Arklow Bank Wind Park 2

Environmental Impact Assessment Report

Volume III, Appendix 6.1: Marine Physical Processes Numerical Modelling (Revised March 2026)

sse Renewables

Arklow Bank Wind Park 2:

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Commercial in Confidence

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Statement of Authority

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1 Definitions

1.1 Units and Conventions

The following list describes the units and conventions used in this report. Units have been expressed using the International System of Units (SI) convention.

- Current direction is expressed in compass points or degrees, relative to true North [°T], and describes the direction **towards** which the currents are flowing.
- Current speeds are expressed in metres per second [m/s].
- Water levels are expressed in metres [m].
- Positions are quoted relative to WGS 84 except where stated.
- All times are quoted in Coordinated Universal Time [UTC].

1.2 Glossary of commonly used terms

The following list describes common metocean terms used throughout this report.

Levels	Description
LAT	Lowest Astronomical Tide. Minimum level of sea surface due to tidal forcing alone.
MSL	Mean Sea Level. Mean sea surface elevation over a prolonged period of time.
Currents	**Description**
Current speed	Magnitude of local current flow.
Offshore Construction	**Description**
Array Area	The Array Area is the area within which the Wind Turbine Generators (WTGs), the Offshore Substation Platforms (OSPs), and associated cables (export, inter- array and interconnector cabling) and foundations will be installed.
Cable Corridor and Working Area	The Cable Corridor and Working Area is the area within which export, inter-array and interconnector cabling will be installed This area will also facilitate vessel jacking operations associated with installation of WTG structures and associated foundations within the Array Area.
TSHD	Trailing suction hopper dredger. Self-propelled vessel able to remove sediments from the seafloor to a hopper in the hull, for subsequent disposal elsewhere.
WTG	Wind Turbine Generator.
OSPs	Offshore Substation Platforms.
HDD	Horizontal Directional Drilling. Method of installing underground cables using a drill.

2 Introduction

2.1 Background

GoBe Consultants Ltd contracted MetOceanWorks to provide marine processes modelling services, for the Arklow Bank Wind Park 2 (ABWP2). The ABWP2 site is being developed by Sure Partners Limited (SPL).

ABWP2 is situated on a long narrow sandbank approximately 10 km off the Wicklow Coast, near the town of Arklow (see Figure 6.1.1). The site area is approximately 27 km x 2.5 km and water depths within the Array Area range from approximately 2 m to more than 40 m below LAT [1]. Subsea cables will link the wind farm with the power delivery network at the adjacent coast. Figure 6.1.1 shows the proposed Array Area and the proposed Cable Corridor and Working Area. Numerical modelling has been carried out to assess the likely impact of the construction and operation of the wind farm and its associated infrastructure, on the marine environment.

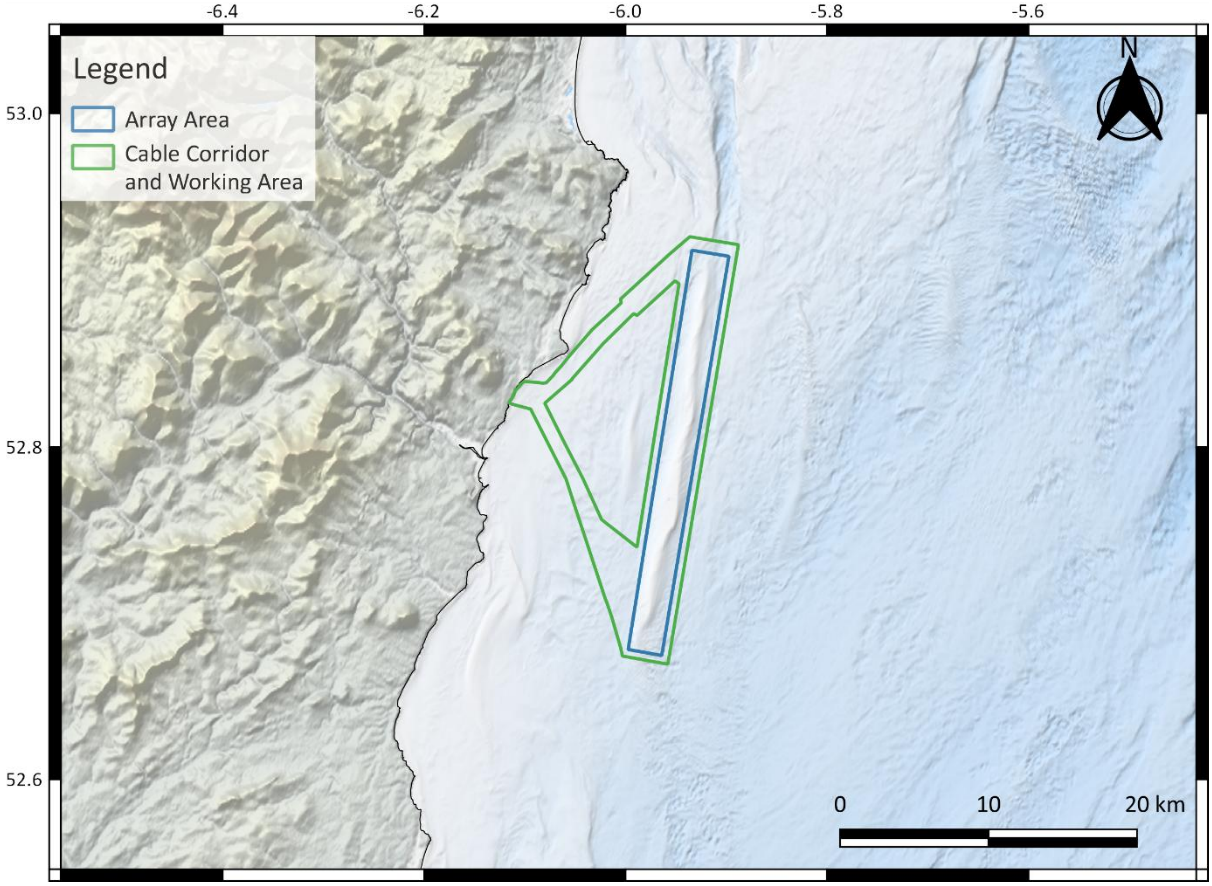


Figure 6.1.1: Overview of ABWP2 area including the Array Area and Cable Corridor and Working Area.

2.2 Report Structure

This document describes the various data sources, marine process models and analysis methods used throughout the study.

Modelling details are discussed in Sections 3 to 5, initially introducing common model inputs (Section 3) before moving onto the models themselves. By way of introduction to the overall approach:

- **Hydrodynamics** were modelled using the MIKE21FM 2D flexible mesh modelling package. Modelled currents and water levels have been validated against measurements from several locations. See Section 4 for details. The validated hydrodynamic model was then used to drive the particle tracking module.
- The **Particle Tracking** module was used to simulate the extent and fate of sediments disturbed during construction activities (Section 5).

Thereafter, Section 6 provides a description of the results. The document concludes with a list of the references used throughout.

3 Common Modelling Inputs

3.1 Bathymetry

A representative bathymetry dataset was required as input to the hydrodynamic model. This was achieved by merging four different datasets which originated from:

- European Marine Observation and Data Network (EMODnet)
- MarineFIND
- SeaDataNet
- SPL-supplied survey data from 2019

Far-field bathymetry data for the models were sourced from the EMODnet Bathymetry Data Portal [2]. EMODnet provides a service for viewing and downloading a harmonised Digital Terrain Model (DTM) for the European sea regions that is generated by an ever-increasing number of bathymetric survey data sets provided by national hydrographic institutions, research bodies and academia. As of 2018, these data are available at a resolution of approximately 130 m.

These data were then merged with MarineFIND [3] raster charts which have a resolution of 1 arc-second (or approximately 25 m, depending on latitude), whereby physical features such as trenches, ridges, sand banks and sand waves are represented. Figure 6.1.2 shows the available coverage of MarineFIND data with the tiles procured highlighted in green.

To provide the highest possible resolution input data for the Western Irish Sea, surrounding Arklow Bank, individual survey datasets were procured from SeaDataNet [4]. Merged available survey datasets in the region of the project are shown in Figure 6.1.3 and have various resolutions between approximately 4 m and 11 m. Overlapping or duplicated datasets were removed, leaving 22 individual survey datasets which were merged, and any small gaps were filled using linear interpolation.

The SPL-supplied survey data from 2019 [5] are also highlighted in this figure, using a different colour scale. These data have a spatial resolution of 1 m and cover the entire array area.

A critical aspect of the bathymetry development for the numerical modelling purposes was to ensure no vertical discontinuities at the boundaries between the SeaDataNet and 2019 survey data. Therefore, the two datasets were merged using a tapering method to avoid sudden vertical shifts at dataset edges. For further details of the bathymetry treatment, please see the Metocean Data Overview Report [6].

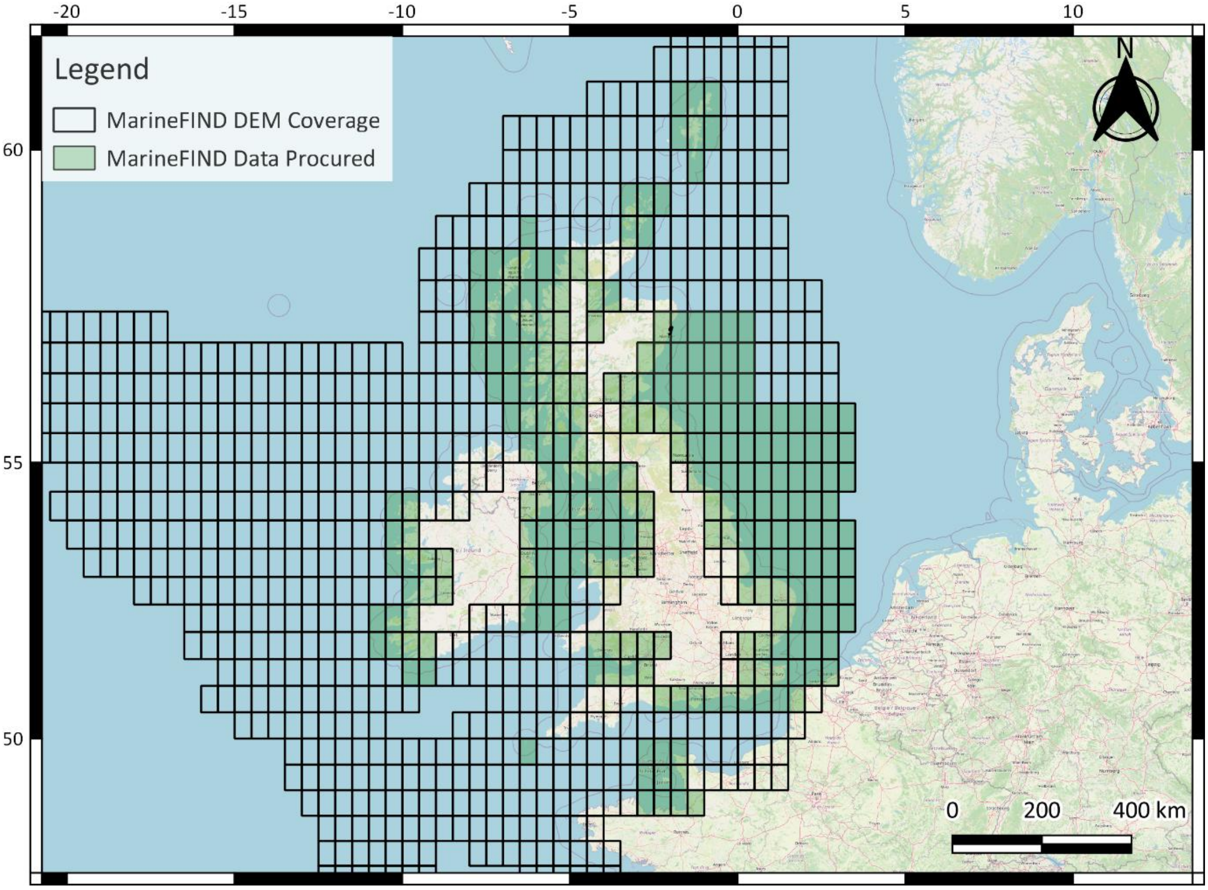


Figure 6.1.2: Coverage of MarineFIND data, and DTM tiles procured shown in green.

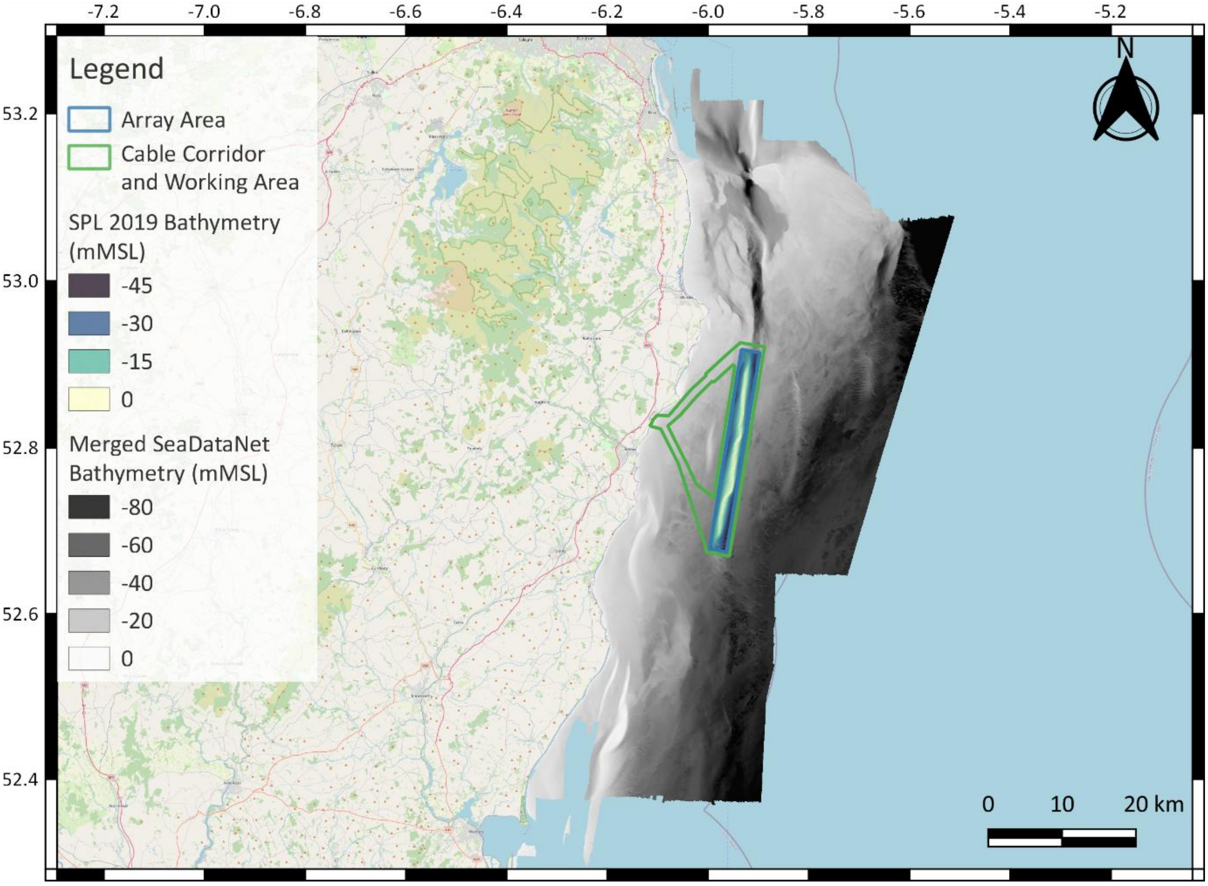


Figure 6.1.3: Merged available bathymetry surveys from SeaDataNet and SPL 2019 bathymetry overlain.

