NORTH FALLS

Offshore Wind Farm

Hydrodynamic and Dispersion Modelling Report (Tracked)

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NORTH FALLS
Offshore Wind Farm

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Glossary of Acronyms

DCO	Development Consent Order
DHI	Danish Hydraulic Institute
DTM	Digital Terrain Model
DWR	Deep Water Route
EIA	Environmental Impact Assessment
ES	Environmental Statement
HD	Hydrodynamic
Hs	Significant Wave Height
KKE	Kentish Knock East
LAT	Lowest Astronomical Tide
MarLIN	Marine Biological Association
MCZ	Marine Conservation Zone
MFE	Mass Flow Excavation System
MLS	Margate and Long Sands
MR	Megaripples
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
MT	Mud transport
NE	Natural England
NFOW	North Falls Offshore Wind Farm Ltd
OCP	Offshore converter platform
ODN	Ordnance Datum Newlyn
OSP	Offshore substation platform
OWF	Offshore Wind Farm
RHDHV	Royal HaskoningDHV
RWE	RWE Renewables UK Swindon Limited
SAC	Special Area of Conservation
SSC	Suspended Sediment Concentration
SSER	SSE Renewables Offshore Windfarm Holdings Limited
SHD	Suction Hopper Dredger
SW	Sandwaves
Tp	Peak Wave Period
WTG	Wind turbine generator

Glossary of Terminology

Array area	The offshore wind farm area, within which the wind turbine generators, array cables, platform interconnector cables, offshore substation platform(s) and/or offshore converter platform will be located.
Array cables	Cables which link the wind turbine generators with each other, the offshore substation platform(s) and/or the offshore converter platform.
Landfall	The location where the offshore export cables come ashore at Kirby Brook.
Offshore cable corridor	The corridor of seabed from array area to the landfall within which the offshore export cables will be located.
Offshore converter platform	Should an offshore connection to a third party High Voltage Direct Current (HVDC) cable be selected, an offshore converter platform would be required. This is a fixed structure located within the array area, containing HVAC and HVDC electrical equipment to aggregate the power from the wind turbine generators, increase the voltage to a more suitable level for export and convert the HVAC power generated by the wind turbine generators into HVDC power for export to shore via a third party HVDC interconnector cable.
Offshore export cables	The cables which bring electricity from the offshore substation platform(s) to the landfall, as well as auxiliary cables.
Offshore project area	The overall area of the array area and the offshore cable corridor.
Offshore substation platform (OSP)	Fixed structure(s) located within the array area, containing HVAC electrical equipment to aggregate the power from the wind turbine generators and increase the voltage to a more suitable level for export to shore via offshore export cables.
Platform interconnector cable	Cable connecting the offshore substation platforms (OSP); or the OSP and offshore converter platform (OCP).
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project Or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Wind turbine generator (WTG)	Power generating device that is driven by the kinetic energy of the wind.

1 EXECUTIVE SUMMARY

1.1.1 The North Falls Offshore Wind Farm project, a joint venture between SSE Renewables Offshore Windfarm Holdings Limited (SSER) and RWE Renewables UK Swindon Limited (RWE), has submitted a Development Consent Order (DCO) application to the Planning Inspectorate on 26 July 2024.

1.1.2 Natural England has expressed concerns over the potential impacts of construction and operation of North Falls on sediment transport processes and benthic ecology.

1.1.3 This report presents a numerical modelling study to predict potential change of hydrodynamics and the extent of suspended sediment plume and deposition caused by the construction of North Falls Offshore Wind Farm.

1.1.4 The study adopted the MIKE software package to simulate tidal hydrodynamics and sediment plume dispersion around the project site. The tidal hydrodynamic model has been calibrated and validated using measured water level and current speed data obtained from British Oceanographic Data Centre (BODC).

1.1.5 The tidal hydrodynamic model was run for the baseline and proposed wind farm scenario with 57 Wind Turbine Generators (WTGs), 2 Offshore Substation Platforms (OSPs) and export cable protection. The smaller WTGs layout option with 57 WTGs has been chosen as worst case because the larger WTGs layout comprises of only 34 WTGs.

1.1.6 The hydrodynamic model results show that the difference in current speed between the baseline and the proposed wind farm scenario during spring and neap tides is less than 2% across all cable protection sections. At the Array area, the majority of change in current speed is less than 3%, apart from small, localised areas on the eastern edge of the Array area which reach up to 4 percent.

1.1.7 The change in bed shear stress is also minimal, with localiszed areas experiencing up to a 10% increase limited at the cable protection and up to a 5% increase in the array area.

~~1.1.7~~1.1.8 The sediment dispersion model was run to simulate dispersion of sediment plumes arising from levelling, trenching, dredging and drilling activities associated with the wind farm construction. The key findings of the sediment dispersion modelling for levelling, trenching, dredging and drilling are:

- The largest plume and highest suspended sediment concentrations are created by the levelling of sandwaves along the Offshore export cables and Array cables. This is due to the high volume that is being released at a high rate. However, even the highest suspended sediment concentrations only last a few hours and are then dispersed to levels below the ambient level of 15 mg/l.

- The trenching activities along the export cables and array cables result in suspended sediment concentrations higher than 50 mg/l immediately around the cables. Any peak in Suspended Sediment Concentration (SSC) (i.e. SSC exceeds 50 mg/l) only lasts for approximately 8 hours or less.
- The dredging activities around the Sunk and Trinity DWR and Pilot Boarding Area are below 20 mg/l and last no longer than 2 hours.
- The SSCs for drilling activities inside the array area for both layouts are below 5 mg/l which is well below the threshold.
- The total sediment deposition thickness is greatest for the levelling of sandwaves along the offshore export cables and array cables, however the high spots are located close to the cables themselves, whilst the wider extent of deposition is between 0.05 to 0.2m.
- The trenching activities along the export cables and array cables result in total sediment deposition thickness of less than 5 cm.

~~1.1.8~~1.1.9 The sediment dispersion model was also used to investigate sediment dispersion and deposition after dredged material is disposed at the northern end of the array area for fine and coarse sediments. The key findings of the sediment dispersion modelling for the disposal are:

- For sediment disposal at slack water, the maximum sediment concentration and extent are broadly the same throughout the water column. The length of the area with the maximum suspended sediment concentration above 5mg/l is estimated to be around 12km for disposal of relatively fine sediments.
- For sediment disposal at peak flood and peak ebb, the maximum sediment concentrations are greatest near seabed and gradually become less when reaching water surface. The length of the area with the maximum suspended sediment concentration above 5mg/l is estimated to be around 16km for disposal of relatively fine sediments.

2 INTRODUCTION

2.1 Background

1. A Development Consent Order (DCO) application for North Falls Offshore Wind Farm (hereafter 'North Falls') has been submitted by North Falls Offshore Wind Farm Ltd (NFOW) ('the Applicant') (a joint venture between SSE Renewables Offshore Windfarm Holdings Limited (SSER) and RWE Renewables UK Swindon Limited (RWE)) to the Planning Inspectorate on 26 July 2024.

2.1.1 Natural England has expressed concerns over the potential impacts of construction and operation of North Falls on sediment transport processes and benthic ecology, particularly regarding the Margate and Long Sands (MLS) Special Area of Conservation (SAC) and Kentish Knock East (KKE) Marine Conservation Zone (MCZ).

2.1.2 Additionally, the Applicant is investigating the implications of Shipping and Navigation stakeholders' requests for the burial of cables to a sufficient depth so as not to impede or prevent future dredging to a level of 22m Chart Datum within the Sunk and Trinity Deep Water Routes (DWRs). This request intends to facilitate potential future vessel keel depths over the life of the Project. This would require additional dredging as the current seabed level is 19-20m LAT in these areas resulting in revised sediment disposal volumes.

2.1.3 Therefore, bespoke hydrodynamic and sediment dispersion modelling undertaken for North Falls aims to refine the assessments of ES Chapter 8 Marine Geology Oceanography and Physical Processes **[APP-022]** and ES Chapter 10 Benthic and Intertidal Ecology **[APP-025]** to corroborate its conclusions that no significant effects are expected as a result of North Falls' construction and operation in respect of sediment transport processes or benthic ecology features.

2.1.4 Assessments of the modelling results in relation to changes in suspended sediment concentrations, seabed level changes and associated benthic ecology, are respectively discussed in the following technical notes:

- Sediment dispersion modelling – results interpretation **[Document Reference 9.56],** and
- Supporting information on offshore additional mitigation **[Document Reference 9.55]**.

2.1.5 This modelling exercise considers North Falls' design envelope and constructive methods as presented in ES Chapter 5 Project Description **[APP-019]** and its updates as presented in the Supporting Information on Offshore Additional Mitigation **[Section 2, Document Reference: 9.55]**. Indicative cable routes for the offshore export and array cables, together with indicative layouts for the distribution of smaller and larger wind turbine generators (WTGs) within the array area. A precautionary approach has been undertaken, and the simulations consider realistic worst case scenarios for construction method and locations regarding designated sites.

2.2 Updates to this version

2.2.1 This version of the Hydrodynamic and Dispersion Modelling Report (Revision 1), has been updated to include:

- An additional scenario considering the cumulative effects of North Falls in addition to all proposed and constructed windfarms (Five Estuaries, East Anglia ONE North, East Anglia TWO, London Array, Gunfleet Sands, Thanet, Galloper, Greater Gabbard and East Anglia ONE); and
- Sediment dispersion model simulations for Dredging at the Pilot Boarding Area (Simulation 13, Section 6.16);

~~2.2~~2.3 Scope

~~2.2.1~~2.3.1 The aims of this study are:

- to simulate tidal hydrodynamics around the project site and quantify potential effect in hydrodynamics by the proposed North Falls Offshore Wind Farm; and
- to simulate the dispersion of sediment plume arising from levelling, trenching and dredging activities associated with the North Falls Wind Farm.

3 APPROACH

3.1.1 Royal HaskoningDHV utilized the MIKE software package developed by DHI, which includes the MIKE21 (2D) and MIKE3 (3D) Hydrodynamic Models (HD), for simulating water level and current speeds in response to tidal and atmospheric forcing.

3.1.2 The study adopted Royal HaskoningDHV's existing regional hydrodynamic model of the UK, which has been calibrated by water level data at numerous sites around the UK coastline. The regional model provided water level and velocity boundary conditions for the local hydrodynamic model to simulate tidal hydrodynamics and sediment plume dispersion.

3.1.3 The local hydrodynamic model was developed using the latest available bathymetric data at the site and calibrated by measured water levels and current speeds. The calibrated local model was used to quantify the potential effect in hydrodynamics by the proposed windfarm development. The local hydrodynamic model was also coupled with the MIKE Mud Transport (MT) module to simulate sediment plume dispersion in 3D.

3.1.4 The results of this modelling study will inform the responses to stakeholder queries submitted through the Examination process of North Falls DCO application.

4 INPUT DATA

4.1 Introduction

4.1.1 This section summarizes the data that has been collated and utilized for the hydrodynamic (HD) model setup and calibration.

4.1.2 This section also gives details of the data that was used for the dispersion (MT) model.

4.2 Bathymetry

4.2.1 For the regional hydrodynamic model, the bathymetry was based on EMODnet bathymetry data supplemented by more recent bathymetry data from the UK Hydrographic Office's Admiralty Maritime Data Solutions[1] (Figure 4-1).

[1] Seabed Mapping (admiralty.co.uk)

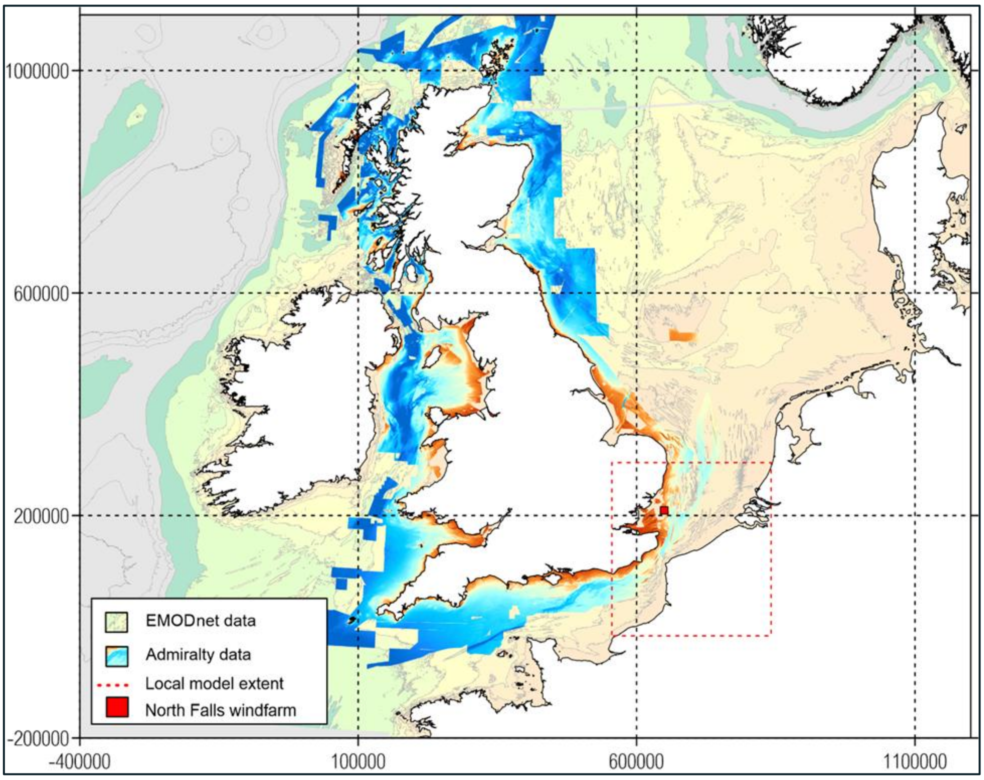


Figure 4-1 EMODnet and Admiralty Maritime Data Solutions' data for regional model

4.2.2 The following bathymetry was used in the local hydrodynamic model:

- Detailed bathymetry survey data from 2021 was provided by the Applicant covering the North Falls Offshore project area which includes the array area and the offshore cable corridor (Figure 4-2).
- For offshore areas where there was no detailed bathymetry available from the Applicant, EMODnet bathymetry data has been downloaded from the EMODnet Bathymetry Portal[2] and used in the hydrodynamic model.

[2] EMODnet Map Viewer (europa.eu)

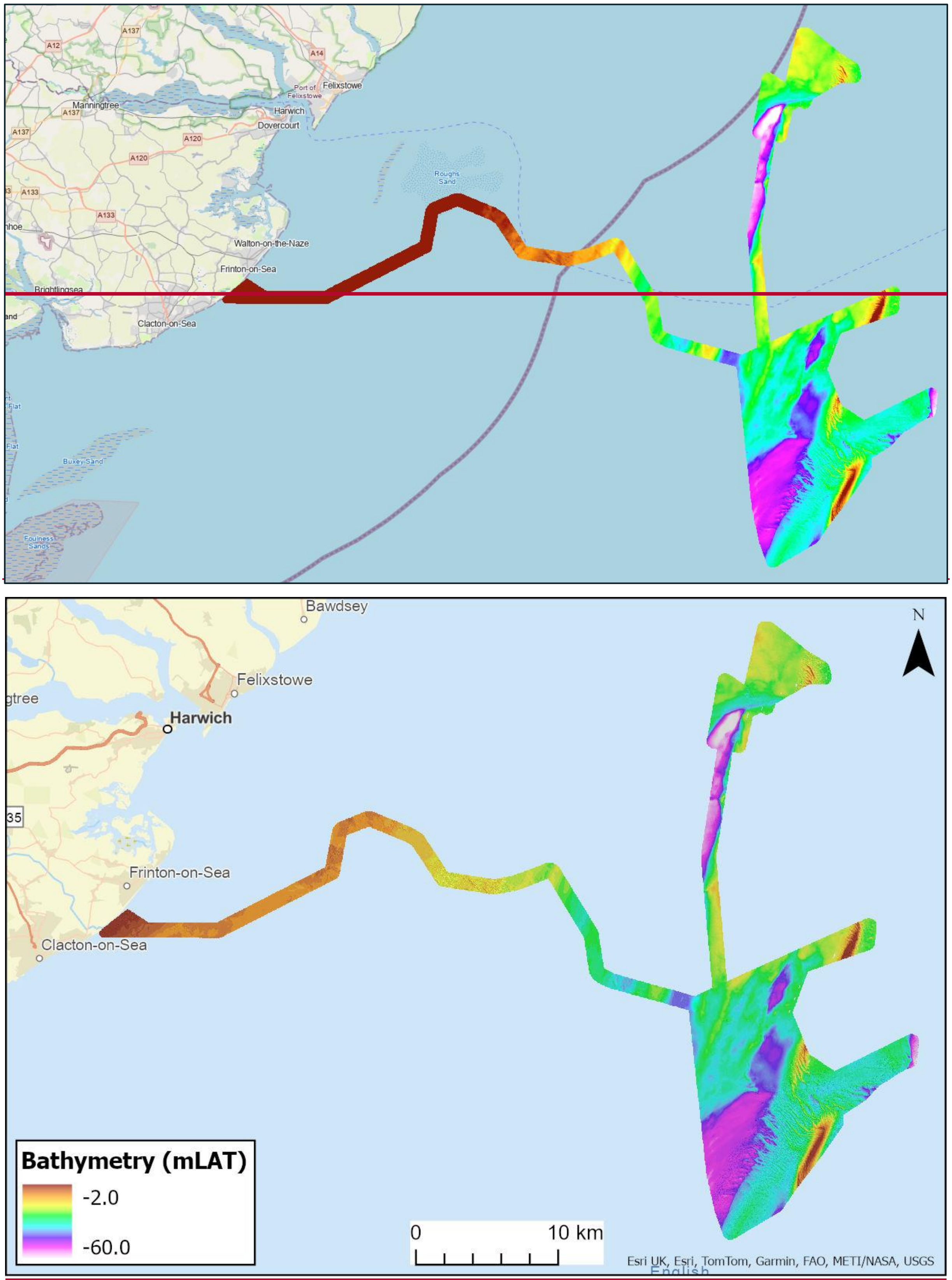


Figure 4-2: Detailed bathymetry of North Falls Offshore Project area Note: Shows PEIR boundaries including Northern Array now removed from the Project.

4.3 Water level

4.3.1 Measured water levels from 01 June 2024 to 30 November 2024 downloaded from British Oceanographic Data Centre (BODC)[3] recorded at two A-Class tide gauge locations: Harwich and Sheerness. And a dataset of water level measurements from 1998 at the RN-8158 tide gauge station has also been downloaded from the BODC website.

4.3.2 The locations of these three tide gauges are shown in Figure 4-3 and the coordinates of these locations are provided in Table 4-1. The water levels at Harwich and Sheerness were used to calibrate the regional model while the 1998 measurements at the RN-8158 tide gauge station were used to calibrate the local model.

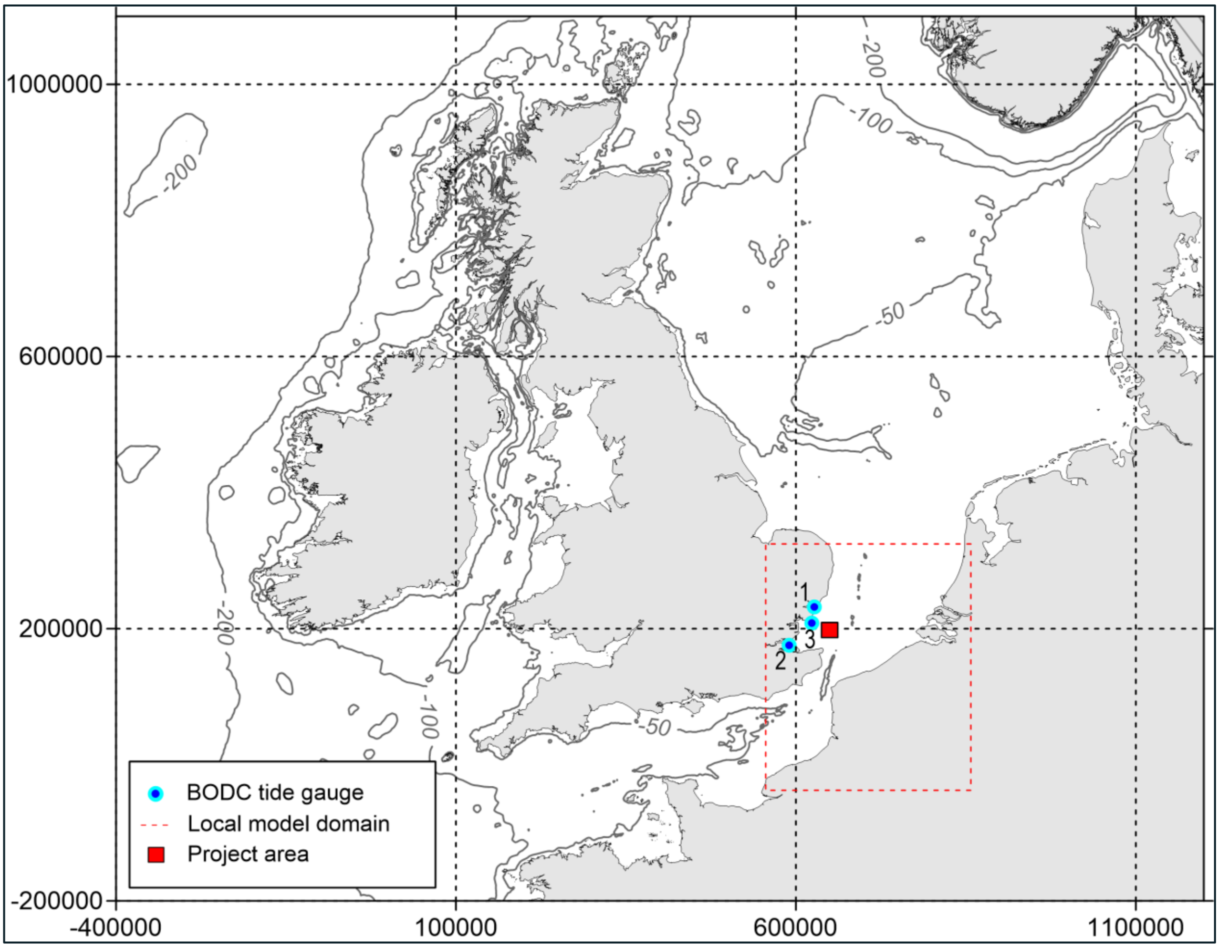


Figure 4-3 Indication of tidal gauge locations

[3] www.bodc.ac.uk

Table 4-1 Location of the measured water levels

ID	STATION NAME	LONGITUDE	LATITUDE	TIME INTERVAL (MINUTE)	DURATION	DESCRIPTION
1	Harwich	1.29	51.94	15	6/2024 – 30/11/2024	Water level
2	Sheerness	0.74	51.44	15	6/2024 – 30/11/2024	Water level
3	RN-8158	1.60	51.79	10	1/4-16/5/1998	Water level

4.4 Currents

4.4.1 The measured current data was downloaded from BODC. A description of the measured data including locations is provided in Figure 4-4 and Table 4-2.

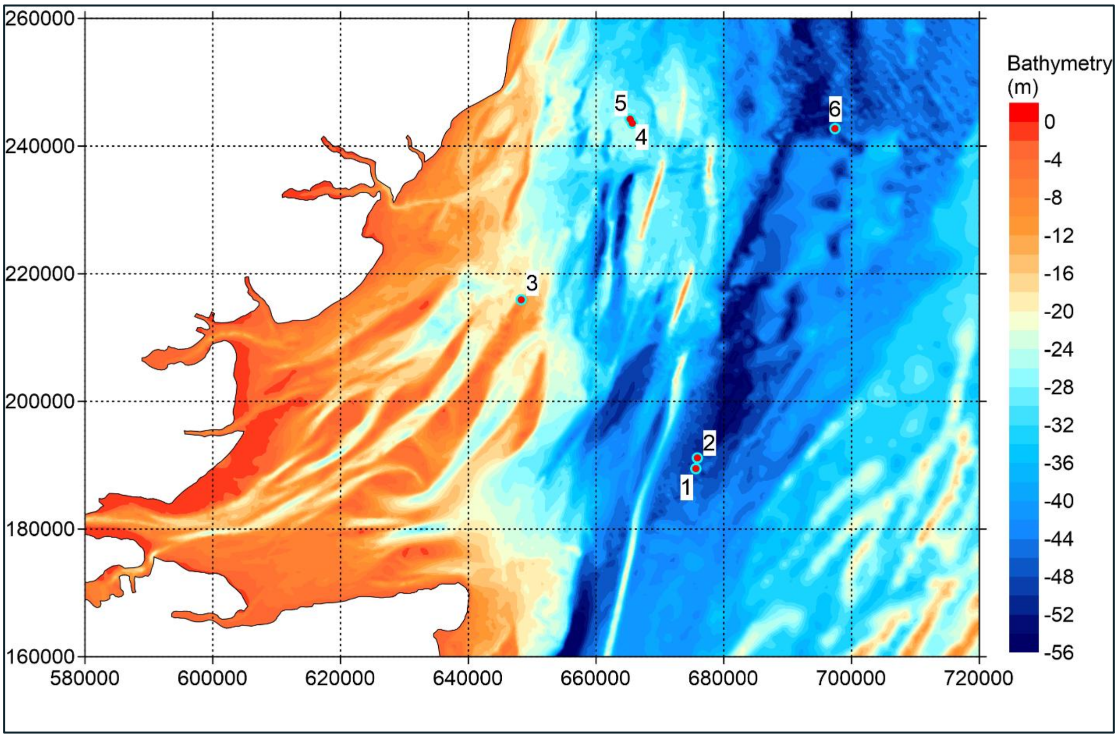


Figure 4-4 Location of current measurements

Table 4-2 Details of the measured current and water level locations

ID	STATION NAME	LONGITUDE	LATITUDE	TIME INTERVAL (MINUTE)	DURATION	DESCRIPTION
1	RN-9660	1.97	51.54	10	18/5-23/5/1979	Current speed
2	RN-7222	1.98	51.55	10	17/1-29/1/1980	Current speed
3	RN-8158	1.60	51.79	10	1/4-16/5/1998	Current speed
4	RN-7069	1.87	52.02	10	22/5-1/6/1980	Current speed
5	RN-6699	1.86	52.03	10	27/10-6/11/1979	Current speed
6	BSR0057 7444	2.33	52.0	10	22/1-29/1/1996	Current speed

4.5 Sediment Data

4.5.1 A site-specific seabed sediment grab sampling campaign totalling 33 samples with particle size distribution analysis was completed by Fugro (2021). Seventeen of these samples were collected along the Offshore Cable Corridor and 16 within the array area. (Figure 4-5). The composition of the sediment samples was interrogated to create particle size distribution zones for input into the model. For details on how this data has been applied in the dispersion model refer to Section 5.3.

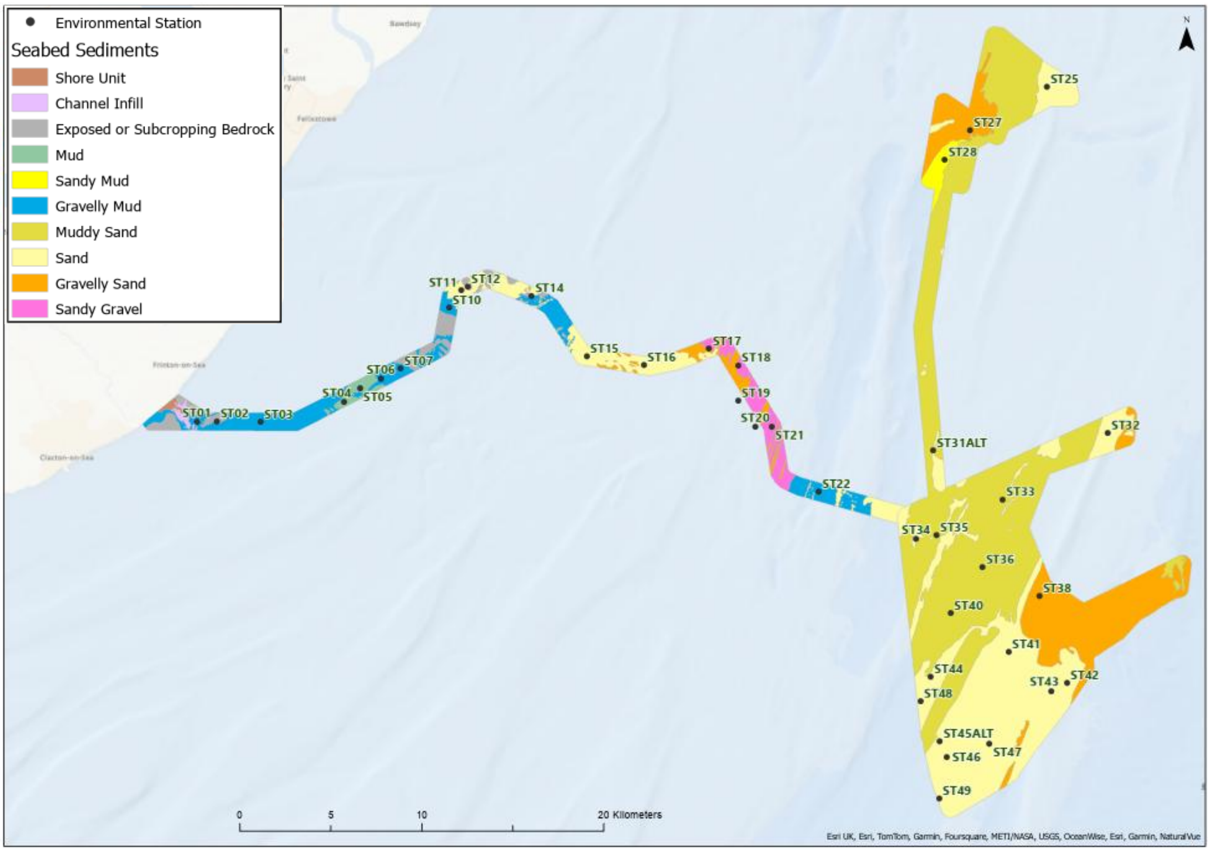


Figure 4-5 Locations of seabed sediment samples overlaid on seabed sediment map. Note: Shows PEIR boundaries including Northern Array now removed from the Project.

5 HYDRODYNAMIC MODEL

5.1 Introduction

5.1.1 This section of the report describes the hydrodynamic modelling exercise that was undertaken to investigate the effect in hydrodynamics by the foundations of proposed turbines and sub-station and cable protection. The numbers and size of the foundations and cable protection are given in Section 5.3.

5.1.2 In addition to this effect of North Falls windfarm, the cumulative effect of all proposed and constructed windfarms in the surrounding area (Five Estuaries, East Anglia ONE North, East Anglia TWO, London Array, Gunfleet Sands, Thanet, Galloper, Greater Gabbard and East Anglia ONE) have also been investigated.

5.1.3 The hydrodynamic model was built in MIKE21/3 software developed by DHI.

5.1.4 The MIKE21/3 model was later coupled with a sediment dispersion model built in MIKE3-MT to investigate the suspended sediment dispersion described in Section 6.

5.2 Hydrodynamic Model Setup

5.2.1 The modelling undertaken in this study utilised the MIKE software package. The MIKE model mesh utilises a flexible, unstructured, and triangular mesh approach, enabling the model user to carefully construct a spatially varying mesh resolution which takes into consideration the changes in seabed level and complex geometries of the coastline.

5.2.2 For the regional model the computational mesh consisted of 292,000 elements and 143,000 nodes. As the regional model was developed for simulation of the large scale circulation patterns, the mesh resolution is relatively coarse, ranging from 1km to 5km. In general, the grid resolution increases towards the coastline in order to capture the nearshore shallow water (Figure 5-1).

