impact Assessment (EIA) of marine, coastal and estuarine projects with respect to physical processes. The Guidance Note refers to two Natural Resource Wales' (NRW) evidence reports. The first provides guidance on best practice for physical processes baseline survey and monitoring, and the second provides advice on numerical modelling assessments. The evidence reports are linked below, respectively.

Evidence Report No: 243 Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects.

Evidence Report No: 208 Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments.

The content of this guidance is a synopsis of the extensive technical information contained within the evidence reports which is aimed at informing the design of survey and monitoring strategies in relation to marine, coastal and estuarine major development projects and the application of numerical modelling where appropriate.
We have prepared this guidance as part of our role as environmental advisor. In this role NRW Advisory provide advice to developers, our staff in the regulatory arm of the

organisation (NRW Permitting Service) and other regulatory organisations on likely environmental effects from marine development proposals and activities.
This guidance note does not comprise legal advice and should not be interpreted as such. Project proposers should seek their own independent legal advice on any matters arising in connection with this note in respect of a specific activity or development project.

This guidance does not prejudice any advice that NRW might provide as part of any application for a specific activity or development project.

## Who is this document for?

This guidance is for anyone seeking to undertake environmental or ecological impact assessments for a proposed marine development or activity, and NRW staff. The guidance is principally aimed at major development projects but should be seen as scalable in this respect.

## Contact for queries and feedback

marine.advice@cyfoethnaturiolcymru.gov.uk

## Version History

| Document Version | Date Published | Summary of Changes |
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| **1.0** | [04-2020] | Document published |
| **1.1** | [09-2020] | Document published in accessible format |

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To report issues or problems with this guidance contact Guidance Development

# Contents

# 1. General Introduction

The guidance presents a summary of the two detailed reports on physical processes, highlighting methods and approaches that are considered by NRW Advisory to constitute best practice. We advise you to follow them if you are preparing and carrying out an EIA associated with a major development project in the marine, coastal or estuarine environment.

This guidance also provides advice on the detail that NRW Advisory would expect to see when presented with either proposals for, or reports on physical process baseline survey and modelling as part of either pre-application advice (if sought) or, the application process. Providing the required information at the appropriate level of detail will assist your application.

This guidance also provides links to other NRW Guidance relevant to assessment of major projects in the marine, coastal and estuarine environment. For example, GN013 Scoping an Environmental Impact Assessment for Marine Development and GN030 Benthic habitat assessment guidance for marine developments and activities.

This guidance is not intended to cover water quality or contaminated sediments, although there is information contained within the evidence reports which may help to inform such assessments.

# 2. Survey and Monitoring

**Evidence Report No: 243 Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects.**

The purpose of this evidence report is to provide guidance on best practice for physical processes baseline survey to inform EIA and post consent monitoring requirements of major development projects; see section 1 of the report, namely:

- Port and harbour developments,
- Aggregate extraction,
- Power stations (including nuclear),
- Offshore wind,
- Other renewable energy developments including:

  - tidal range,

  - tidal stream,

- wave,

- Sub-sea cables (especially where they make landfall),

In addition, the advice contained within the evidence report can be used to inform other types of development.

## 2.1 Overview

Major developments within the marine environment have the potential to cause physical changes to water column properties as well as morphological change to the sub-tidal, inter-tidal and supra-tidal environment. In order to provide robust estimates of the temporal and spatial scale of these changes in advance of project construction and operation, it is essential that marine and coastal physical processes in the vicinity of the development are well understood. This understanding is typically achieved through the analysis of new and existing field data along with existing studies, complemented (where necessary) through numerical modelling. The evidence report was produced taking into account all relevant EIA guidance pertinent to marine and coastal physical processes; see Table 2 and Appendix A of the report. This literature review was then expanded upon by employing the authors' assessment of impacts observed at specific major development projects in a series of case studies; see Table 4 of the report.