Finally, the bathymetry data were converted from LAT to MSL datum prior to use, as required by the modelling software. These datum differences were calculated from the Finite Element Solution FES2014 dataset, a 35-constituent, global tidal database available from AVISO [7].

3.2 Coastline

The coastlines of England, Scotland and Wales were discretised using the Boundary-Line™ mean high water mark vector product, from the Ordnance Survey, which describes the position of Mean High-Water Springs (broadly analogous to the High Water Mark). For continental Europe, the island of Ireland, and the Isle of Man, the coastline layer from OpenStreetMap was used. These data were used in conjunction with Google and Bing Maps satellite imagery to provide the most accurate and appropriate coastline description for the models. Furthermore, they were found to have a better representation of coastal features than data available from the Ordnance Survey Ireland.

3.3 Wind

European Centre for Medium-Range Weather Forecasts (ECMWF) ReAnalysis 5 (ERA5) wind data was used to drive the hydrodynamic model. ERA5 is the fifth and latest major global reanalysis produced by ECMWF. Hourly wind speeds are available for the period 1979 to near-present at various levels (including at 10 m above sea level, as used to drive the hydrodynamic model) are available on a 0.25° by 0.25° resolution grid via the

Copernicus Climate Change Service (C3S) Climate Data Store (CDS). Prior to use, the raw ERA5 data is calibrated using a bespoke adjustment developed by MetOceanWorks which improves performance in driving models. These data have been extensively validated against on-site measured LiDAR data. These validations, and adjustments to the input wind fields, are described and presented in the project metocean report [6].

4 Hydrodynamics

Current and water level parameters were produced using a European, basin-scale flexible mesh hydrodynamic model. Depth-averaged currents and water levels were produced to drive the particle tracking model (described in Section 5).

Prior to use in the assessments, the performance of the model in representing currents and water levels was ascertained by comparison against several measured data sources. These are described in Section 4.1.

4.1 Measured Hydrodynamic Data

To support calibration and validation of the hydrodynamic model, measured data from acoustic waves and current recording devices (AWACs) were acquired from Sure Partners Limited. These deployments were commissioned by Sure Partners Limited for the purposes of site characterisation, and to support validation of numerical models of the site. An overview of the measured datasets can be found in Table 6.1.4.1 and Figure 6.1.4.

Table 6.1.4.1: Measured datasets used for hydrodynamic model validation.

Dataset	Location	Time Period	Water Depth [mMSL]
AWAC A	52.9087 °N, 5.9167 °W	6-Nov-2019 to 7-Mar-2021	27.4[†]
AWAC C	52.8218 °N, 6.0206 °W	24-Nov-2019 to 19-May-2020	26.3
AWAC E	52.6906 °N, 5.9940 °W	24-Nov-2019 to 8-Mar-2021	39.0

† No valid data was recorded was at AWAC A after 5th August 2020.

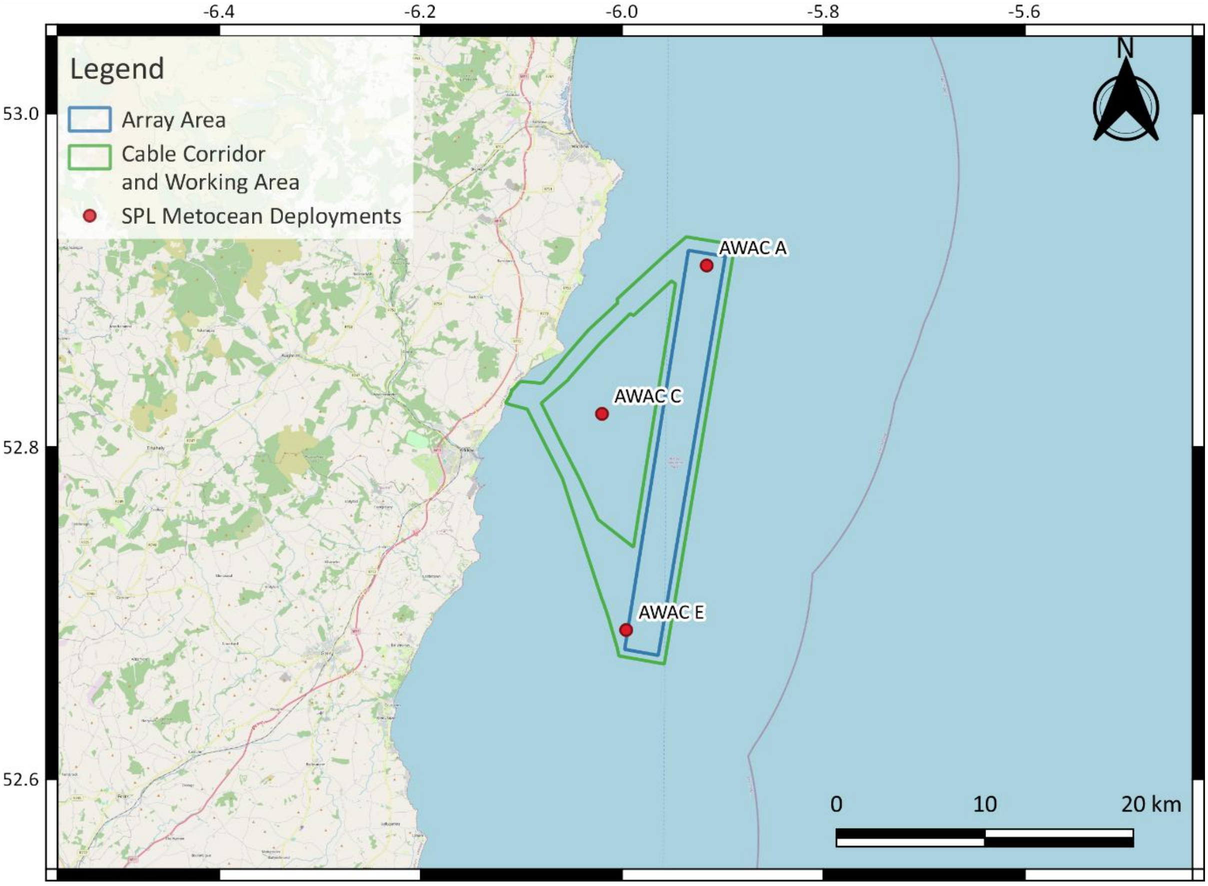


Figure 6.1.4: Measured datasets used for hydrodynamic model validation.

4.2 Modelling Software

The hydrodynamic model has been developed using the MIKE21FM (Flexible Mesh) 2D modelling package [8] [9], a comprehensive modelling system for two-dimensional water modelling developed by DHI. Arklow bank and the surrounding area are subject to strong tidal influence with relatively shallow water depths leading to a vertically well-mixed water column, it is therefore not considered necessary to use a three-dimensional model. Appendix H of the project metocean data overview report [6] provides a comprehensive analysis of the current profile shapes from each of the project AWACs, and demonstrates that currents can be represented using two-dimensional approximation of the vertical profile.

4.3 Model Boundary Conditions and Spatial Extent

The model setup used in the project metocean study is described extensively in the project metocean overview report [6]. The model used comprised two constituent parts – a European basin-scale model, which then fed boundary conditions to a local model of the Arklow area and surrounds. Because in the present project there is a possibility that materials arising from construction activities could advect outside of the local model extents, a modified version of the setup used in the project metocean study was employed. The European basin-scale model and the local model were merged into a single model which had the spatial extents of the European basin-scale model, together with all the embedded resolution local to Arklow of the local model. Whilst this setup is more computationally expensive (and therefore time-consuming), it delivers the same or better model performance, with the added advantage of ensuring that no materials arising from construction activities could leave the model domain.

Tidal boundary conditions to the model originate from the Finite Element Solution FES2014 dataset. This 35-constituent, global data-set has been produced using numerical modelling which assimilates satellite observations of water level and has the best performance of any publicly-available global tide model. The dataset includes tide elevations (amplitude and phase) and tide currents on a 0.0625-degree (approximately 7 km) grid. The model was driven using water levels varying along three open boundaries, as shown in Figure 6.1.5.

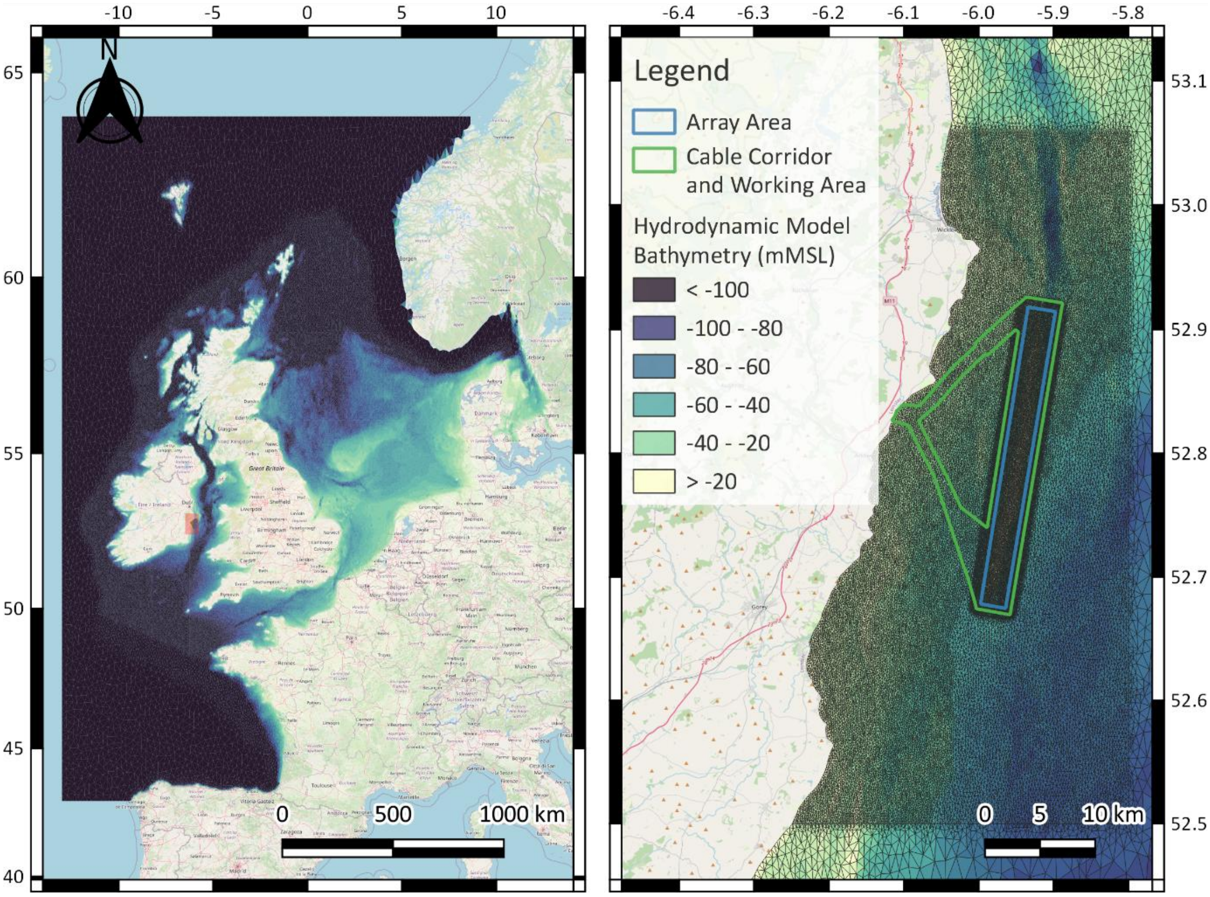


Figure 6.1.5: Regional European MIKE21 flexible model mesh. Bathymetry in m MSL. Whole domain shown in left hand pane, zoom in around the project area shown in right hand pane.

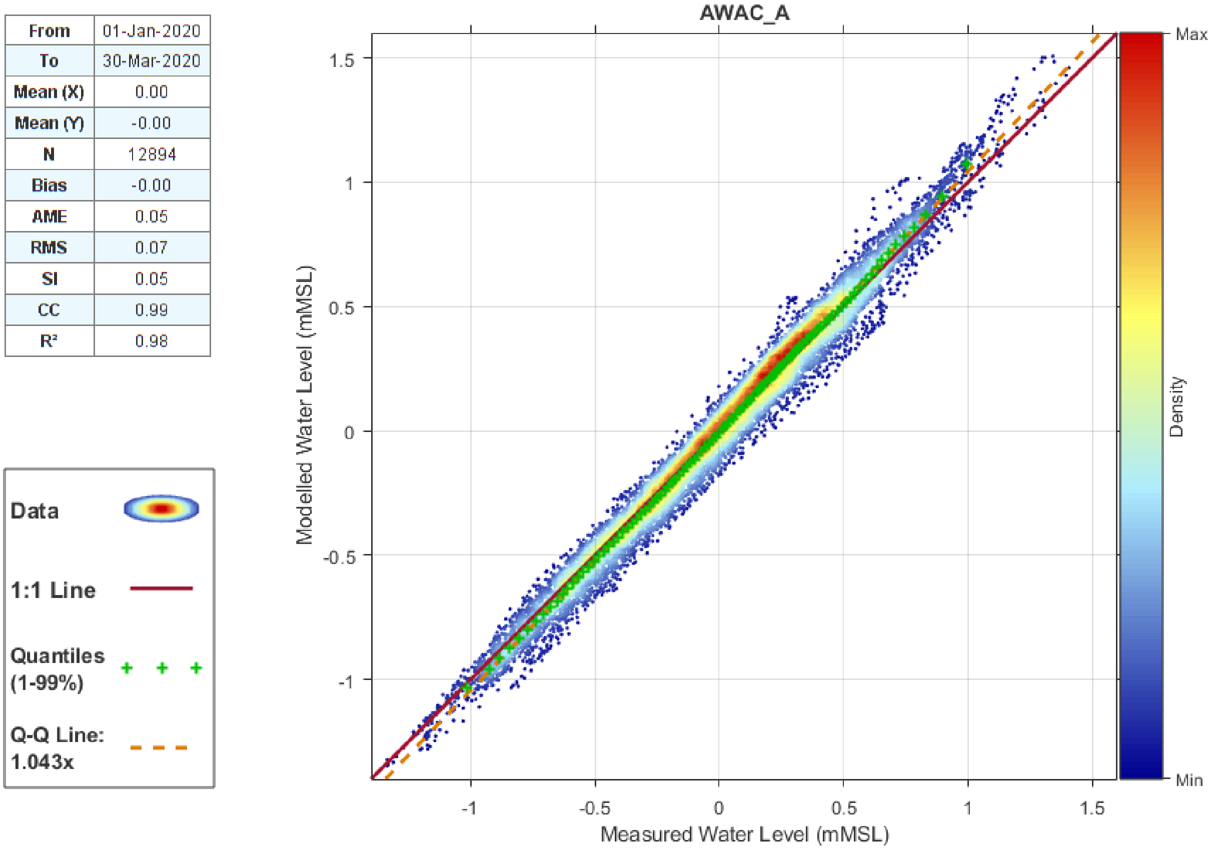
The model had a spatial resolution of 75 m within the Array Area boundary including a 2 km buffer surrounding it. Beyond this buffer, the model had a resolution of approximately 150 m in depths shallower than 40 m and a resolution of 225 m further offshore in the Irish Sea.