5.2.3 The model bathymetry is presented in Figure 5-2.

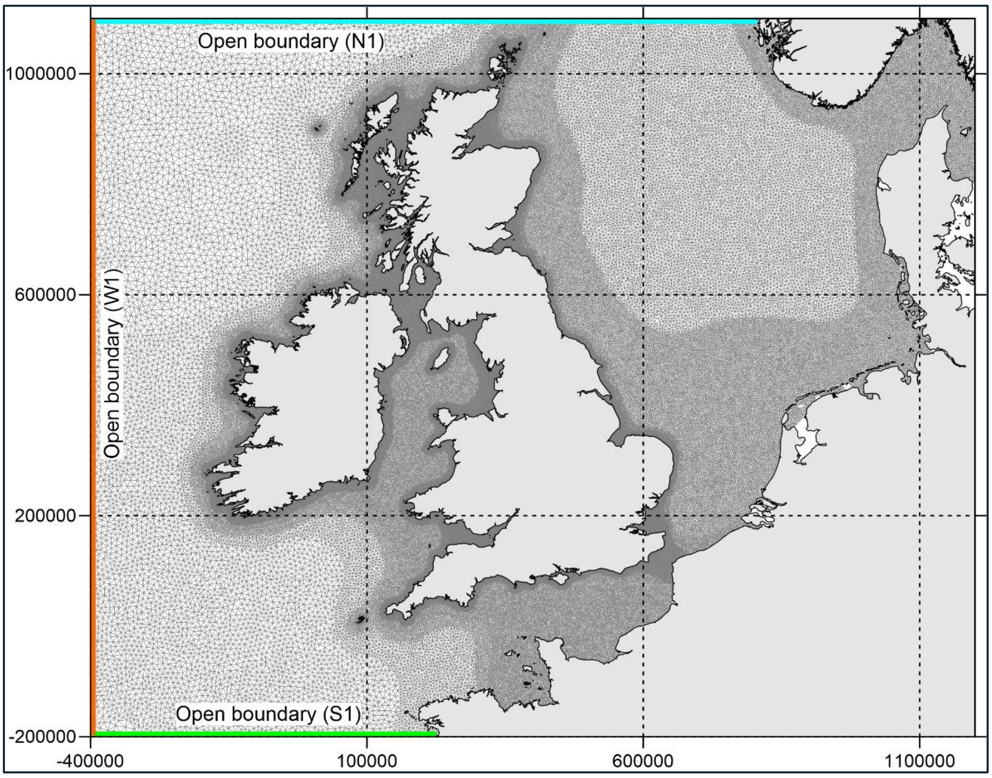


Figure 5-1 Regional HD model mesh

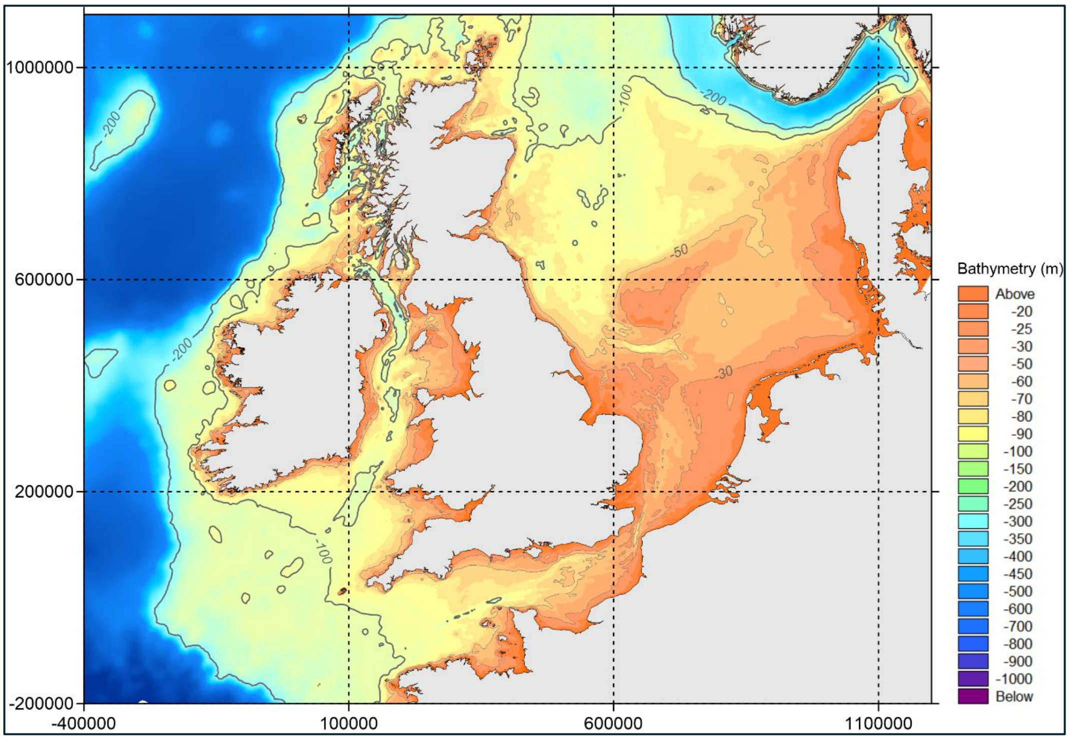


Figure 5-2: Regional model bathymetry

5.2.4 The computational mesh for the local model for calibration consisted of 52,516 elements and 26,799 nodes, where a coarser grid (1000-2000m) was used in remote areas and a finer grid (200-300m) in the areas of interest. For later model application runs for assessing the potential impact, the computational mesh was further refined around the project site.

5.2.5 The model domain was selected to cover the full extent of the offshore project area, with additional areas to the north and south to minimize any potential model boundary effects on the hydrodynamics at the project site. The model mesh and domain for the local model is presented in Figure 5-3 and Figure 5-4.

Figure 5-3: Local model mesh

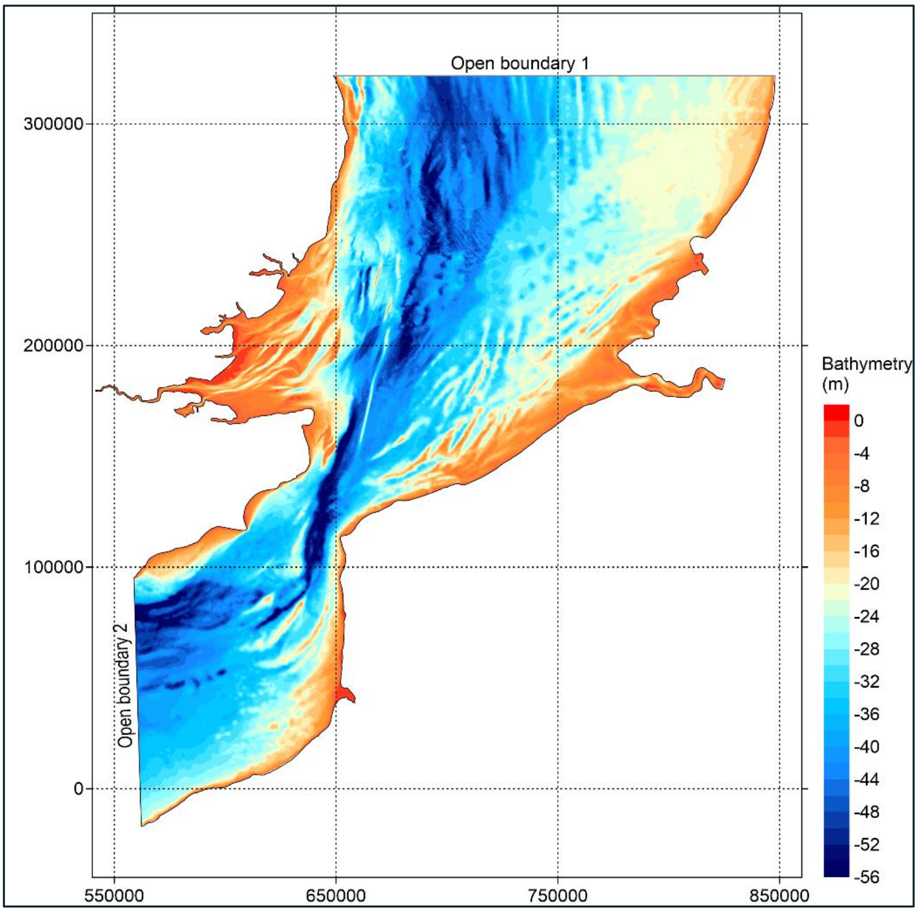


Figure 5-4: Local model bathymetry

5.2.6 To optimise the vertical accuracy of the hydrodynamic model, whilst maintaining realistic computational requirements, 5 vertical 'sigma' layers are adopted in the model setup for the sediment dispersion simulations. The 'sigma' vertical layer is defined as splitting the water column into a number of equally sized vertical bins and therefore, size of these bins is variable dependant on the water depth at each location.

5.2.7 The local model has been calibrated using measured water levels recorded at Station RN-8158. Figure 5-5 shows a comparison between the simulated and observed water level at Station RN-8158.

5.2.8 Table 5-1 Table 5-1 presents quantified errors in model water levels.

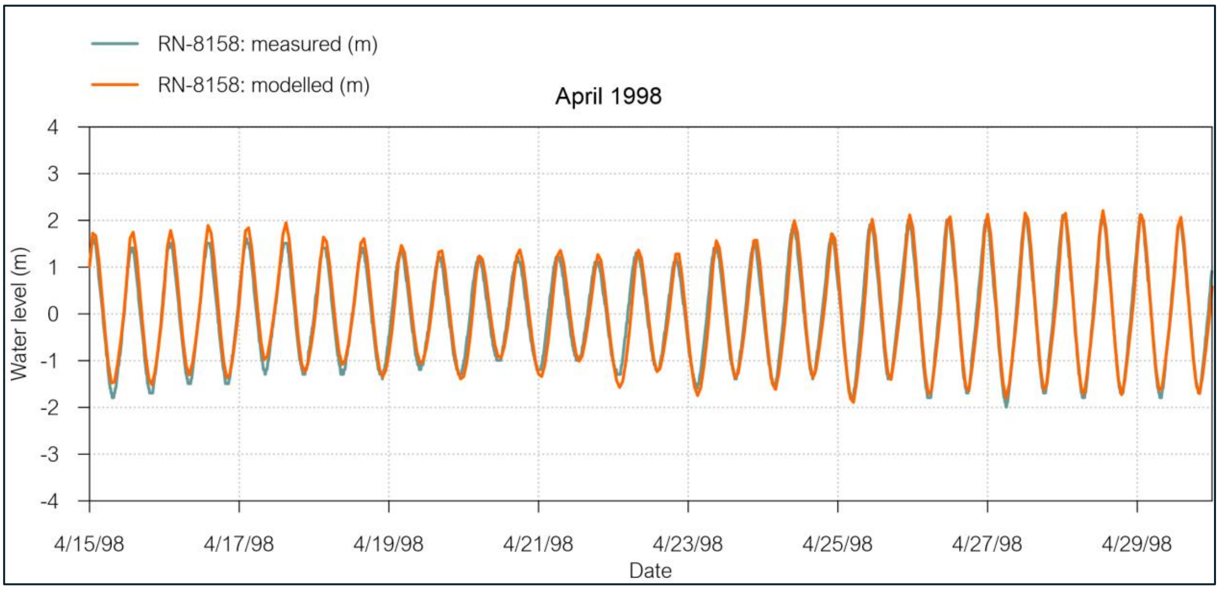


Figure 5-5. Time series comparison between simulated vs observed water levels at RN-8158 station in April 1998 (Local model)

Table 5-1: Model errors in water level (Local model)

Name of station	ME (m)	MAE (m)	Std (m)	R
RN-8158	0.02	0.16	0.20	0.96

***Note:** *ME: Mean Error; MAE: Mean Absolute Error; Std: Std. dev of Residuals; R: Coefficient of Determination*

5.2.9 The local model has been calibrated using measured current data recorded at 6 locations. Model calibration performance is assessed by both visual comparison and quantifying errors using statistical parameters including Correlation Coefficient and Mean Absolute Error.

5.2.10 Figure 5-6 to Figure 5-17 show the modelled and measured current speed and direction. Locations are provided in Figure 4-4 and Table 4-2.

5.2.11 Table 5-2 presents quantified errors in model current speeds.

5.2.12 The model errors in predicted current speed are low, no more than 0.05m/s in Mean Absolute Error, which provides confidence in using the model to assess potential impact on tidal currents and associated bed shear stress.

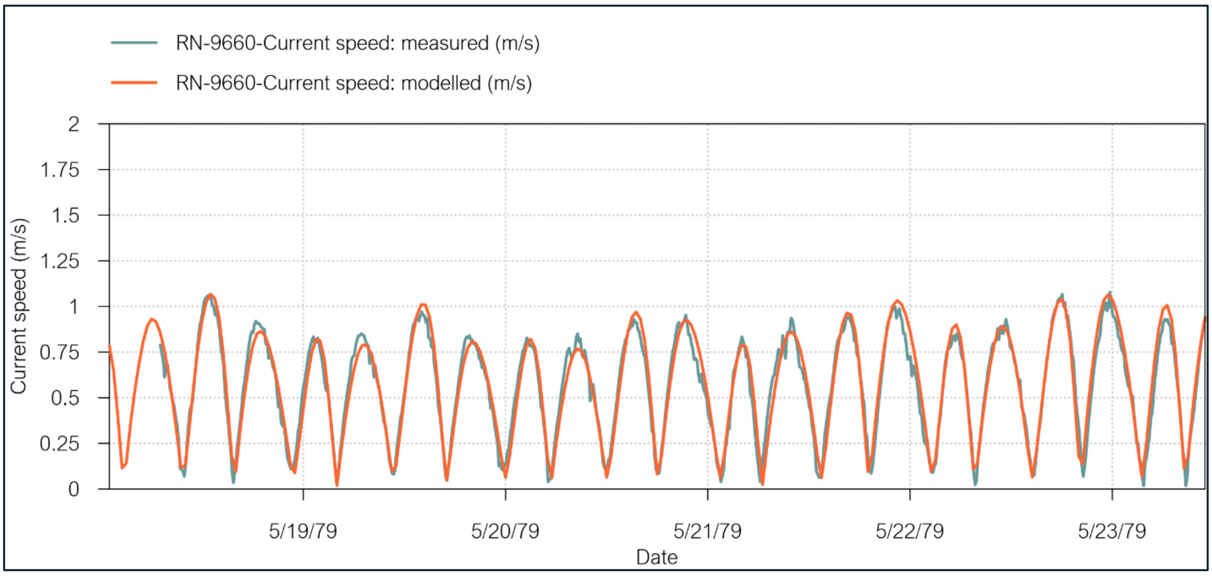


Figure 5-6: Time series comparison between simulated vs observed current speeds at RN-9660 station in May 1979 (Local model)

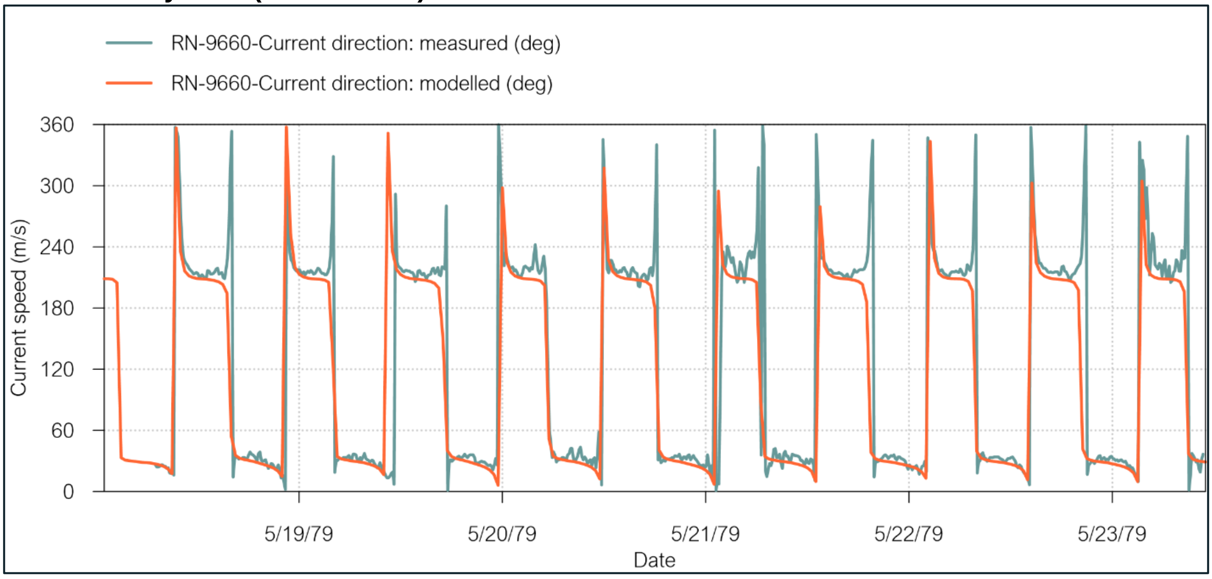


Figure 5-7: Time series comparison between simulated vs observed current directions at RN-9660 station in May 1979 (Local model)

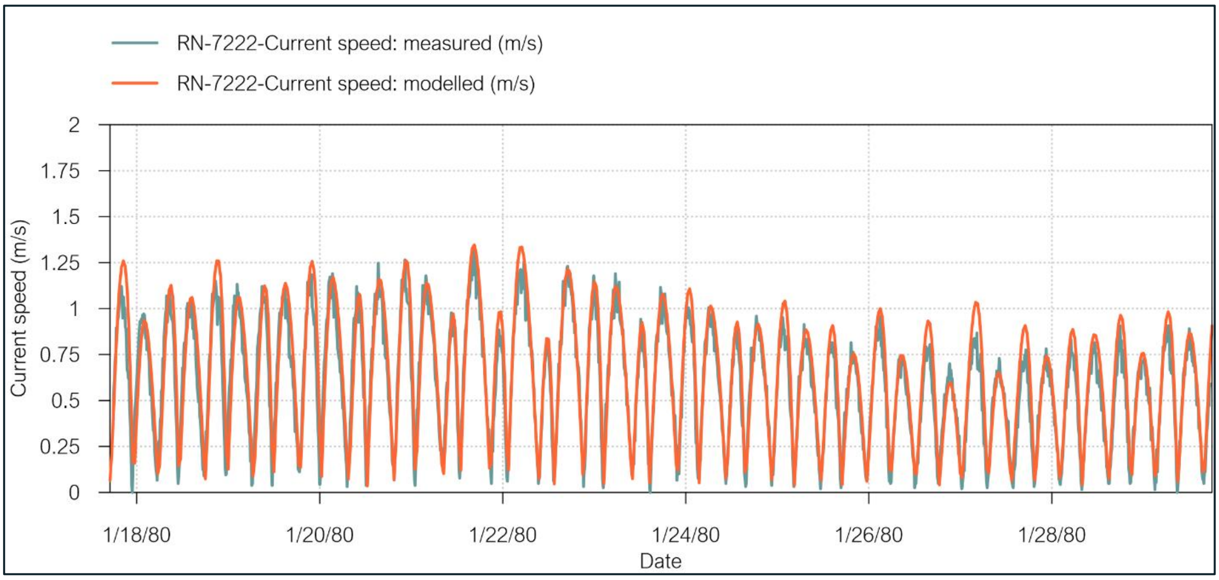


Figure 5-8: Time series comparison between simulated vs observed current speeds at RN-7222 station in Jan 1980 (Local model)

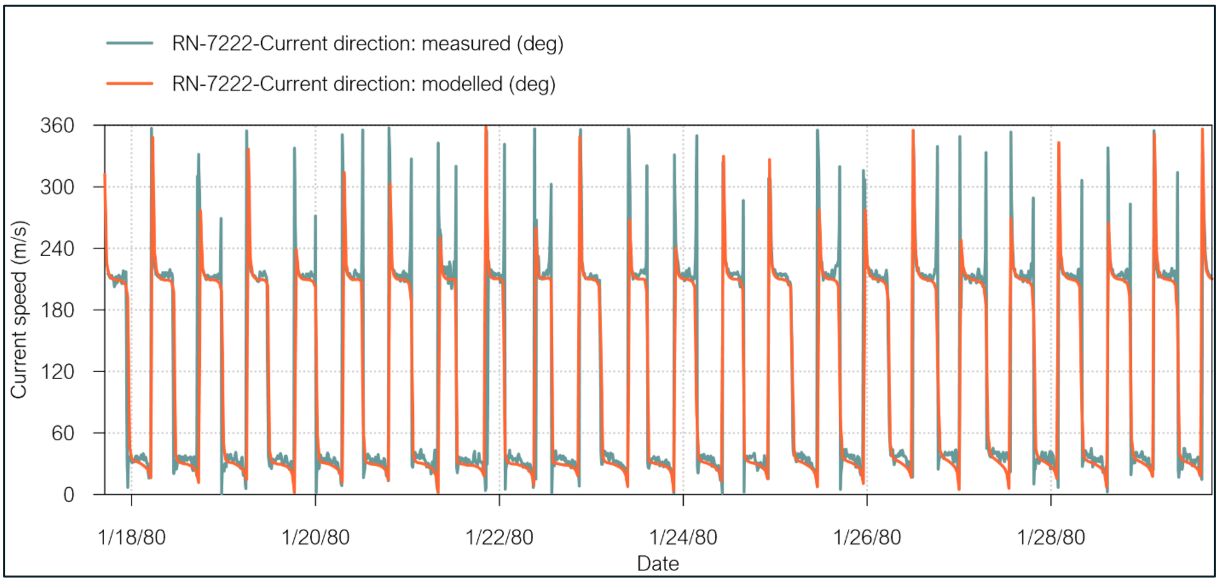


Figure 5-9: Time series comparison between simulated vs observed current directions at RN-7222 station in Jan 1980 (Local model)

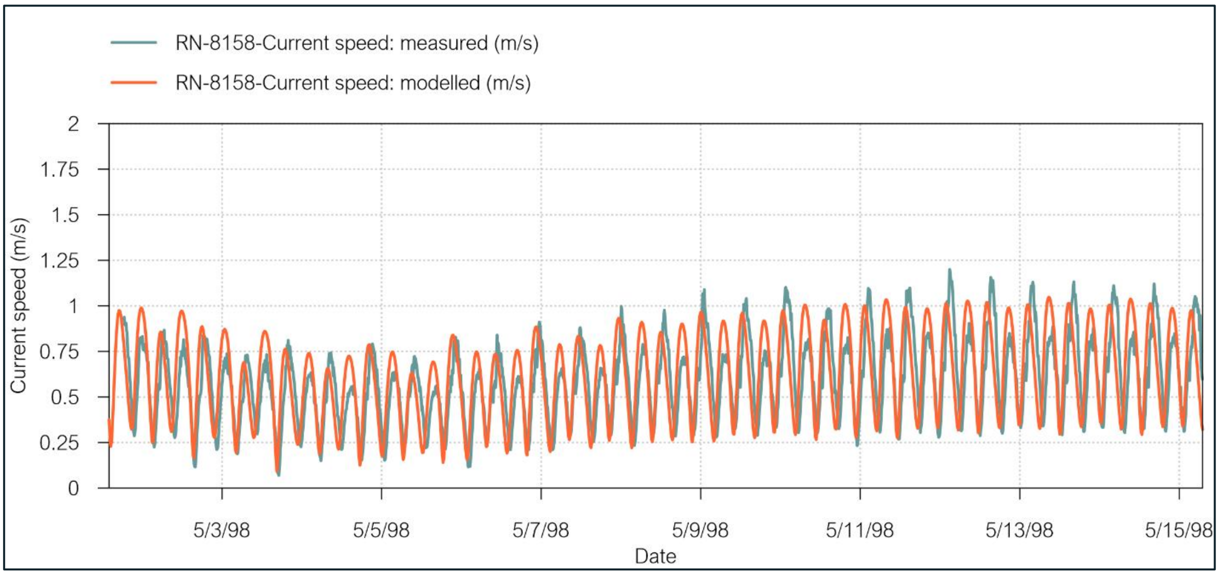


Figure 5-10: Time series comparison between simulated vs observed current speeds at RN-8158 station in May 1998 (Local model)

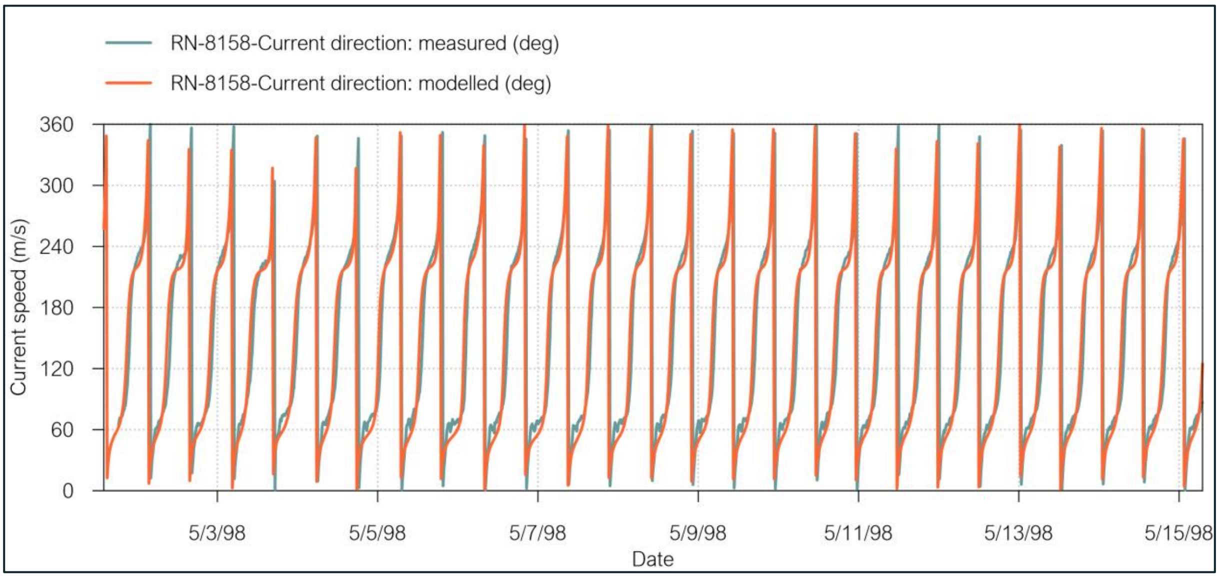


Figure 5-11: Time series comparison between simulated vs observed current directions at RN-8158 station in May 1998 (Local model)

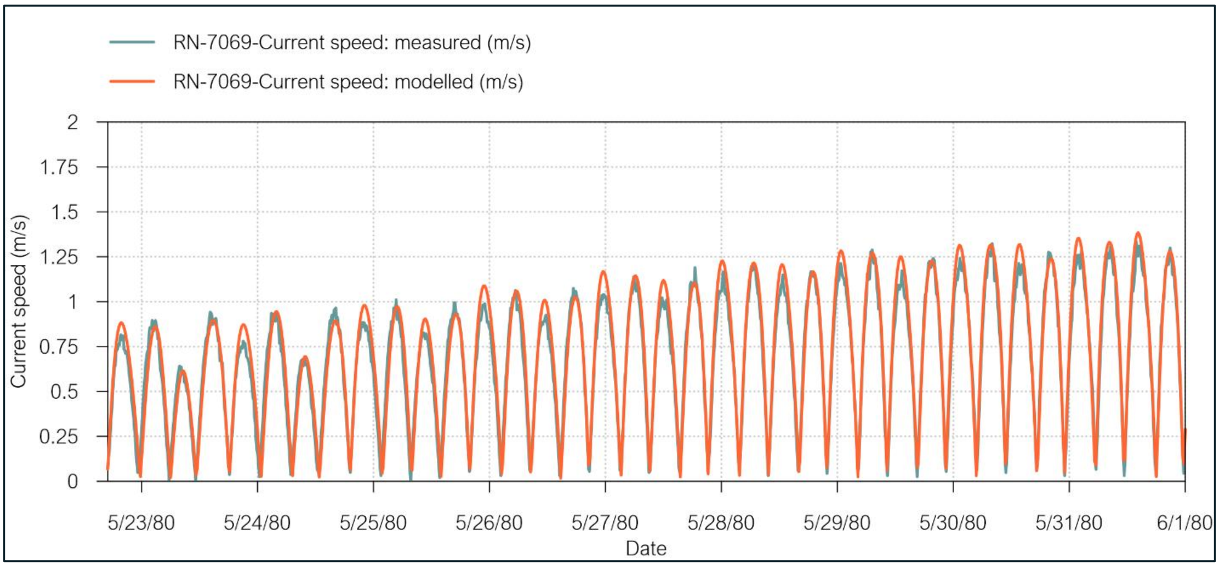


Figure 5-12: Time series comparison between simulated vs observed current speeds at RN-7069 station in May 1980 (Local model)

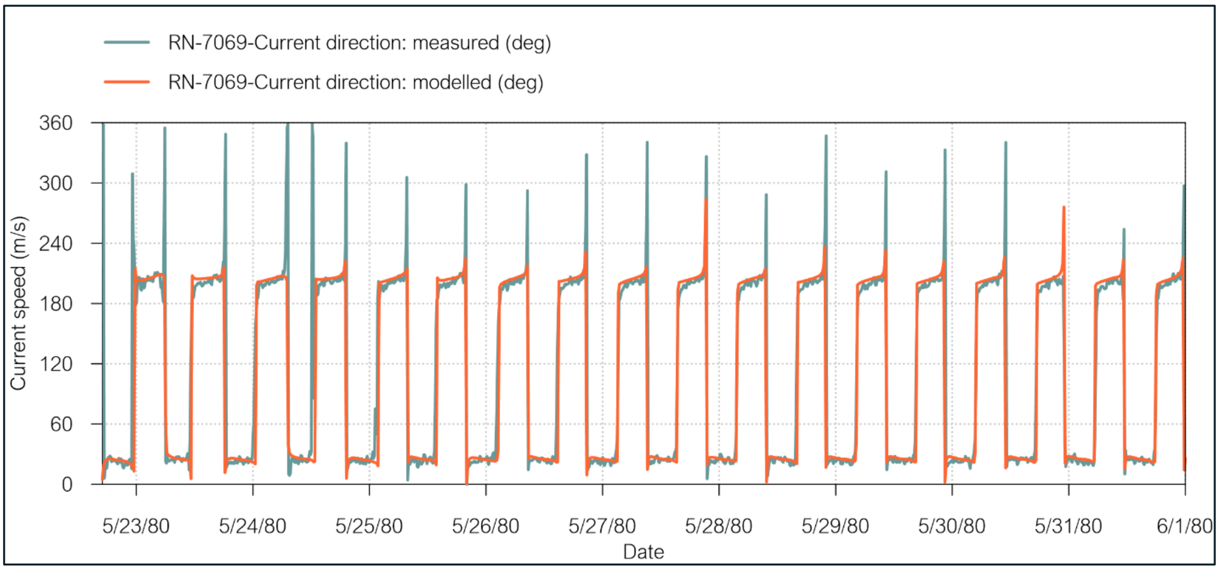


Figure 5-13: Time series comparison between simulated vs observed current directions at RN-7069 station in May 1980 (Local model)

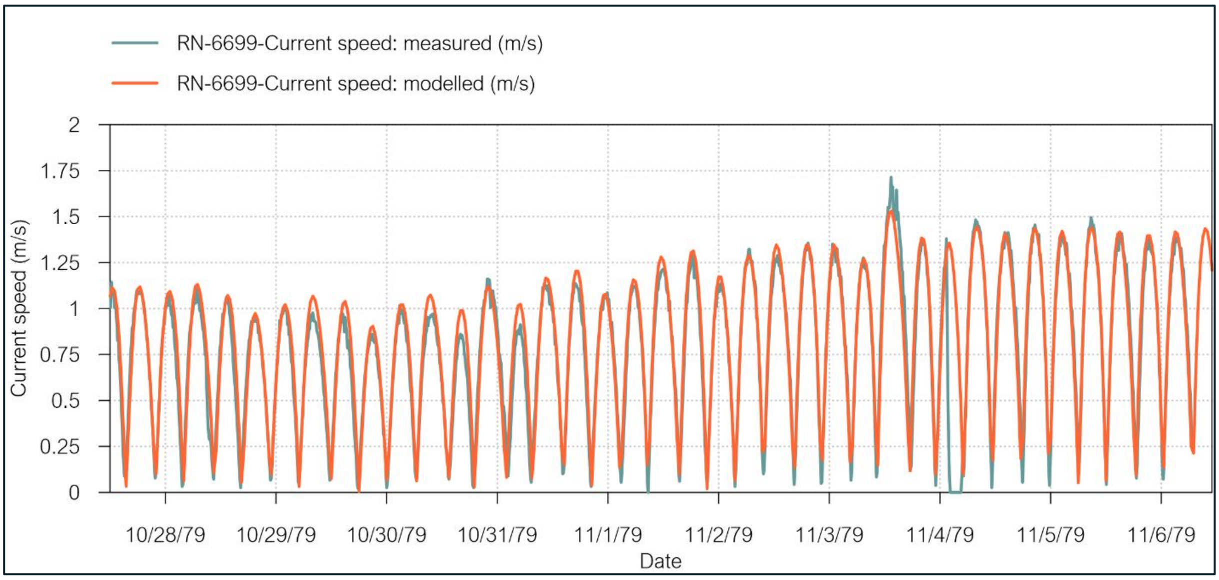


Figure 5-14: Time series comparison between simulated vs observed current speeds at RN-6699 station in October 1979 (Local model)

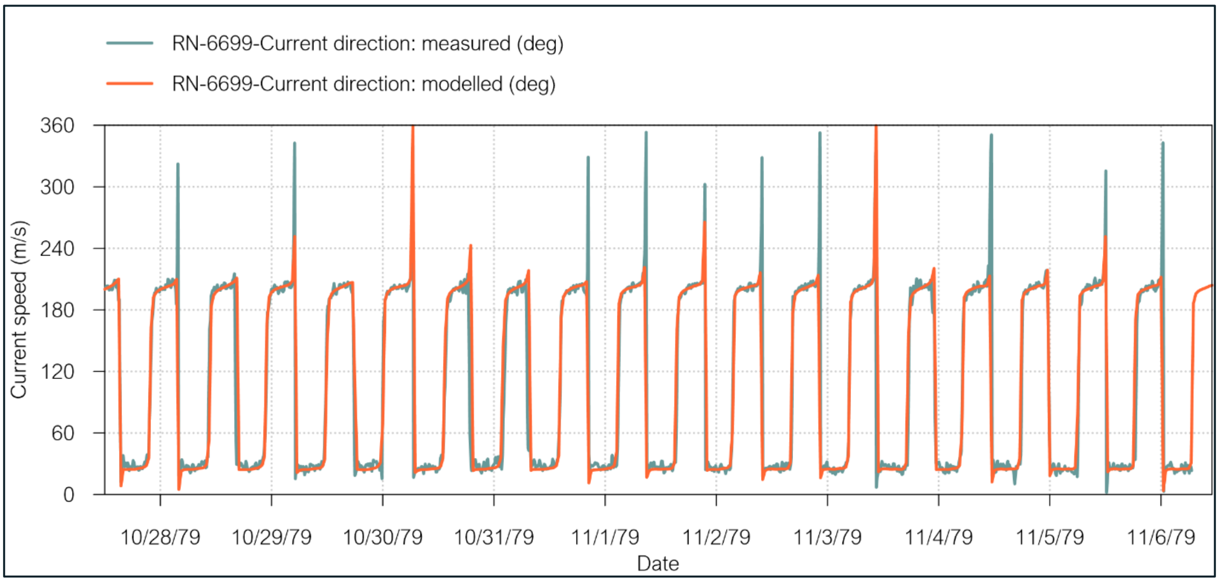


Figure 5-15: Time series comparison between simulated vs observed current direction at RN-6699 station in October 1979 (Local model)