The evidence report identifies the sources, pathways and receptors relevant to a given project throughout its development stages; construction, operation, decommissioning, see Figure 2 of the report. It also provides advice on establishing characterisation and baseline survey, data collection requirements, and subsequent advice on monitoring strategy. The key sections of the evidence report are:

- Section 2 Background: Marine and Coastal Physical Processes
- Section 3 Literature Review of EIA Baseline Survey and Monitoring Requirements
- Section 4 Review of EIA Project Information: 'Lessons Learnt' from extant projects
- Section 5 Potential Impacts of Major Developments
- Section 6 Data Requirements for EIA Baseline Characterisation (Survey)
- Section 7 Good Practice for Marine and Coastal Physical Process Monitoring
- Section 8 Survey Techniques

## 2.2 Development of project conceptual understanding

The term marine and coastal physical processes is generally used as a collective for the following themes:

- Hydrodynamics (waves, tidal currents and water levels);
- Sediments, sediment transport and geology; and
- Topography/ morphology.

Combined knowledge of these parameters is central to developing ‘conceptual understanding’ of a system, which describes how the processes of a system link together and evolve in response to applied forces. Survey data (both new and existing) as well as outputs from numerical models (e.g. considering waves, tides, salinity and sediment transport) can be used to support the development, quantification and testing of the conceptual understanding although any numerical modelling should be viewed as a supporting tool, rather than as a substitute. Development of a conceptual understanding is considered critical to inform data requirements and review of existing data, gap analysis and then survey design. The presents a summary of baseline data requirements organised into hydrodynamic, sediments and geology and topography and morphology themes; see section 2 and 6 of the report for further detail.

### 2.2.1 Baseline data requirements

#### Hydrodynamics

- Tidal regime (water level range, current speed and direction)
- Wind wave and swell wave conditions (wave height, period and direction)
- Residual water movement
- Surge water levels and currents
- Temperature, salinity and stratification

#### Sediments and Geology

- Characteristics of seabed sediments
- Particle size and density
- Lithology (origin, composition)
- Thickness of sediment units (including consolidation and change over time)
- Suspended sediment concentrations
- Seabed mobility
- Sediment transport pathways and rates

### Topography/ Morphology

- Bathymetry
- Bedforms and notable seabed features
- Coastal topography, configuration and notable features

The development of a conceptual understanding will determine the adequacy of existing data, highlight data gaps, and therefore the requirement to conduct further surveys and collect new data; see Table 5 of the report with respect to data suitability, and section 8 with respect to survey techniques.

The baseline survey should ensure sufficient temporal and spatial resolution to adequately characterise the physical environment under consideration and be suitable to fulfil the requirements of numerical modelling boundary conditions.

## 2.3 Required data collection principles

We recommend that the following data collection principles should be applied at all project sites:

### Principles of data collection

- The data should provide appropriate temporal and spatial coverage and resolution,
- The data should be collected and analysed in accordance with recognised standards (See Section 8 and Appendix B of the report),
- The type of data collected should be appropriate for EIA and for the objectives of data requirements set out in Section 6.2 of the report,
- The data should be accompanied by sufficient metadata (descriptions of the data source, location, date, time, time-step, instrument used, etc.) such that their context and limitations are understood. These requirements are set out in MEDIN (2019).
- Quality Control procedures should be undertaken on any data used (an assessment of the data quality, checking whether the data conform to the expected ranges of values; non-conforming data are flagged or excluded) to reduce uncertainty,
- Data must also be of sufficiently high accuracy that potential inherent error in the field data is small in comparison to the absolute values (e.g. the tidal range) and the natural range of the parameter in question (e.g. spring-neap variability in tidal range),
- The distance between the location(s) of the measurement(s) and the location(s) of interest should be minimized: the greater the offset distance and the greater the spatial complexity, the less representative the data will be of the key site of interest.

## 2.4 Survey and Monitoring strategy and implementation

We recommend an approach to survey which will provide flexibility in design options where details of the whole project are not available. This will ensure that the impacts of the final development are fully assessed by the EIA. See section 6.7 of the report for detail and below for a synopsis of NRW survey strategy design principles and technical specification requirements.

We recommend the following survey design principles, noting that we define the Zone of Influence as the area of the seabed or foreshore that could be affected by the proposed development or activity, during both construction and/or operation.