Atmospheric forcing for the hydrodynamic model originated from the ECMWF ERA5 dataset and was applied to ensure that atmospheric surge effects were properly represented in the model. This comprised of

MetOceanWorks adjusted wind speeds (see Section 3.3), unadjusted wind directions, and unadjusted pressure fields.

4.4 Model Validation

Validation of the hydrodynamic model used in this study was extensively reported in the project metocean overview report [6]. To ensure that the slightly different model setup used in this study had a similar or better level of performance, validations were carried out for water levels and currents for the three AWAC locations (see Figure 6.1.4) from the project metocean survey [1]. These additional validations are shown in Figure 6.1.6 to Figure 6.1.20.



From	01-Jan-2020
To	30-Mar-2020
Mean (X)	0.00
Mean (Y)	-0.00
N	12894
Bias	-0.00
AME	0.05
RMS	0.07
SI	0.05
CC	0.99
R²	0.98

Figure 6.1.6: Validation plot of water levels at AWAC A.

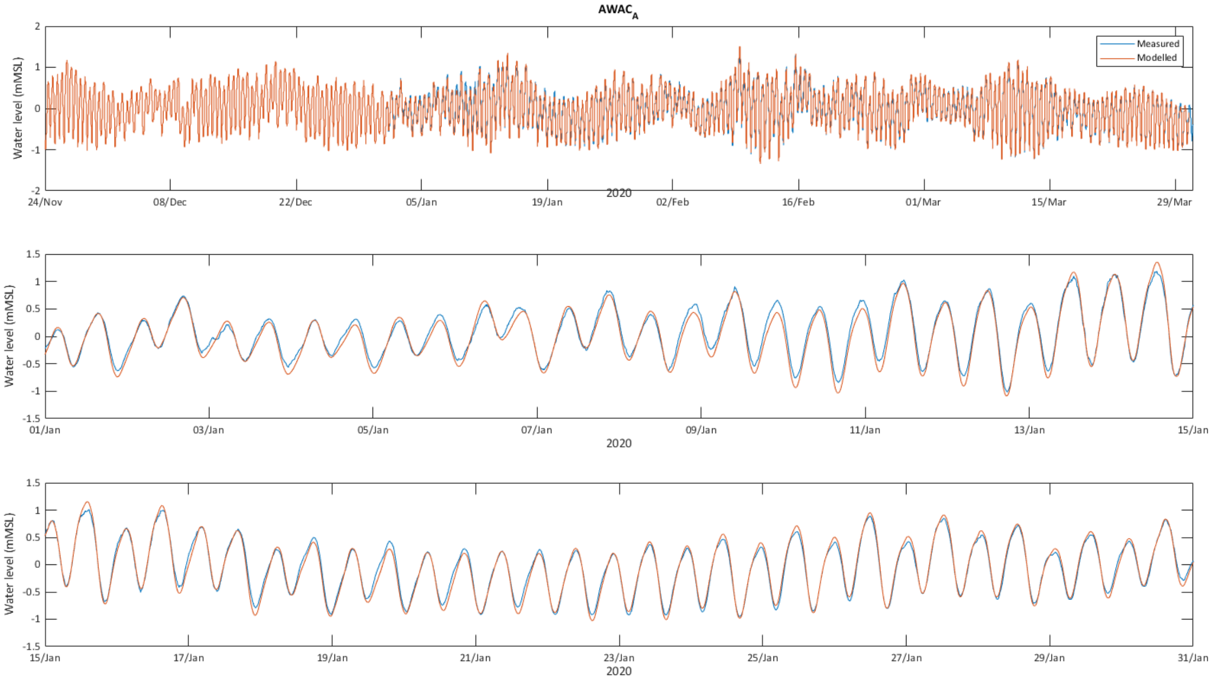
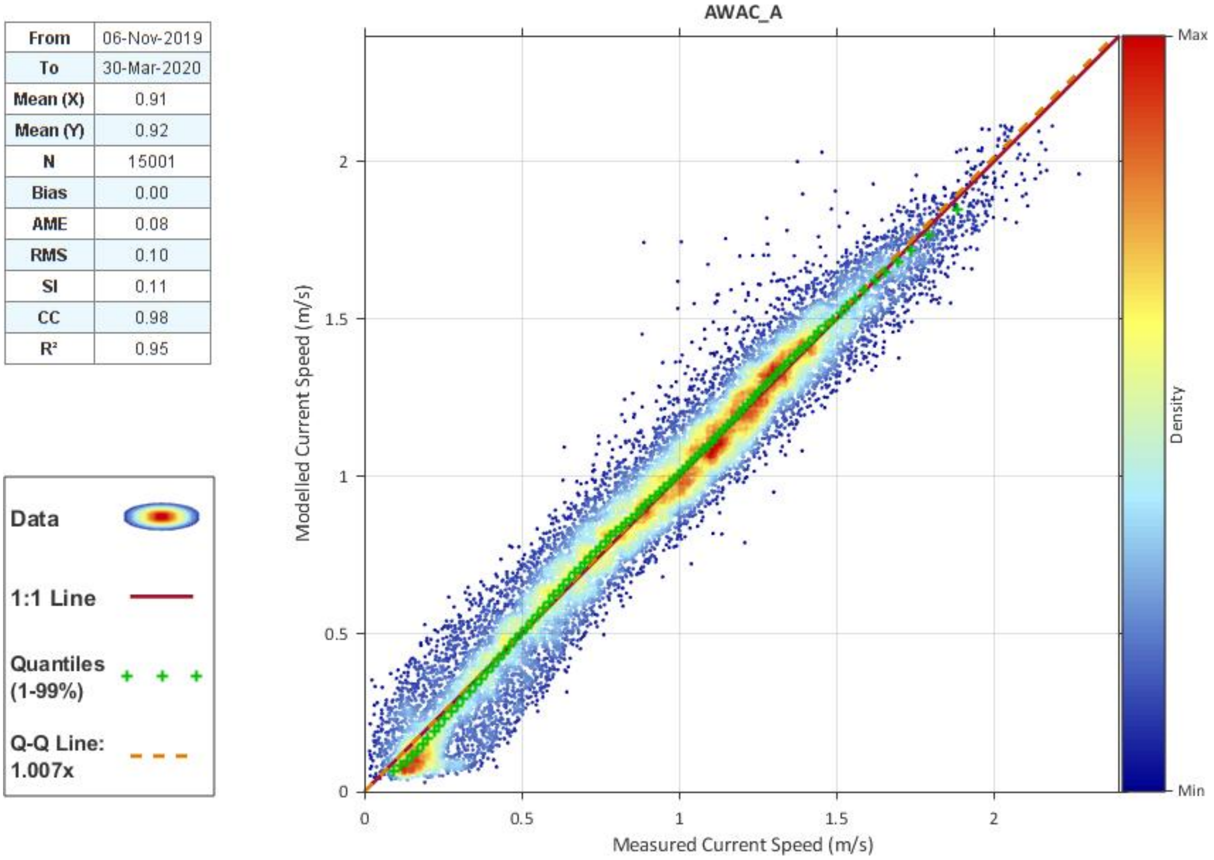


Figure 6.1.7: Time series plot of water levels at AWAC A.



From	06-Nov-2019
To	30-Mar-2020
Mean (X)	0.91
Mean (Y)	0.92
N	15001
Bias	0.00
AME	0.08
RMS	0.10
SI	0.11
CC	0.98
R²	0.95

Figure 6.1.8: Validation plot of currents at AWAC A.

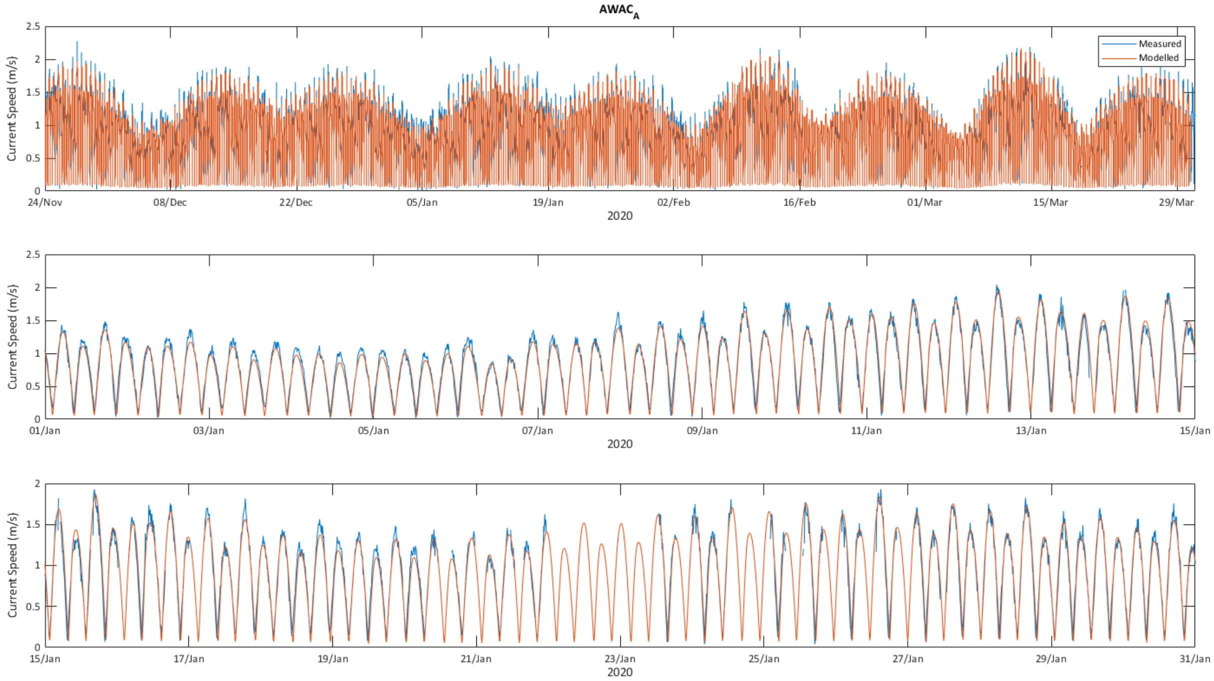


Figure 6.1.9: Time series plot of currents at AWAC A.

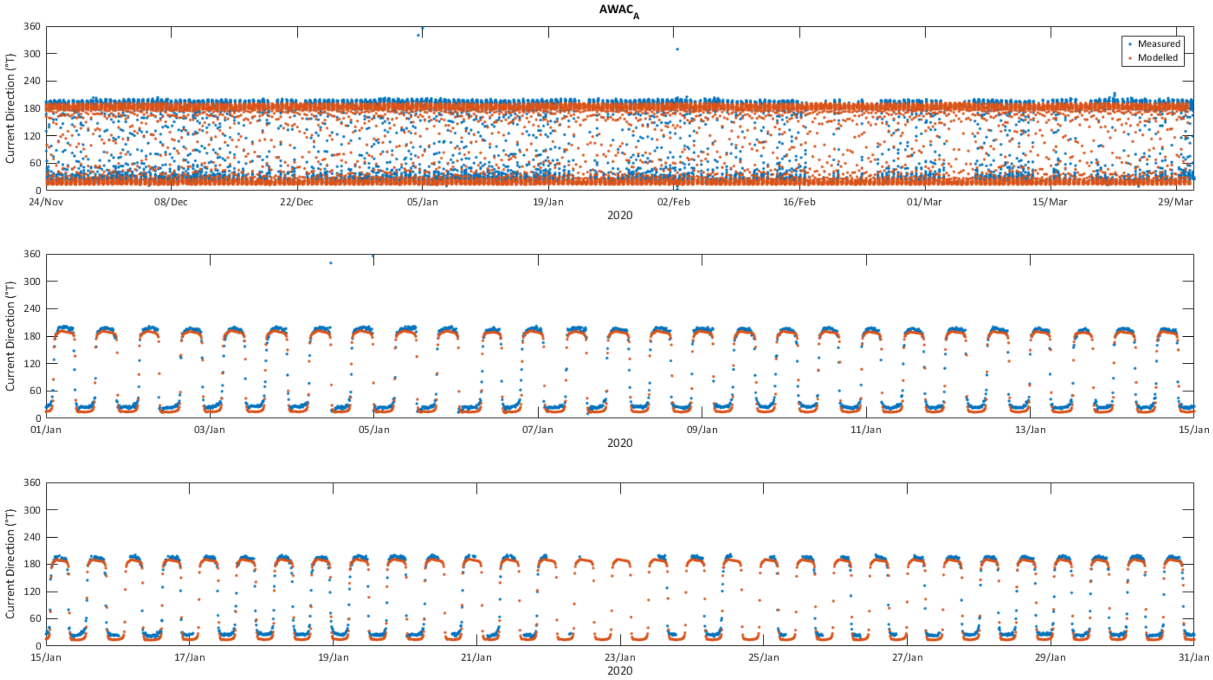
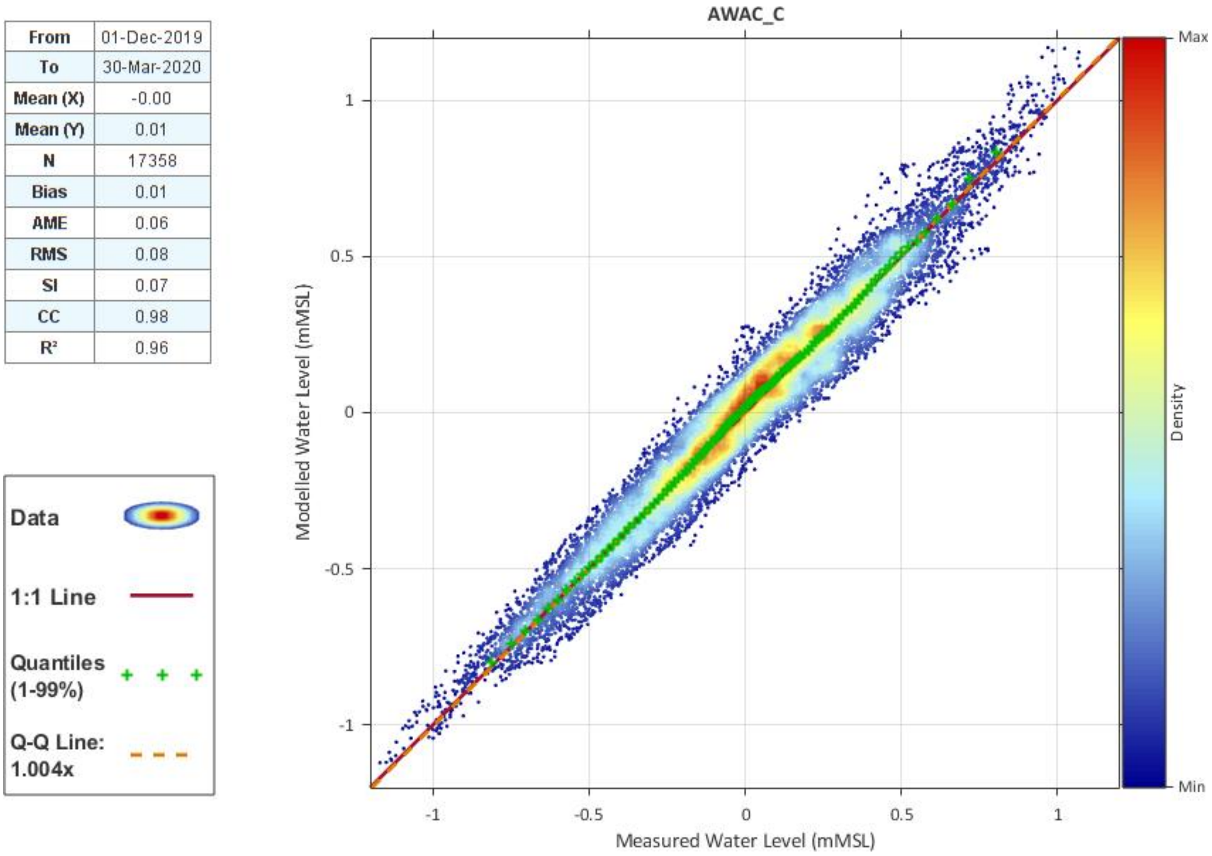


Figure 6.1.10: Time series plot of current directions at AWAC A.