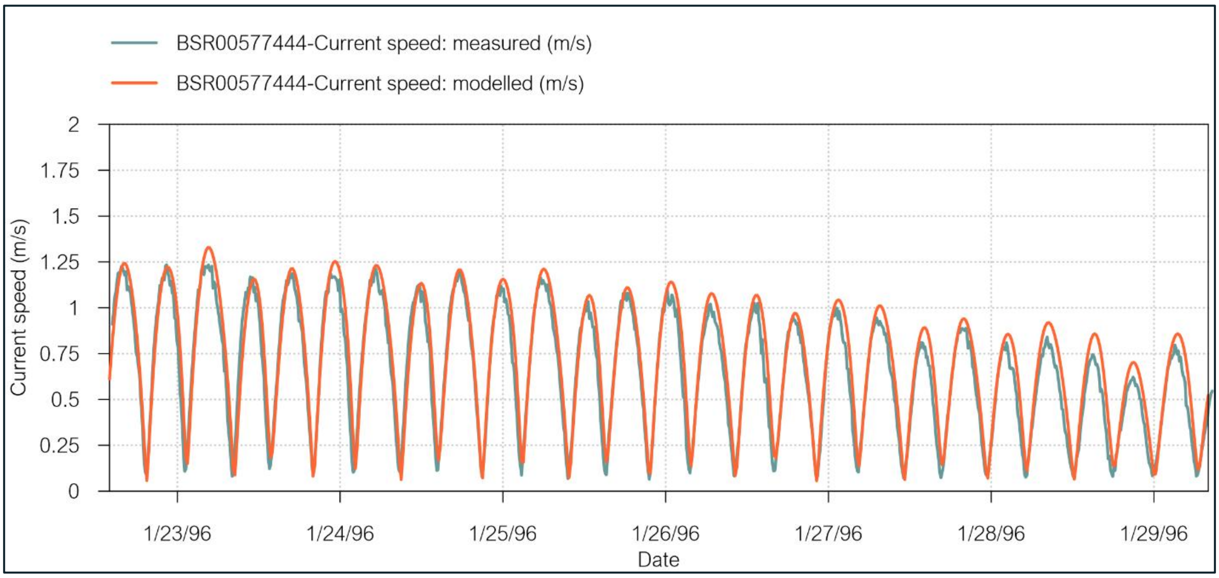


Figure 5-16: Time series comparison between simulated vs observed current speeds at BSR00577444 station in October 1996 (Local model)

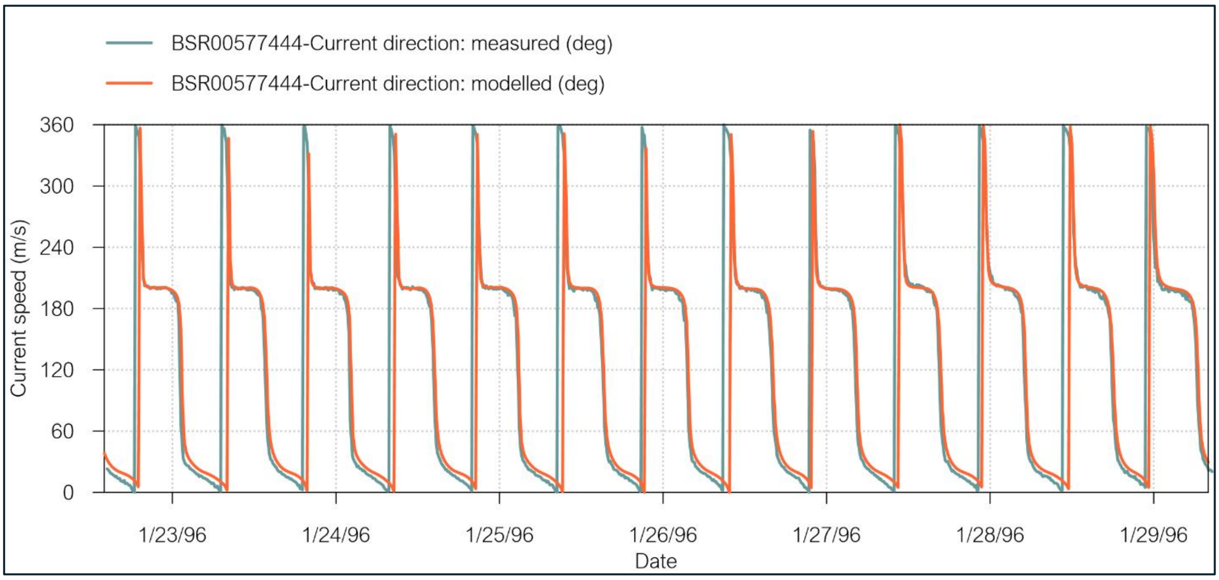


Figure 5-17: Time series comparison between simulated vs observed current direction at BSR00577444 station in October 1996 (Local model)

Table 5-2: Model errors in current speeds (Local model)

Name of station	ME (m/s)	MAE (m/s)	Std (m/s)	R
RN-9660	-0.01	0.05	0.06	0.94
RN-7222	-0.04	0.08	0.11	0.90
RN-8158	-0.03	0.16	0.18	0.45
RN-7069	-0.03	0.06	0.07	0.96
RN-6699	0.14	0.17	0.14	0.82
BSR00577444	-0.05	0.08	0.08	0.94

*__Note:__ *ME: Mean Error; MAE: Mean Absolute Error; Std: Std. dev of Residuals; R: Coefficient of Determination*

5.3 Hydrodynamic Model Runs

5.3.1 The calibrated 2D hydrodynamic model has been run for a full spring-neap tidal cycle from 1st to 17th October 2025 covering the whole of the North Falls Offshore Project Area.

5.3.2 The 2D HD model has been run for threewo scenarios:

- Without North Falls (hereafter 'Baseline');, and
- With North Falls (hereafter ('Option'), using the indicative smaller Wind Turbine Generators (WTGs) layout and offshore export cable protection;. and
- Above 'Option' layout, plus all proposed and constructed windfarms (Five Estuaries, East Anglia ONE North, East Anglia TWO, London Array, Gunfleet Sands, Thanet, Galloper, Greater Gabbard and East Anglia ONE) (hereafter 'Cumulative').

5.3.3 The smaller WTGs layout option consists of 57 WTGs and has been chosen as worst case for this hydrodynamic modelling as the larger WTGs layout comprises of only 34 WTGs.

5.3.4 Two offshore converter platform (OCP) / offshore substation platform (OSP) have been considered as the design envelope allows for up to two of these structures for both the smaller and larger WTGs layouts.

5.3.5 Indicative locations for export cable protection have been considered along 8 sections of offshore cable corridor and have been positioned considering information of areas that could prove difficult for burying and potential cable crossings.

5.3.6 Table 5-3 and Table 5-4 give details of the structures and the cable protection that were included in the model respectively.

5.3.65.3.7 A map of the 'Option' layout and 'Cumulative' layout are presented in Figure 5-18 and Figure 5-19, respectively. The structure dimensions for all other windfarms can be found in the North Falls Wave Assessment **[APP-093]**.

Table 5-3 Details of structures included in HD model

Structure	No	Main Structure Diameter (M)	Bottom Part Of Structure Height/Width (M)	Scour Protection Height/Width (M)
WTGs	57	17m	H: 8m, W: 38m	H: 2m, W: 198m
OCP/OSP	2	17m	n/a	H: 2m, W: 93m

Table 5-4 Details of indicative cable protection included in the HD model

Section	Length	Height Above Seabed (M)	Number Of Cables	Distance Between Cables (M)
1	3,933	1.4	2	50
2	300			
3	400			
4	200			
5	100			
6	400			
7	500			
8	400			

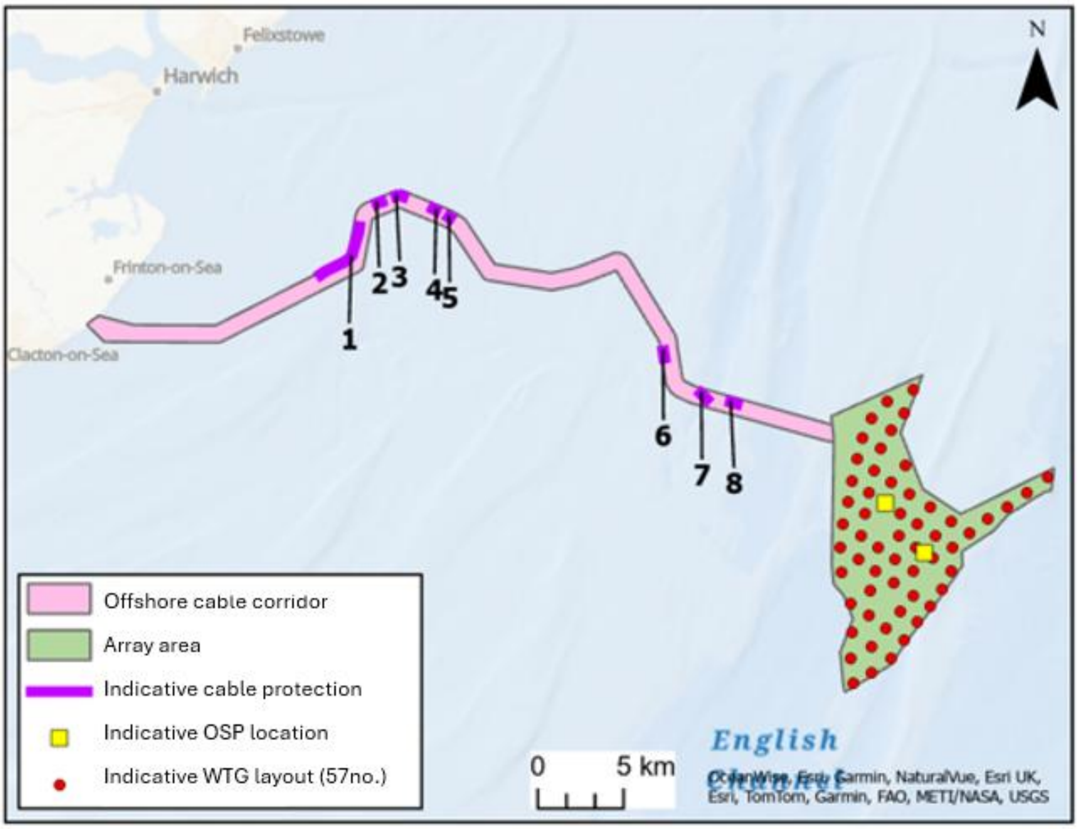


Figure 5-18 Modelled OWF smaller WTGs indicative layout and export cable protection locations.

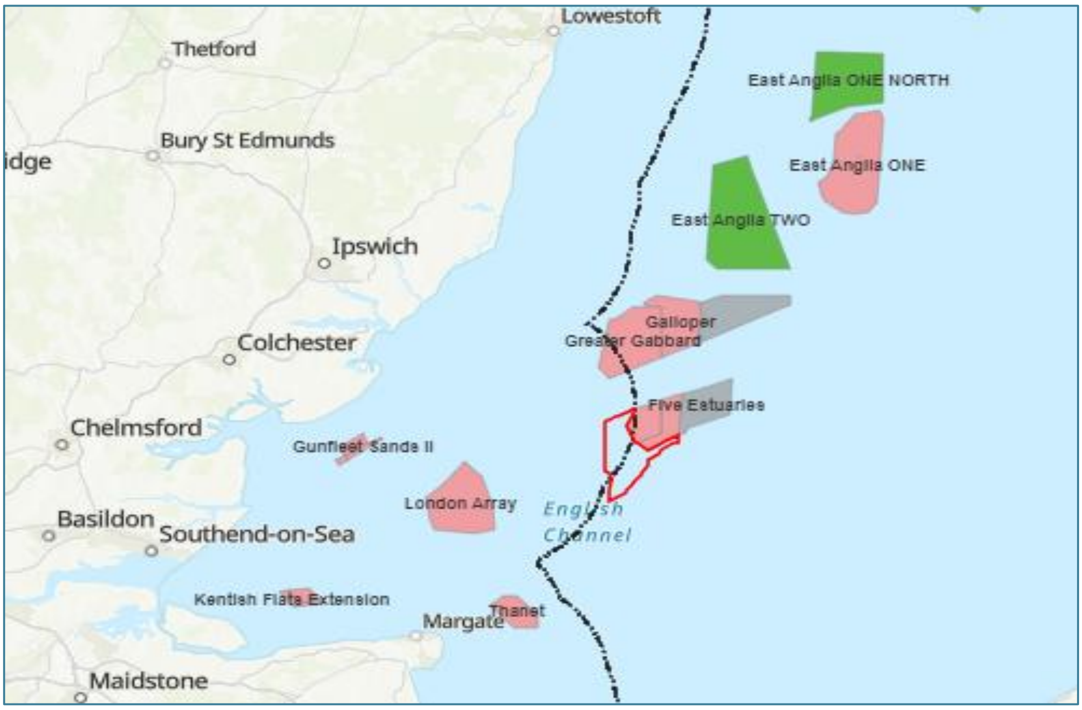


Figure 5-19: All other windfarms in the 'Cumulative' layout

5.4 Hydrodynamic Model Results

5.4.1 The Offshore cable corridor and array area of North Falls are shown as dashed black lines overlayed on the contour plots. Black markers on 'Cumulative' plots show location of turbines and platforms at all other windfarm arrays.

5.4.2 Figure 5-20 to Figure 5-27 present contour plots of predicted current speed for the 'Baseline' scenario, at peak flood and ebb during spring and neap tide. The 'Baseline' currents speeds are presented zoomed in at the North Falls site, as well as across the wider area covering all wind farm sites.

~~5.4.1~~5.4.3 Figure 5-28 to Figure 5-31 present contour plots of predicted current speed for the 'Option' scenario, at peak flood and ebb during spring and neap tide. Figure 5-32 to Figure 5-35 present contour plots of predicted current speed for the 'Cumulative' scenario, at peak flood and ebb during spring and neap tide.

~~5.4.2~~5.4.4 Figure 5-32 to Figure 5-51 present contour plots of predicted current speed for the 'Baseline', 'Option' and 'Cumulative' scenarios, at peak flood and ebb during spring and neap tide.

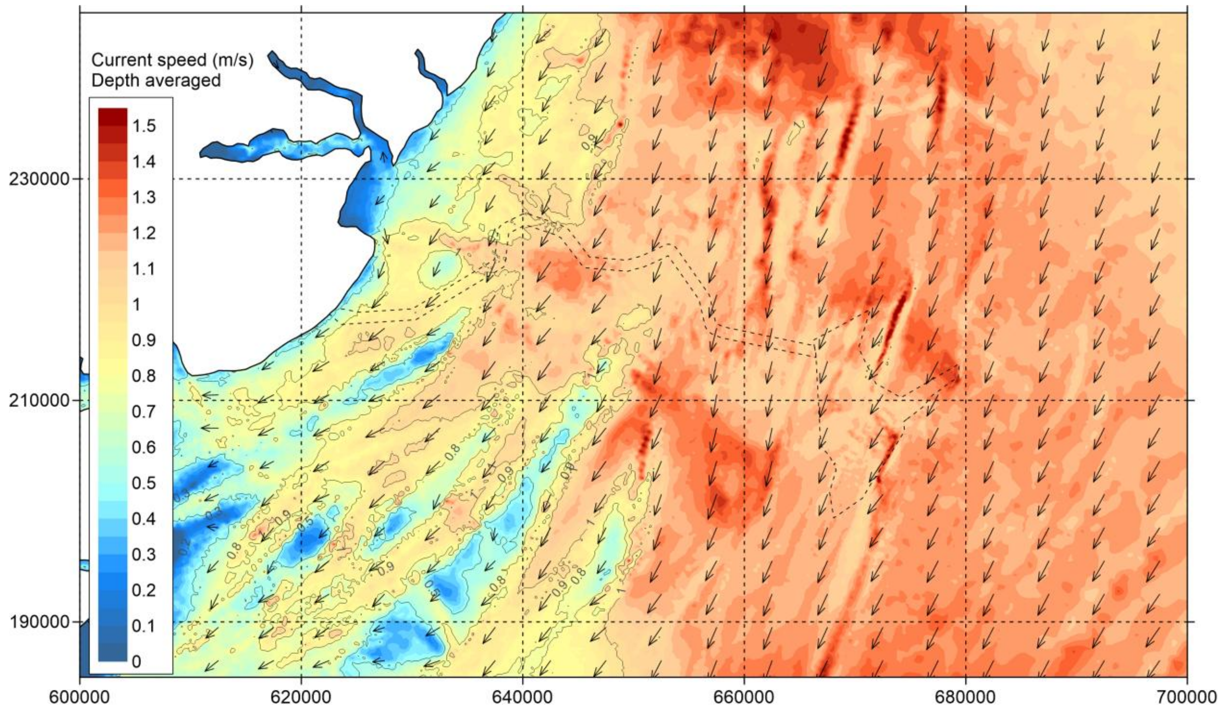


Figure 5-20 Baseline - Current speed during spring tide - peak flood (zoomed in)

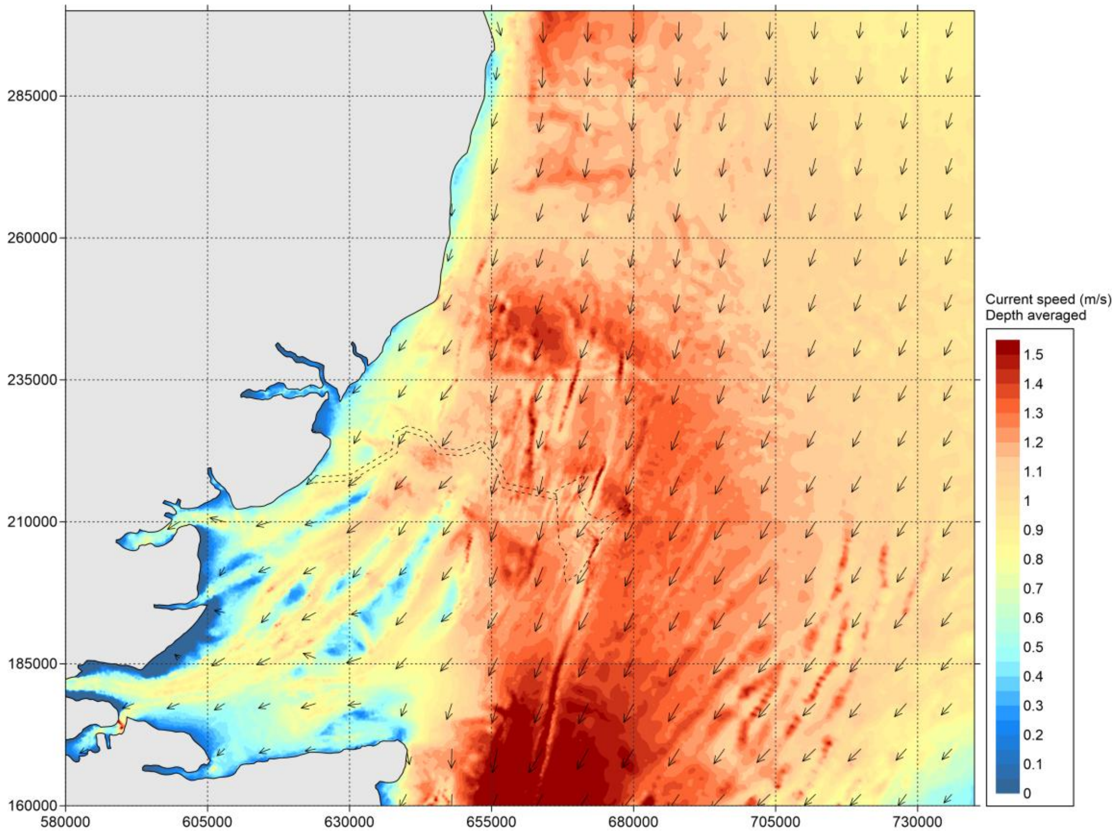


Figure 5-21 Baseline - Current speed during spring tide - peak flood (zoomed out)

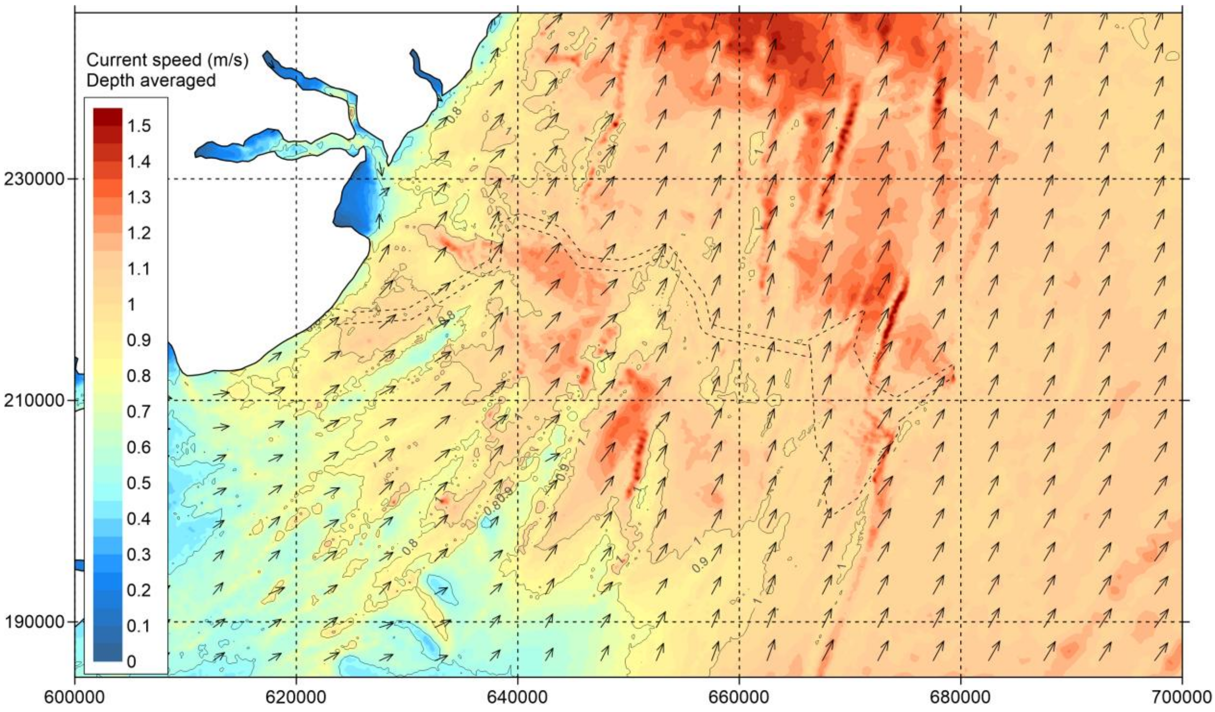


Figure 5-22 Baseline - Current speed during spring tide - peak ebb (zoomed in).

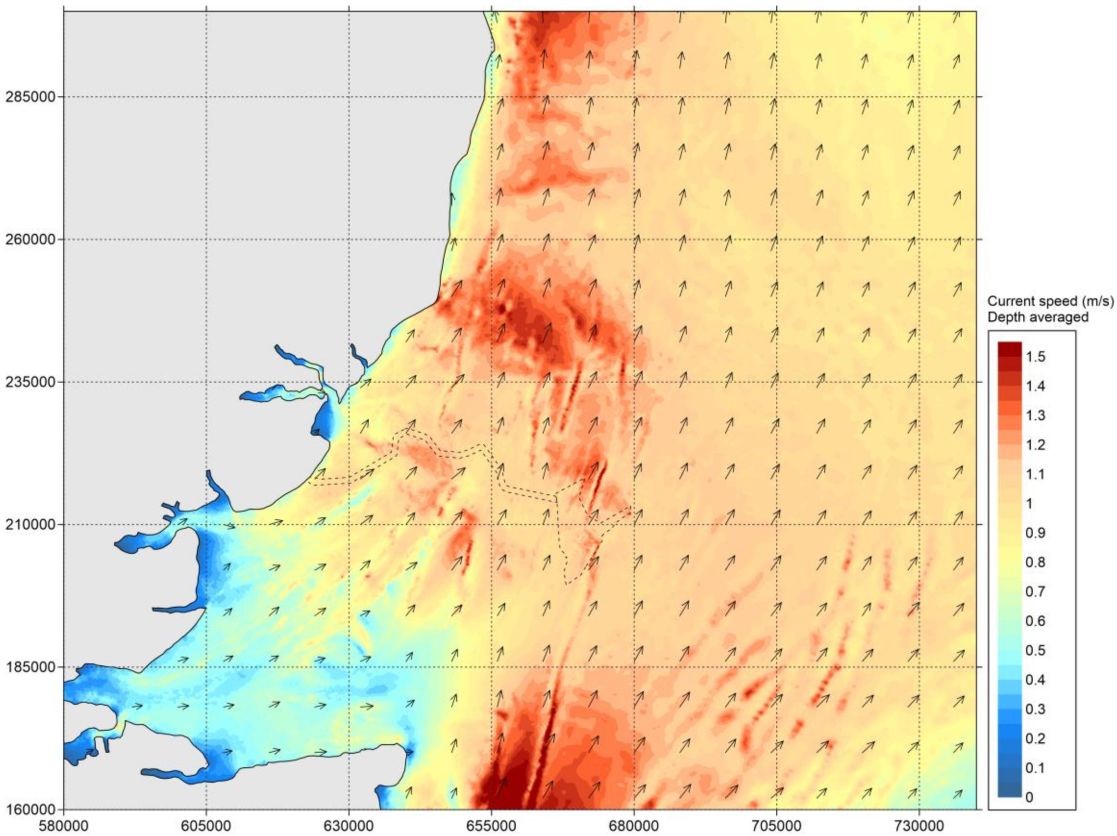


Figure 5-23 Baseline - Current speed during spring tide - peak ebb (zoomed out)

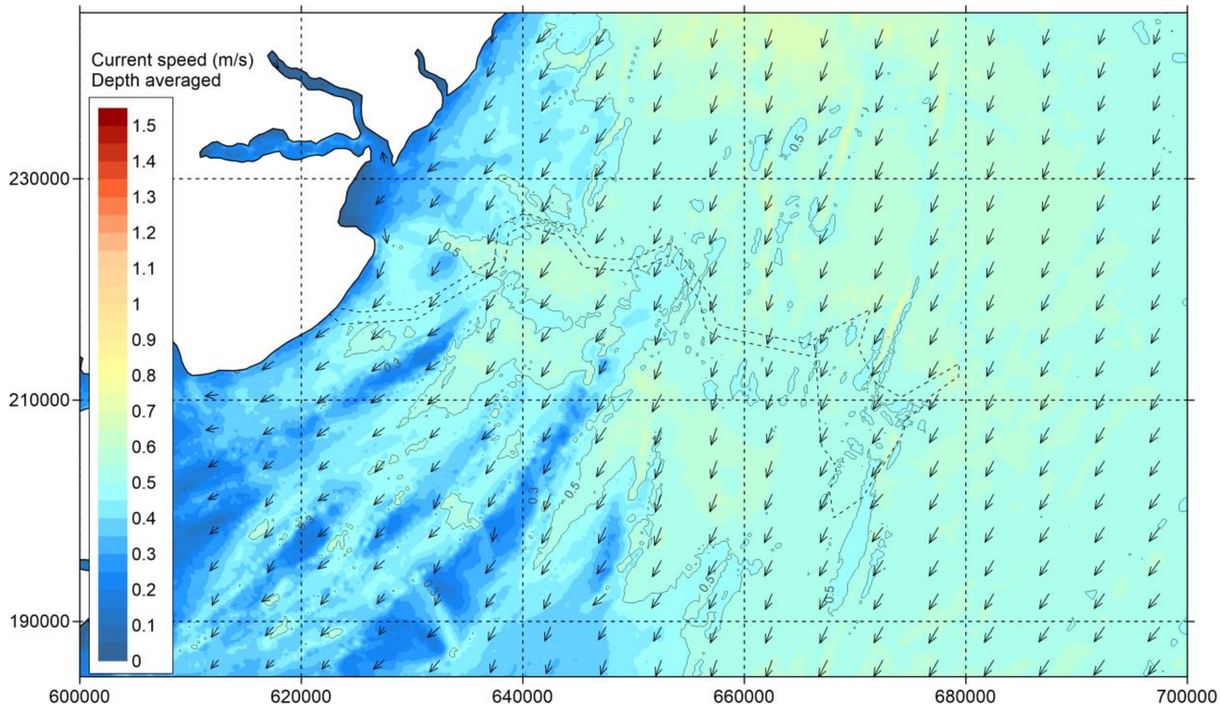


Figure 5-24- Baseline - Current speed during neap tide - peak flood (zoomed in)

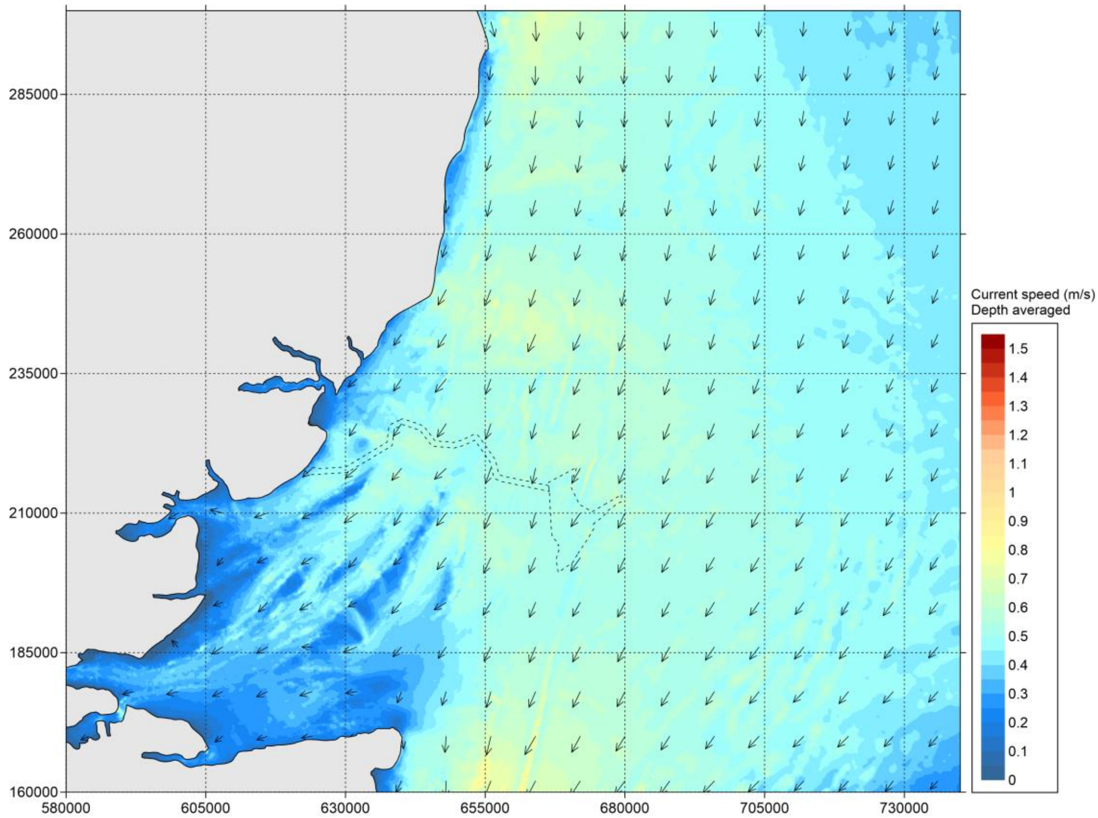


Figure 5-25 Baseline - Current speed during neap tide - peak flood (zoomed out).

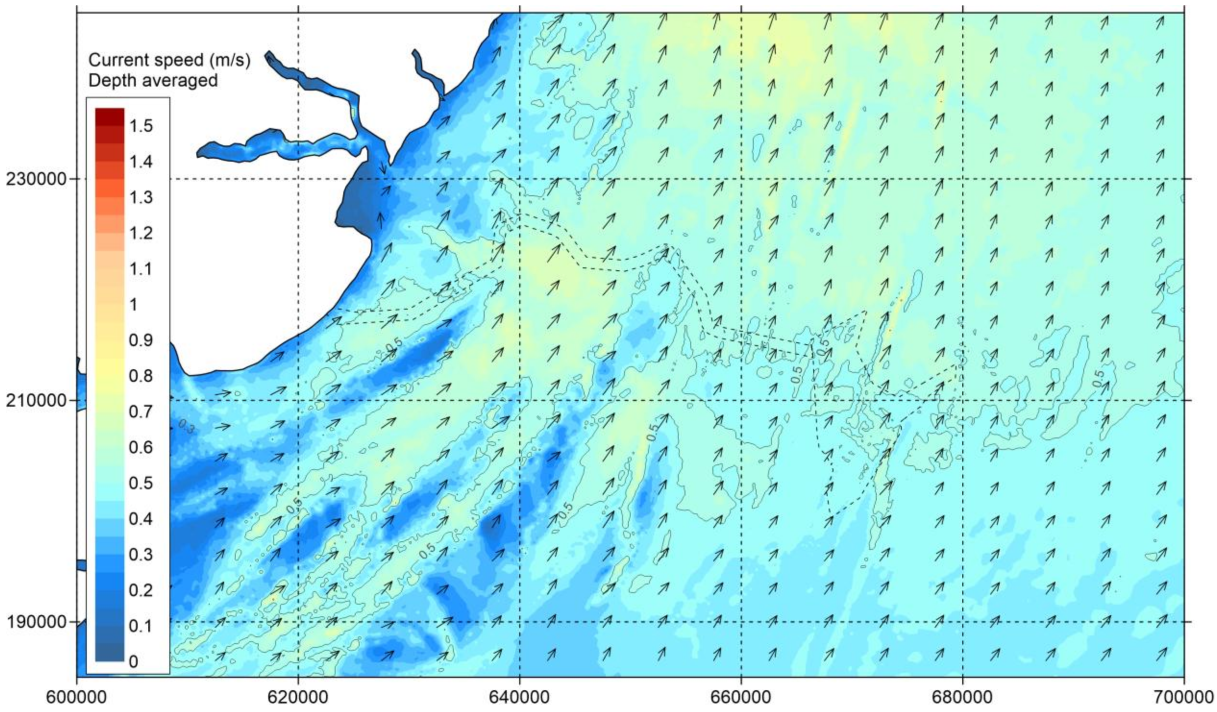


Figure 5-26 Baseline - Current speed during neap tide - peak ebb (zoomed in).