## Survey design principles

- Understanding of the approximate geographical scale of the development and realistic worst-case aspects of the design,
- Anticipated maximum zone of influence of the development, utilising:
    - Spring tidal excursion ellipses,
    - Numerical modelling and field evidence from analogous developments,
    - Littoral sub-cell boundaries,
- A high-level conceptual understanding of the system,
- A source-pathway-receptor map,
- A list of the key relevant questions which require consideration,
- A map showing the geographical locations of existing, and accessible, data holdings as well as key metrics, for example:
    - Bathymetry
    - Wave field

## Survey design technical specifications

- Spatial and temporal coverage,
- Sampling density,
- Data collection techniques; see section 8 of the report,
- Data standards; these requirements are set out in MEDIN (2019),
- Analytical techniques,
- Statistical techniques,
- Quality control.

Prediction of future hydrodynamic or morphological change can be uncertain and therefore adaptive management may be required. Monitoring schemes can be adopted via regulatory processes, which ensure effective adaptation to receptor response by enabling identification of the pathway from the source. Mitigation or design change measures can then be employed actively as the project develops to ensure receptor sensitivity tipping points are not exceeded. The evidence report discusses good monitoring practice; see section 7 of the report.

We encourage development of a monitoring strategy which will address the following design principles:

## Monitoring design principles

- What are the monitoring objectives/ hypotheses?
- Likely trend of change of a pathway or receptor, and how is that likely to change both naturally and anthropogenically in the future,
- What is the likely future impact of different management interventions on the site and adjacent features?
- What is the likely impact of climate- related changes on the site in the future?
- What are the likely future short-term impacts on the site due to short term events i.e. storms?
- What is the site's ability to recover/ site resilience?
- Which parameters should be investigated,
- How should the parameters of interest be measured?
- The time of year/ frequency with which the parameter will be measured,
- The establishment of review periods providing the ability to stop or modify the monitoring exercise if the measurements suggest no change,
- The identification of appropriate thresholds of change,
- Identification of remedial action.

# 3. Modelling

Evidence Report No: 208 Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments.

The purpose of this report is to inform organisations of best practice when considering the use of numerical modelling to support an Environmental Impact Assessment, Habitats Regulations Assessment or Water Framework Directive assessment related to a development within the marine, coastal or estuarine environment. The report considers:

- establishment of a physical processes baseline to support modelling assessments
- choice of model scenarios for assessment
- model design, set-up and calibration procedures
- model validation procedures
- how the results of numerical modelling should be interpreted and used in conjunction with information from other methods as part of an overall Integrated Assessment process

Models vary greatly in type and complexity and it is essential that the model chosen is (a) appropriate to the environment and situation to which it is being applied, and (b) capable of reproducing the range of processes identified as important to the study, both in terms of the baseline environment and the potential impacts of a scheme.

## 3.1 Overview

The evidence report is based on a review of available modelling methods, a review of the types of numerical models currently available and most commonly used in the UK to investigate hydrodynamics, sediment transport and water quality, and a review of relevant published literature. Based on these reviews, the report makes a number of recommendations relating to the requirements for modelling-supported assessments of potential development impacts in the coastal /and marine environments.

Numerical modelling should not necessarily be viewed as an essential requirement in potential impact assessments, especially in the case of smaller schemes where the time and cost requirement may not be justified. Assessments should never be based on numerical modelling alone, and any numerical model results should be compared with results from data analysis and other forms of investigation such as physical modelling. The quality and relevance of numerical modelling results is heavily dependent on the quality of the data used to construct and validate the model, and all modelling should be accompanied by a programme of data collection and/ or collation (See section 2 above). Key issues to be addressed at this early stage are the required spatial and temporal scales of any modelling which may be required, the best type of model(s) to use in order to identify potential impact pathways between sources and receptors, the scenarios which need to be modelled, and the requirements for data collection both to allow model development and validation, and to provide independent evidence to be used in the overall process of integrated assessment. The key sections of the evidence report are:

- Section 2 Review of existing coastal numerical modelling guidance
- Section 3 Types of models
- Section 4 Best practice in numerical modelling of coastal areas in support of EIA studies
- Section 5 Establishing a physical processes baseline to support modelling
- Section 6 Error, uncertainty and confidence in model results
- Section 7 Combining numerical modelling results with other methods of assessment

## 3.2 Suggested requirements with respect to numerical modelling

When consulted, ideally at pre-application stage, we would like to see the following submissions each of which is expanded upon in the report:

## Numerical modelling requirements

You should include first and foremost:

- A definition of the problem being addressed, and the study objectives;
    - Likely trend of change of a pathway or receptor, and how is that likely to change both naturally and anthropogenically in the future,
    - What is the likely future impact of different management interventions on the site and adjacent features?
    - What is the likely impact of climate- related changes on the site in the future?
    - What are the likely future short-term impacts on the site due to short term events i.e. storms?
    - What is the sites ability to recover/ site resilience?