From	01-Dec-2019
To	30-Mar-2020
Mean (X)	-0.00
Mean (Y)	0.01
N	17358
Bias	0.01
AME	0.06
RMS	0.08
SI	0.07
CC	0.98
R²	0.96

Figure 6.1.11: Validation plot of water levels at AWAC C.

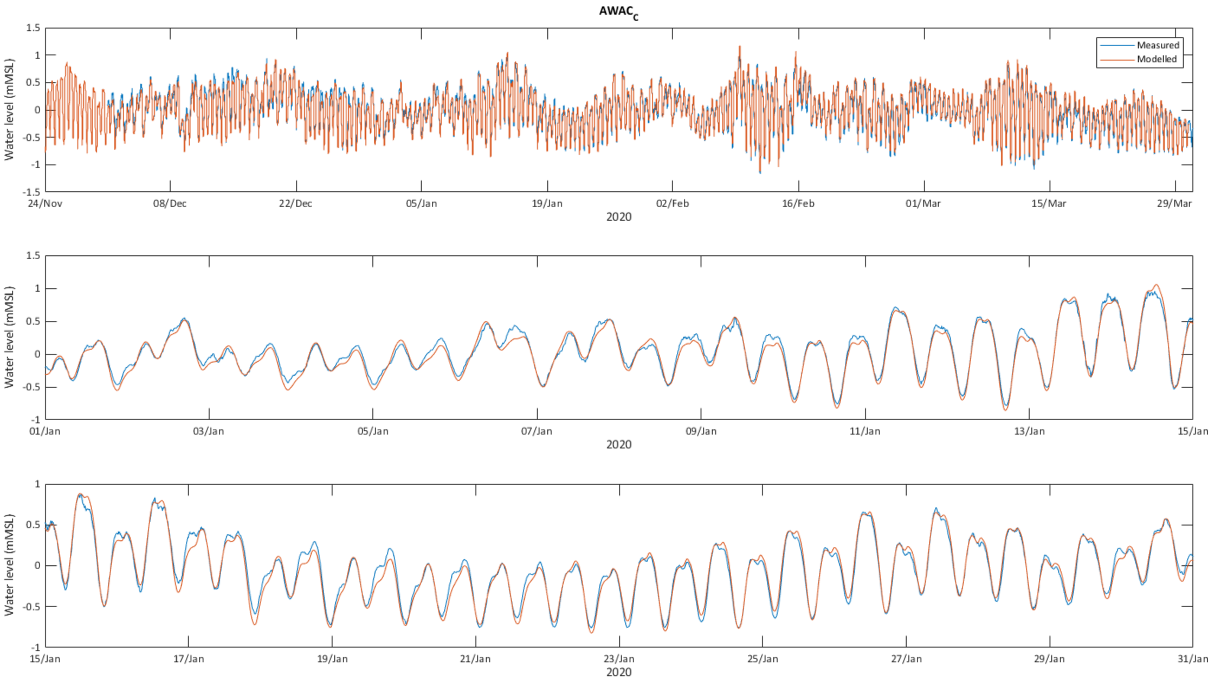
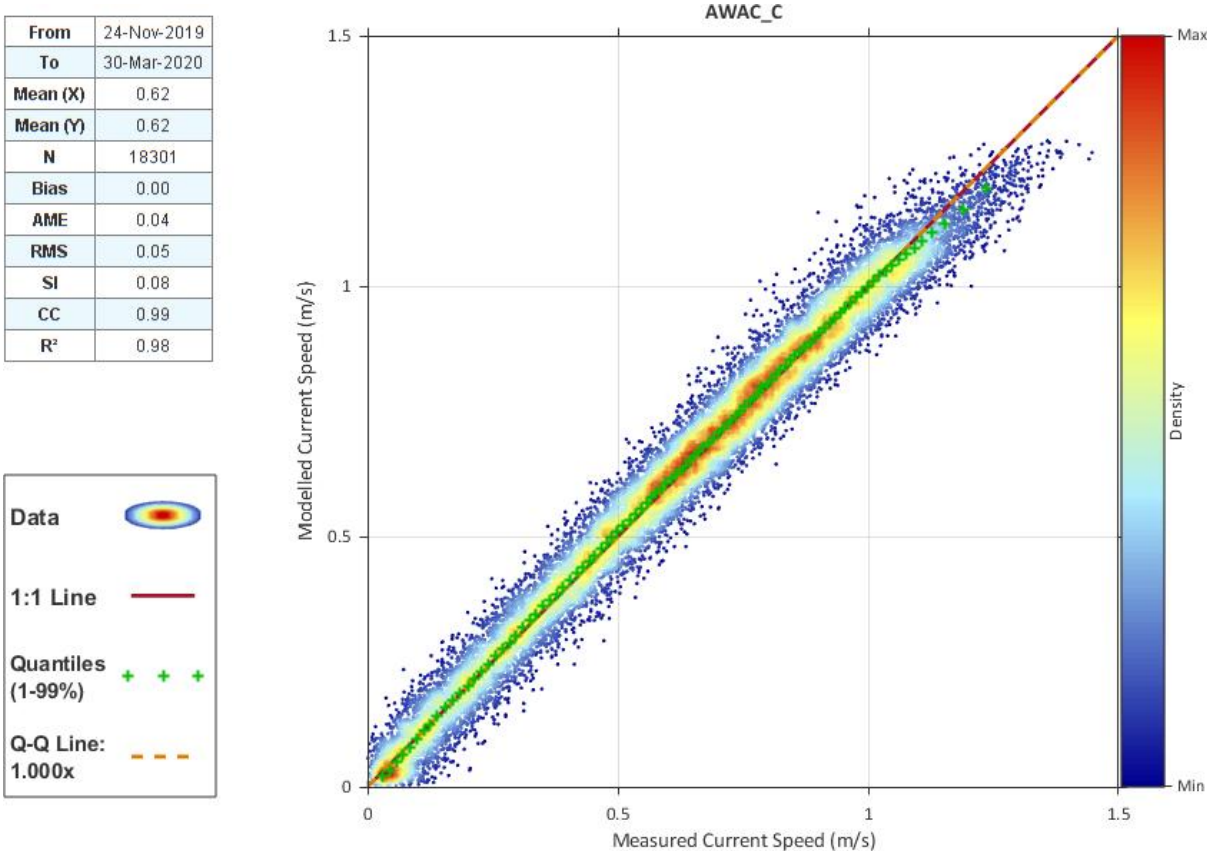


Figure 6.1.12: Time series plot of water levels at AWAC C.



From	24-Nov-2019
To	30-Mar-2020
Mean (X)	0.62
Mean (Y)	0.62
N	18301
Bias	0.00
AME	0.04
RMS	0.05
SI	0.08
CC	0.99
R²	0.98

Figure 6.1.13: Validation plot of currents at AWAC C.

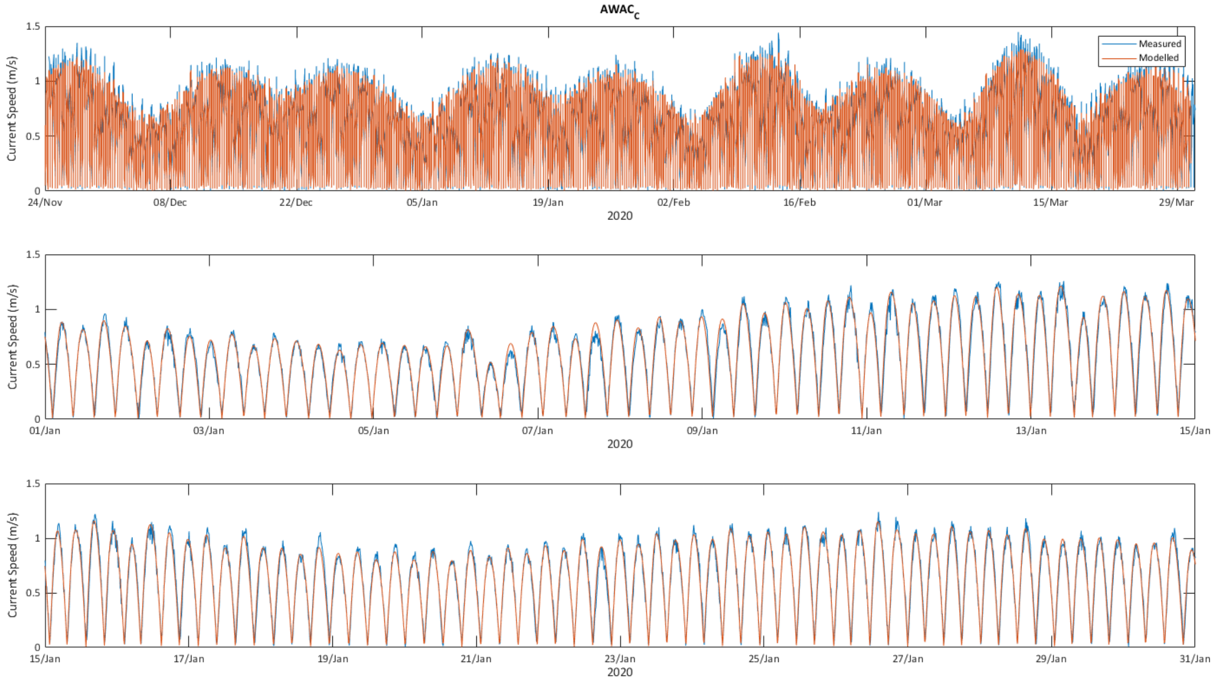


Figure 6.1.14: Time series plot of currents at AWAC C.

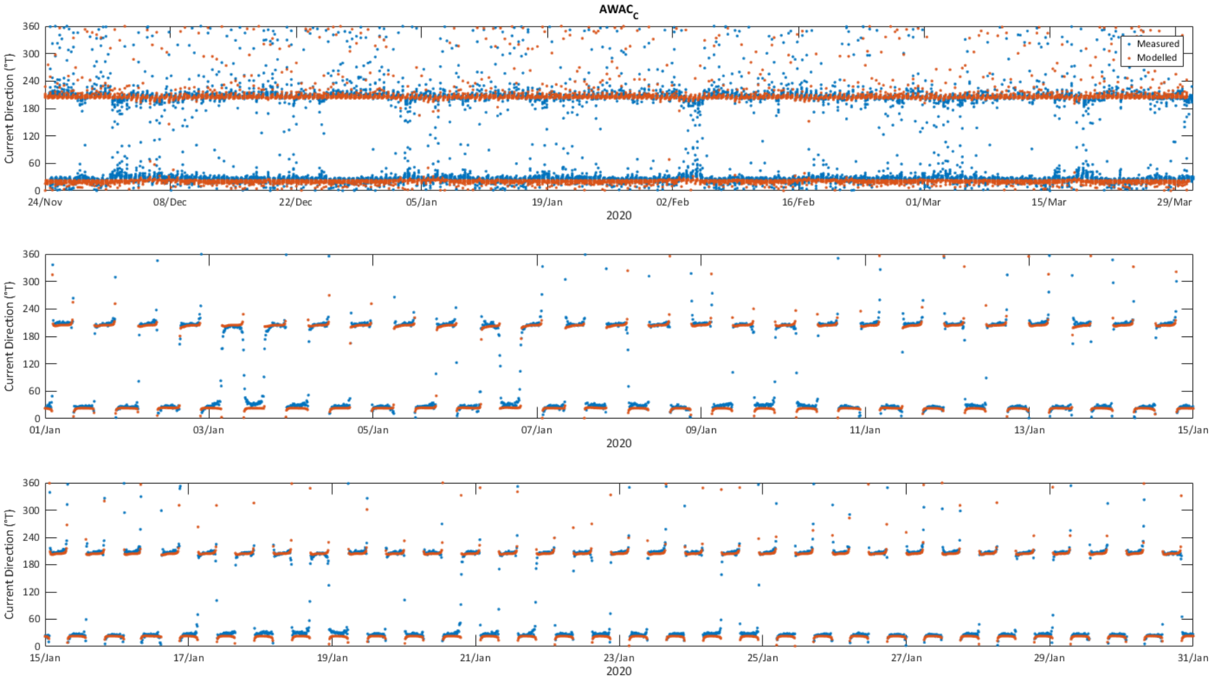
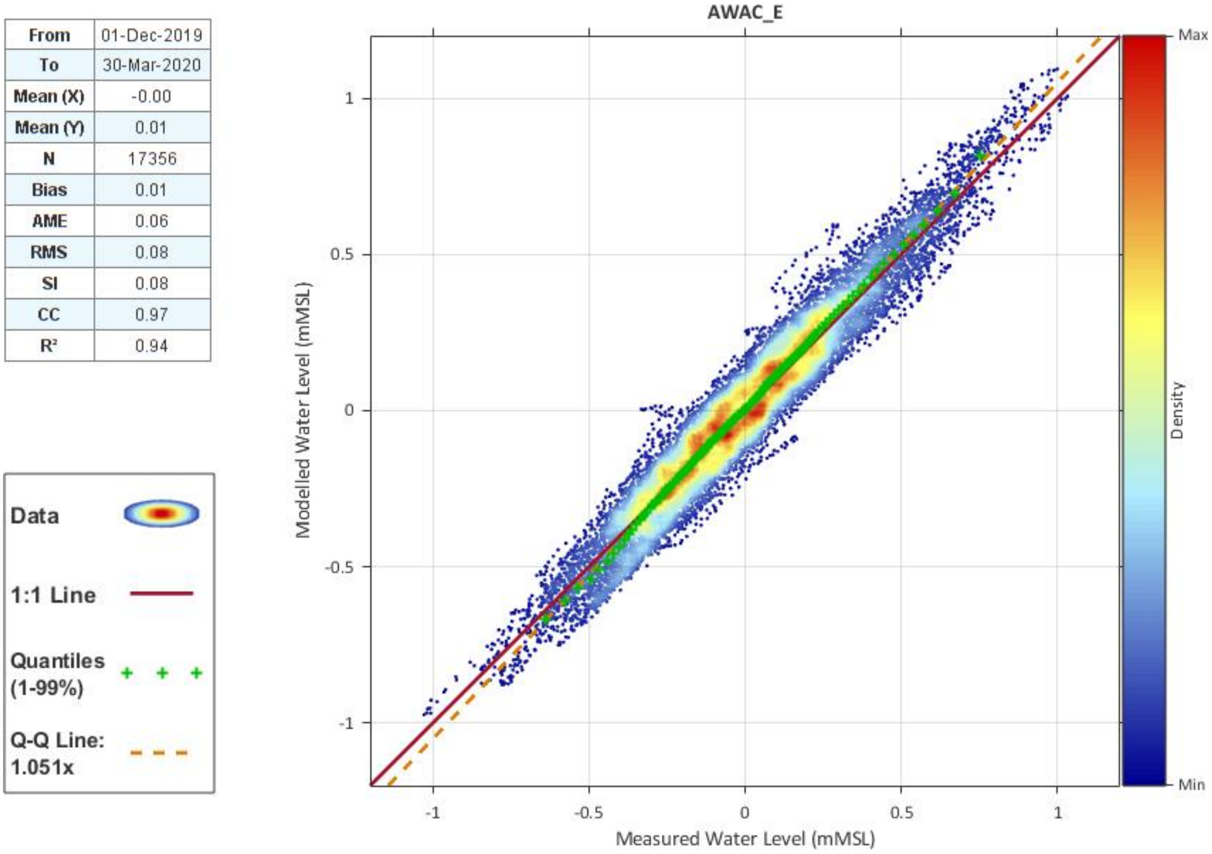


Figure 6.1.15: Time series plot of current directions at AWAC C.