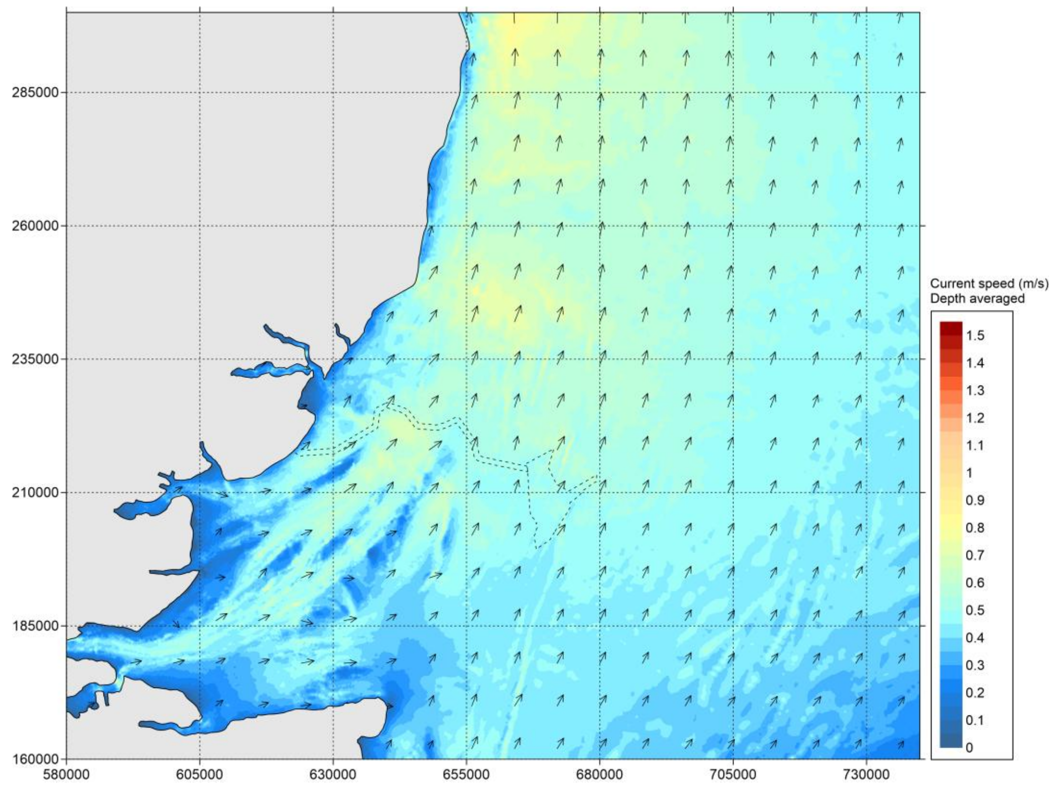


Figure 5-27 Baseline - Current speed during neap tide - peak ebb (zoomed out).

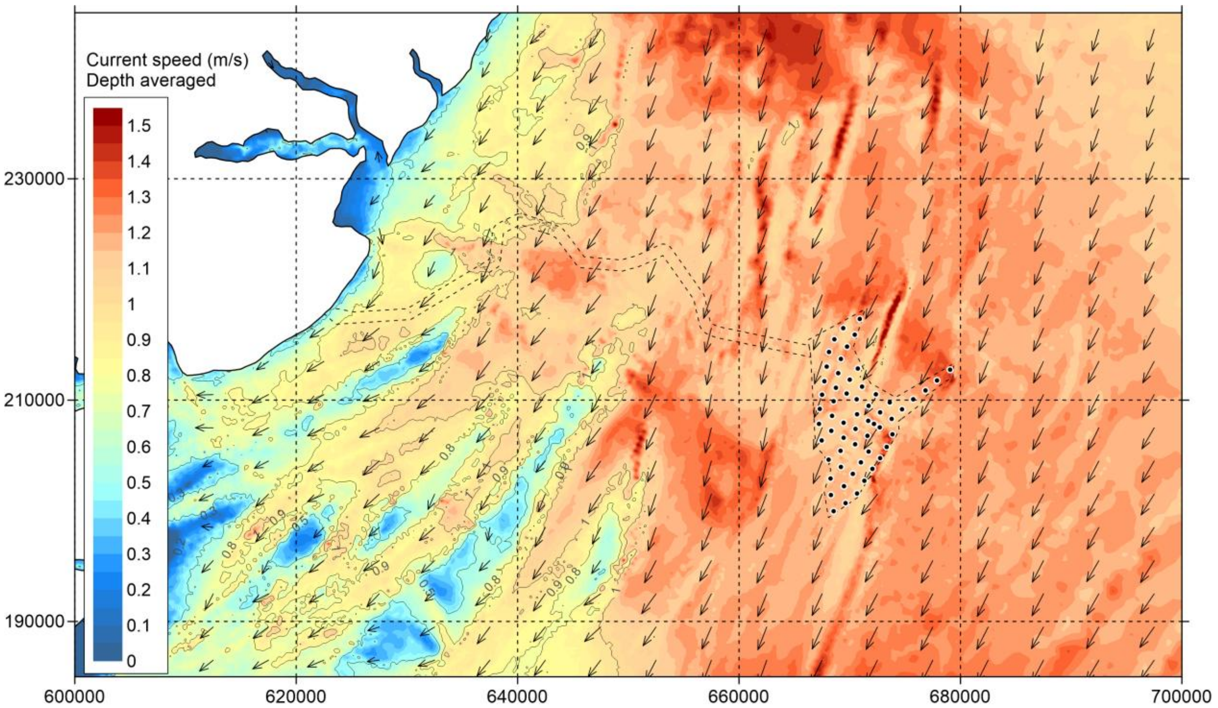


Figure 5-28 Option - Current speed during spring tide - peak flood.

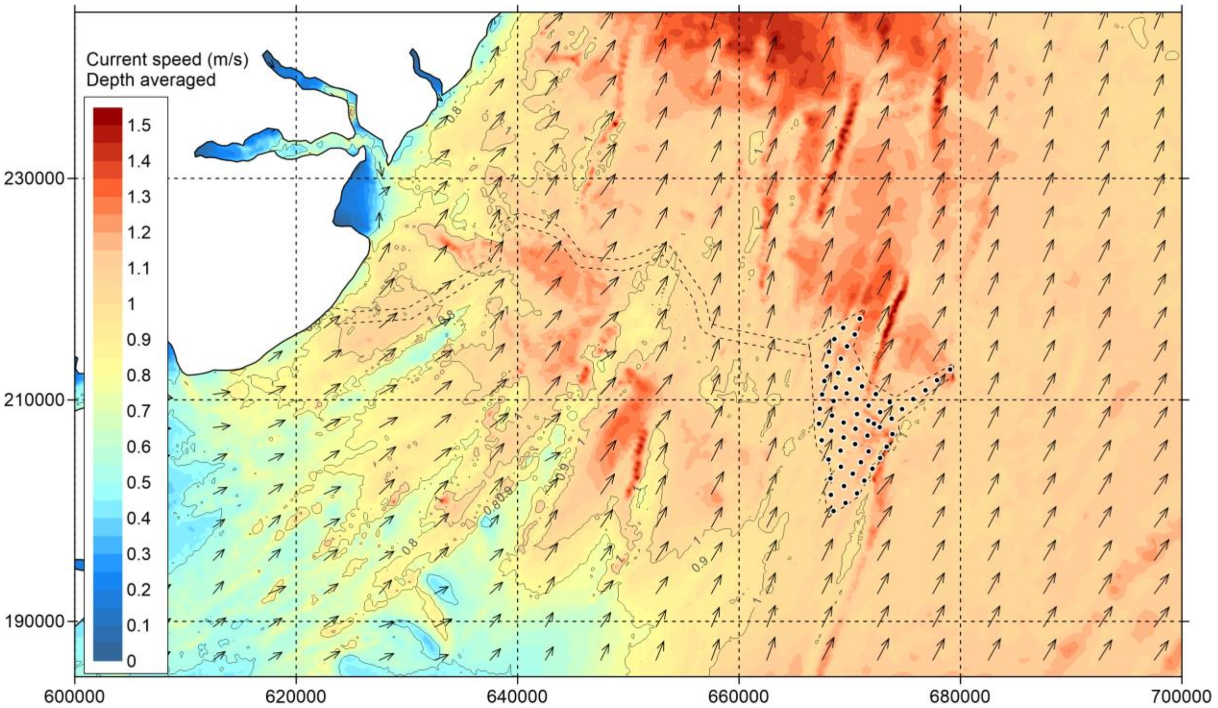


Figure 5-29 Option - Current speed during spring tide - peak ebb

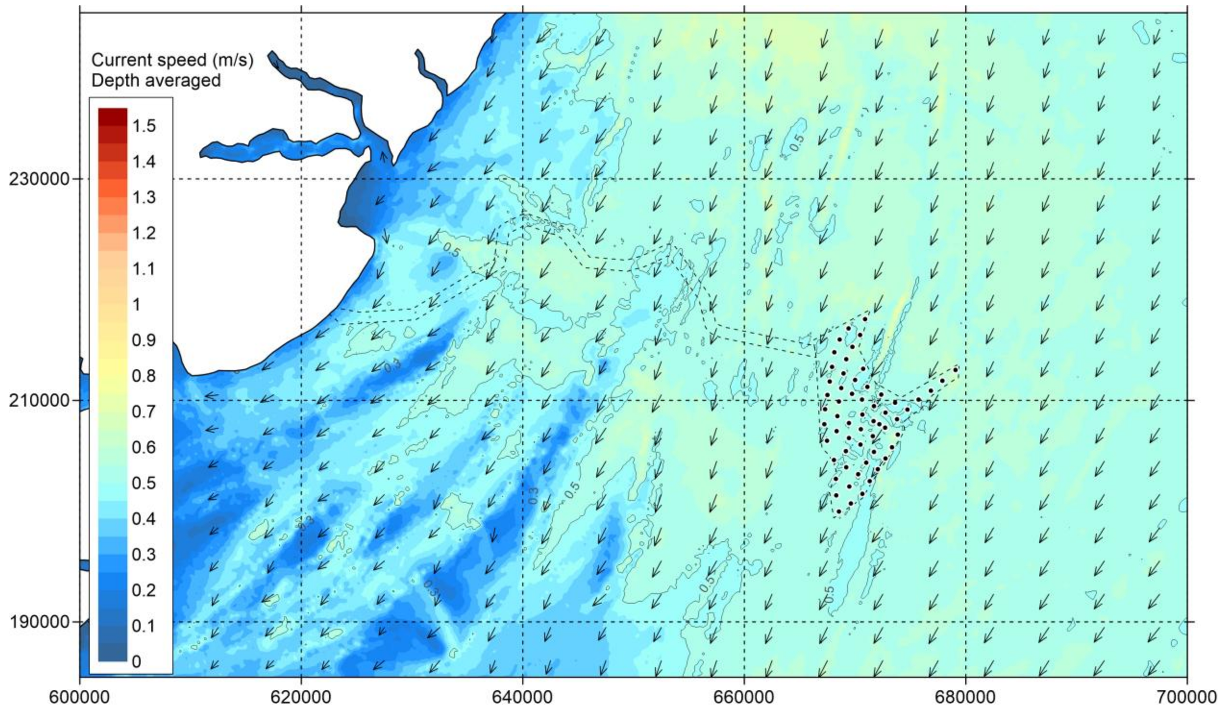


Figure 5-30 Option - Current speed during neap tide - peak flood.

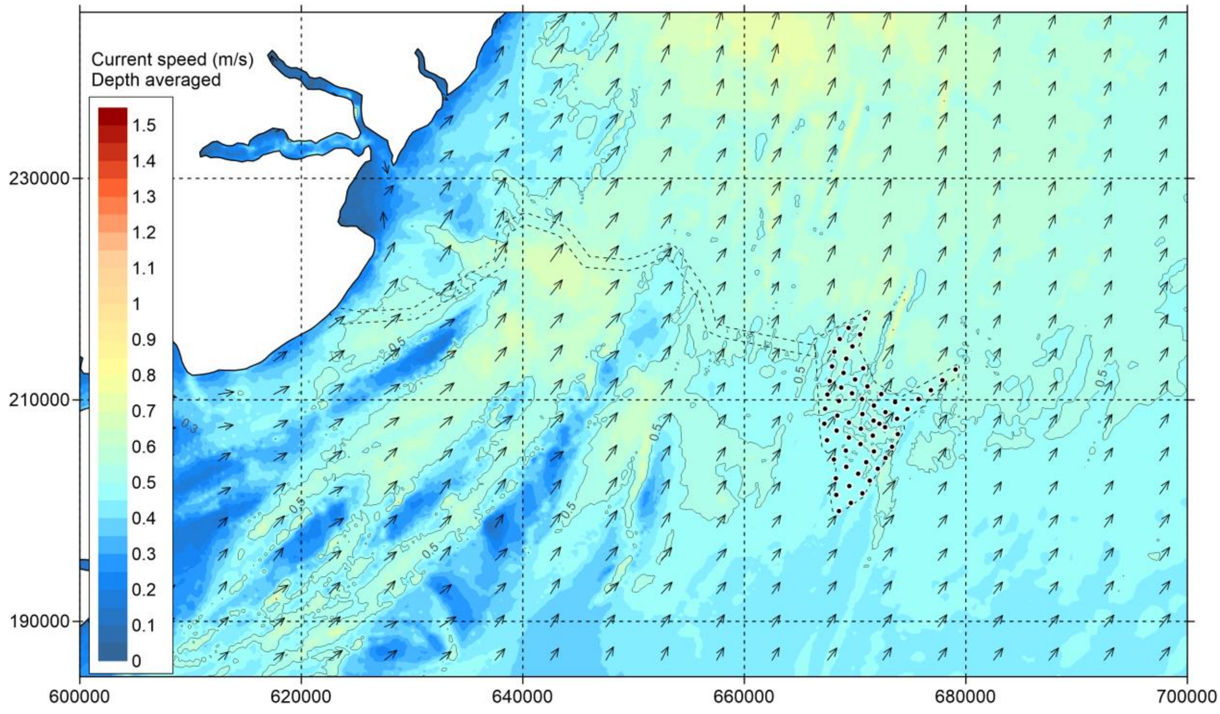


Figure 5-31 Option - Current speed during neap tide - peak ebb.

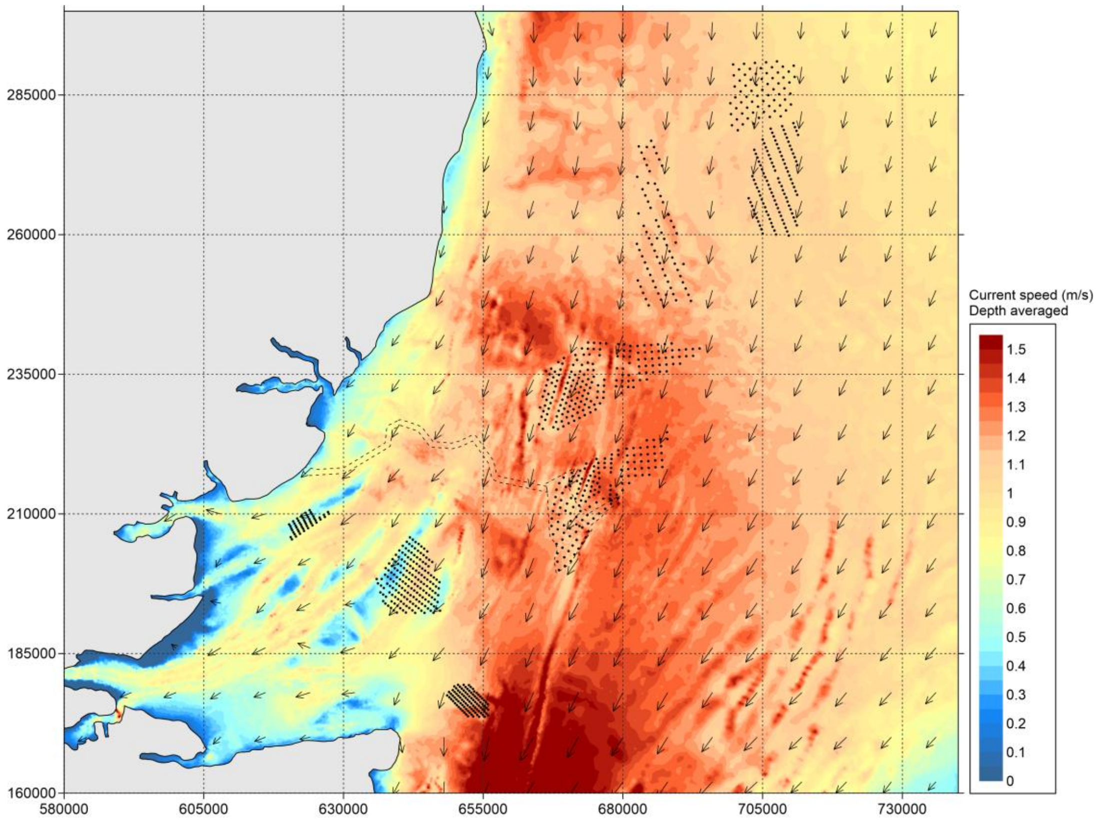


Figure 5-32 All windfarms ('Cumulative') - Current speed during spring tide - peak flood.

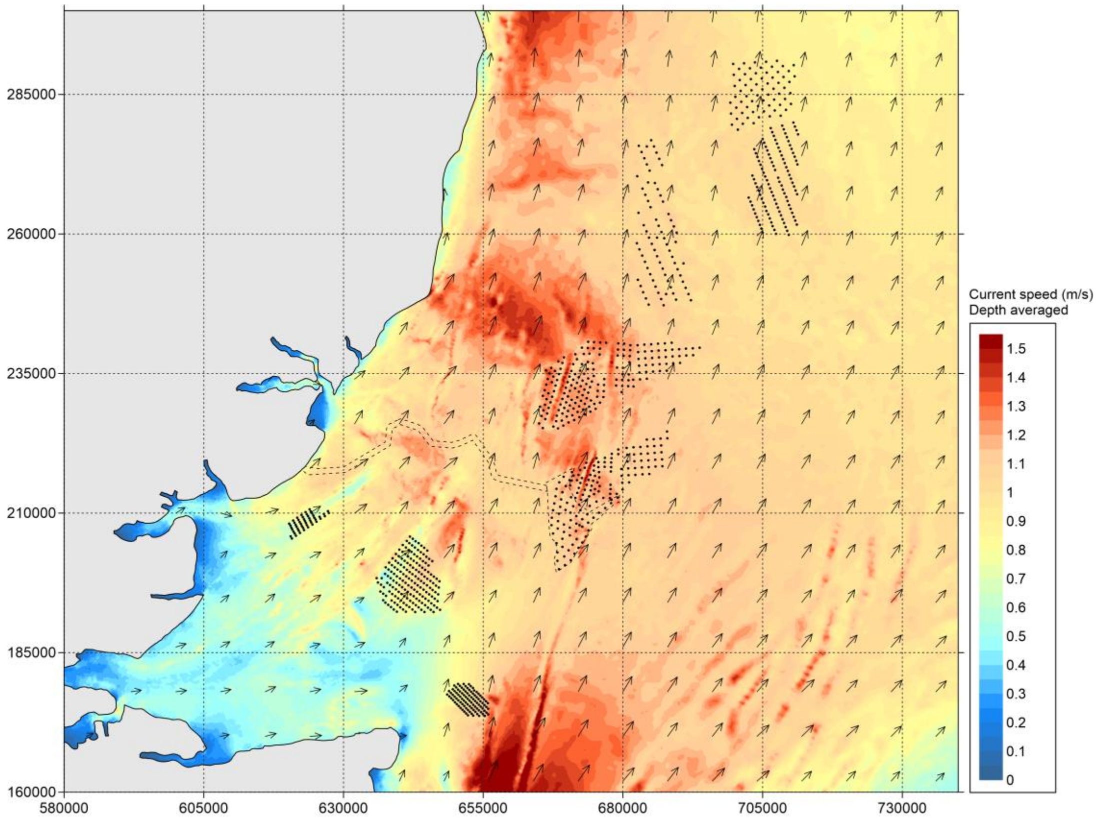


Figure 5-33 All windfarms ('Cumulative') - Current speed during spring tide - peak ebb.

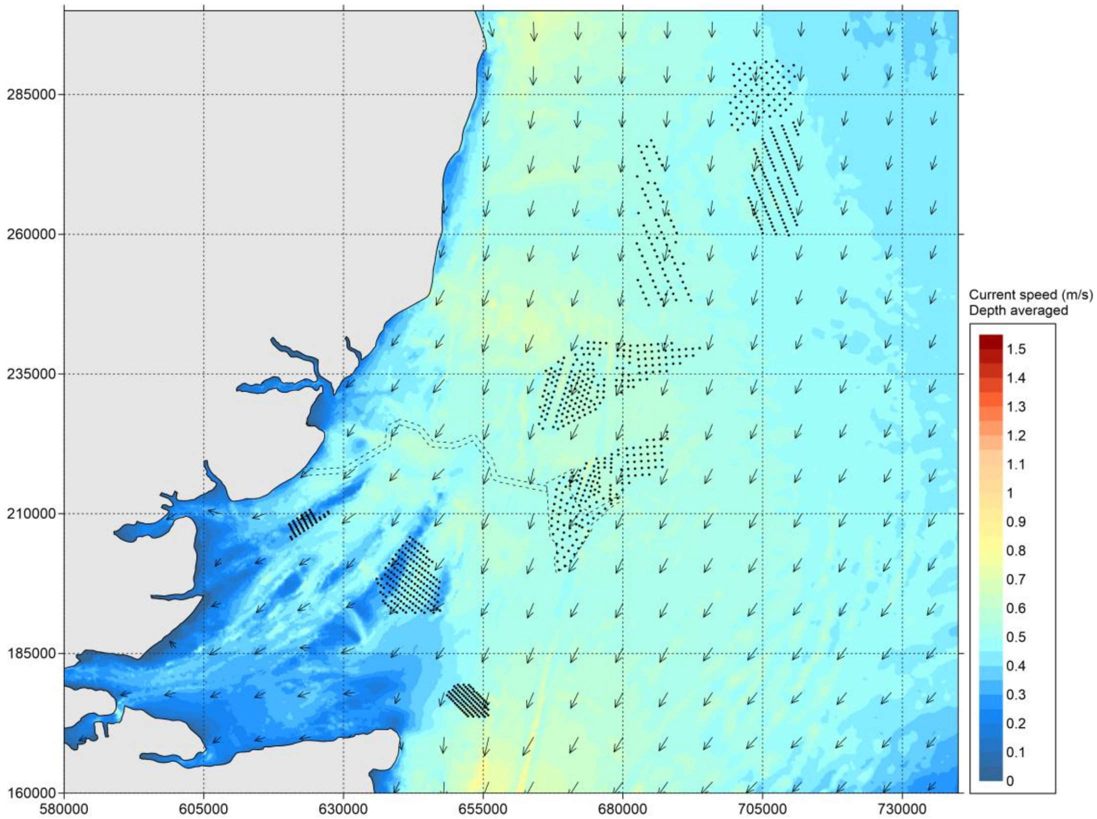


Figure 5-34 All windfarms ('Cumulative') - Current speed during neap tide - peak flood.

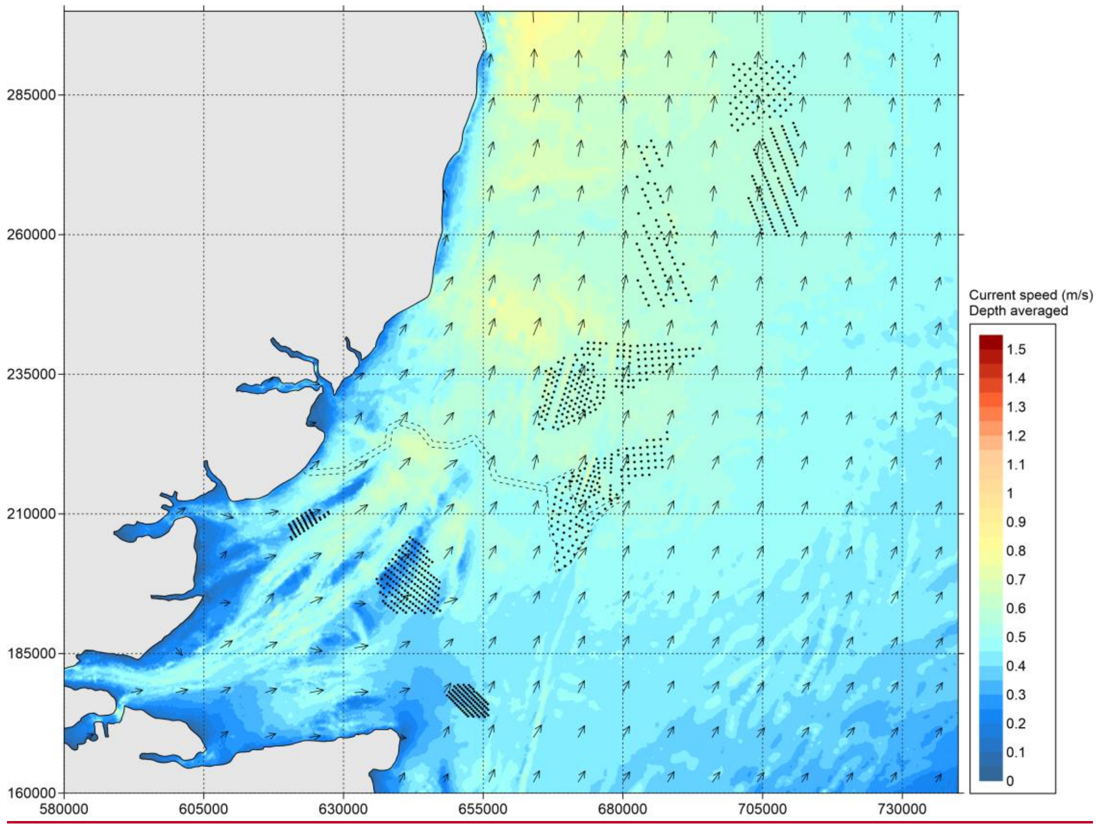


Figure 5-35 All windfarms ('Cumulative') - Current speed during neap tide - peak ebb.

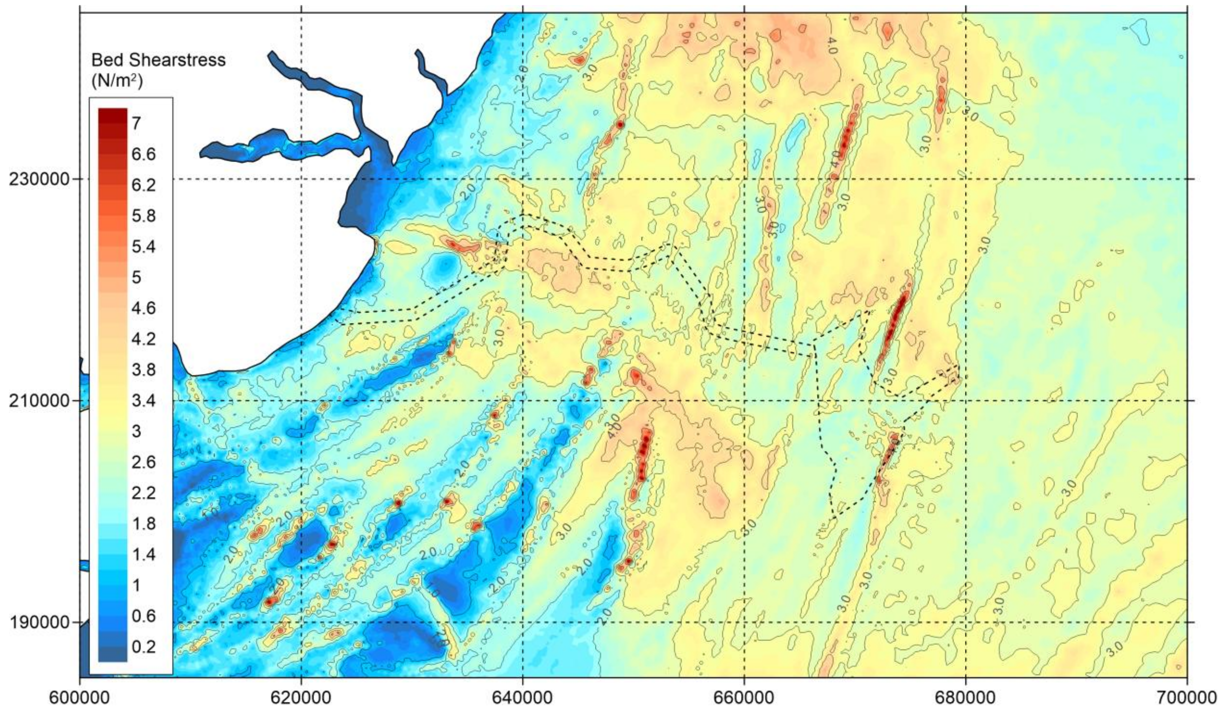


Figure 5-36 Baseline – Bed shear stress during spring tide - peak flood (zoomed in).

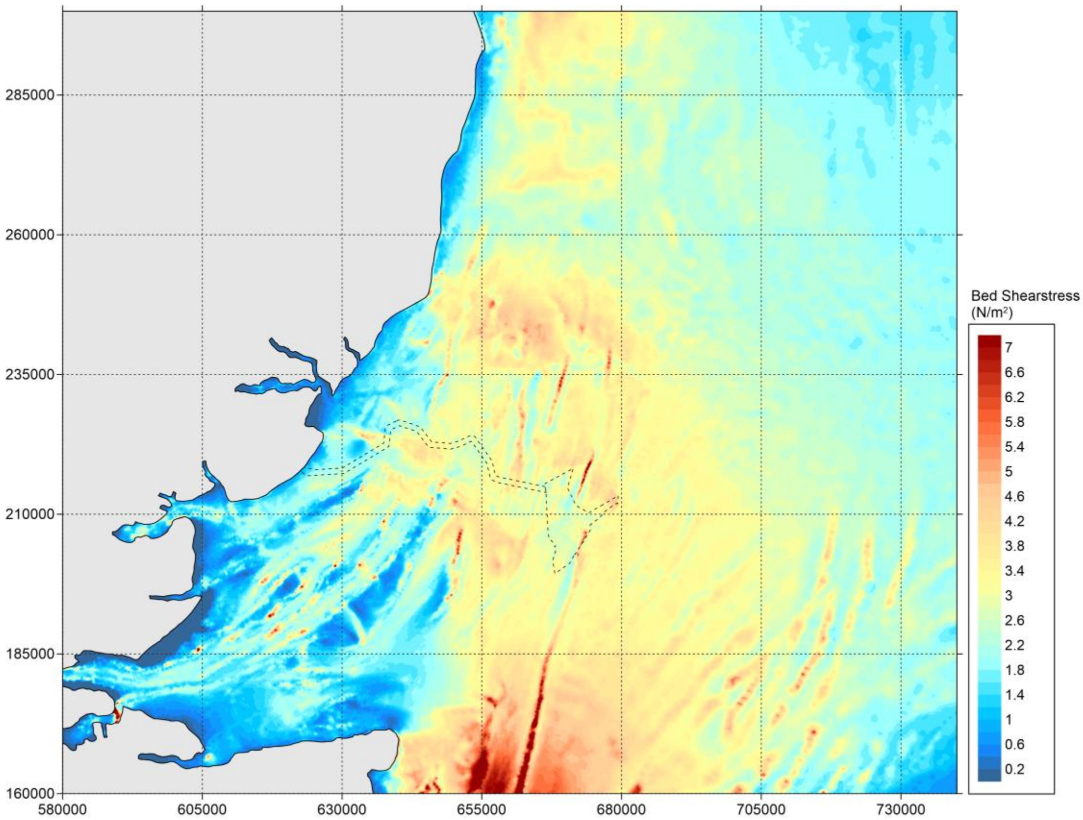


Figure 5-37 **Baseline – Bed shear stress during spring tide - peak flood (zoomed out).**

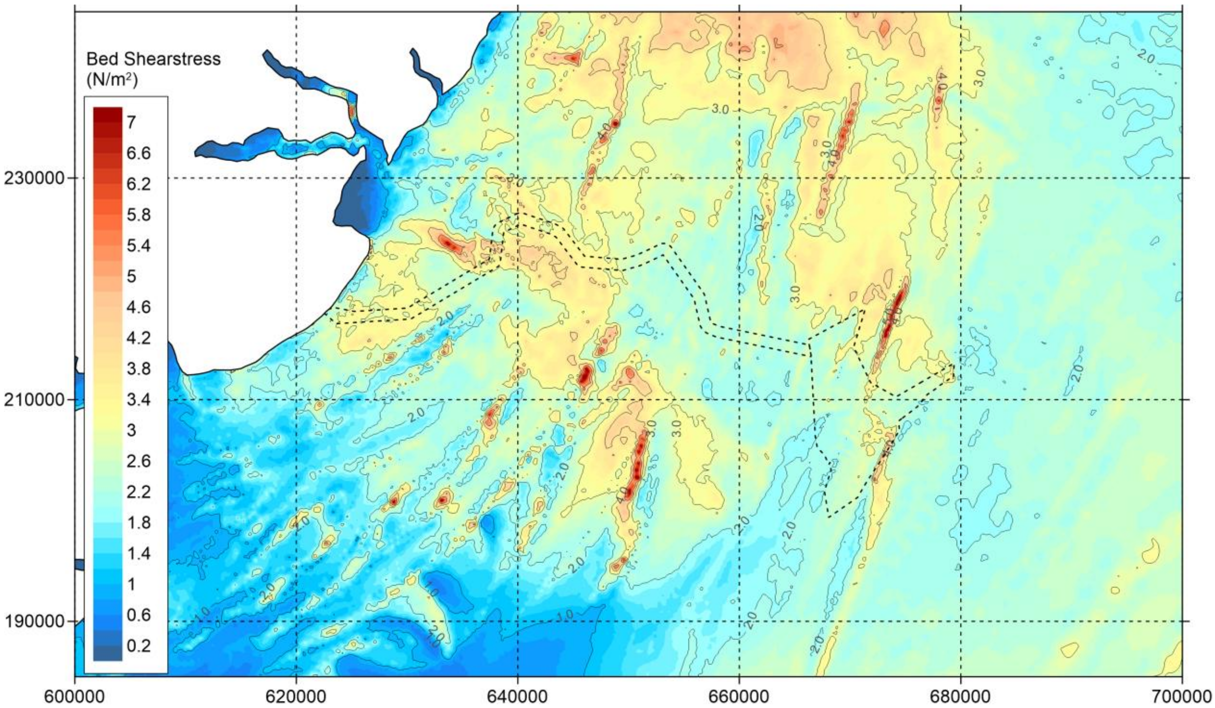


Figure 5-38 **Baseline – Bed shear stress during spring tide - peak ebb (zoomed in).**

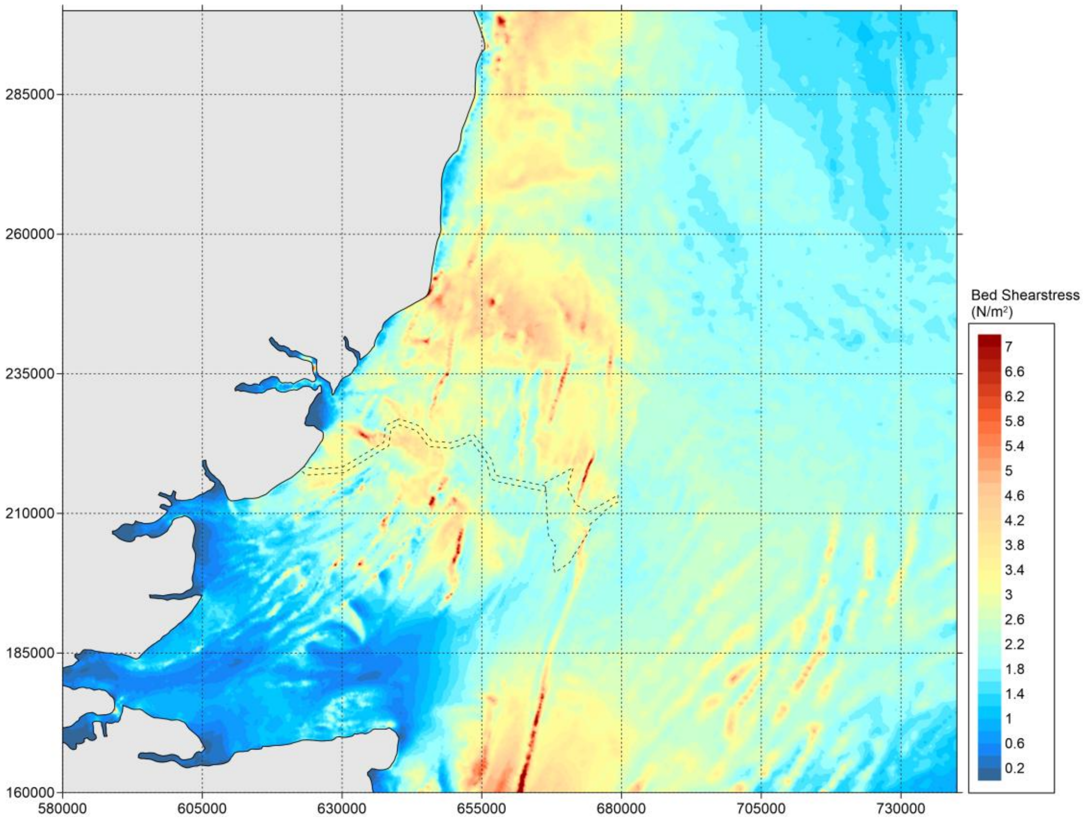


Figure 5-39 Baseline – Bed shear stress during spring tide - peak ebb (zoomed out).