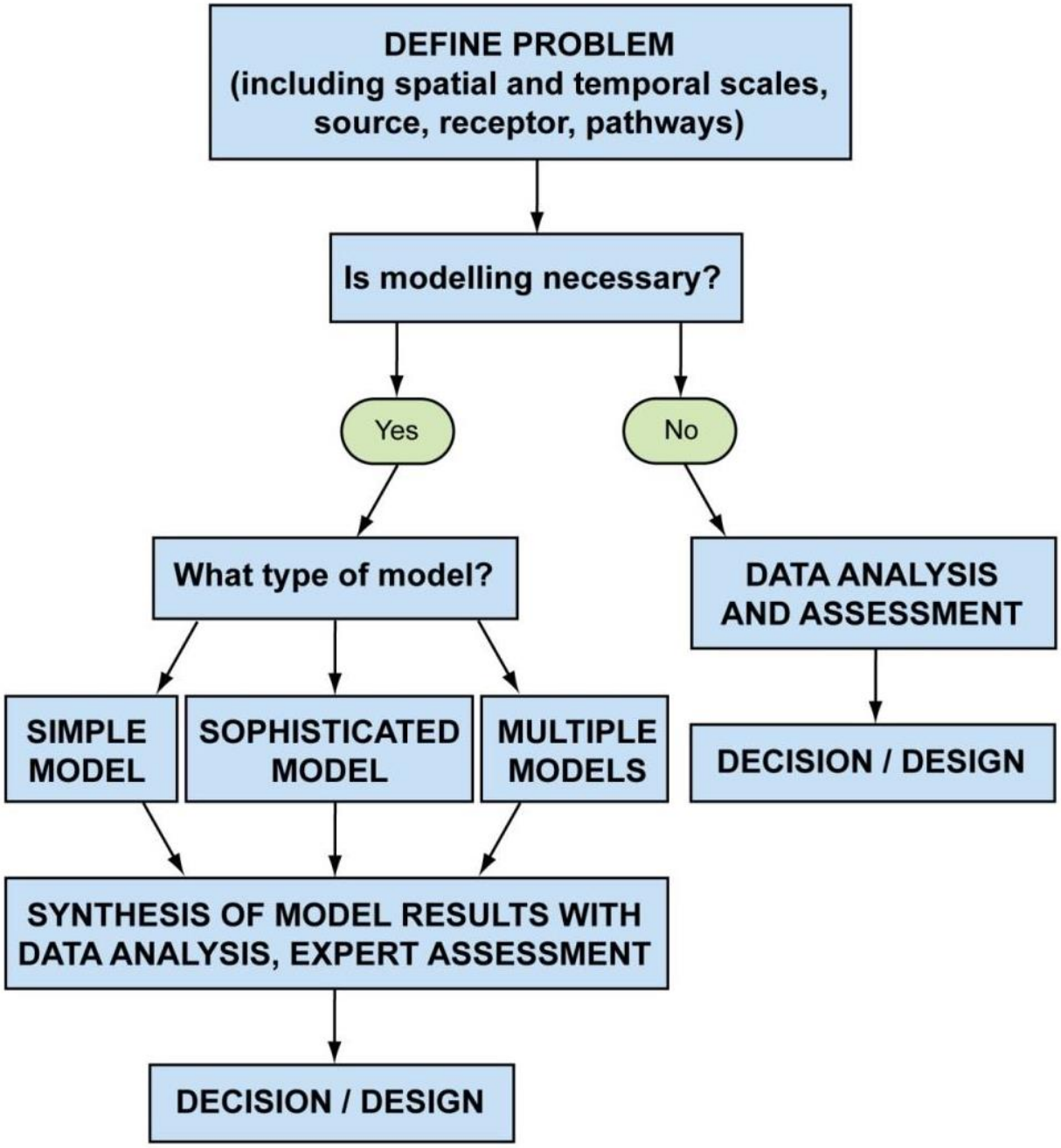
Then go on to provide:

- A Definition of a relevant source – pathway- receptor framework for investigation; see Figure 1,
- A review of the available evidence base; see section 2, 3 and Appendix B of the report,
- Justification for the decision whether or not to use modelling; see Figure 2 of the report,
- Justification for the choice of any model used (ID, 2D, 3D etc.); see section 4 of the report,
- Technical description of the model(s), including development history, examples of previous applications and experience of the model users; see section 4 of the report,
- The basis for the definition of the model domain; see section 4 of the report,
- The basis for the type of mesh chosen; see section 4 of the report,
- The basis for selection of model boundary conditions; see section 4 of the report,
- The nature of any existing data used (bathymetry, water levels, currents, waves, sea bed characterization, sediment concentrations and particle size, water salinity, temperature and concentration of any other relevant features (phytoplankton, coliforms etc.), including their currency, spatial and temporal resolution, and procedures used to check data quality; see section 5 of the report,

- The nature of any new data collected, including measurement methods and procedures for data quality control; see section 5 of the report,
- The nature of any sensitivity tests to undertake; see section 4 of the report,
- The basis for selection of critical model parameter values (e.g. bed roughness, bed sediment size), and method of representation in the model; see section 4 of the report,
- The methods used for model calibration; see section 4 of the report,
- The methods used for model validation and assessment of ‘performance’ of the model; see section 4 and 6 of the report,
- The magnitude of possible errors / bias in the modelling results and the potential implications for the conclusions reached; see section 6 of the report,
- Full reference to data and metadata archiving methods, including full descriptions of the modelling procedures which can be audited by the regulator or other bodies if required.

You should be conscious of whether value will be added in making your decision to implement a numerical modelling strategy. For example, will value be added by understanding the effects at different phases of development: construction, operation and decommissioning, on the physical processes of the particular environment, associated with the project.

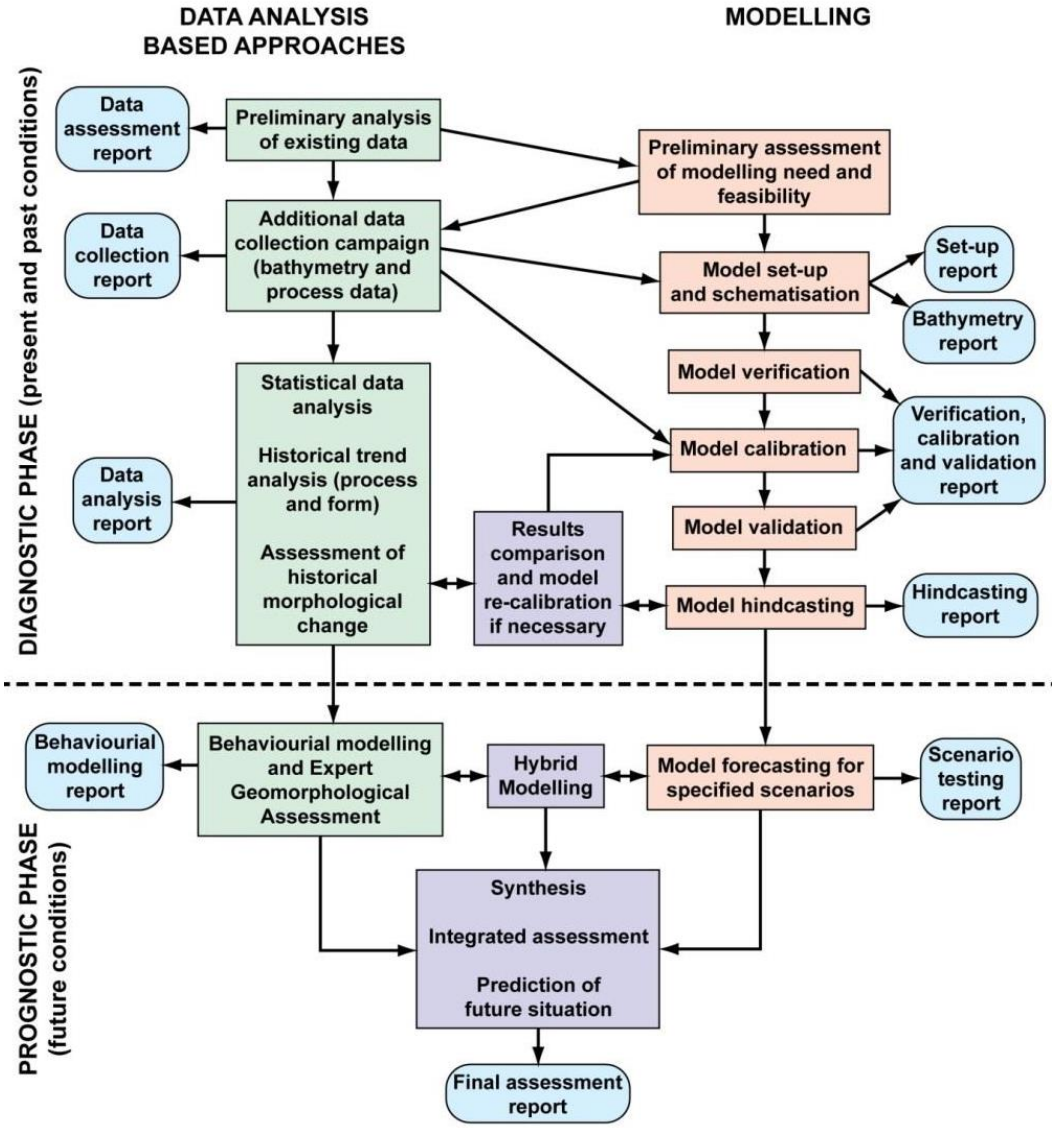
## EIA strategy and numerical modelling decision tree