From	01-Dec-2019
To	30-Mar-2020
Mean (X)	-0.00
Mean (Y)	0.01
N	17356
Bias	0.01
AME	0.06
RMS	0.08
SI	0.08
CC	0.97
R²	0.94

Figure 6.1.16: Validation plot of water levels at AWAC E.

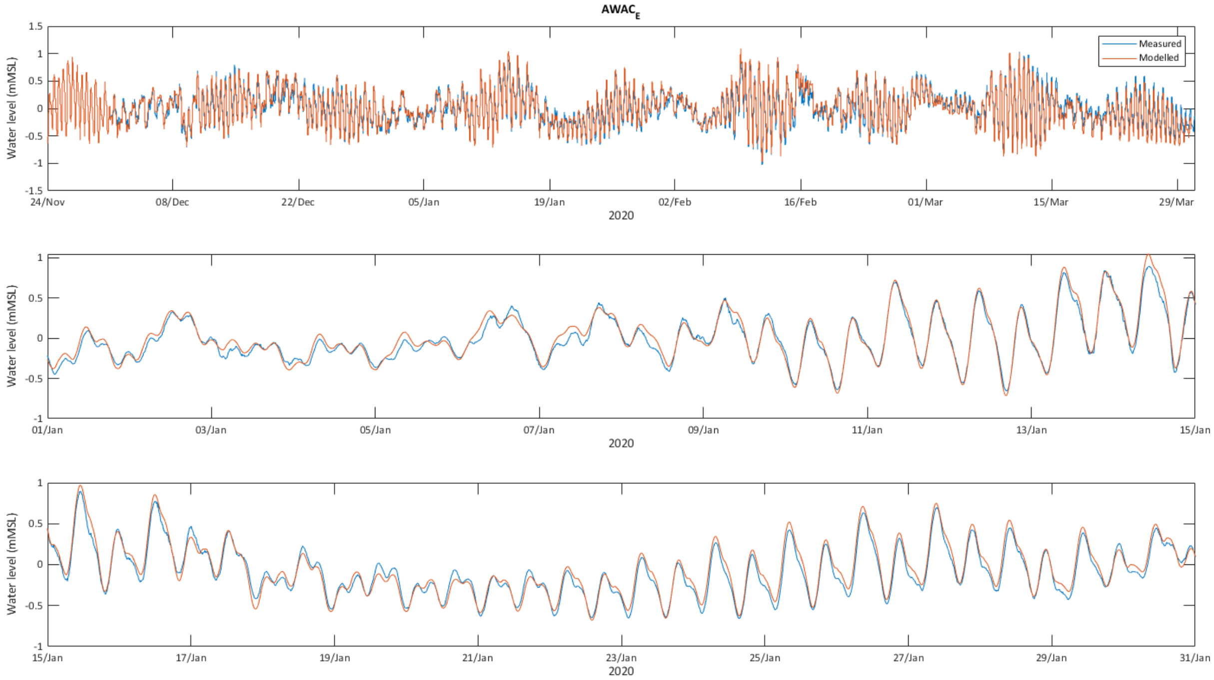
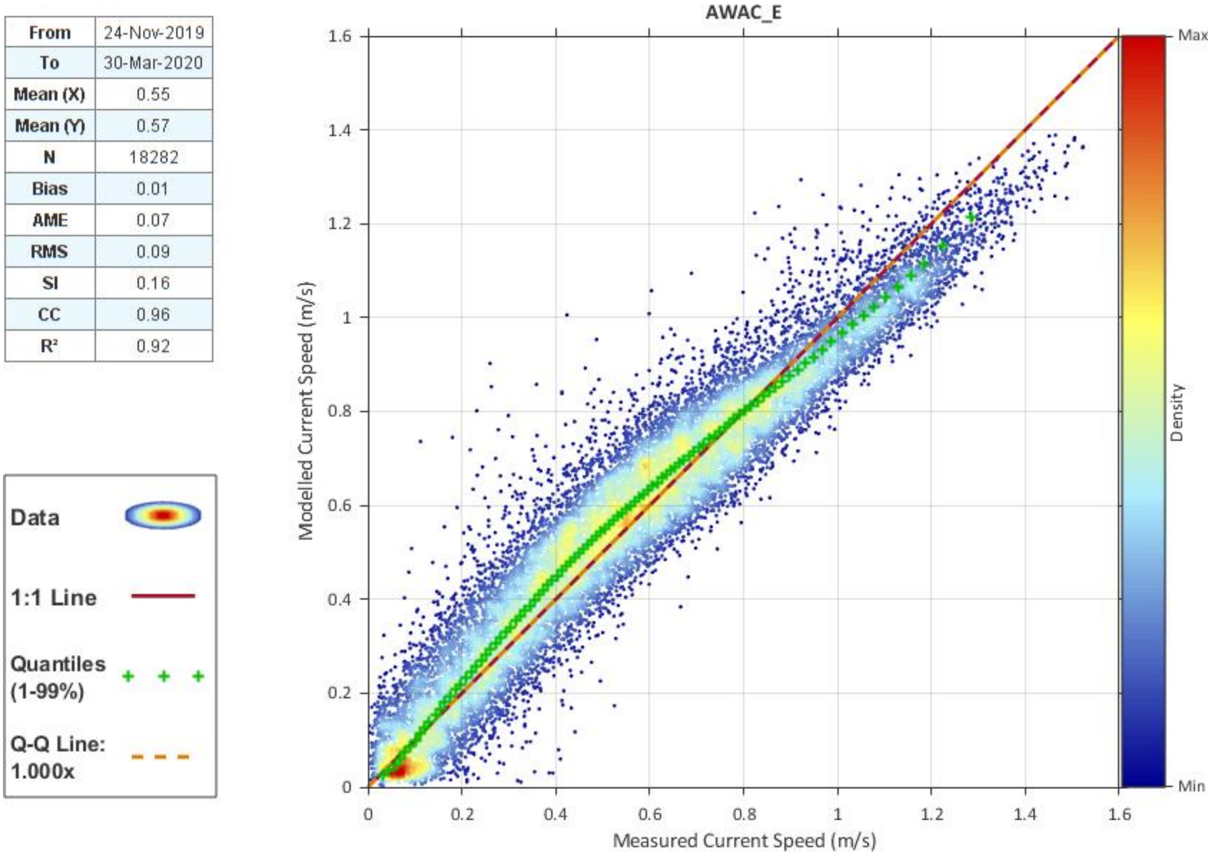


Figure 6.1.17: Time series plot of water levels at AWAC E.



From	24-Nov-2019
To	30-Mar-2020
Mean (X)	0.55
Mean (Y)	0.57
N	18282
Bias	0.01
AME	0.07
RMS	0.09
SI	0.16
CC	0.96
R²	0.92

Figure 6.1.18: Validation plot of currents at AWAC E.

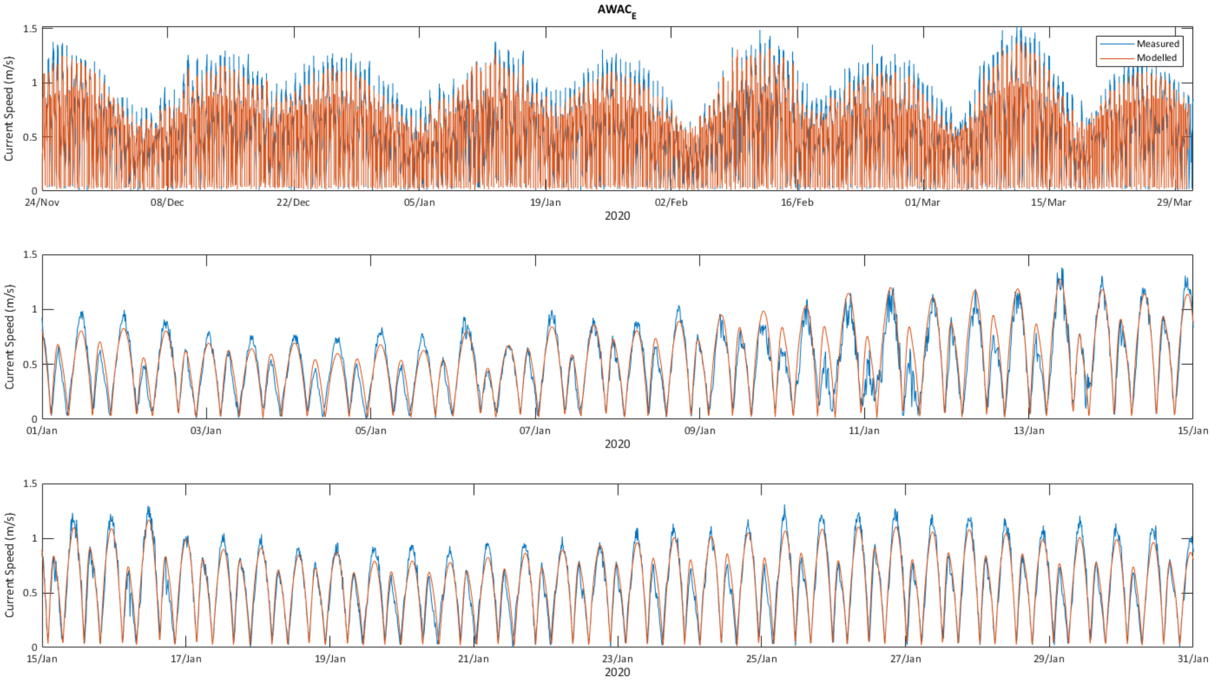


Figure 6.1.19: Time series plot of currents at AWAC C.

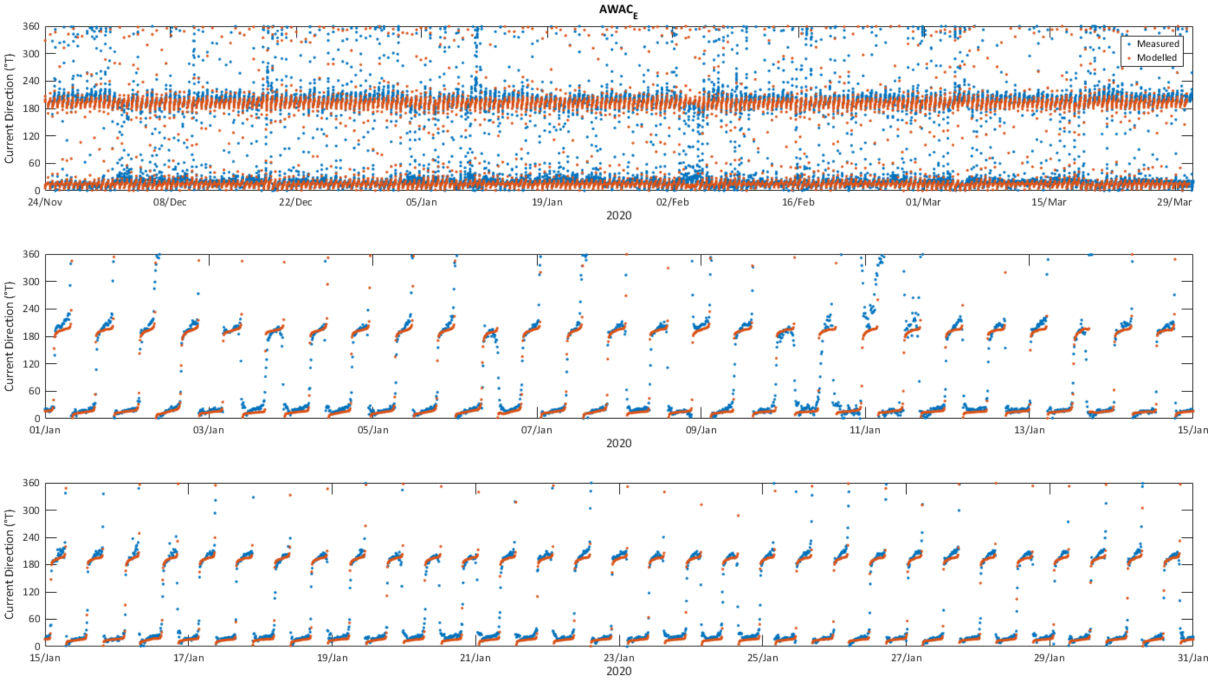


Figure 6.1.20: Time series plot of current directions at AWAC C.

These plots demonstrate that the model has a slightly improved level of performance compared to the version of the model used in the project metocean study [6] (improvements of between 1 and 7% across all current speed metrics). When assessing the slope and R^2 values, performance can be classed as excellent at all locations [10].

4.5 Selection of Tidal Events

Four tidal events were selected for particle tracking modelling to encompass the largest (spring) and smallest (neap) likely tidal advection pathways on both flood (northerly) and ebb (southerly) phases of the tide. These are shown in Table 6.1.4.2:

Table 6.1.4.2: Events selected for hydrodynamic modelling.

Event Name	Description
Peak Spring flood	Flood (northerly) current speed that would be exceeded approximately seven times per year (therefore in the top 1% of peak flood current speeds)
Peak Neap flood	Flood (northerly) current speed that would not be exceeded approximately seven times per year (therefore in the bottom 1% of peak flood current speeds)
Peak Spring ebb	Ebb (southerly) current speed that would be exceeded approximately seven times per year (therefore in the top 1% of peak ebb current speeds)
Peak Neap ebb	Ebb (southerly) current speed that would not be exceeded approximately seven times per year (therefore in the bottom 1% of peak ebb current speeds)

5 Particle Tracking

The Particle Tracking module of MIKE 21 Flow Model FM (Flexible Mesh) is used for modelling the transport and fate of suspended and sedimented substances discharged in estuaries and coastal areas or in the open sea. The material is considered as particles forming a sediment plume being advected with the surrounding water body and dispersed as a result of random (turbulent) processes in three dimensions. Multiple sediment classes can be simulated. The particles from each class settle with a constant settling velocity. A mass is attached to each particle. The following processes are attached to individual particle classes:

- Settling;
- Re-erosion;
- Flocculation;
- Moving sources; and
- Horizontal and vertical dispersion.

In this study, several representative sediment classes were used. These are detailed in Table 6.1.5.1. Representative samples where obtained from the most recent Arklow Environmental Survey [13].