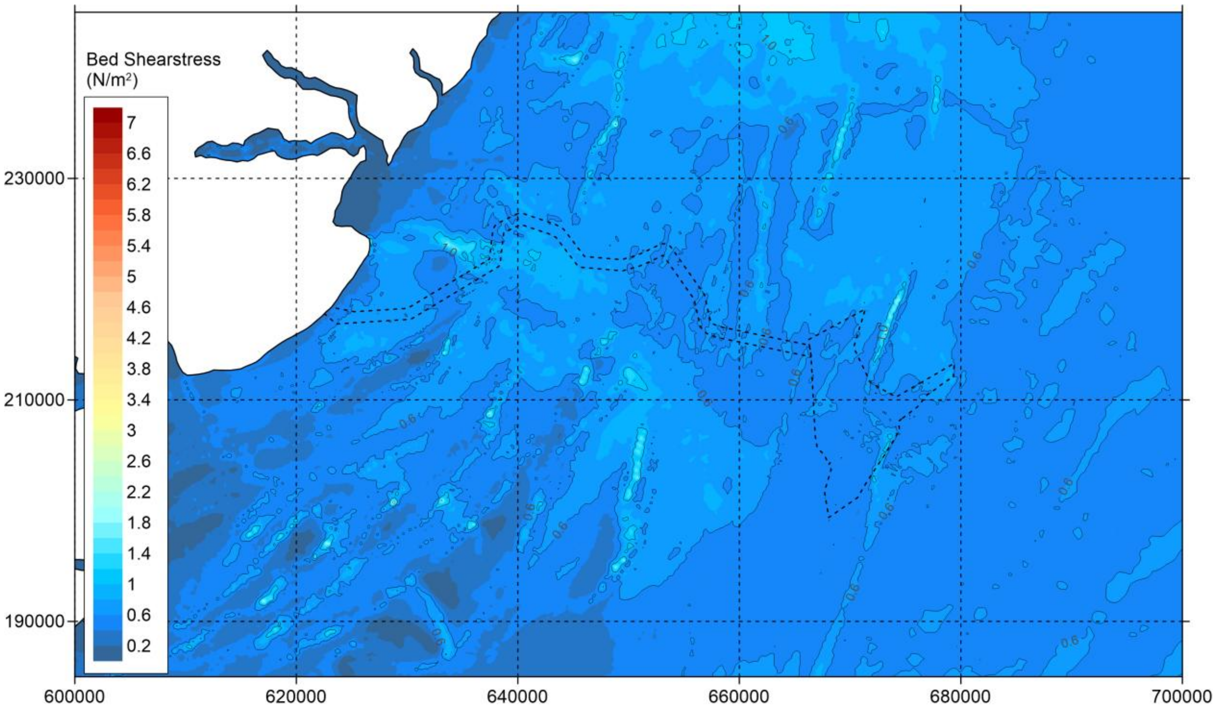


Figure 5-40 Baseline – Bed shear stress during neap~~spring~~ tide - peak flood (zoomed in).

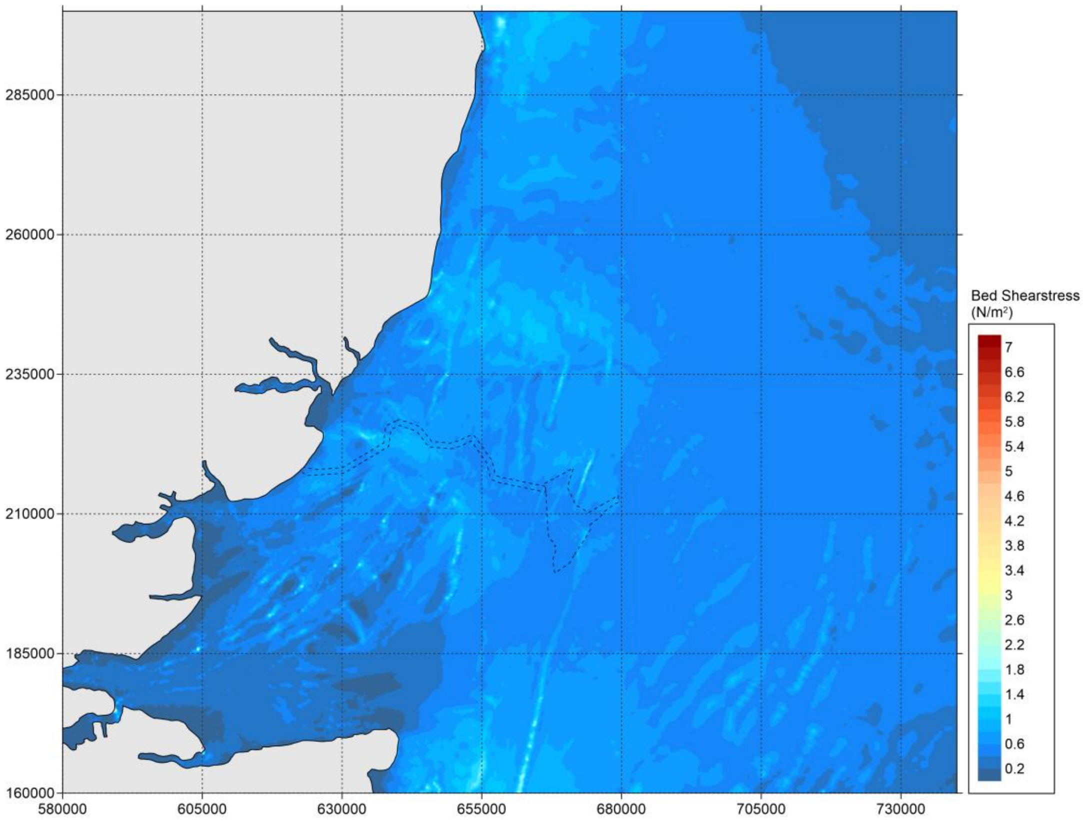


Figure 5-41 Baseline – Bed shear stress during neap tide - peak flood (zoomed out)

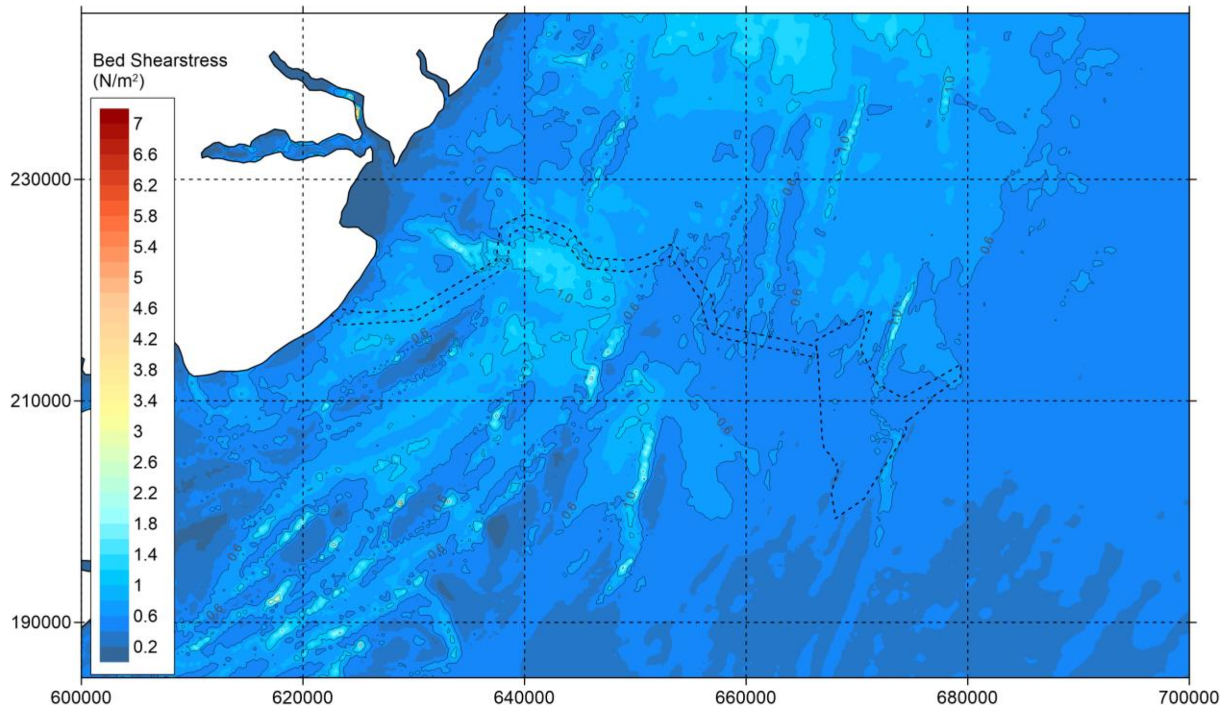


Figure 5-42 Baseline – Bed shear stress during ~~spring~~neap tide - peak ebb~~flood~~ (zoomed in).

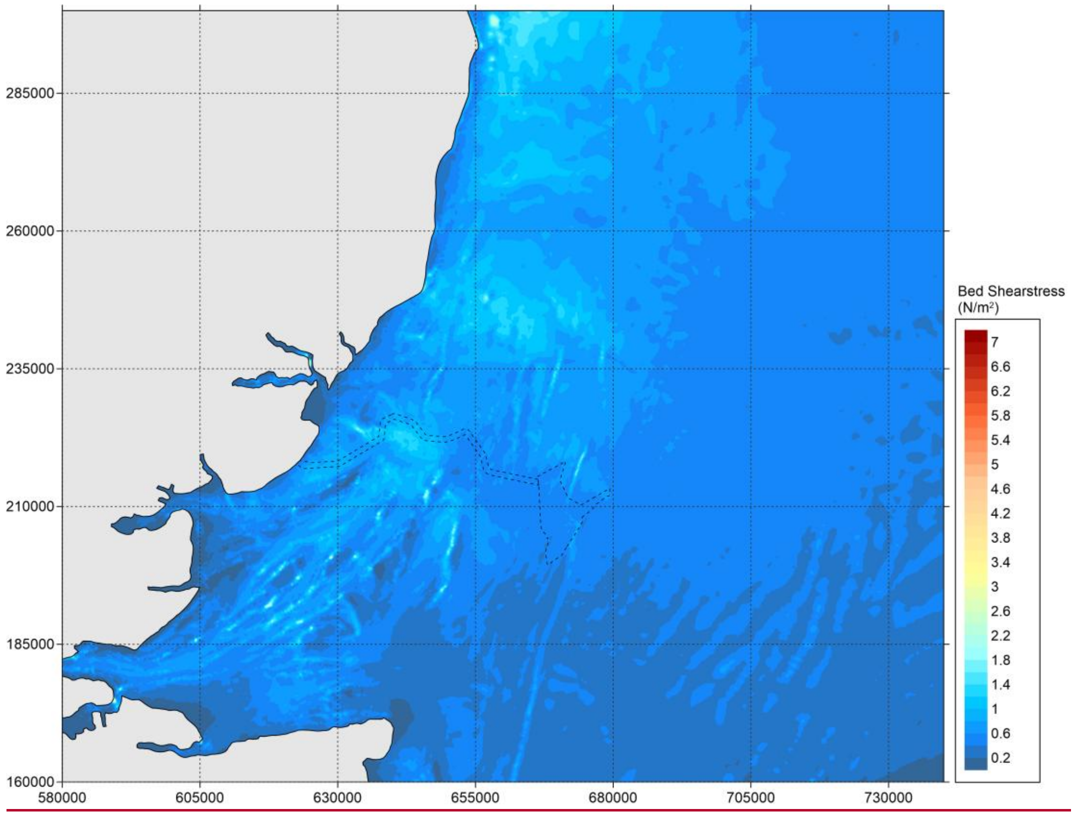


Figure 5-43 Baseline – Bed shear stress during neap tide - peak ebb (zoomed out).

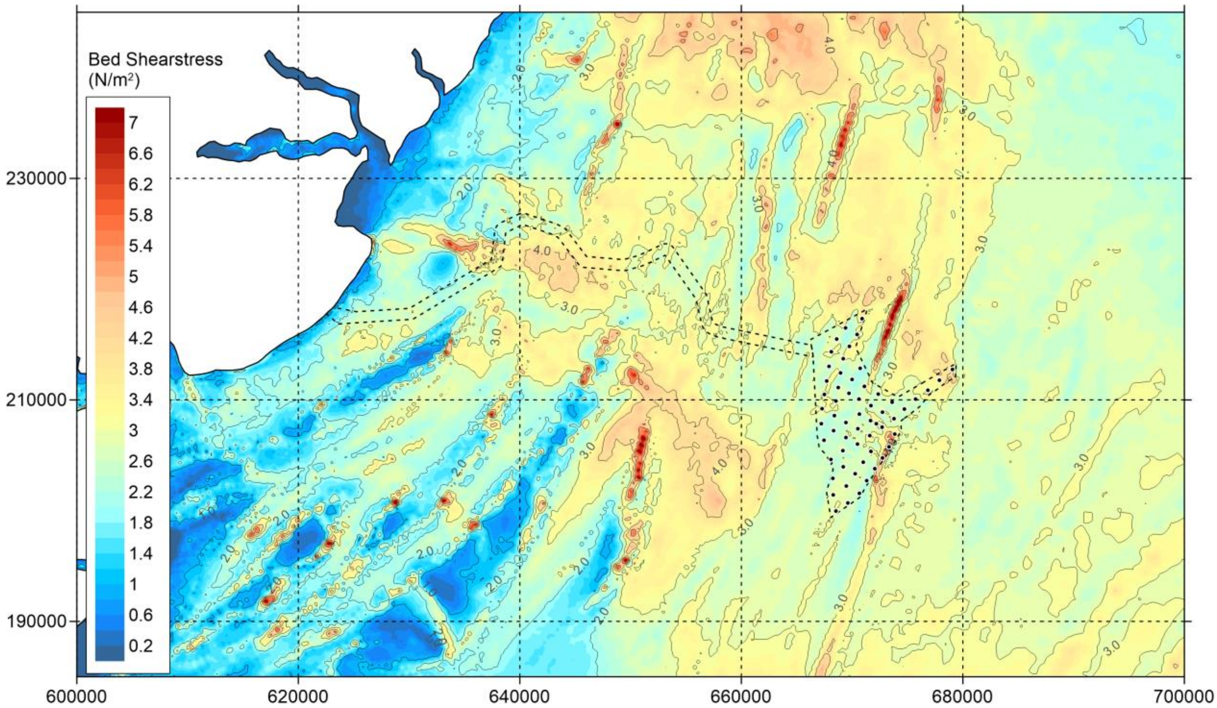


Figure 5-44 Option – Bed shear stress during spring tide - peak flood.

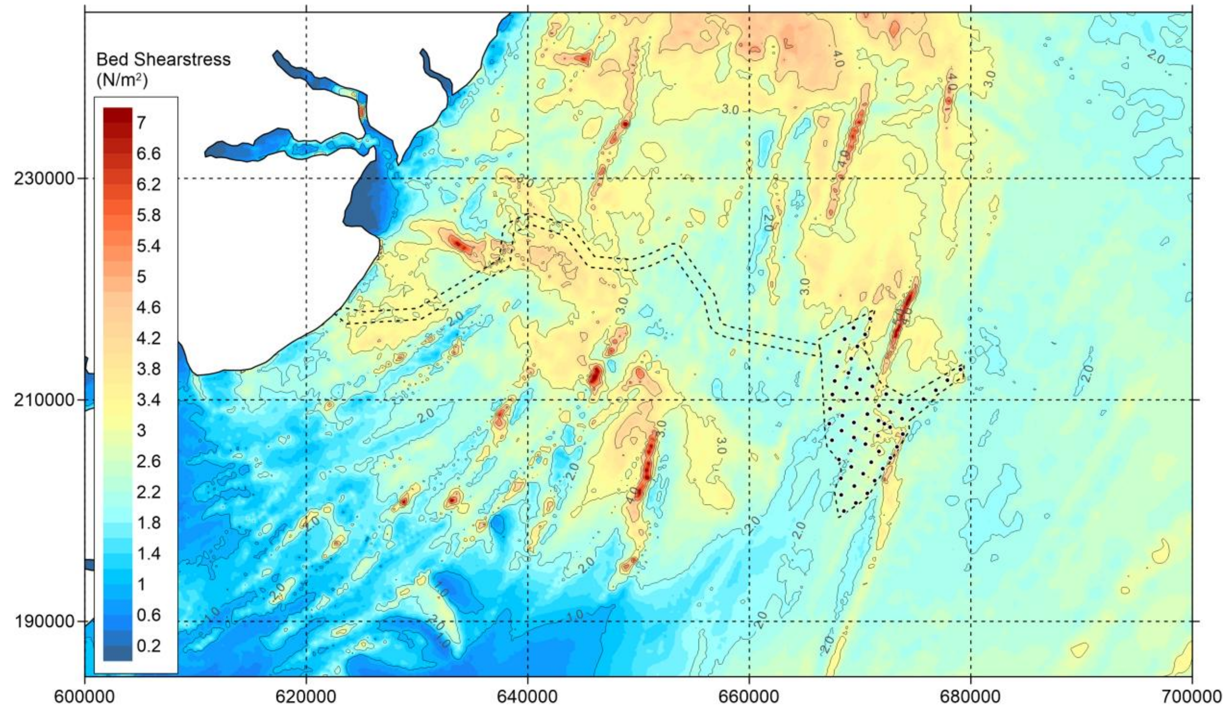


Figure 5-45 Option – Bed shear stress during spring tide - peak ebb.

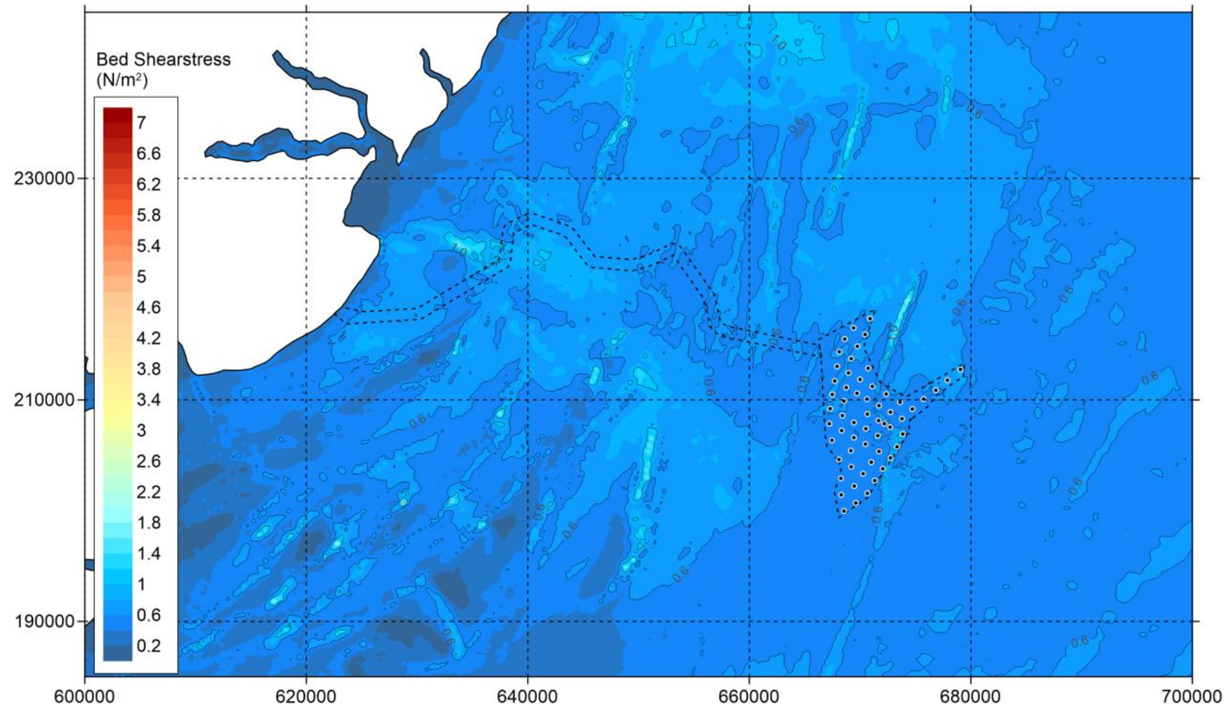


Figure 5-46 Option – Bed shear stress during neap tide - peak flood.

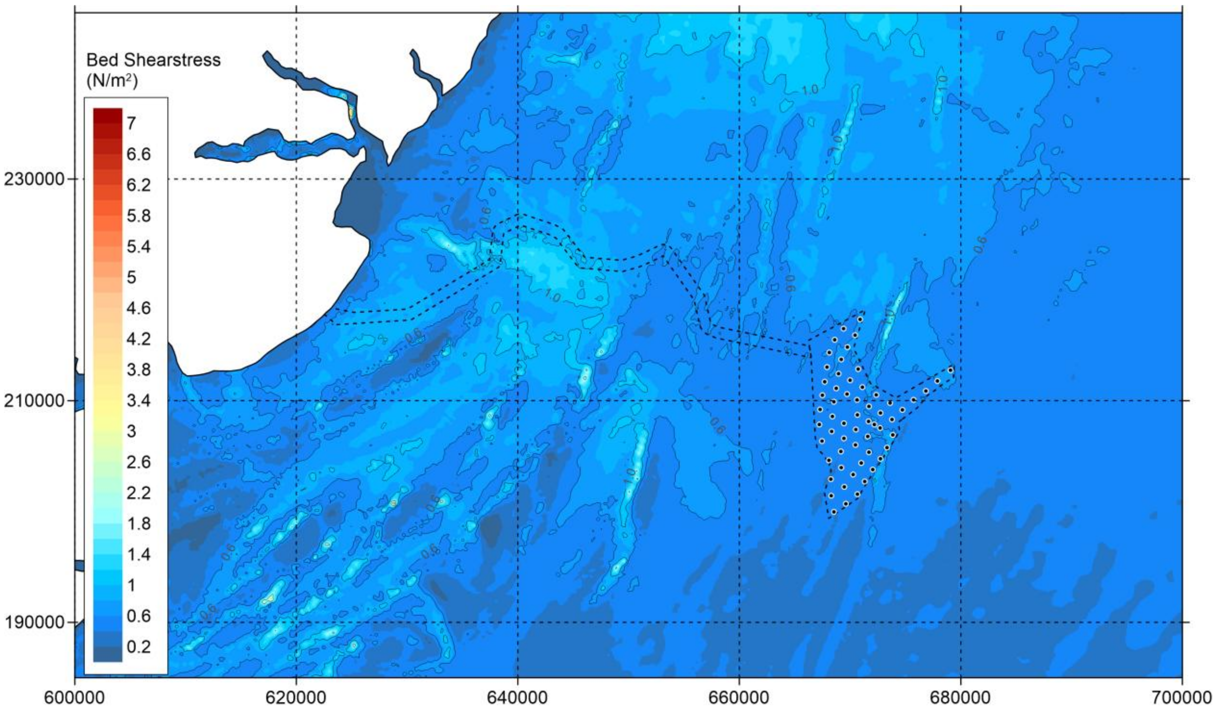


Figure 5-47 Option – Bed shear stress during neap tide - peak ebb~~flood~~.

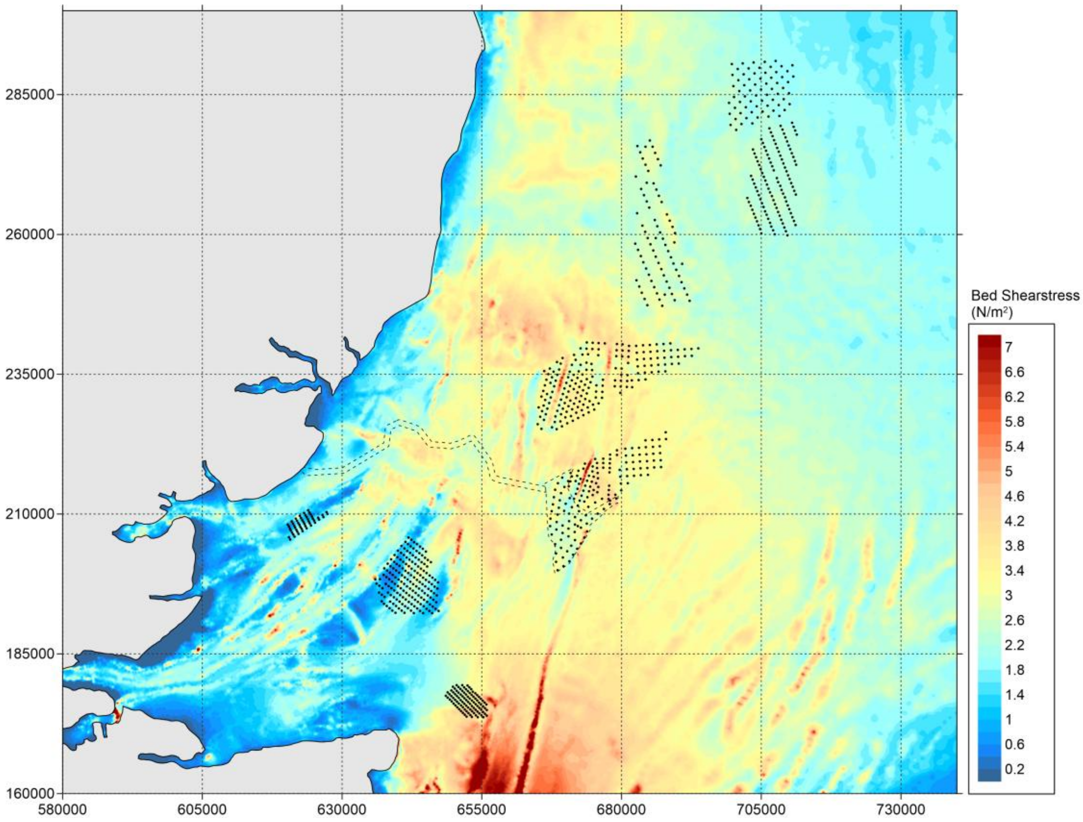


Figure 5-48 All windfarms ('Cumulative') – Bed shear stress during spring tide - peak flood.

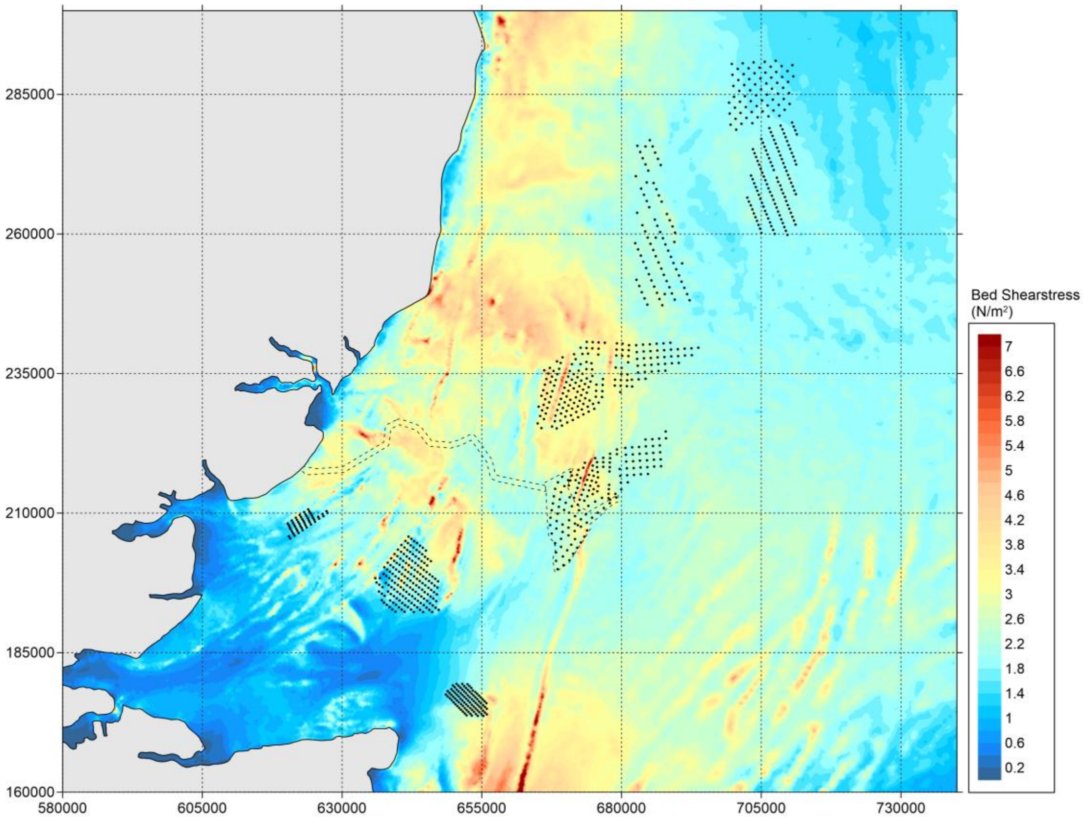


Figure 5-49 All windfarms ('Cumulative') – Bed shear stress during spring tide – peak ebb

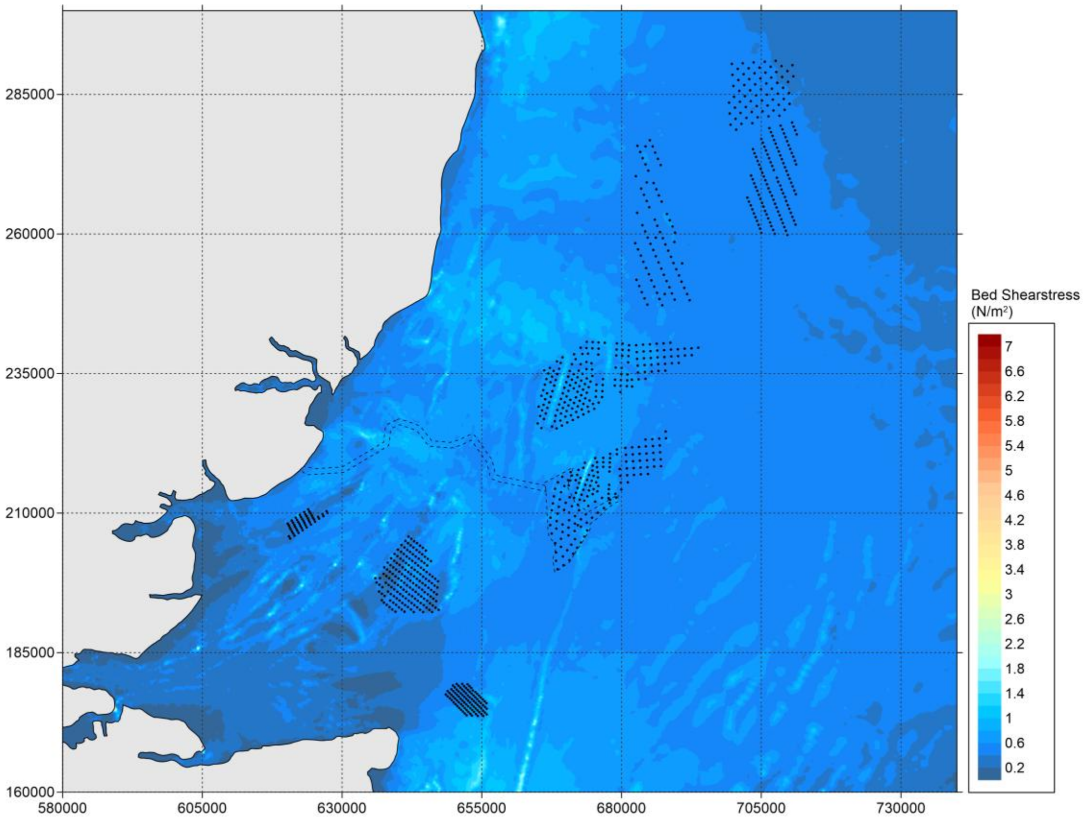


Figure 5-50 All windfarms ('Cumulative') – Bed shear stress during neap tide – peak flood.