## Illustration of the complementarity of phased development assessment, data analysis and numerical modelling

The following schematic; see section 7 of the evidence report, portrays a summary of a developments phased assessment, and the complementarity of data-based analysis and numerical modelling approaches. Data and survey requirements to support any such

analysis and modelling is discussed in section 2 of this report in relation to Evidence Report 243.




# 4. Further guidance

## 4.1 Marine and Coastal Guidance

Here you will find guidance, links and relevant downloads to enable sustainable marine and coastal project development and activities. Of particular significance are the following:

EIA: Information on EIA and how it applies to marine licensing

NRW portal with sections providing detail on:

- Section 1 Background Information
- Section 2 EIA screening and scoping
- Section 3 What types of project require an EIA
- Section 4 What information should be included in an ES
- Section 5 2017 Amendment to the Marine Works (EIA) Regulations
- Section 6 Previous EIA consent decisions issued by NRW

GN006 Marine ecology datasets for marine developments and activities

Marine ecology data owned or recommended by NRW and how to access it.

GN013 Scoping an EIA for marine developments

This document sets out NRW guidance on how to identify the key impacts of marine development projects in Wales that require assessment under the EIA directive.

GN030 Assessment guidance for developments and activities

Guidance for undertaking benthic marine habitat survey and monitoring. This GN recommends you include a benthic characterisation survey to increase the resolution of the baseline survey and subsequent delivery of a robust EIA. A characterisation survey is conducted to contribute to the overall site characterisation where existing information is insufficient to meet the specified start point to undertake a baseline survey

The Estuary Guide

The Estuary Guide aims to provide an overview of how to identify and predict geomorphological change within estuaries, as a basis for sound management. It supplements the report on numerical modelling provided here by including other techniques such as historical trends analysis and expert geomorphological assessment. NRW supports consideration of these conceptual techniques where appropriate.

# 5. References

MEDIN (2019) Brief guidance notes for the production of discovery metadata for the Marine Environmental Data and Information Network (MEDIN). https://www.oceannet.org/medin/sites/medin/files/documents/MEDIN_Schema_Documentation3_0_brief.pdf

## 5.1 Recommended citation:

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**Published by:**
Natural Resources Wales
Cambria House
29 Newport Road
Cardiff
CF24 0TP
0300 065 3000 (Mon-Fri 8am-6pm)
enquiries@naturalresourceswales.gov.uk
www.naturalresourceswales.gov.uk