The model calculates the path of each particle and outputs the instantaneous concentrations of individual classes in two dimensions, as well as the settled mass. The output concentration is based on the mass of particles present in the volume of water in a given model cell. The settled mass is converted to a deposition depth by dividing by the settled dry density of the material under consideration [14]. For the purpose of the present assessment, re-erosion of settled material is conservatively not considered for the majority of scenarios, to ensure the maximum depth of deposition is determined. However, as a part of sensitivity analysis, re-erosion was switched on in the model for the northern Electrical Cable Corridor (ECC) Controlled Flow Excavation (CFE). This location was chosen based on its proximity to the nearby Wicklow Reef SAC. The Developer has considered several methods as part of seabed preparation along the export cable corridor, and while not all of these methods will be used CFE has the greatest potential to disturb sediment and therefore was chosen for this sensitivity analysis. Re-erosion was also switched on for the foundation installation (dredging at WTG54) scenario. This location was chosen due to the dynamic nature of the seabed. It is anticipated that dredging will take place at this location prior to release at the SE -Zone 2, and its selection was also based on proximity to sensitive receptors at the southern end of the Array Area, with SE - Zone 2 also being the disposal site receiving the greatest volume of sediment. Flocculation was not considered for the present study owing to the very low content of cohesive sediments, and the offshore and coastal nature of the environment.

The hydrodynamic model (and therefore the output grid) has a spatial resolution featuring a triangular mesh with 75 m resolution in ABWP2 development area and surrounds. For the purposes of environmental assessment, a minimum material concentration of 1 mg/l above background was chosen to be resolved by the model, this being well within the accuracy of turbidity measuring instruments. Given that some releases are modelled near to the shallow coastal waters (for instance, Bentonite release), the model was also required to resolve these minimum concentrations in areas of relatively shallow water. A cut-off water depth of 1.5 m was chosen for resolving the minimum required concentrations in the model. Whilst resolving concentrations down to 1 mg/l in water depths of less than 1.5 m would be possible, it would require greater computational effort, and therefore this depth was chosen as a sensible compromise between computational efficiency, and the requirements of the assessment. Assuming that the triangular mesh is composed of triangles tending toward an equilateral shape, and a water depth corresponding with mean sea level, the volume of water in an individual mesh element with water depth 1.5 m is 8,438 m^3. In order to resolve to 1 mg/l in this volume of water, each particle must have a maximum mass of 8.4 kg. Therefore, a sufficiently high number of particles was released in each run such that each particle was assigned a maximum mass of 8.4 kg in the model. Although each particle has a representative maximum mass 8.4 kg, it inherits the settling velocities of its class from Table 6.1.5.1. Proportions of each sediment type in the modelled releases were defined by GoBe, or by reference to the project environmental survey report in the later assessments [13].

Table 6.1.5.1: Details of the representative sediment types.

Sediment type	Size range (mm)	Settling velocity (m/s)
Coarse sand	0.500 to 1.0	0.0663
Medium sand	0.250 to 0.500	0.0287
Fine sand	0.125 to 0.250	0.018 or 0.0087
Very fine sand	0.063 to 0.125	0. 0065
Coarse silt	0.031 to 0.063	0.0014 or 0.0023
Medium silt	< 0.0031	0.00001

Brief details of the model set-up for each of the scenarios follows. With the exception of foundation installation drilling in the Array Area and WTG54/disposal zone 2 Trailing Suction Hopper Dredger (TSHD) scenarios (for which detail is provided in Volume II, Chapter 4: Description of Development), for each scenario, four different current events were simulated, as described in Section 4.5. These are high and low current speeds, flowing northward (flood) and southward (ebb).

After the release is finished, the model is then allowed to run for at least a further 48 hours to allow the far-field fate of the material to be ascertained. This time period allows all material to settle out from suspension. For instance, for the ‘Coarse Silt’ category, the rate of settlement specified is 0.0014 m/s, equating to a total distance of 242 m in 48 hours – this is much greater than any of the depths within the project area or surrounds.

For the array drilling scenario, a drilling event is expected to continue for several days, much longer than the 48-hour model runs used for the other scenarios. Therefore, in this case, only two scenarios were run (spring and neap – since flood and ebb tidal cycles lose significance over such long time period), and these runs were allowed to continue for the full 188-hour drilling period, plus 48 hours after the end of drilling operations.

Furthermore, as a part of sensitivity analysis for the models, a full campaign of TSHD dredging and disposal (including re-erosion) was simulated at the WTG54/Disposal Zone 2. This operation was simulated to take place over a single period of 23 days, with the model allowed to continue running for an additional five days after the end of operations.

The geographical positions of each of the sediment release locations described below are shown in the figures in Sections 5.1 and 5.2. In all cases, the volumes, release rates and geographical positions of the releases were defined following a review of the engineering designs and local environmental sensitivities by the Developer and their environmental consultants

5.1 Array Area

5.1.1 Foundation Installation – Drilling

Two locations are simulated as being drilled – WTG24 from the 47 WTGs layout, and the southern OSP. The release of drill arisings is simulated to persist for 88 hours (at WTG24), followed by a 12 hour pause, followed by another 88-hour period of drilling (at the southern OSP), with the current speed peak occurring six hours before the release ends at WTG24. Because the material is released in stages, a different representative settled bed density is used for each sediment type to calculate the sediment deposition thicknesses:

- For fine sand, 780 kg/m^3
- For very fine sand, 460 kg/m^3
- For coarse silt, 290 kg/m^3, and
- For medium silt, 200 kg/m^3

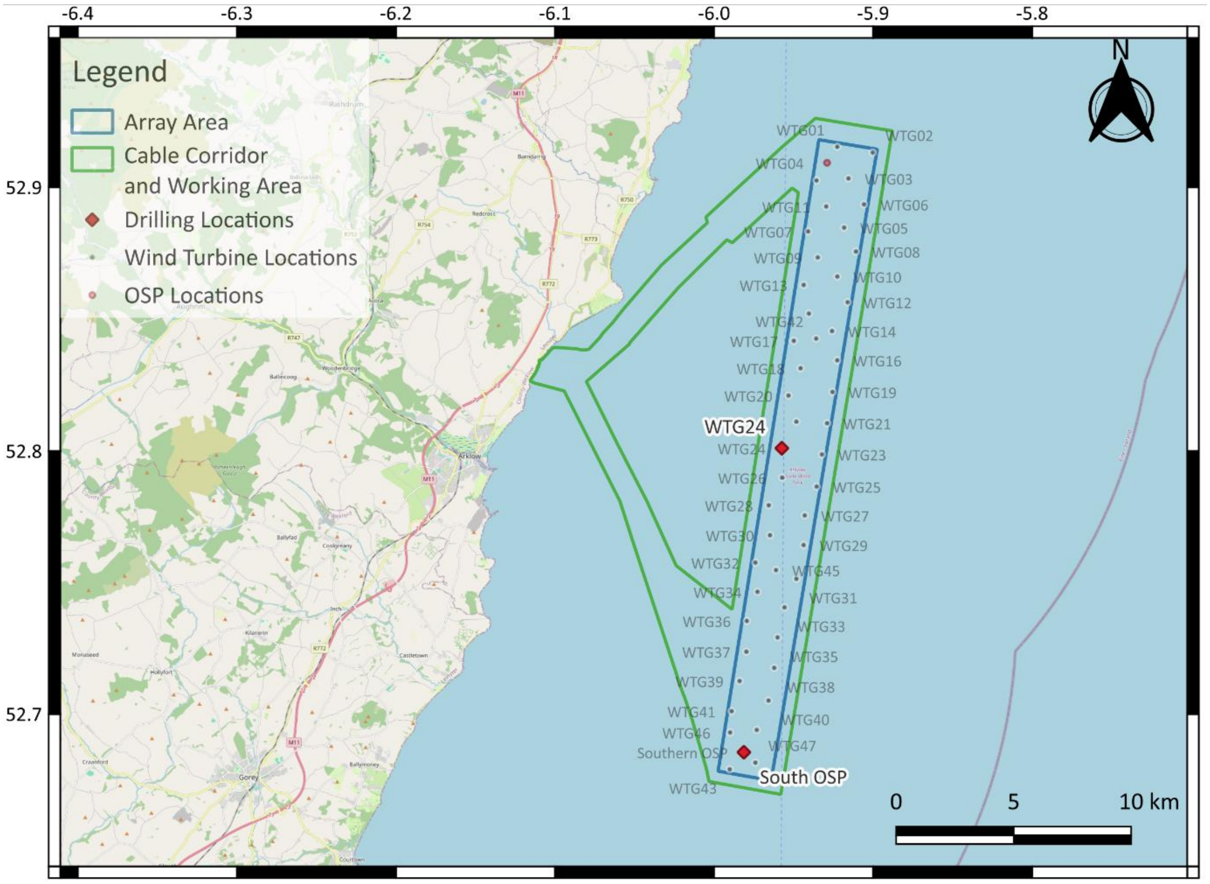


Figure 6.1.21: Release locations for Foundation Installation – Drilling scenario.

5.1.2 Foundation Installation – Dredging WTG31

A single TSHD hopper load is simulated as being filled (including overspill discharges), and then discharged at an indicative disposal site. The foundation site where overspill from the hopper commences is WTG31 from the 53 WTG Option layout, and the disposal site is approximately 2.1 km to the north west of WTG31 in that layout (at disposal Zone 3). The TSHD loading phase, including initial hopper loading, overspilling and manoeuvring, is 10.18 hours at the WTG location. There is then a 13-minute break in discharge during demob and transit to the disposal site, before a 15-minute discharge period at the disposal site. The current speed peaks at the beginning of the discharge phase. For the overspill phase the material is released into the model at the water surface, and for the discharge phase the material is released 10 m below the surface. To convert the settled mass from the model into a depth in mm, a settled density of 1,400 kg/m³ was used.

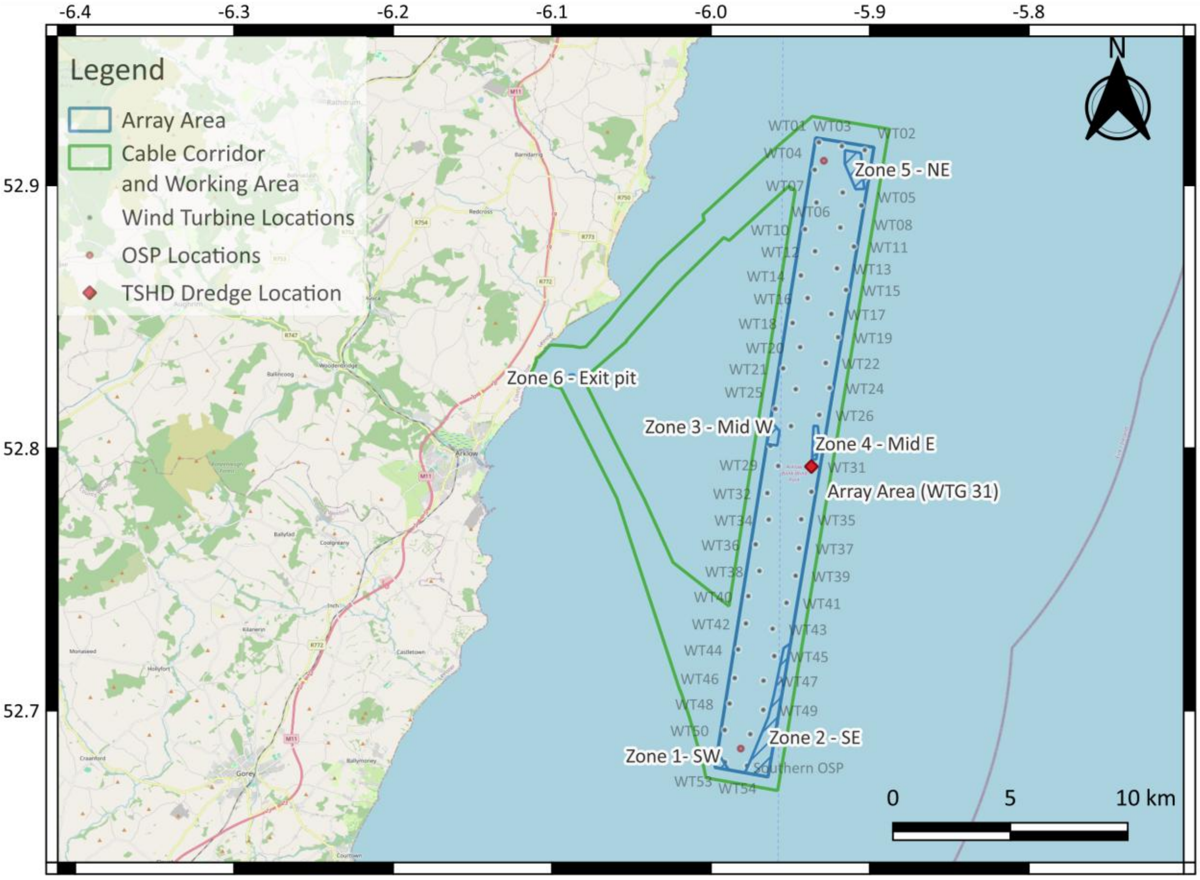


Figure 6.1.22: Release locations for Foundation Installation – Dredging WTG31 scenario.

5.1.3 Foundation Installation – Dredging WTG27

A single TSHD hopper load is simulated as being filled (including overspill discharges), and then discharged at an indicative disposal site. The foundation site where overspill from the hopper commences is WTG27 from the 53 WTG Option layout, and the disposal site is approximately 1.2 km to the south east (at disposal Zone 4). The TSHD loading phase, including initial hopper loading, overspilling and manoeuvring, is 10.18 hours at the WTG location. There is then a 13-minute break in discharge during demob and transit to the disposal site, before a 15-minute discharge period at the disposal site. The current speed peaks at the beginning of the discharge phase. For the overspill phase the material is released into the model at the water surface, and for the discharge phase the material is released 10 m below the surface. To convert the settled mass from the model into a depth in mm, a settled density of 1,400 kg/m³ was used.

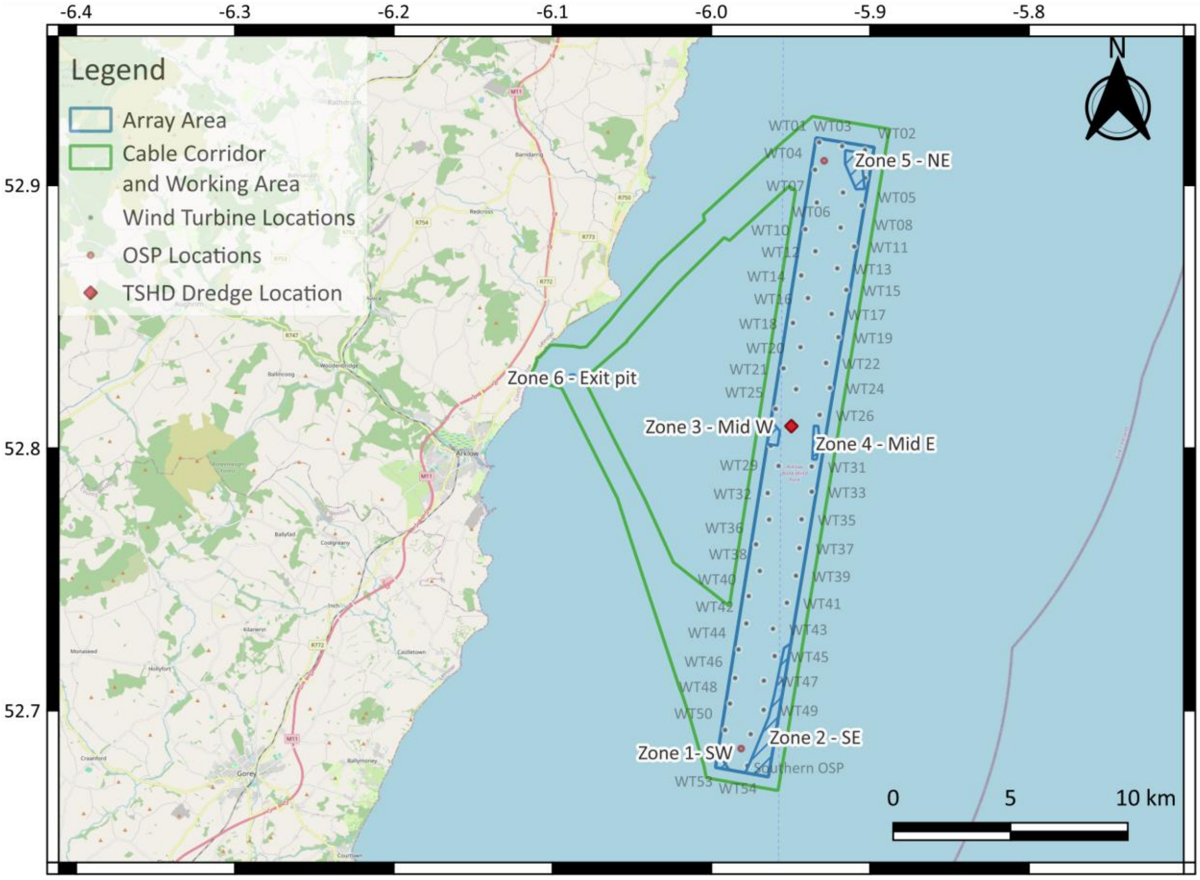


Figure 6.1.23: Release locations for Foundation Installation – Dredging WTG27 scenario.