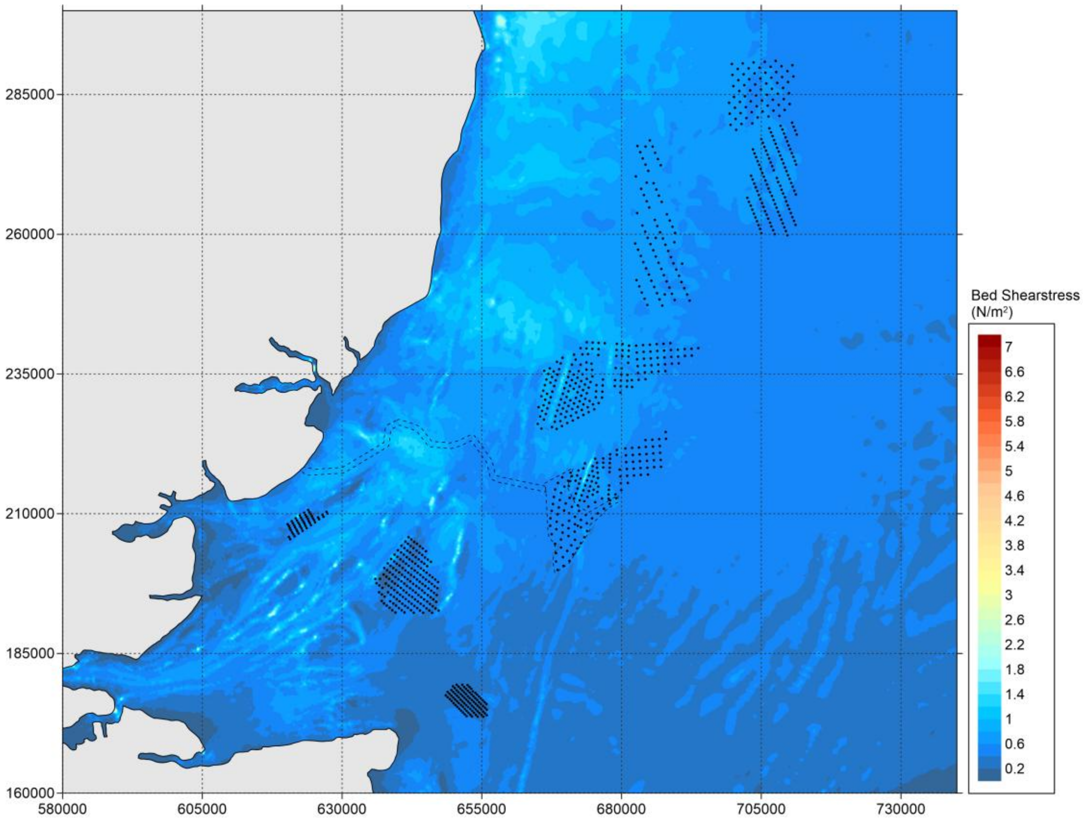


Figure 5-51 All windfarms ('Cumulative') – Bed shear stress during neap tide – peak ebb.

5.4.35.4.5 Figure 5-52 and Figure 5-53 and present the difference in current speed in meters between the 'Baseline' and the 'Option' during a spring tide at peak flood and peak ebb, respectively.

5.4.45.4.6 Figure 5-54 and Figure 5-55 present the difference in current speed in percent between the 'Baseline' and the 'Option' during a spring tide at peak flood and peak ebb, respectively. Where the lowest visible contour band is 0.3%.

5.4.55.4.7 Figure 5-56 and Figure 5-57 and Figure 4.39 present the difference in current speed in meters between the 'Baseline' and the 'Option' during a neap tide at peak flood and peak ebb, respectively.

5.4.65.4.8 Figure 5-58 and Figure 5-59 and Figure 4.41 present the difference in current speed in percent between the 'Baseline' and the 'Option' during a neap tide at peak flood and peak ebb, respectively. Where the lowest visible contour band is 0.3%.

5.4.75.4.9 Figure 5-60 and Figure 5-61 and Figure 4.43 present the difference in bed shear stress in Newtons/Square Meter between the 'Baseline' and the 'Option' during a spring tide at peak flood and peak ebb, respectively.

5.4.85.4.10 Figure 5-62 and Figure 5-63 and Figure 4.45 present the difference in bed shear stress in percent between the 'Baseline' and the 'Option' during a spring tide at peak flood and peak ebb, respectively. Where the lowest visible contour band is 0.3%.

5.4.95.4.11 Figure 5-64 and Figure 5-65 and present the difference in bed shear stress in Newtons/Square Meter between the ‘Baseline’ and the ‘Option’ during a neap tide at peak flood and peak ebb, respectively.

5.4.105.4.12 Figure 5-66 and Figure 5-67 and Figure 4.49 present the difference in bed shear stress in percent between the ‘Baseline’ and the ‘Option’ during a neap tide at peak flood and peak ebb, respectively. -Where the lowest visible contour band is 0.3%.

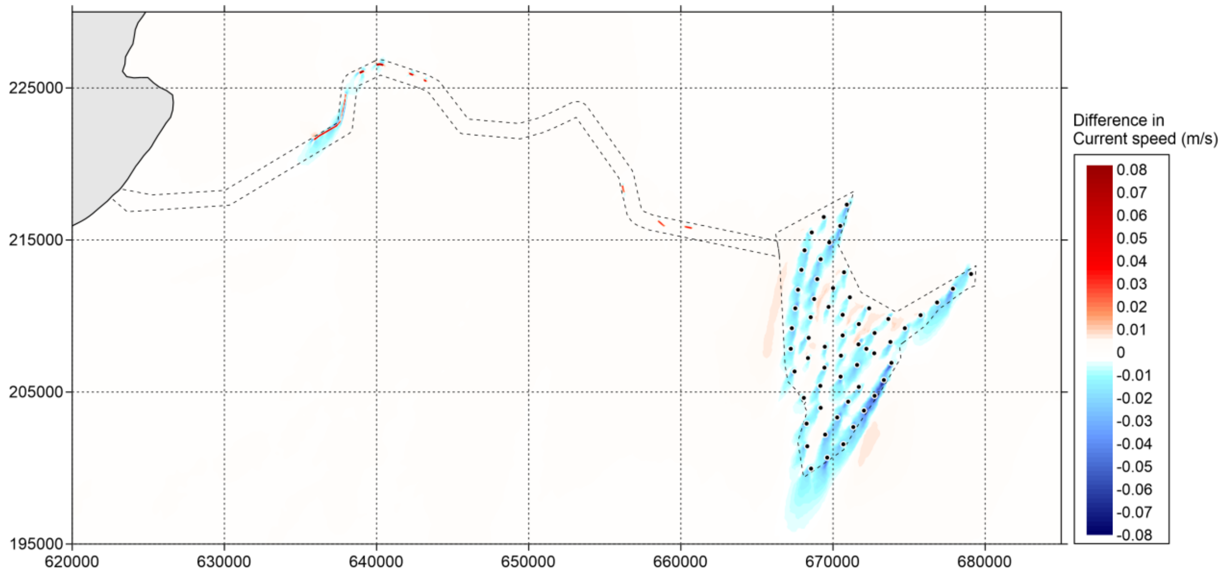


Figure 5-525-52 Difference in current speed (in metres/second) between ‘Baseline’ and ‘Option’ during spring tide (positive means increase of current speed by option and vice versa) – peak flood

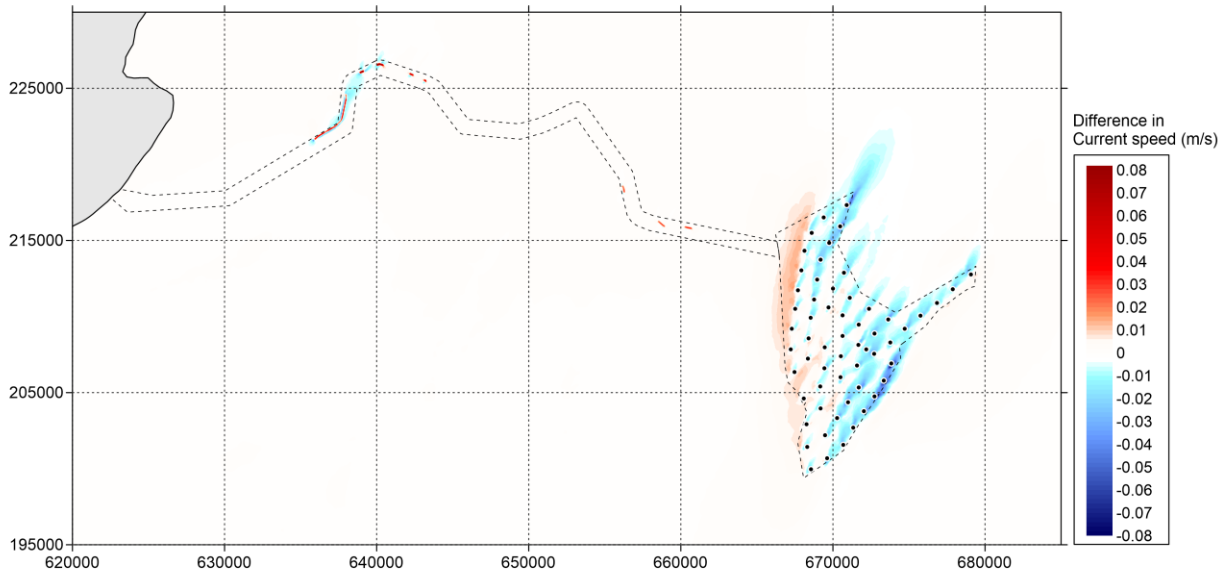


Figure 5-535-53 Difference in current speed (in metres/second) between 'Baseline' and 'Option' during spring tide (positive means increase of current speed by option and vice versa) – peak ebb

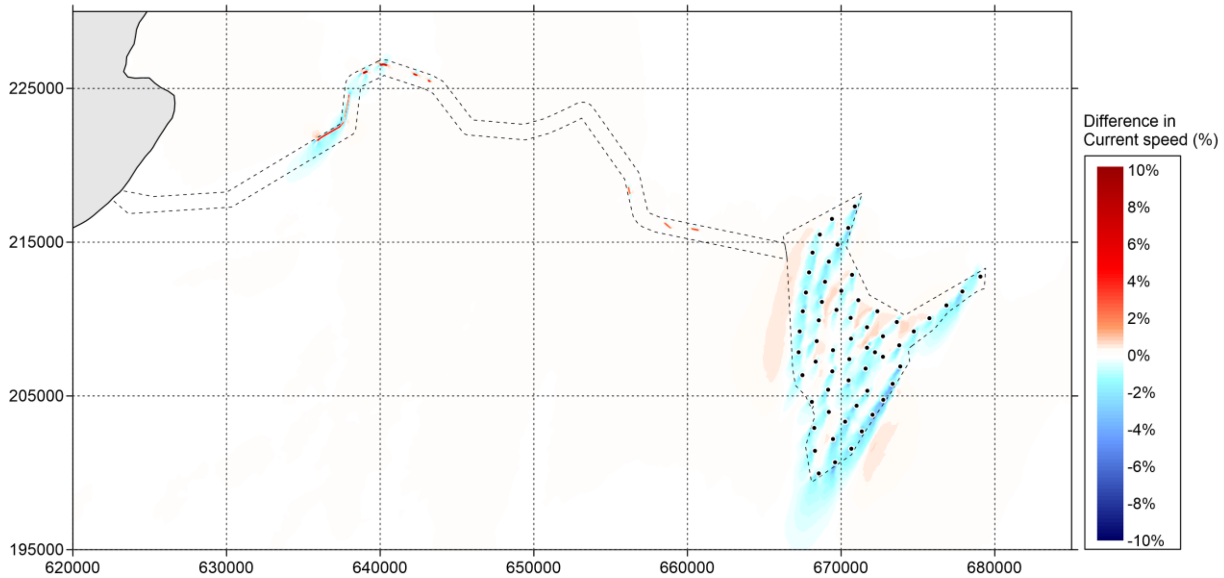


Figure 5-545-54 Difference in current speed (in percent) between 'Baseline' and 'Option' during spring tide (positive means increase of current speed by option and vice versa) – peak flood

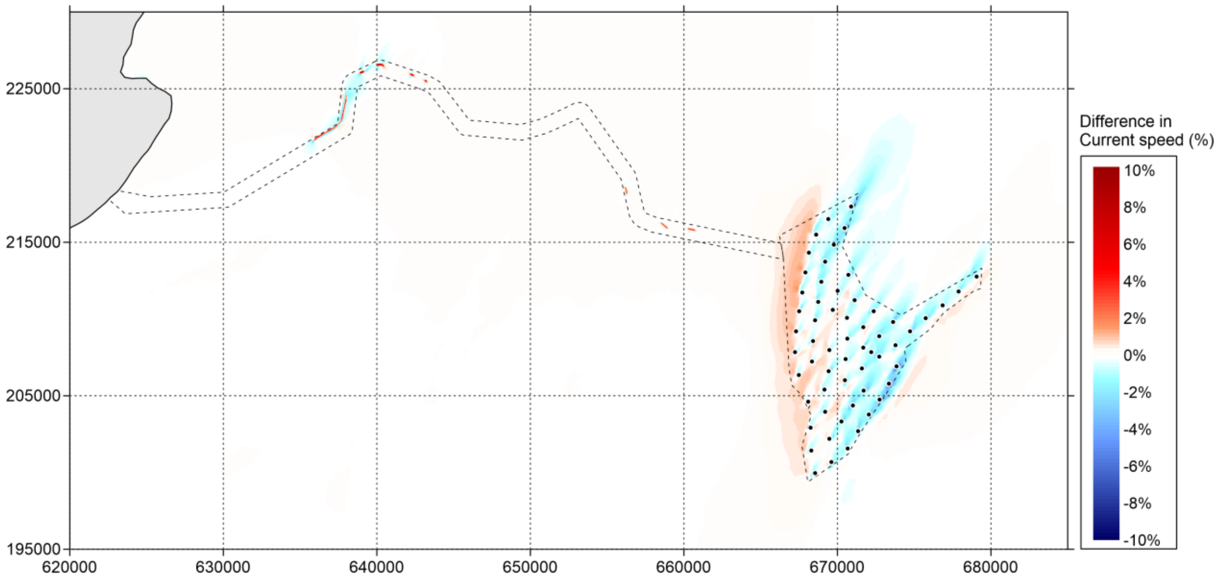


Figure 5-555-55 Difference in current speed (in percent) between 'Baseline' and 'Option' during spring tide (positive means increase of current speed by option and vice versa) – peak ebb

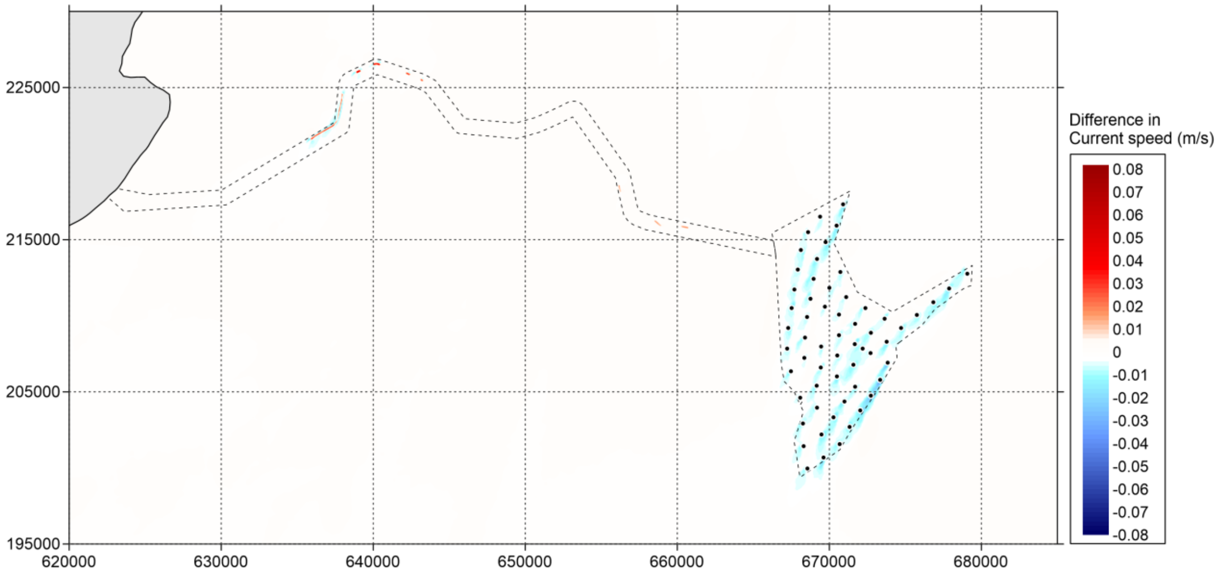


Figure 5-565-56 Difference in current speed (in metres/second) between 'Baseline' and 'Option' during neap tide (positive means increase of current speed by option and vice versa) – peak flood

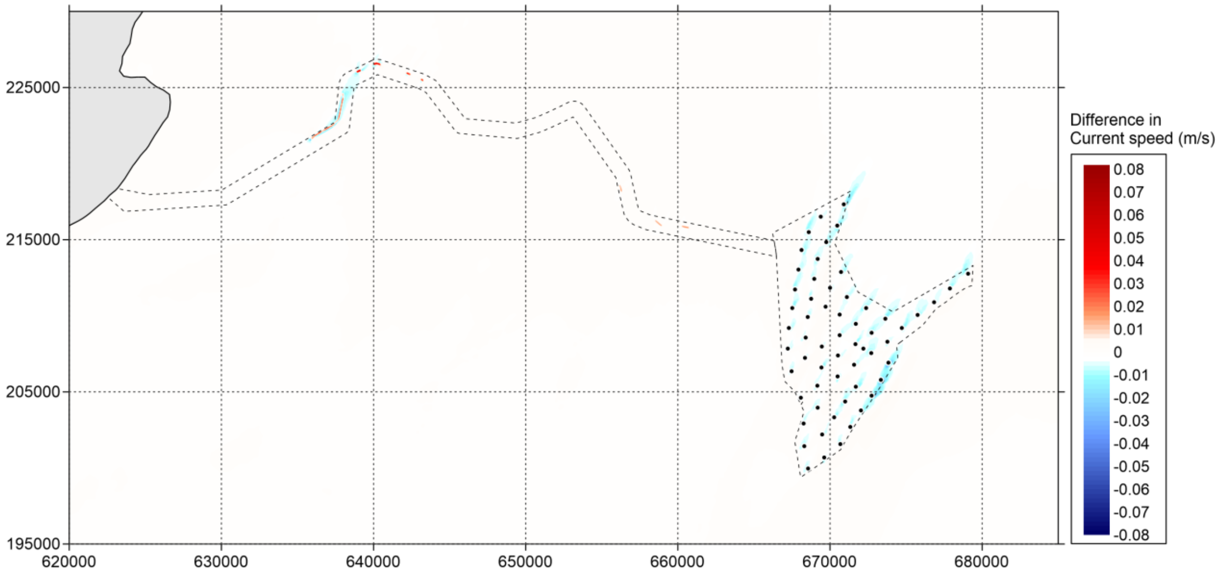


Figure 5-575-57 Difference in current speed (in metres/second) between 'Baseline' and 'Option' during neap tide (positive means increase of current speed by option and vice versa) – peak ebb

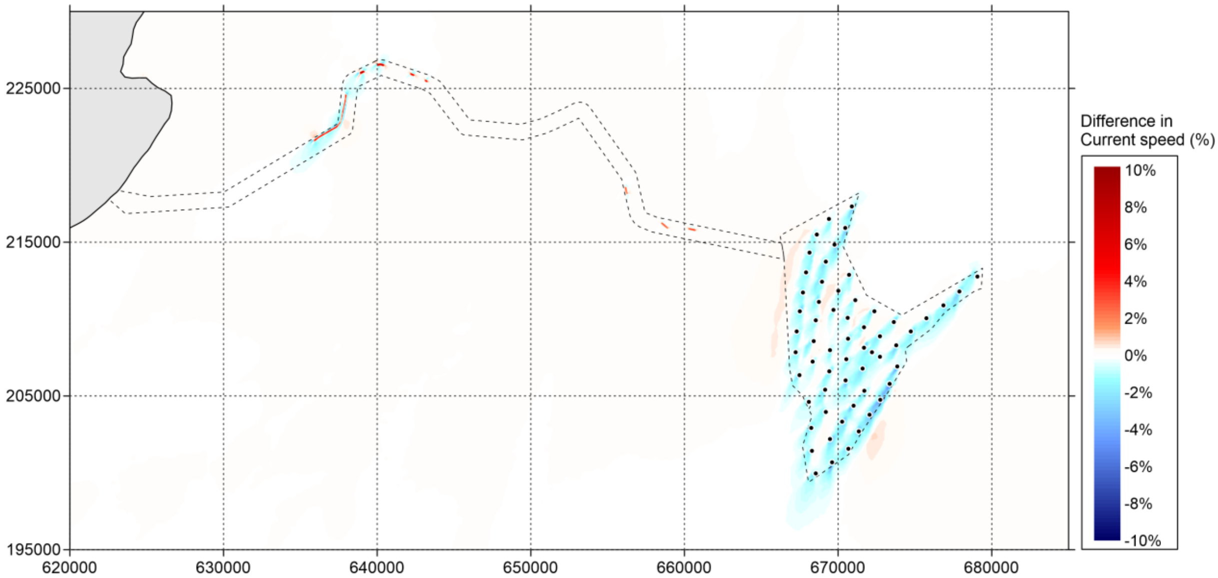


Figure 5-585-58 Difference in current speed (in percent) between 'Baseline' and 'Option' during neap tide (positive means increase of current speed by option and vice versa) – peak flood

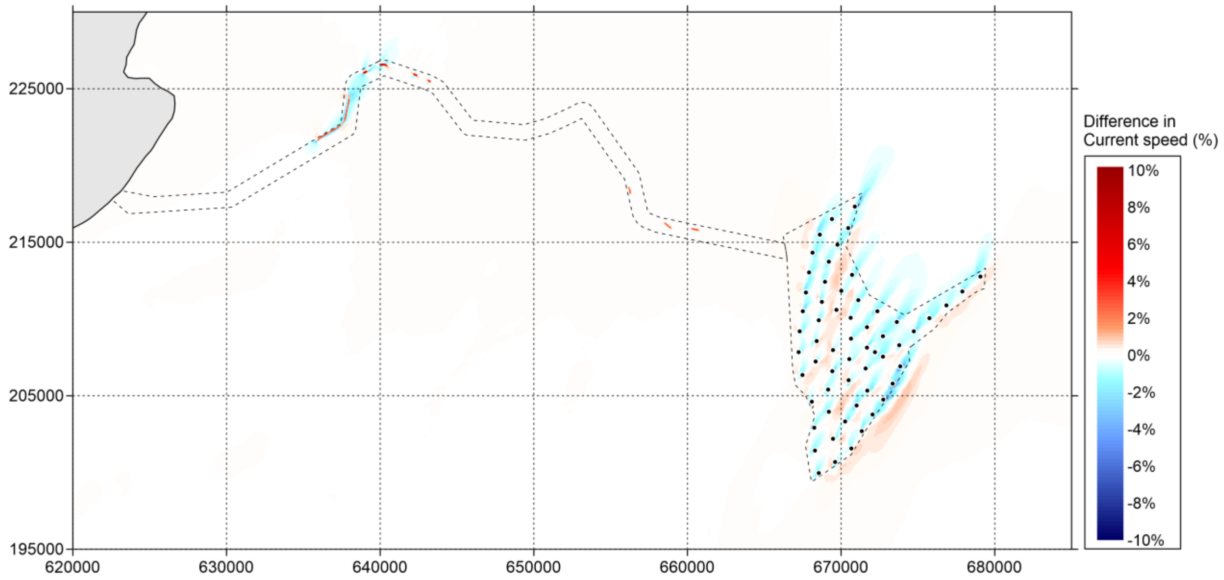


Figure 5-59~~5-59~~ Difference in current speed (in percent) between 'Baseline' and 'Option' during neap tide (positive means increase of current speed by option and vice versa) – peak ebb

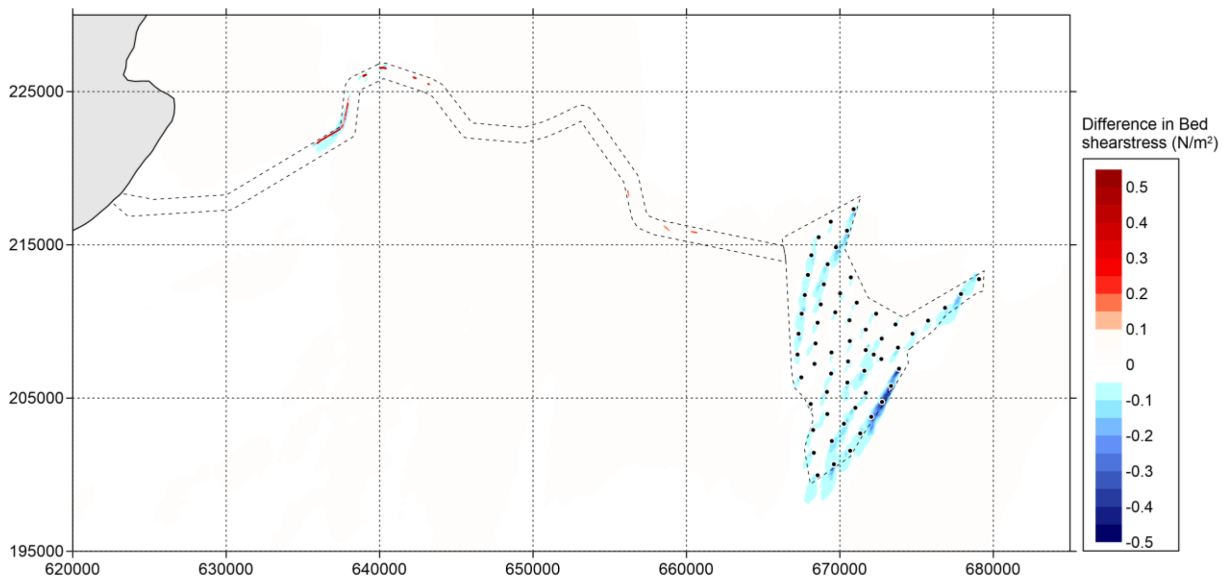


Figure 5-60~~5-605.~~ Difference in bed shear stress (in N/m^2) between 'Baseline' and 'Option' during spring tide (positive means increase of bed shear stress by option and vice versa) – peak flood

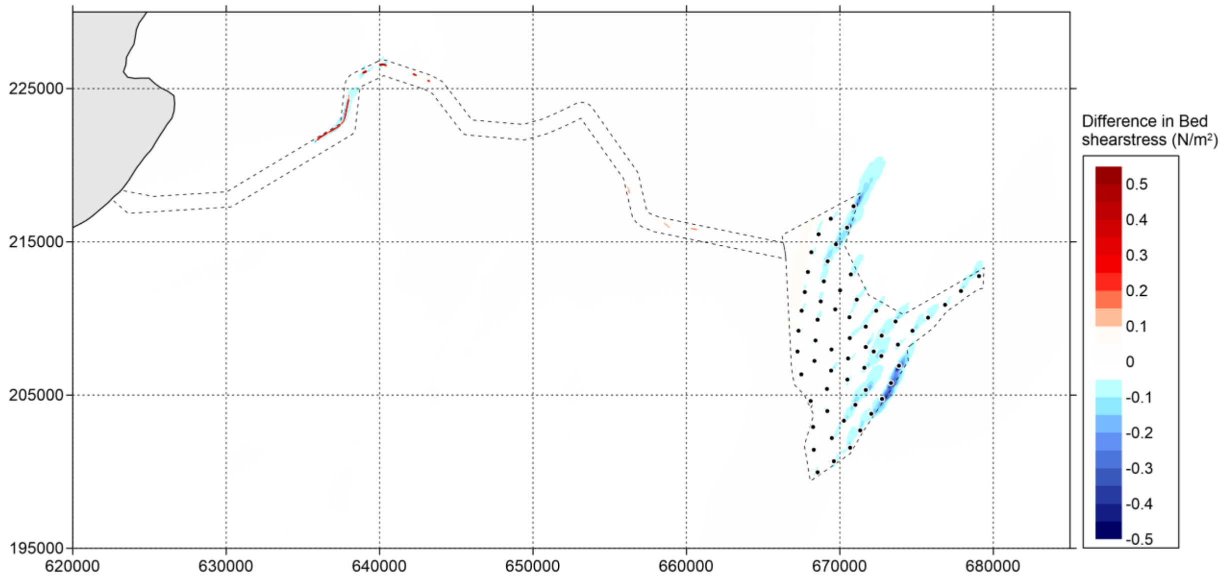


Figure 5-615-615. Difference in bed shear stress (in N/m^2) between 'Baseline' and 'Option' during spring tide (positive means increase of bed shear stress by option and vice versa) – peak ebb

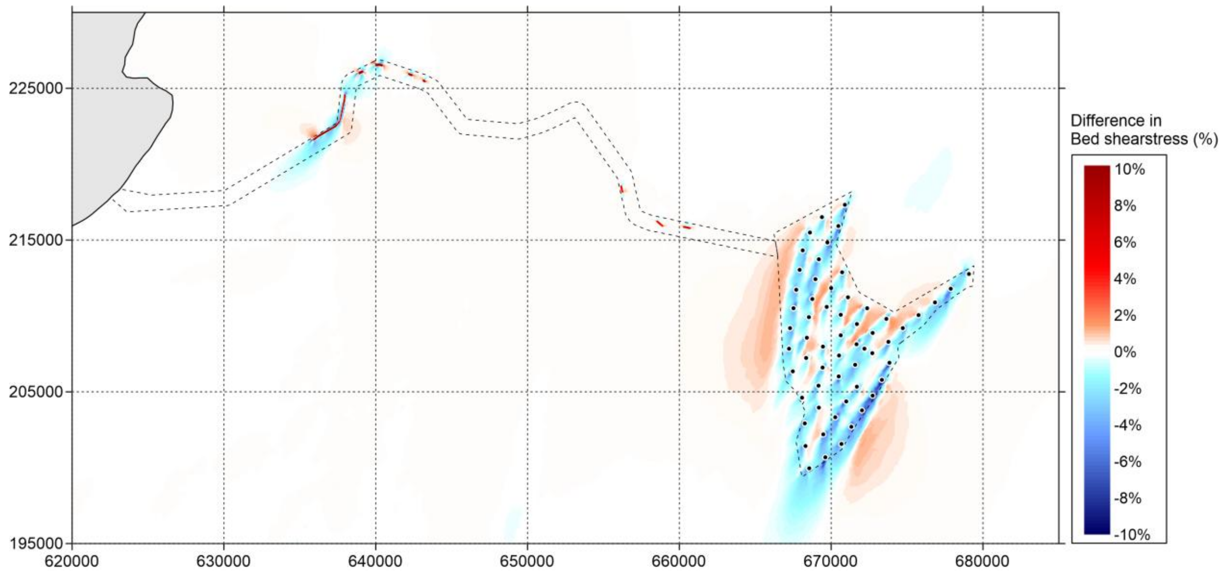


Figure 5-625-625. Difference in bed shear stress (in percent) between 'Baseline' and 'Option' during spring tide (positive means increase of bed shear stress by option and vice versa) – peak flood