5.1.4 Foundation Installation – Dredging WTG54

50 TSHD hopper loads are simulated as being filled (including overspill discharges), and then discharged at an indicative disposal site. The foundation site where overspill from the hopper commences is WTG54 from the 53 WTG Option layout, and the disposal site is approximately 1.2 km to the south east (at disposal Zone 2). The TSHD loading phase, including initial hopper loading, overspilling and manoeuvring, is 10.18 hours at the WTG location. There is then a 13-minute break in discharge during demob and transit to the disposal site, before a 15-minute discharge period at the disposal site. This cycle is then repeated for a total of 50 times, with the total cycle time being 10.86 hours, and the total time being 22 days. The current speed peaks at the beginning of the 48th cycle. For the overspill phase the material is released into the model at the water surface, and for the discharge phase the material is released 10 m below the surface. To convert the settled mass from the model into a depth in mm, a settled density of 1,400 kg/m³ was used.

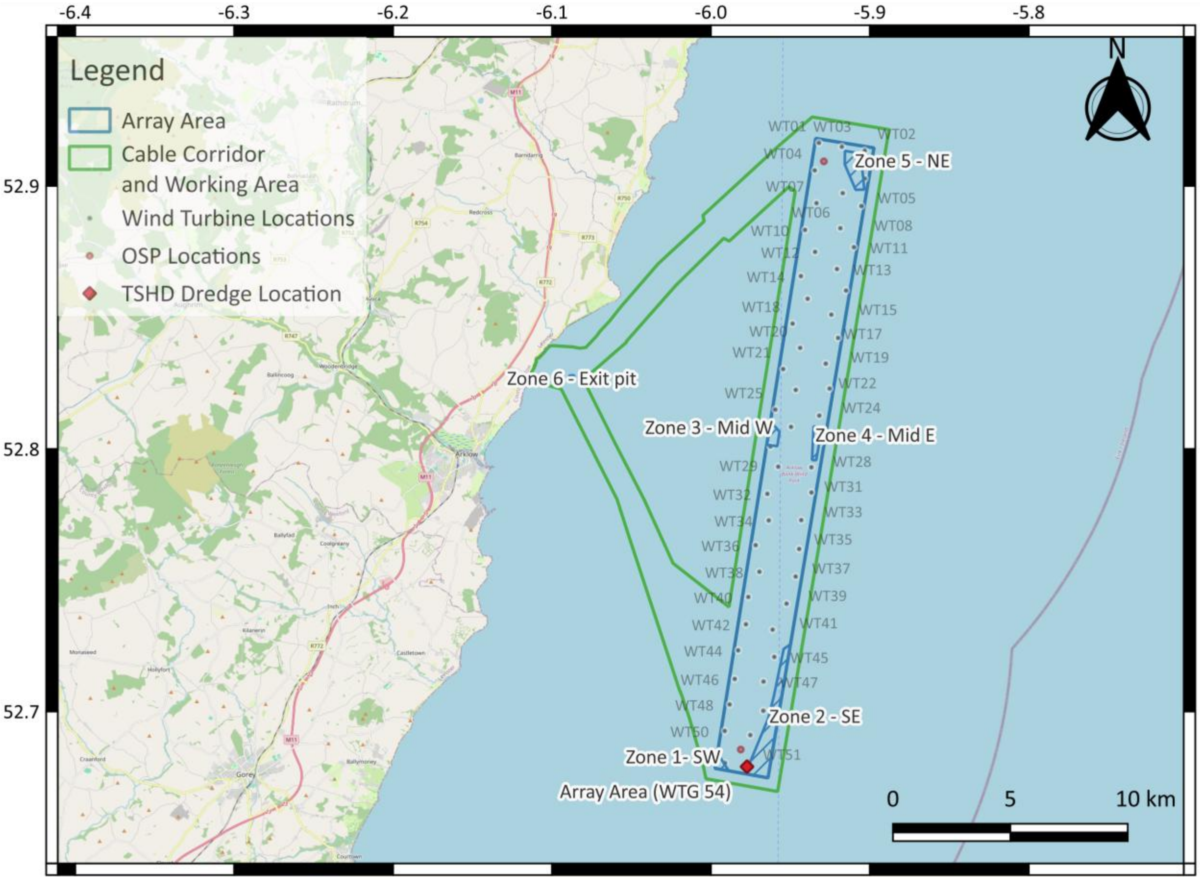


Figure 6.1.24: Release locations for Foundation Installation – Dredging WTG54 scenario.

5.1.5 Northern Array Cable Installation – Controlled Flow Excavation

A single Controlled Flow Excavator is simulated as moving from WTG03 to WTG02, before remobilising to move between WTG02 to WTG01 (WTG labels from the 47 WTG Layout). The current speed peaks occur during the final ten minutes of the first excavation phase. The material is released into the model at 3 m above the bed. To convert the settled mass from the model into a depth in mm, a settled density of 1,000 kg/m^3 was used.

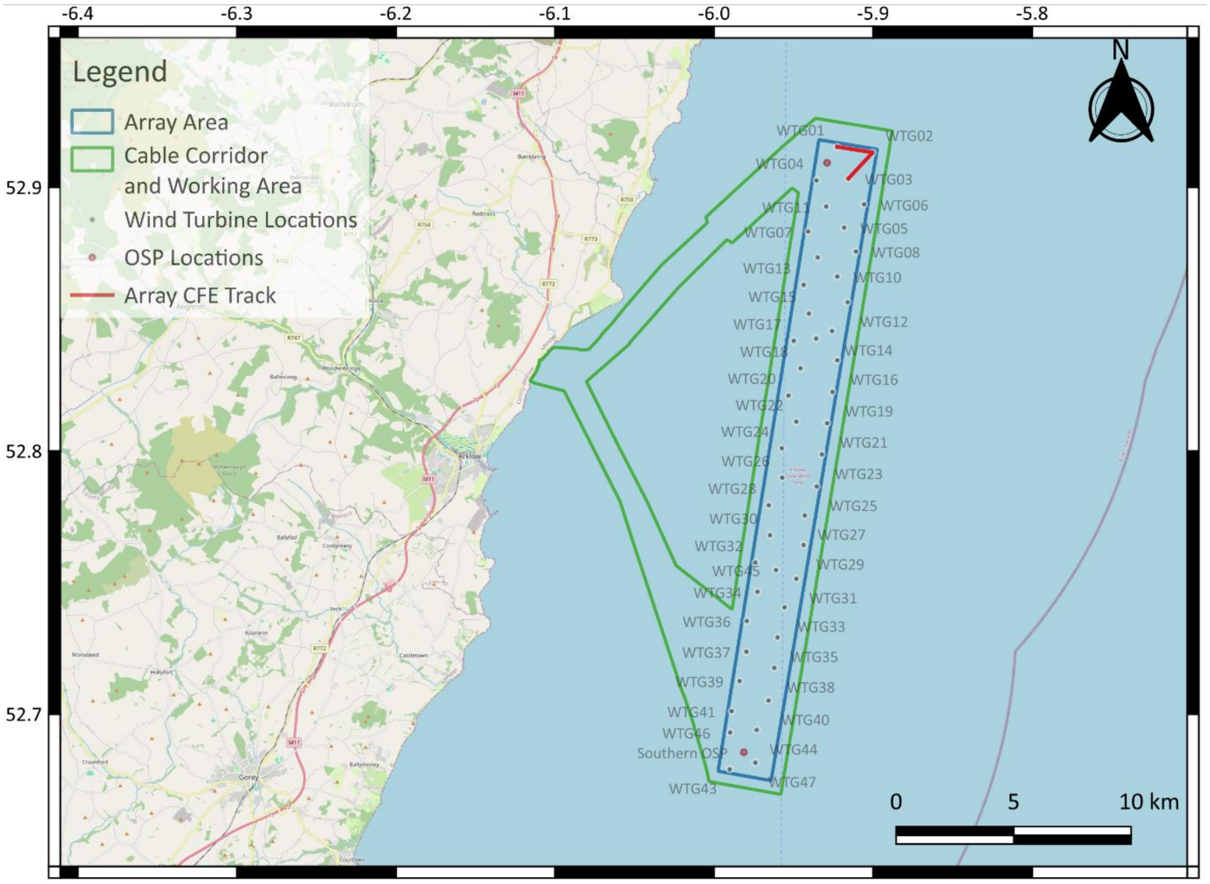


Figure 6.1.25: Release track for Northern Array Cable Installation – Controlled Flow Excavation scenario.

5.1.6 Southern Array Cable Installation – Controlled Flow Excavation

A single Controlled Flow Excavator is simulated as moving from WTG50 to WTG53, and then WTG53 to WTG54 (WTG labels from the 53 WTG Layout). The current speed peaks occur at the mid-point of the operation. The material is released into the model at 3 m above the bed. To convert the settled mass from the model into a depth in mm, a settled density of 990 kg/m³ was used.

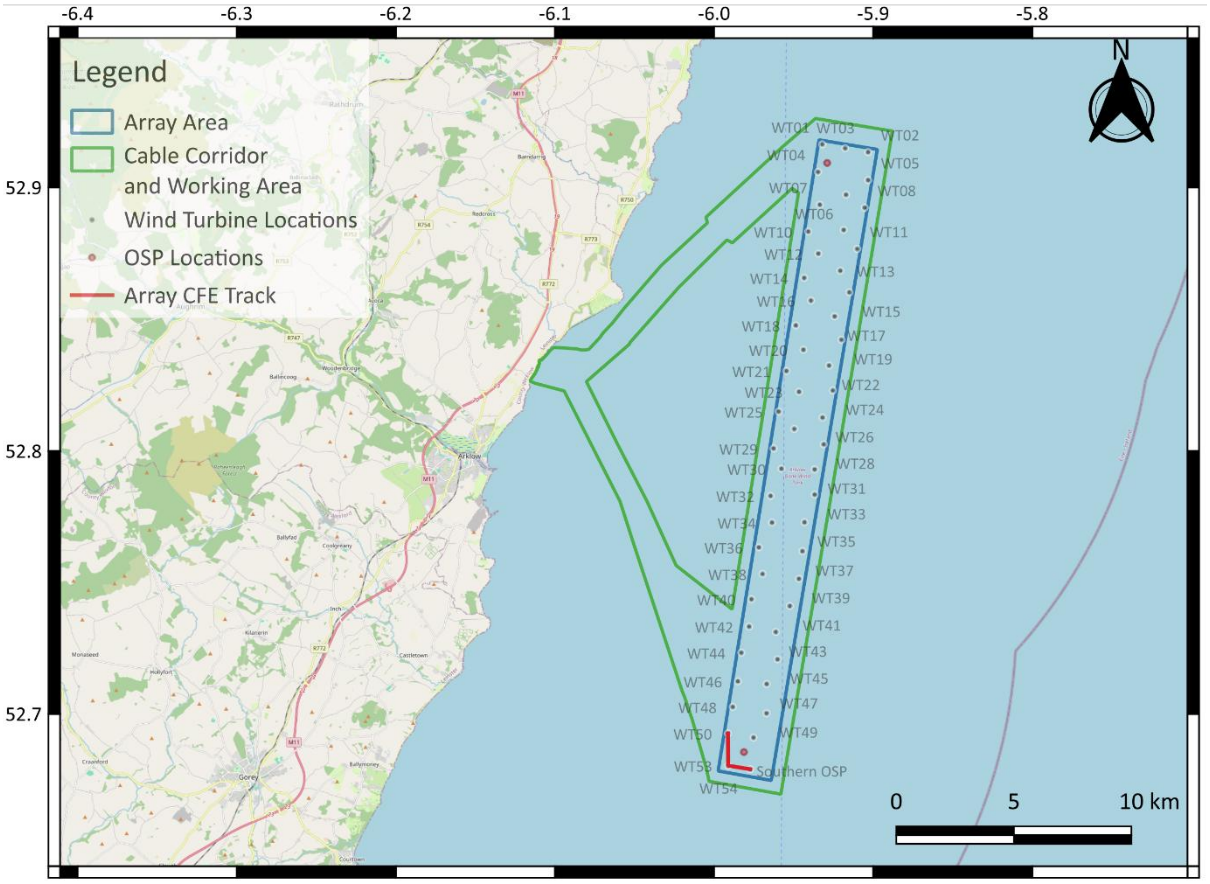


Figure 6.1.26: Release track for Southern Array Cable Installation – Controlled Flow Excavation scenario.

5.2 Export Cable Route

5.2.1 HDD Punch-out - Bentonite Release

A single location for HDD punch-out and associated Bentonite release is simulated. The location is approximately 375 m from shore within the ECC. The release of Bentonite is simulated to last for 4.5 days (initial punch-out followed by a reaming phase), with the current speed peak occurring 20 minutes into the release period. To convert the settled mass from the model into a depth in mm, a settled density of 100 kg/m³ was used.