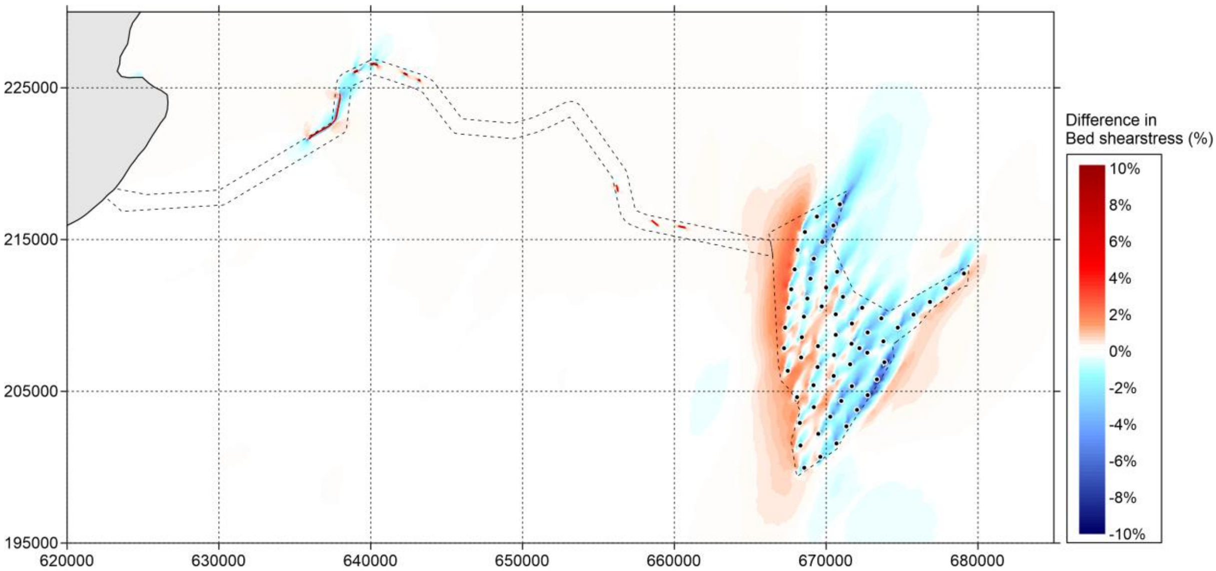


Figure 5-635-635. Difference in bed shear stress (in percent) between 'Baseline' and 'Option' during spring tide (positive means increase of bed shear stress by option and vice versa) – peak ebb

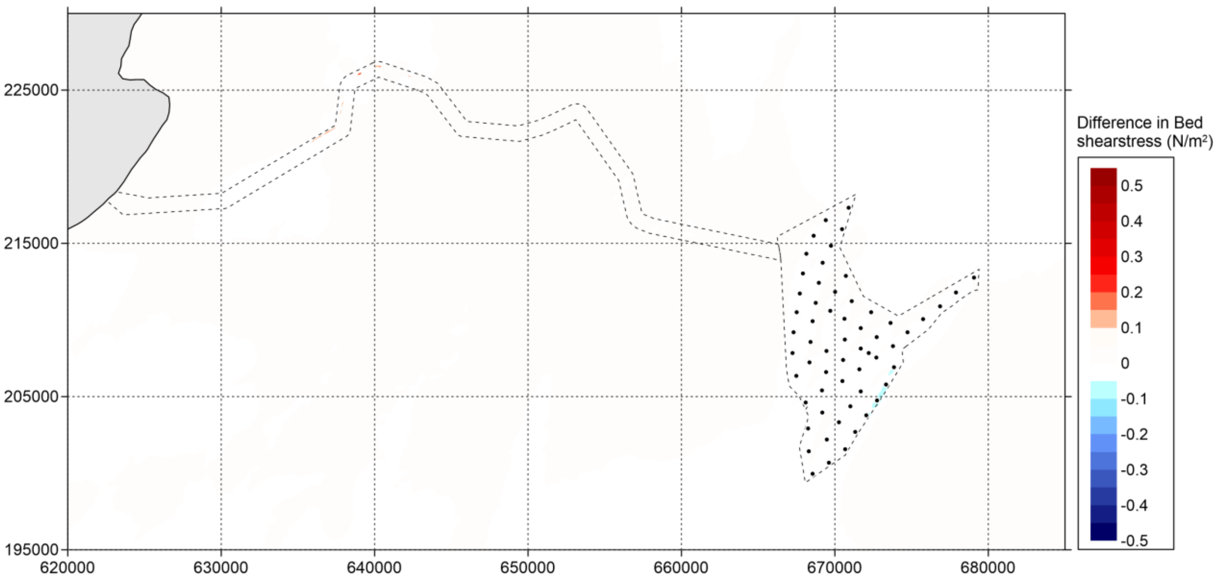


Figure 5-645-645. Difference in bed shear stress (in N/m^2) between 'Baseline' and 'Option' during neap tide (positive means increase of bed shear stress by option and vice versa) – peak flood

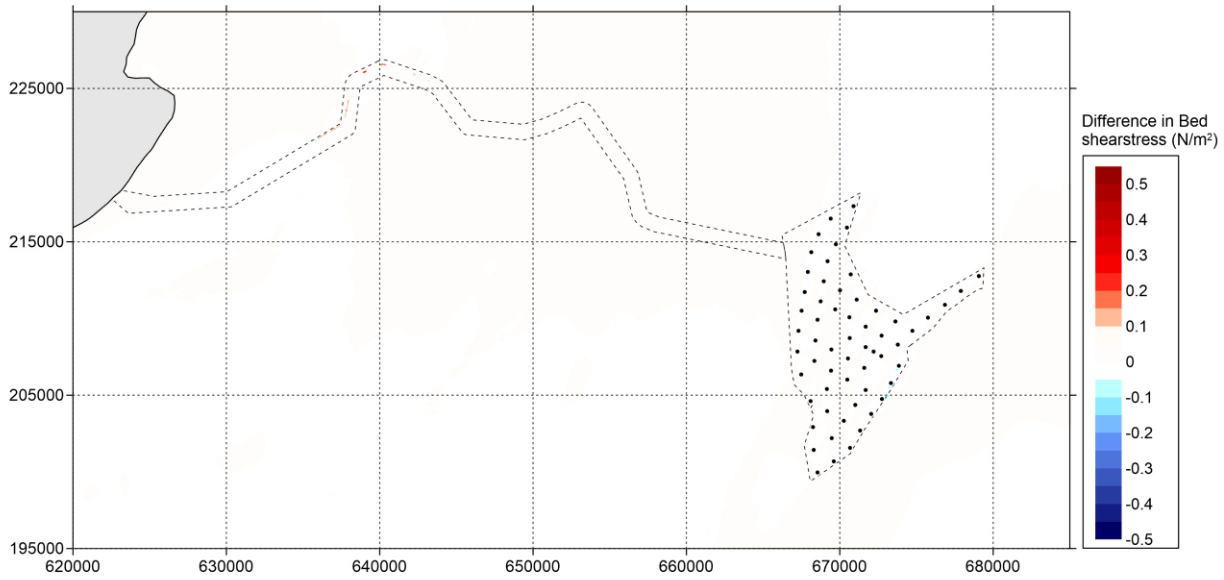


Figure 5-655-655.5. Difference in bed shear stress (in N/m²) between 'Baseline' and 'Option' during neap tide (positive means increase of bed shear stress by option and vice versa) – peak ebb

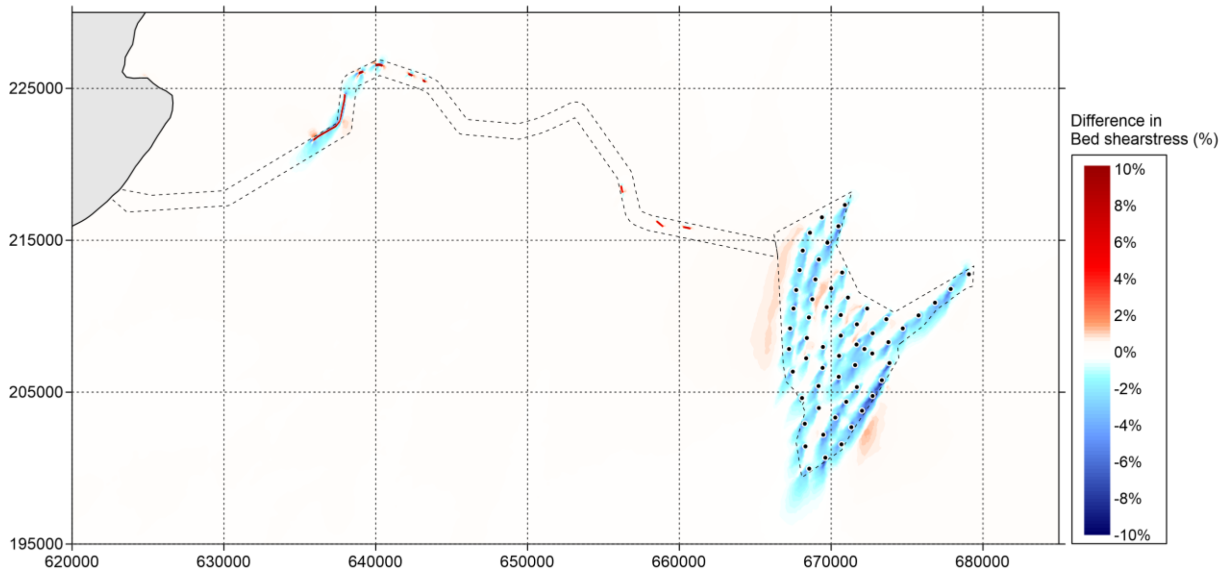


Figure 5-665-66.495.49 Difference in bed shear stress (in percent) between 'Baseline' and 'Option' during neap tide (positive means increase of bed shear stress by option and vice versa) – peak flood

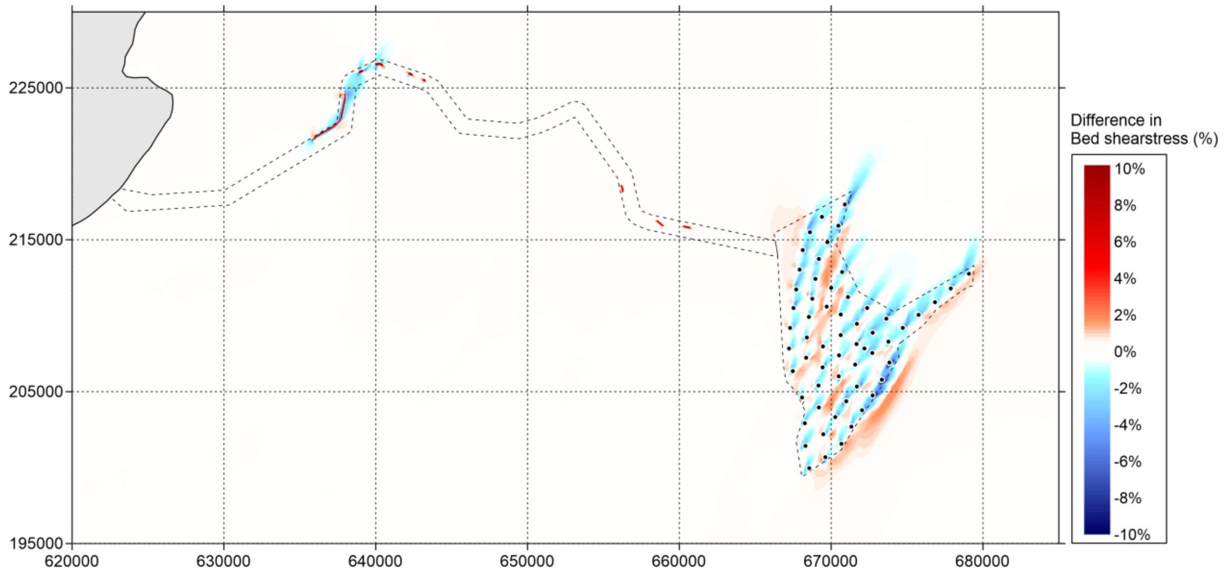


Figure 5-675-675. Difference in bed shear stress (in percent) between 'Baseline' and 'Option' during neap tide (positive means increase of bed shear stress by option and vice versa) – peak ebb

5.4.13 Figure 5-68 and Figure 5-69 present the difference in current speed in meters between the 'Baseline' and the 'Cumulative' during a spring tide at peak flood and peak ebb, respectively.

5.4.14 Figure 5-70 and Figure 5-71 present the difference in current speed in percent between the 'Baseline' and the 'Cumulative' during a spring tide at peak flood and peak ebb respectively. Where the lowest visible contour band is 0.3%.

5.4.15 Figure 5-72 and Figure 5-73 present the difference in current speed in meters between the 'Baseline' and the 'Cumulative' during a neap tide at peak flood and peak ebb, respectively.

5.4.16 Figure 5-74 and Figure 5-75 present the difference in current speed in percent between the 'Baseline' and the 'Cumulative' during a neap tide at peak flood and peak ebb, respectively.

5.4.17 Figure 5-76 and Figure 5-77 present the difference in bed shear stress in Newtons/Square Meter between the 'Baseline' and the 'Cumulative' during a spring tide at peak flood and peak ebb, respectively.

5.4.18 Figure 5-78 and Figure 5-79 present the difference in bed shear stress in percent between the 'Baseline' and the 'Cumulative' during a spring tide at peak flood and peak ebb, respectively.

5.4.19 Figure 5-80 and Figure 5-81 present the difference in bed shear stress in Newtons/Square Meter between the 'Baseline' and the 'Cumulative' during a neap tide at peak flood and peak ebb, respectively.

5.4.20 Figure 5-82 and Figure 5-83 present the difference in bed shear stress in percent between the 'Baseline' and the 'Cumulative' during a neap tide at peak flood and peak ebb, respectively.

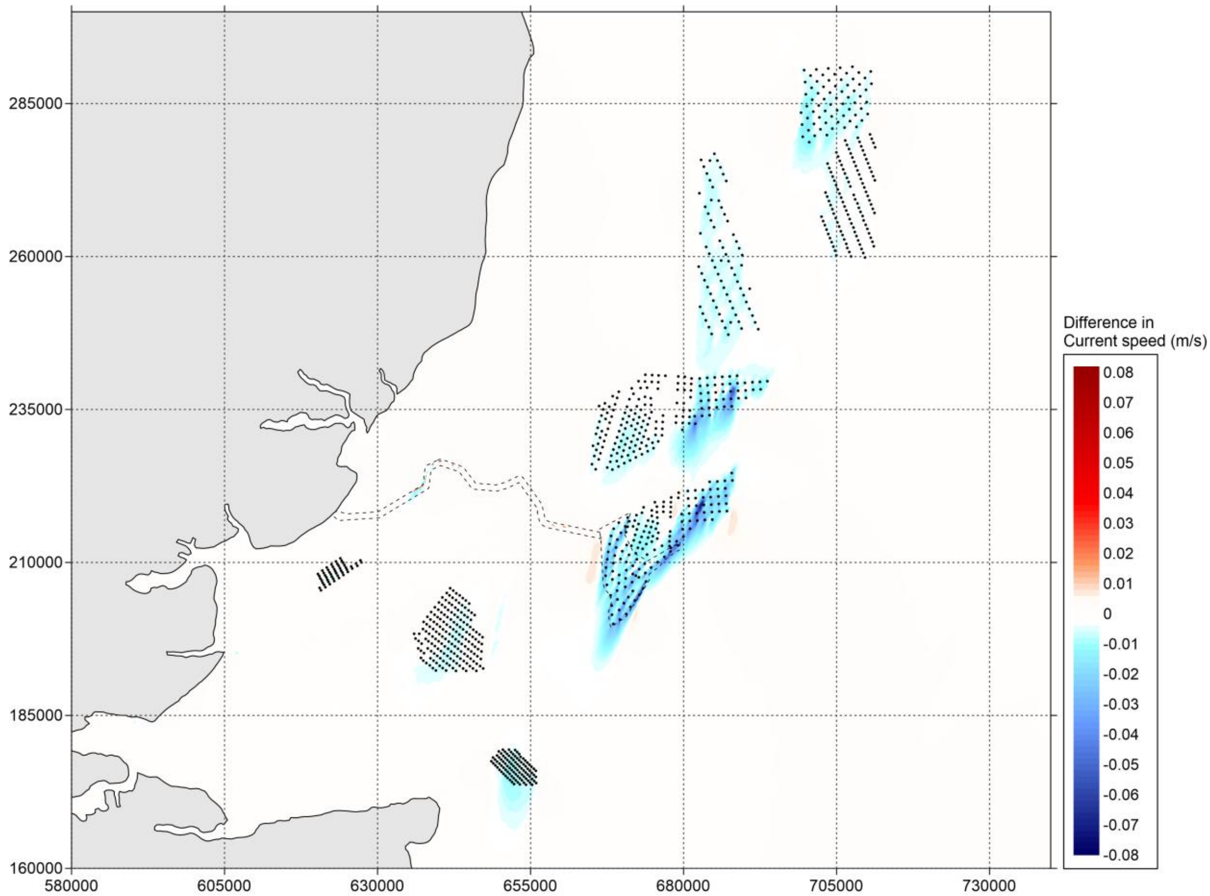


Figure 5-68 **Difference in current speed (in metres/second) between 'Baseline' and 'Cumulative' during spring tide (positive means increase of current speed by option and vice versa) – peak flood**

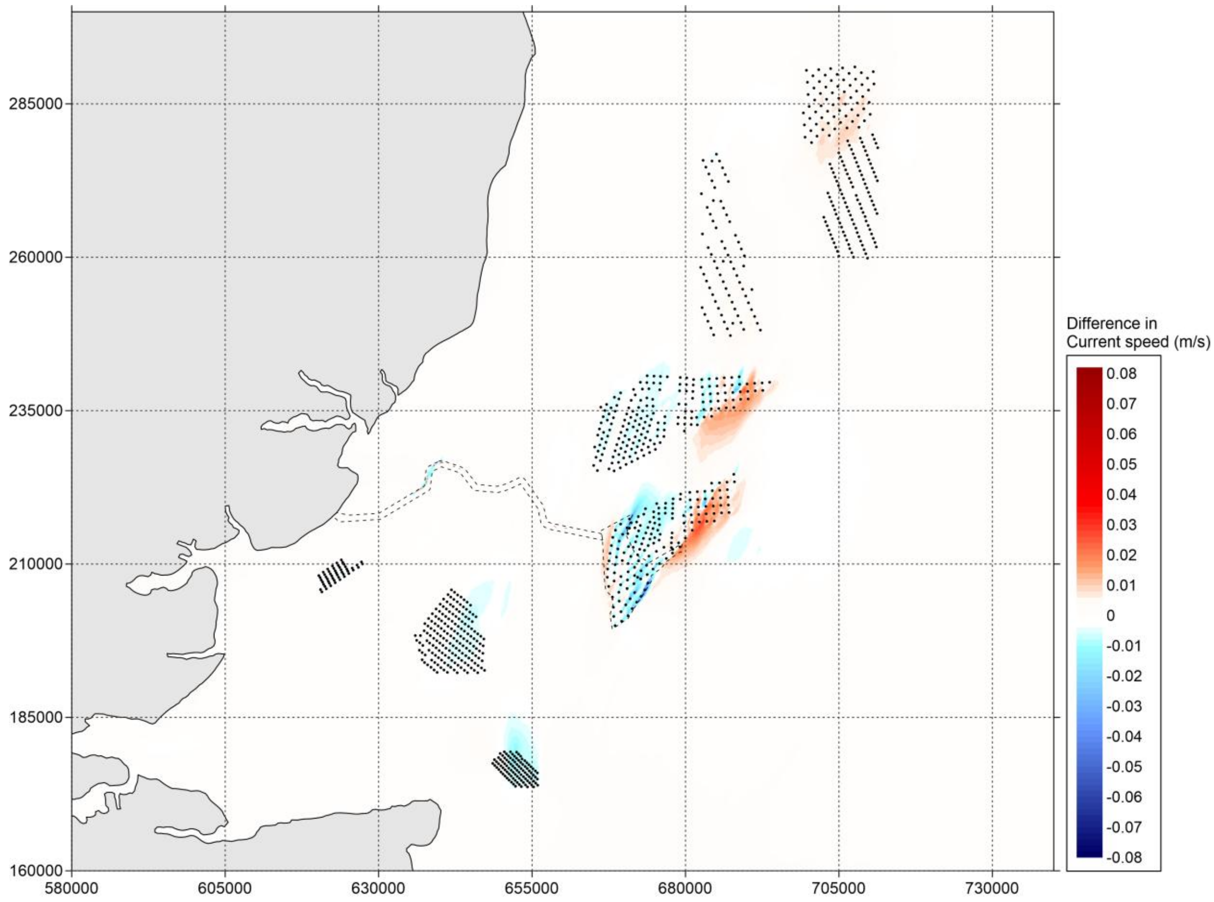


Figure 5-69 Difference in current speed (in metres/second) between 'Baseline' and 'Cumulative' during spring tide (positive means increase of current speed by option and vice versa) – peak ebb

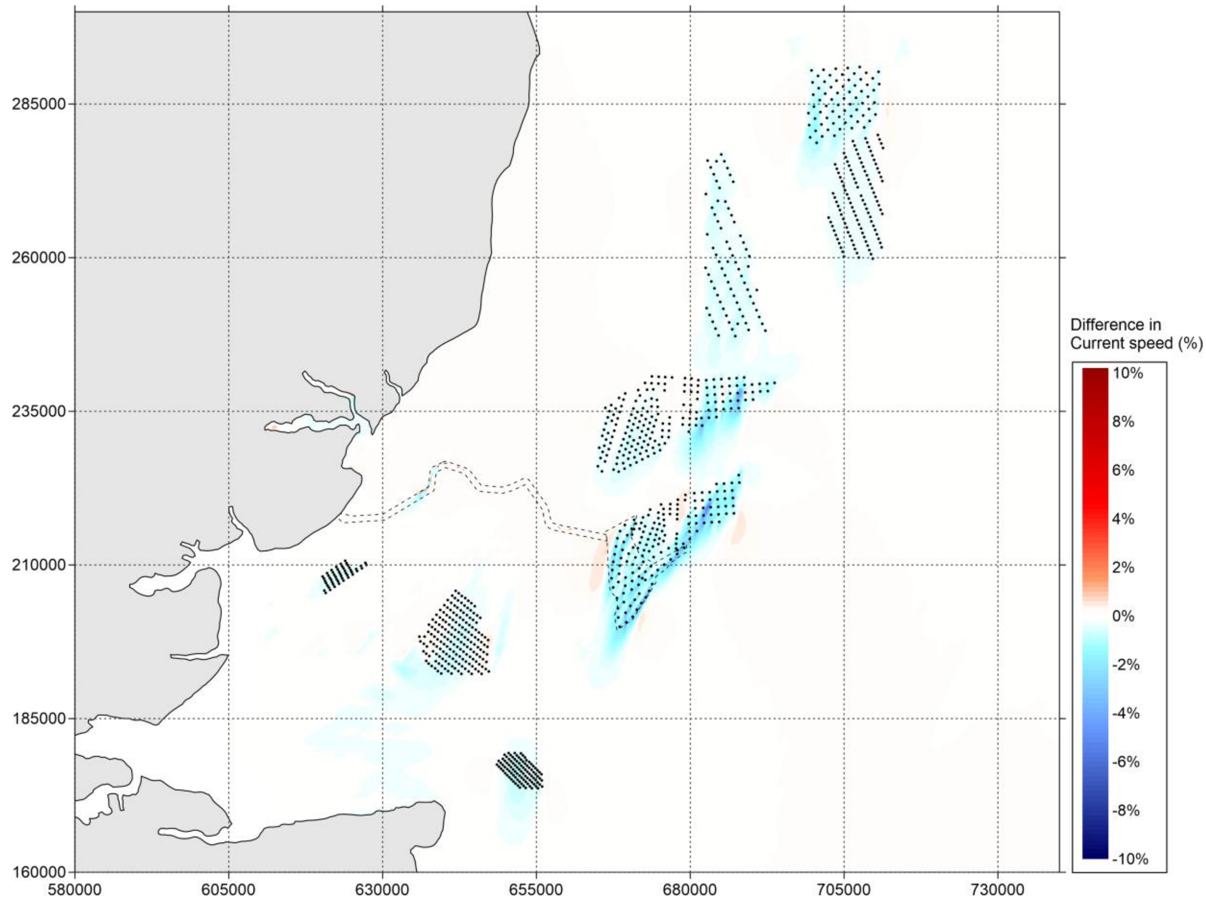


Figure 5-70 **Difference in current speed (in percent) between 'Baseline' and 'Cumulative' during spring tide (positive means increase of current speed by option and vice versa) – peak flood**

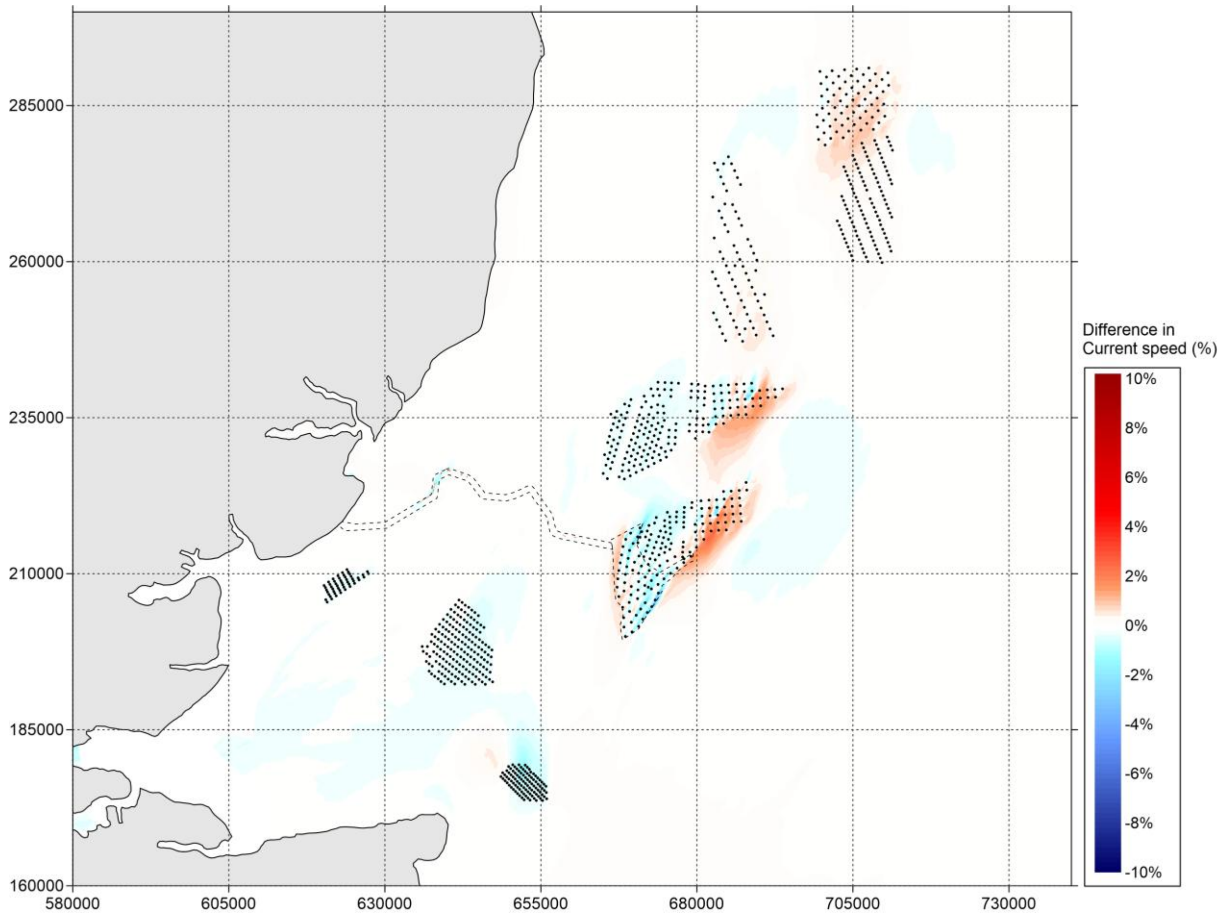


Figure 5-71 Difference **in current speed (in percent) between 'Baseline' and 'Cumulative' during spring tide (positive means increase of current speed by option and vice versa) – peak ebb**

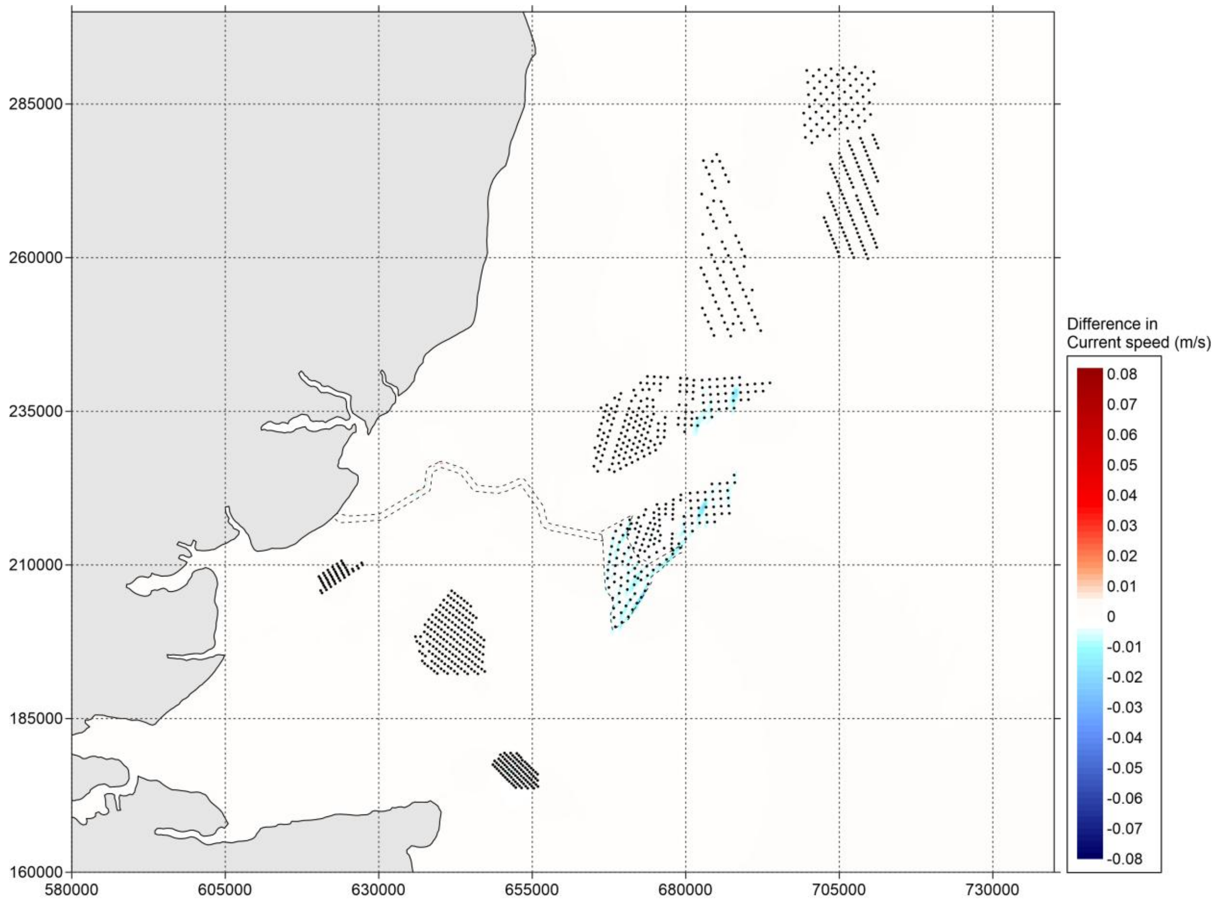


Figure 5-72 Difference in current speed (in metres/second) between 'Baseline' and 'Cumulative' during neap tide (positive means increase of current speed by option and vice versa) – peak flood

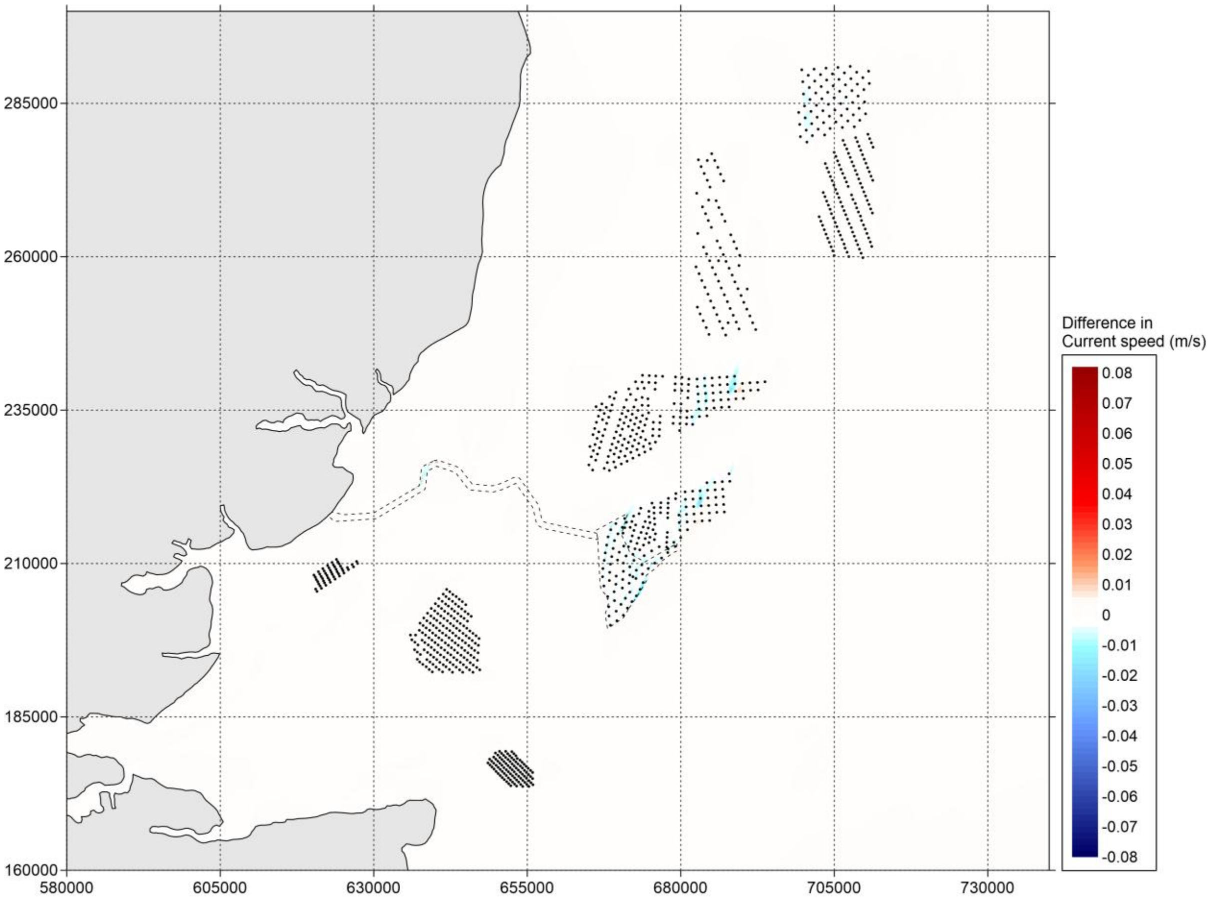


Figure 5-73~~5-735-5741~~ Difference in current speed (in metres/second) between 'Baseline' and 'Cumulative' during neap tide (positive means increase of current speed by option and vice versa) – peak ebb