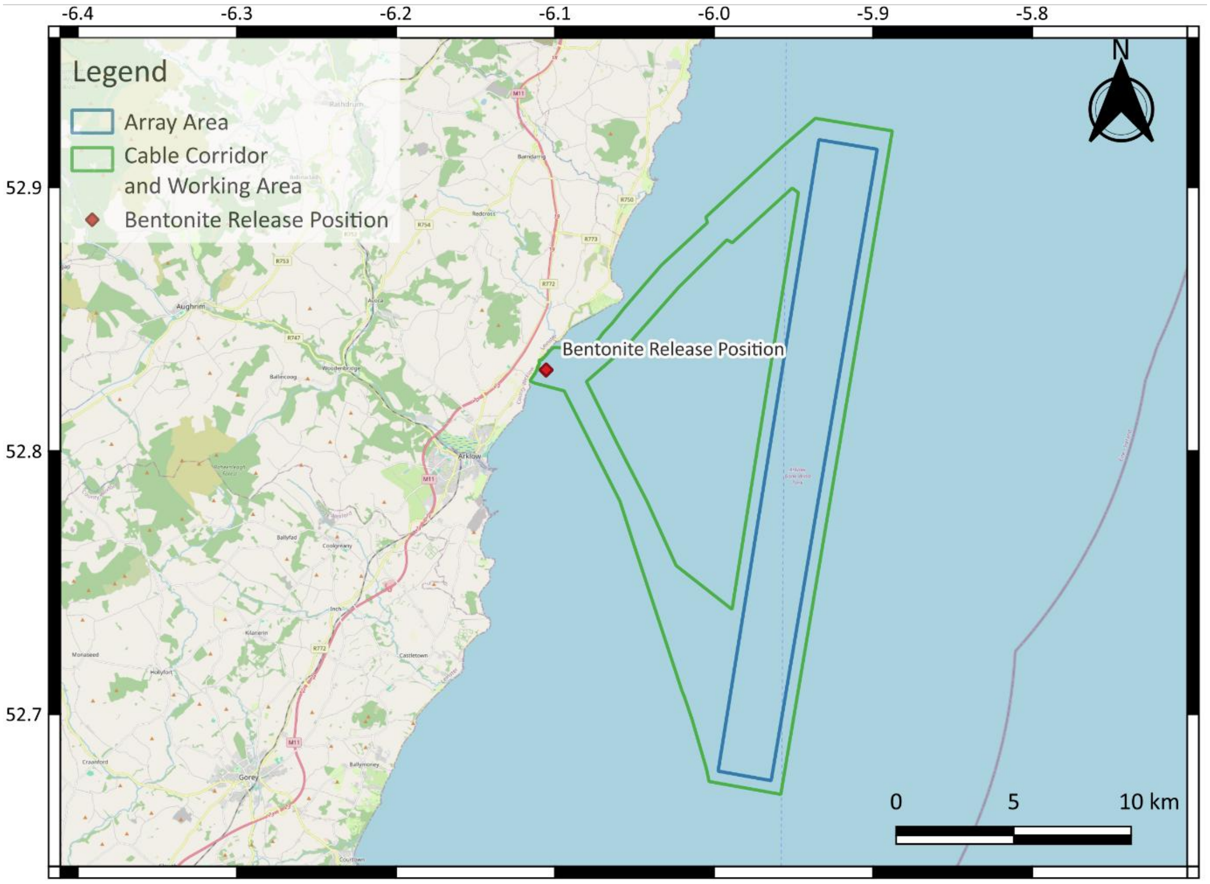


Figure 6.1.27: Release position for HDD Punch-out - Bentonite Release scenario.

5.2.2 Sandwave Clearance using a Dredger – North Eastern Disposal Site

A single TSHD hopper load is simulated as being filled (including overspill discharges), and then discharged at a disposal site. The dredger is simulated as moving along a 2 km line in the centre of the northern cable route for 350 minutes, before transiting to the disposal site approximately 3.2 km to the east (Disposal Zone 5). The overspill phase from the TSHD lasts 290 minutes. There is then a 20-minute break in discharge during demob and transit to the disposal site, before a 15-minute discharge period at the disposal site. The current speed peaks occur at the beginning of the discharge phase. For the overspill phase the material is released into the model at the water surface, and for the discharge phase the material is released 10 m below the surface. To convert the settled mass from the model into a depth in mm, a settled density of 1,400 kg/m³ was used.

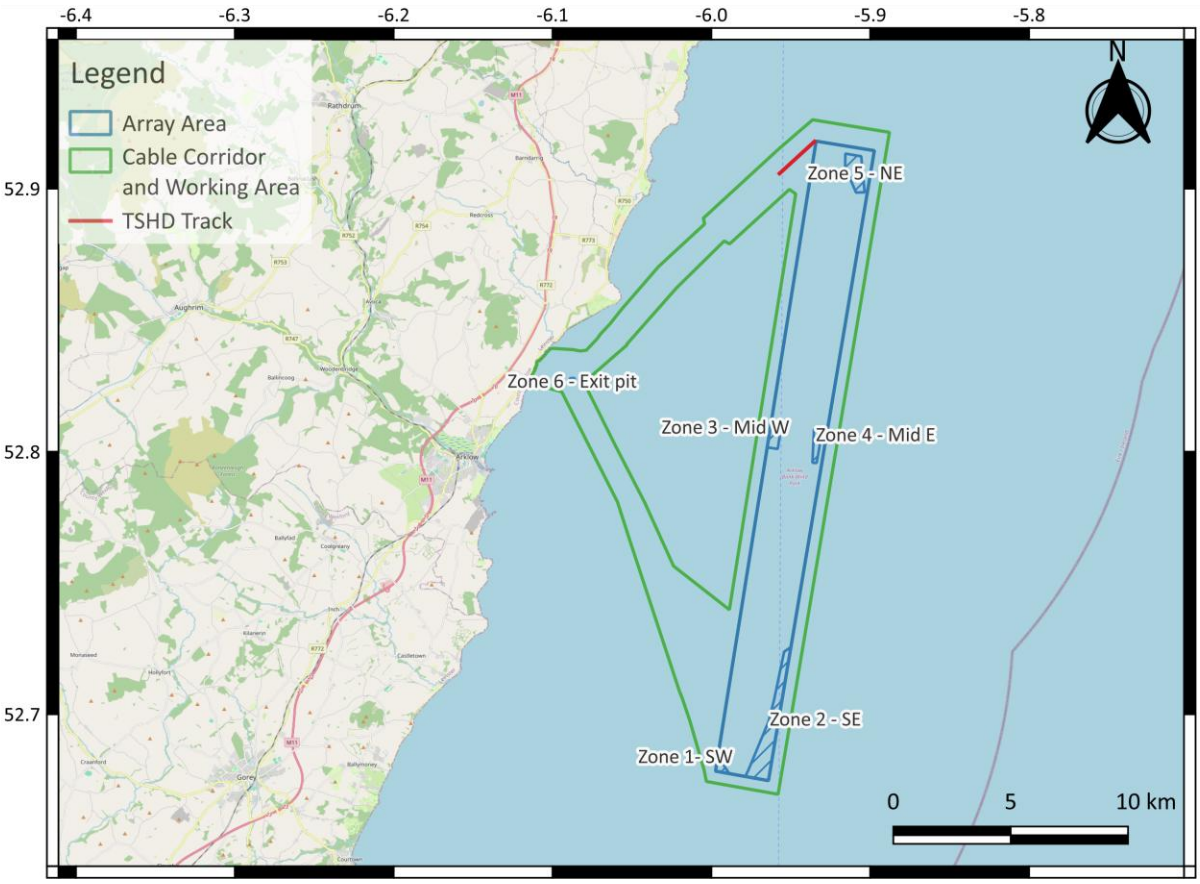


Figure 6.1.28: Release track and position for Sandwave Clearance using a Dredger – North Eastern Disposal Site scenario.

5.2.3 Northern ECC Installation – Controlled Flow Excavation

A single Controlled Flow Excavator is simulated as moving along a 2 km line in the centre of the northern cable route for 300 minutes. The current speed peaks occur at the mid-point of the operation. The material is released into the model at 3 m above the bed. To convert the settled mass from the model into a depth in mm, a settled density of 1,000kg/m³ was used. This model run was also repeated with re-erosion switched on, as a part of sensitivity analysis.

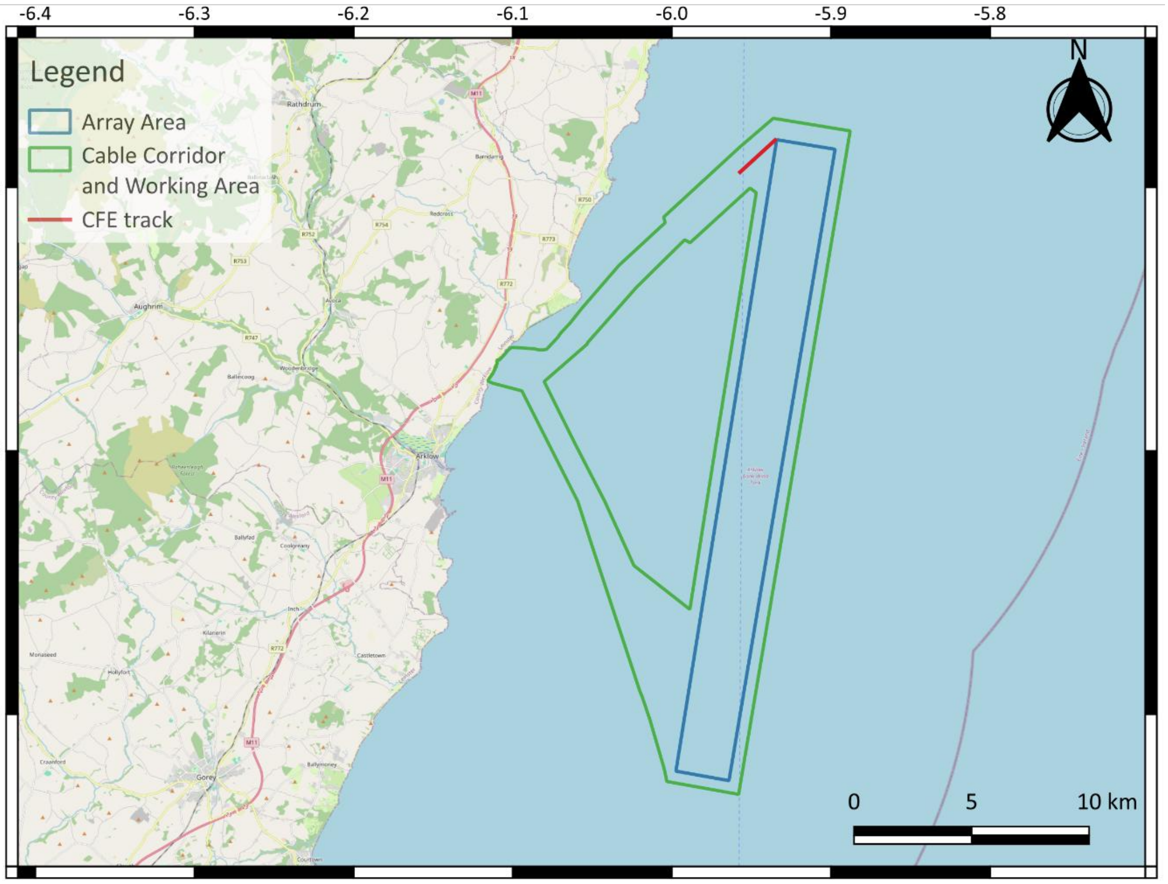


Figure 6.1.29: Release track for Northern ECC Installation – Controlled Flow Excavation scenario.

5.2.4 Southern ECC Installation and Exit Pit Excavation – Controlled Flow Excavation

A single Controlled Flow Excavator is simulated as moving along a 2.2 km line in the centre of the southern cable route for 330 minutes. It then sails to the site of the Exit Pit (taking ten minutes, at a speed of 3.1 m/s), and excavates 400 m along the centre of the Exit Pit for a period of 60 minutes. The current speed peaks occur at the end of the cable route excavation. The material is released into the model at 3 m above the seabed. To convert the settled mass from the model into a depth in mm, a settled density of 920 kg/m³ was used.

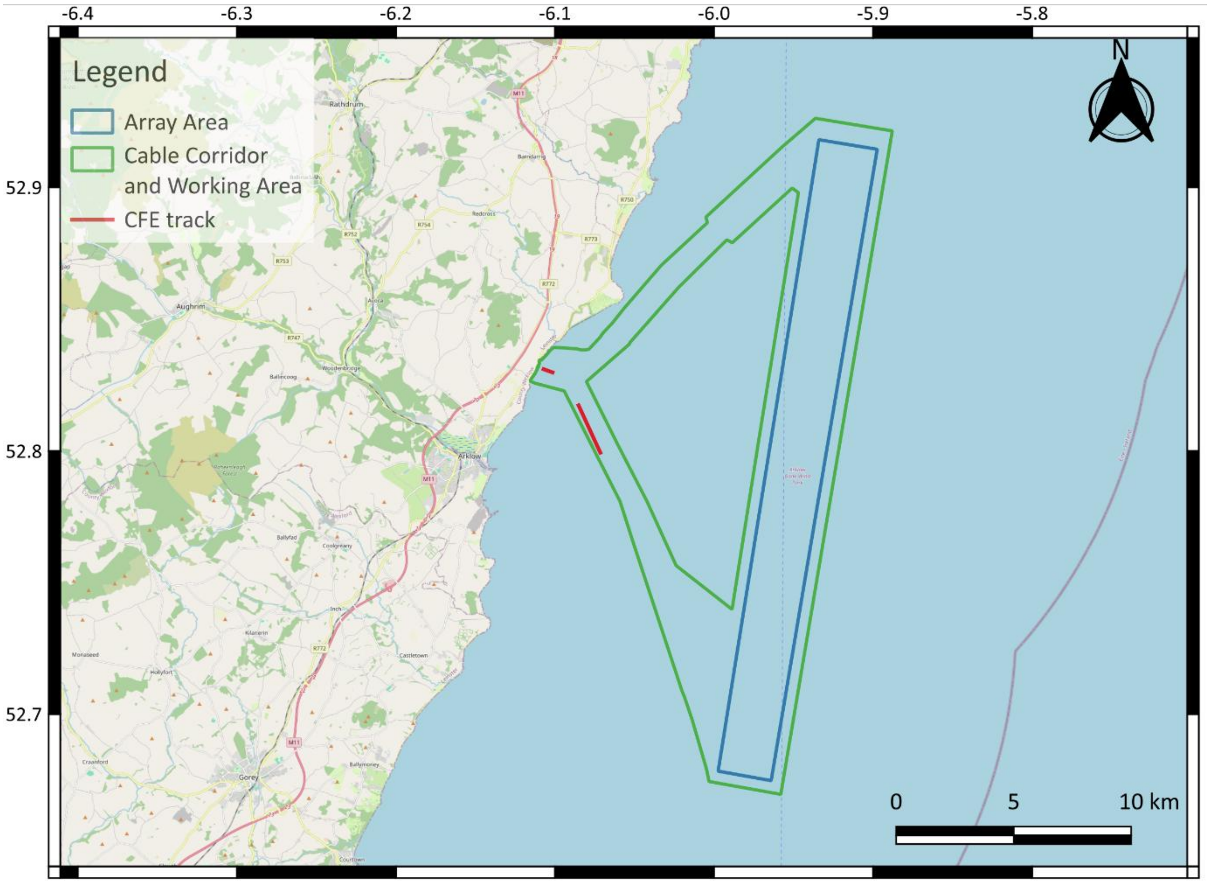


Figure 6.1.30: Release track for Southern ECC Installation and Exit Pit Excavation – Controlled Flow Excavation scenario.

6 Results

Model outputs were provided to GoBe for interpretation in the assessments.

- Two output parameters are provided for particle tracking scenarios:
    - Sedimented (showing the depth of sediment that has settled on the seabed after release).
    - Suspended (showing the depth-averaged concentration of sediment that is in suspension after release).
- For particle tracking scenarios, for each of the current events, and for each output parameter, the following were provided:
    - The situation at 0, 1, 2, 3, 4, 5, 10, 15 and 20 hours (and for the array drilling scenario, additionally 25, 50, 100, 150, 200 and 230 hours, and for the Foundation Installation – Dredging WTG54 scenario, every 12th hour until 660 hours) after the beginning of dredge operations.
    - The maximum of sedimented and suspended. This represents the largest value that occurred in each model grid cell over the entire simulation period. It is not representative of any single instant in time, but does provide a useful indication of the maximal extent of the plume and associated sedimentation. Note that because re-suspension is switched off in the model, the maximum sedimentation is the same as the sedimentation situation at the final model time step.
- For particle tracking scenarios the units of 'suspended' are depth-averaged mg/l. The units of 'sedimented' are mm.

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