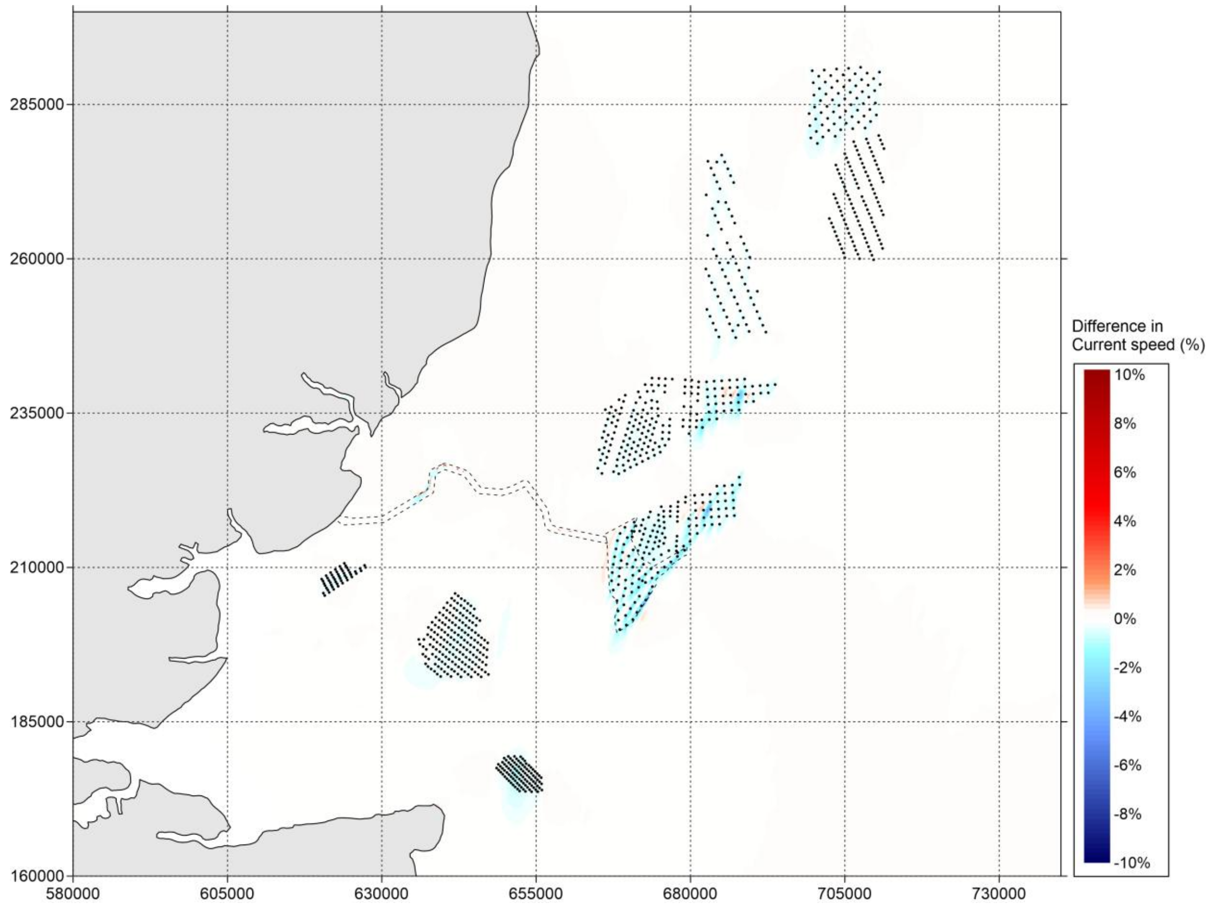


Figure 5-745-745-5842 Difference in current speed (in percent) between 'Baseline' and 'Cumulative' during neap tide (positive means increase of current speed by option and vice versa) – peak flood

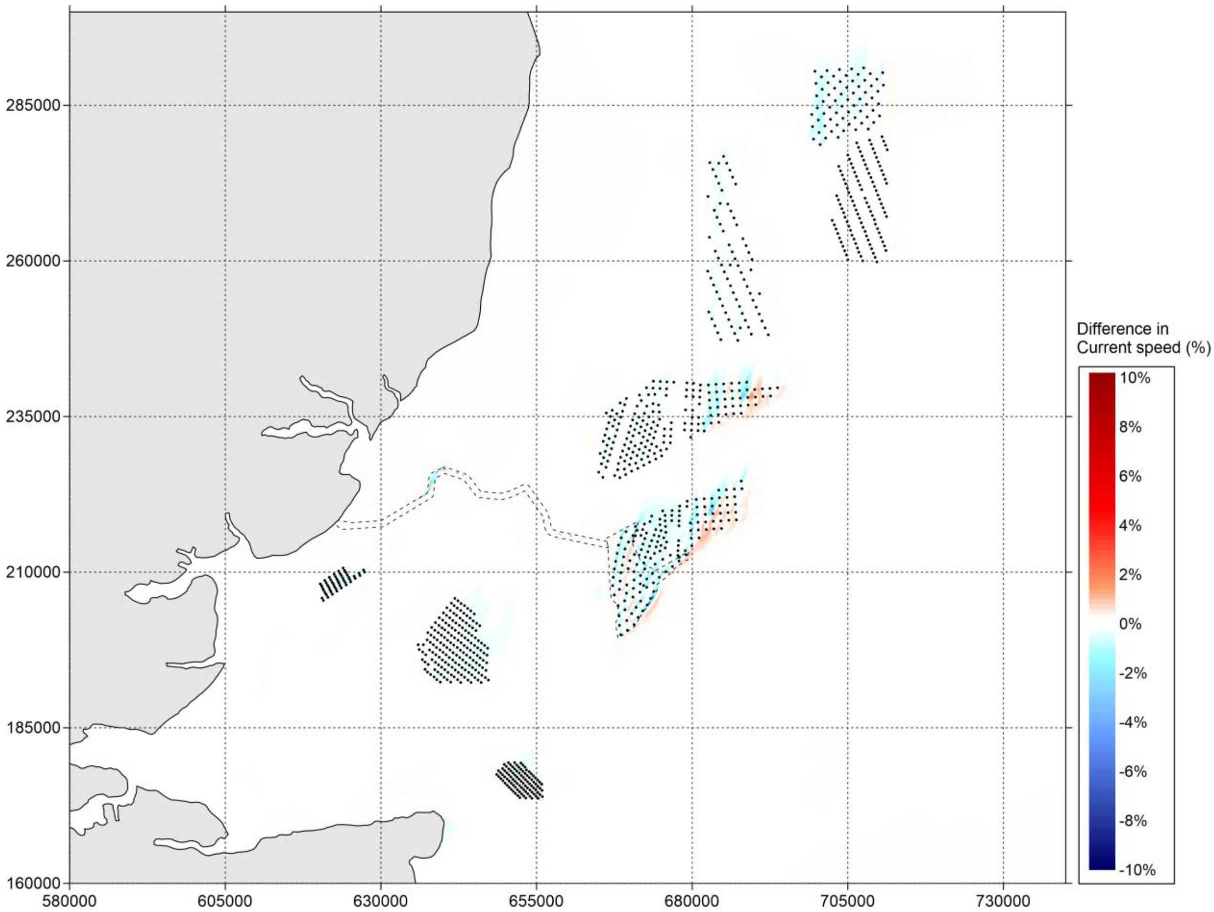


Figure 5-75~~5-755-59~~43 Difference <u>in current speed (in percent) between 'Baseline' and 'Cumulative' during neap tide (positive means increase of current speed by option and vice versa) – peak ebb</u>

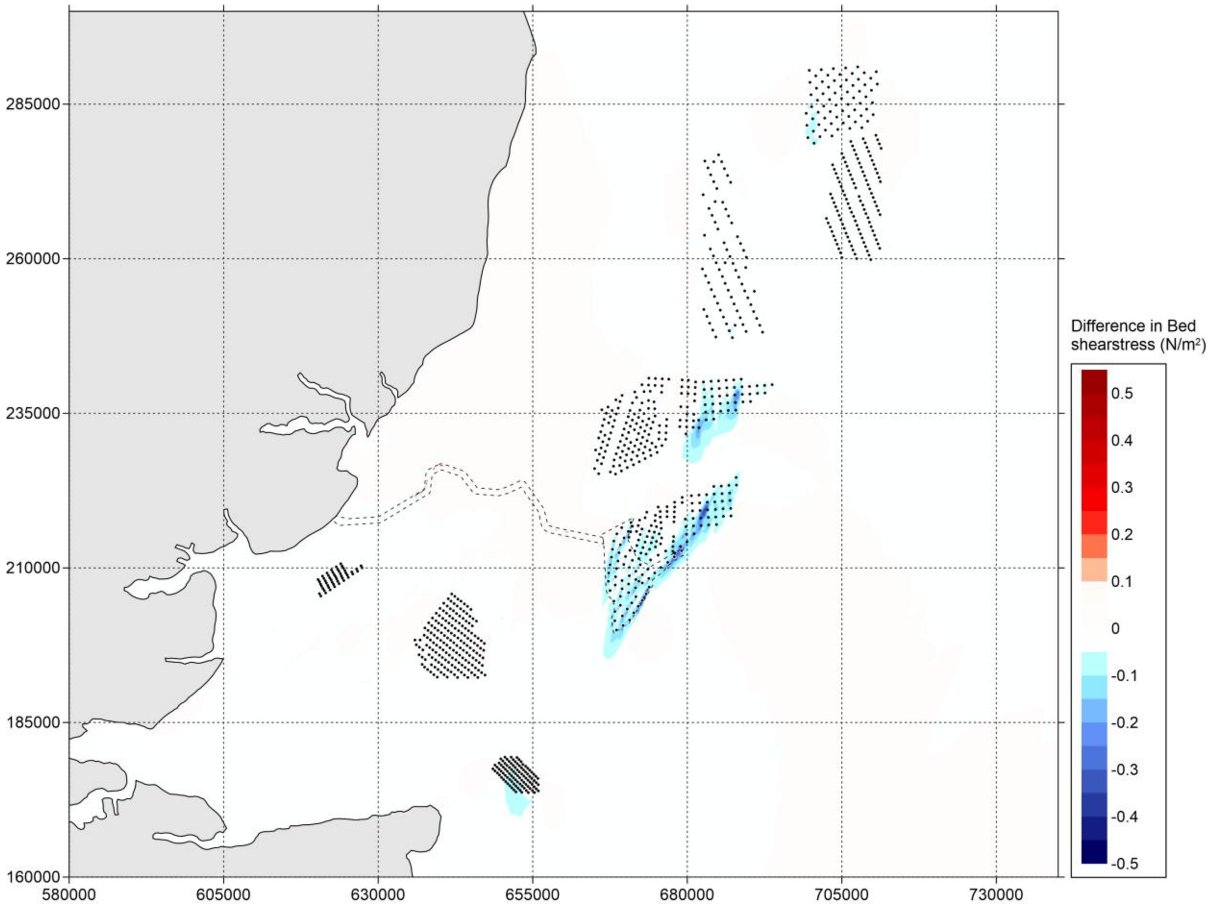


Figure 5-76~~5-765-60~~44 Difference in bed shear stress (in N/m^2) between 'Baseline' and 'Cumulative' during spring tide (positive means increase of bed shear stress by option and vice versa) – peak flood

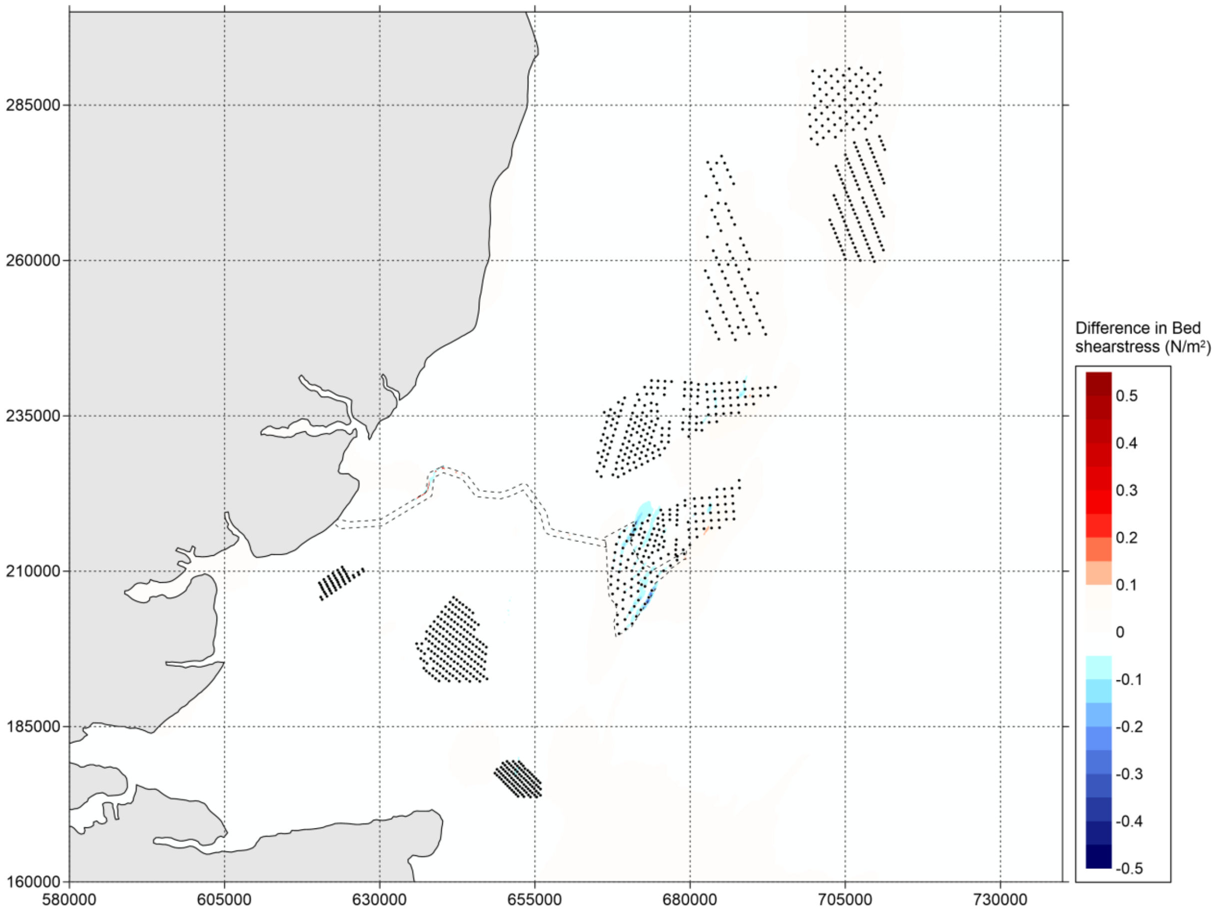


Figure 5-77~~5-775-61~~45 Difference in bed shear stress (in N/m^2) between 'Baseline' and 'Cumulative' during spring tide (positive means increase of bed shear stress by option and vice versa) – peak ebb

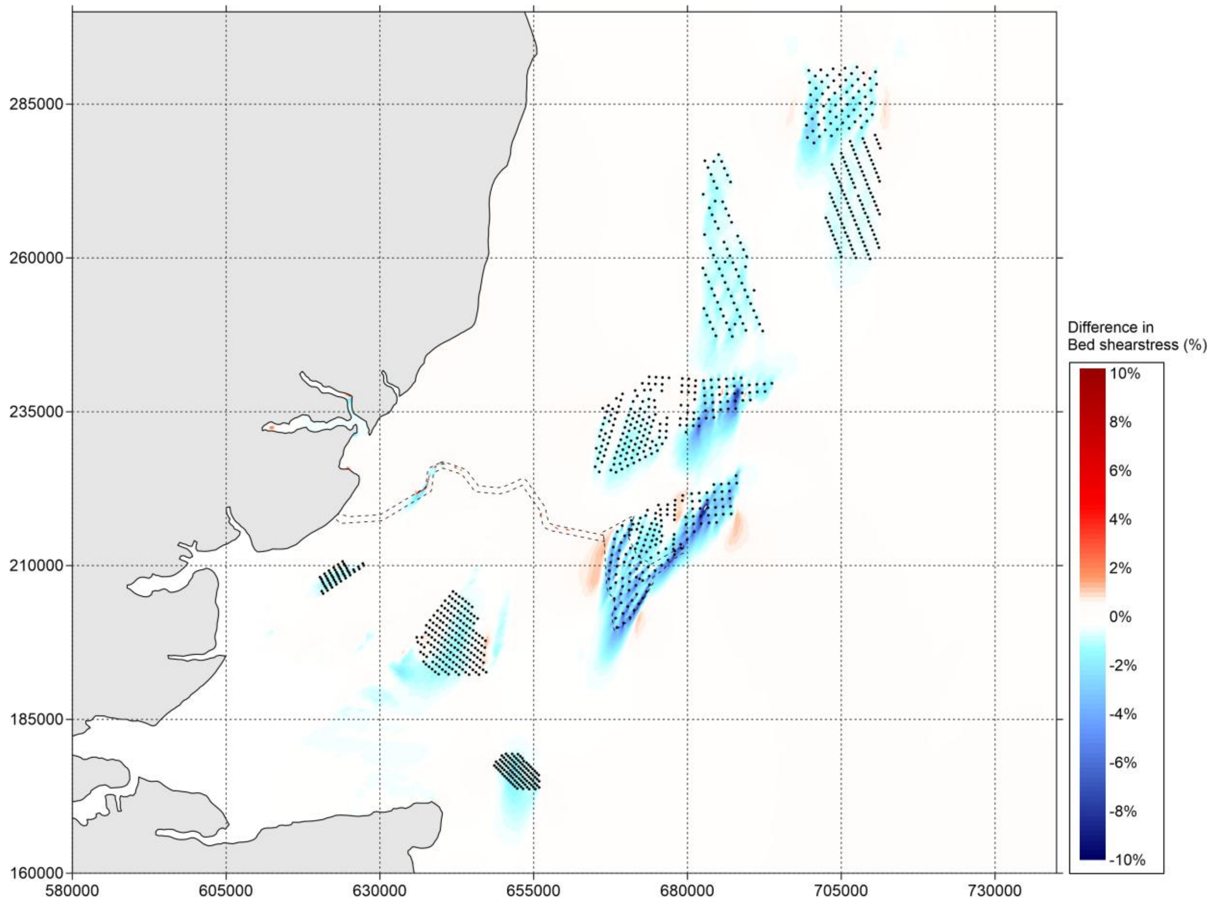


Figure 5-785-785-6246 Difference in bed shear stress (in percent) between ‘Baseline’ and ‘Cumulative’ during spring tide (positive means increase of bed shear stress by option and vice versa) – peak flood

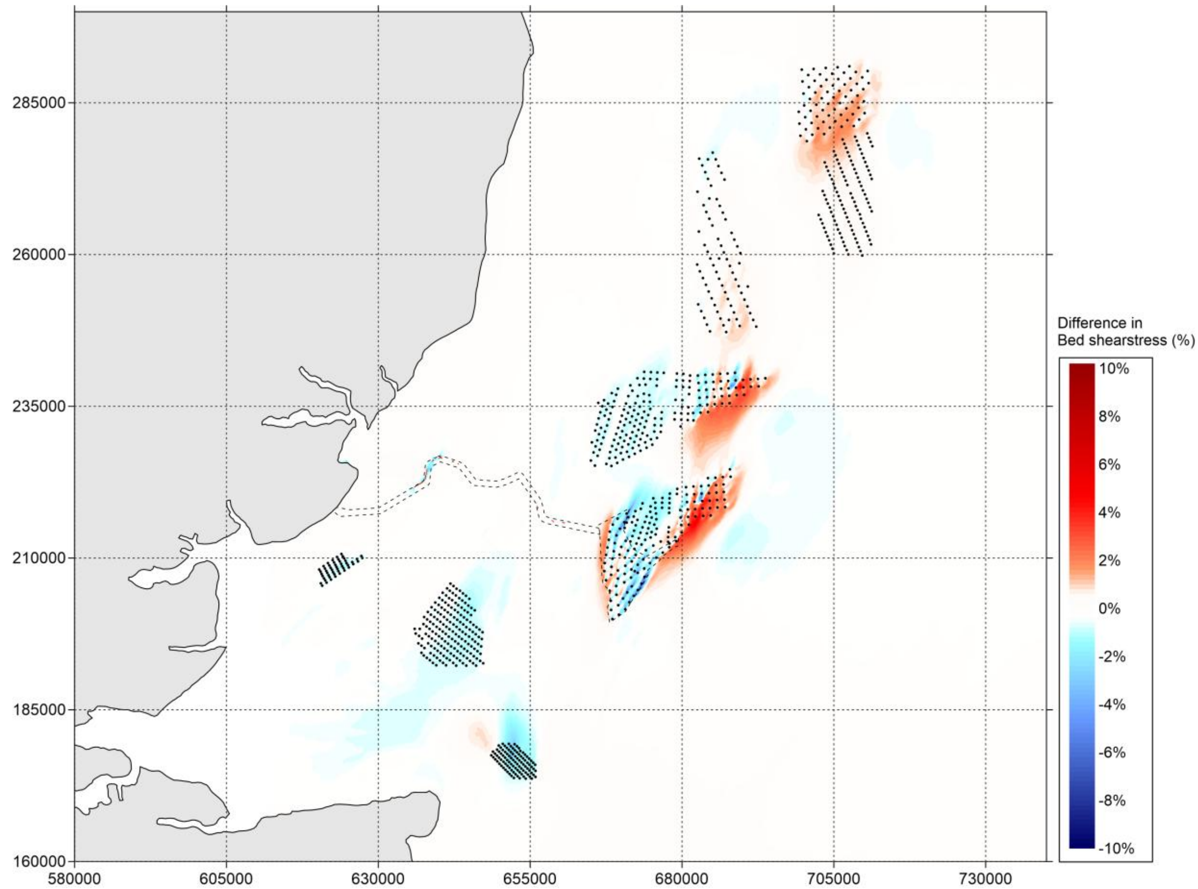


Figure 5-795-795-6347 Difference in bed shear stress (in percent) between 'Baseline' and 'Cumulative' during spring tide (positive means increase of bed shear stress by option and vice versa) – peak ebb.

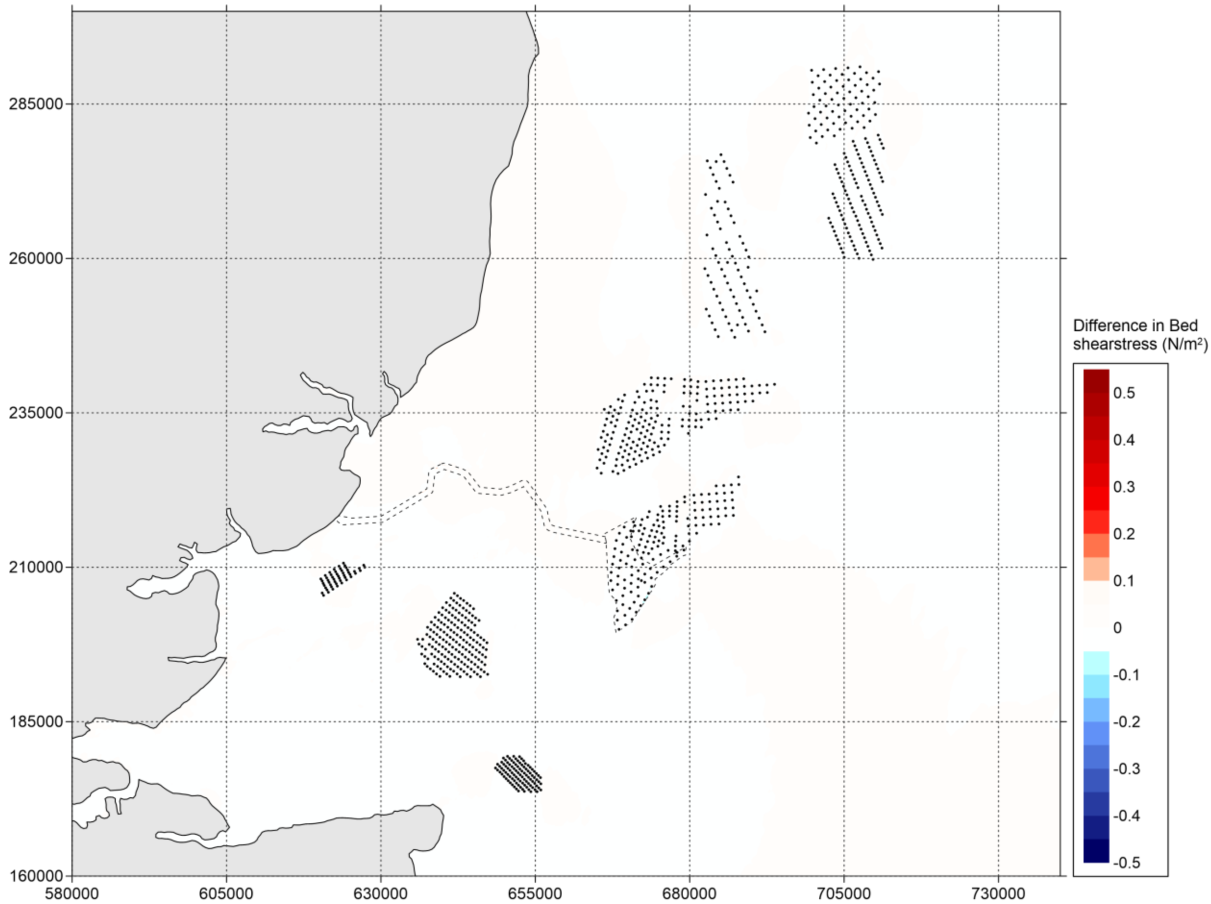


Figure 5-805-805-6448 Difference in bed shear stress (in N/m²) between 'Baseline' and 'Cumulative' during neap tide (positive means increase of bed shear stress by option and vice versa) – peak flood.

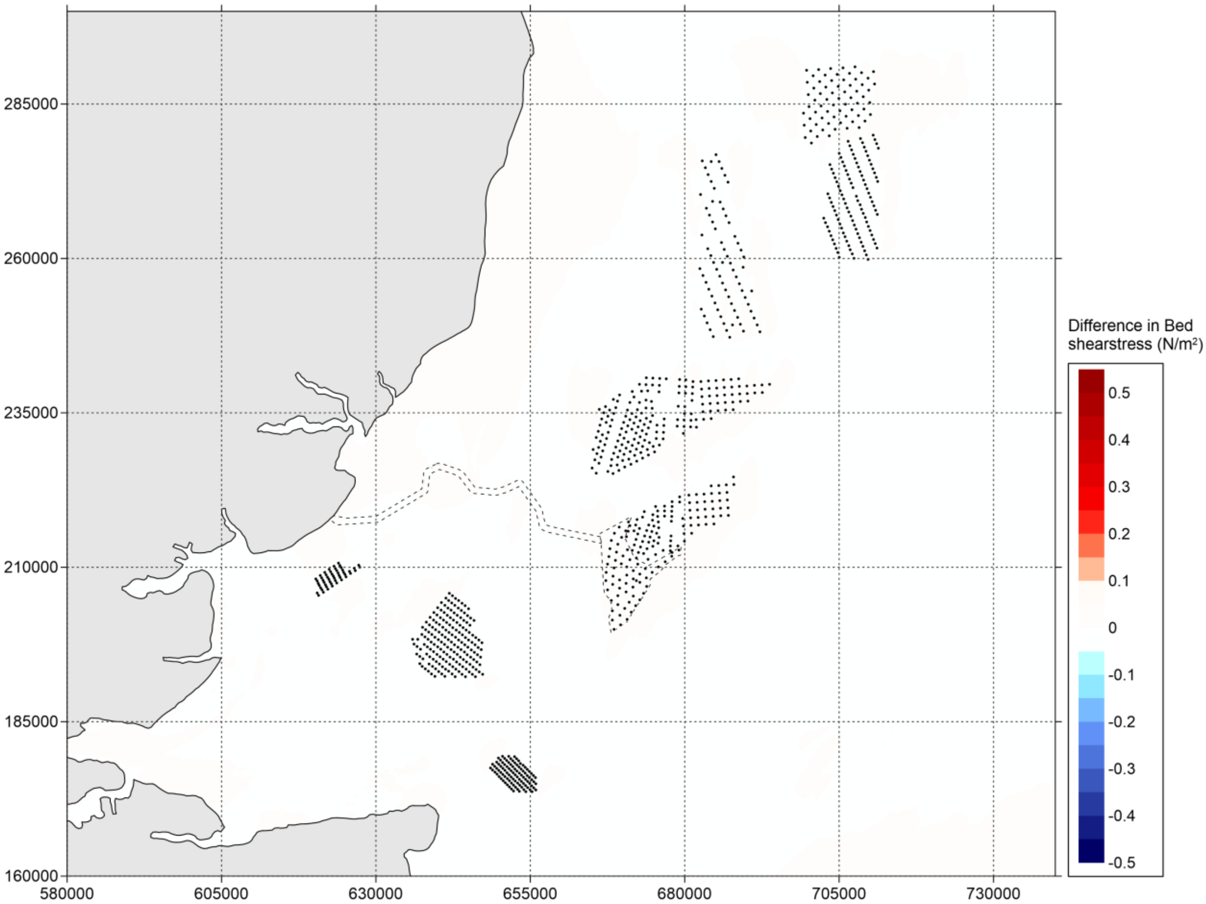


Figure 5-815-815-6549 Difference in bed shear stress (in N/m^2) between 'Baseline' and 'Cumulative' during neap tide (positive means increase of bed shear stress by option and vice versa) – peak ebb.

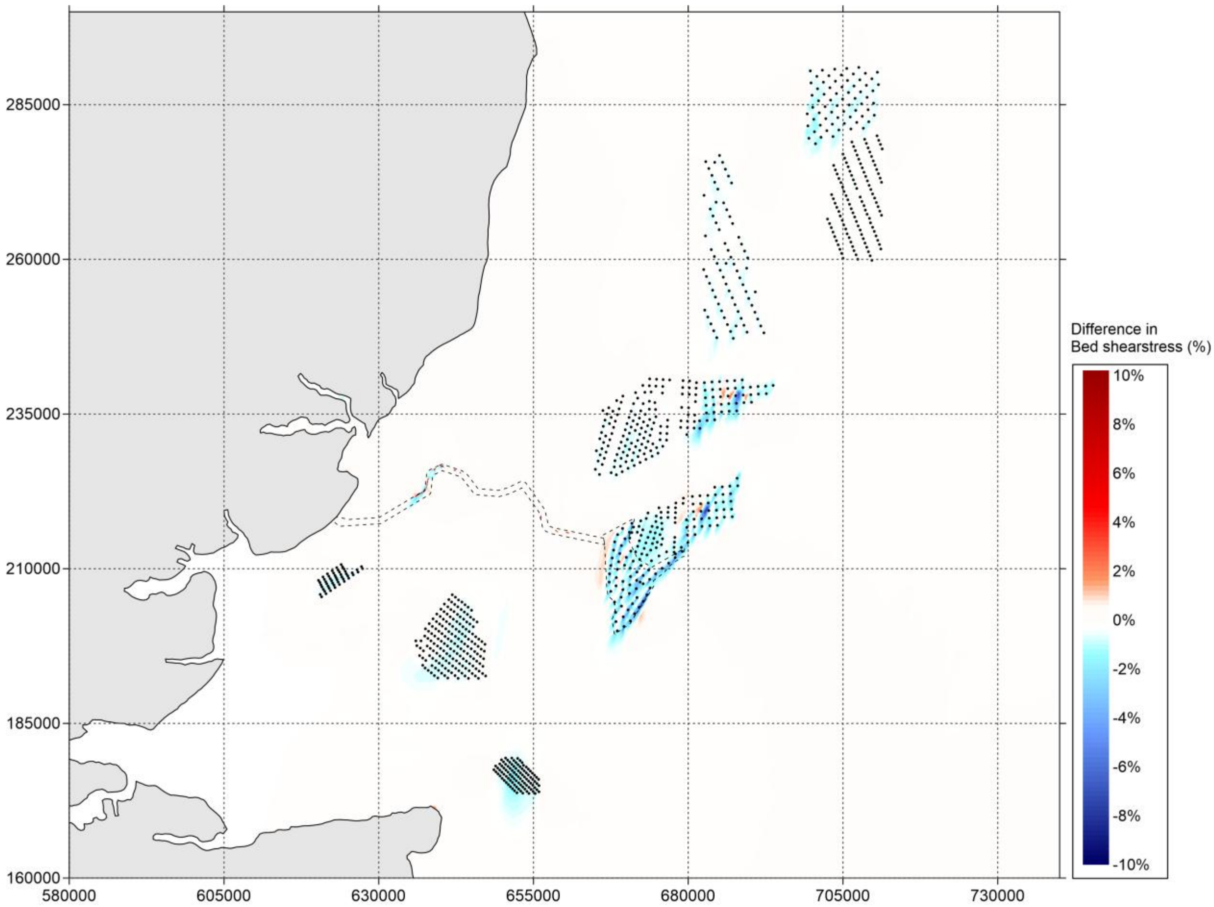


Figure 5-82~~5-825-6650~~ Difference in bed shear stress (in percent) between 'Baseline' and 'Cumulative' during neap tide (positive means increase of bed shear stress by option and vice versa) – peak flood.

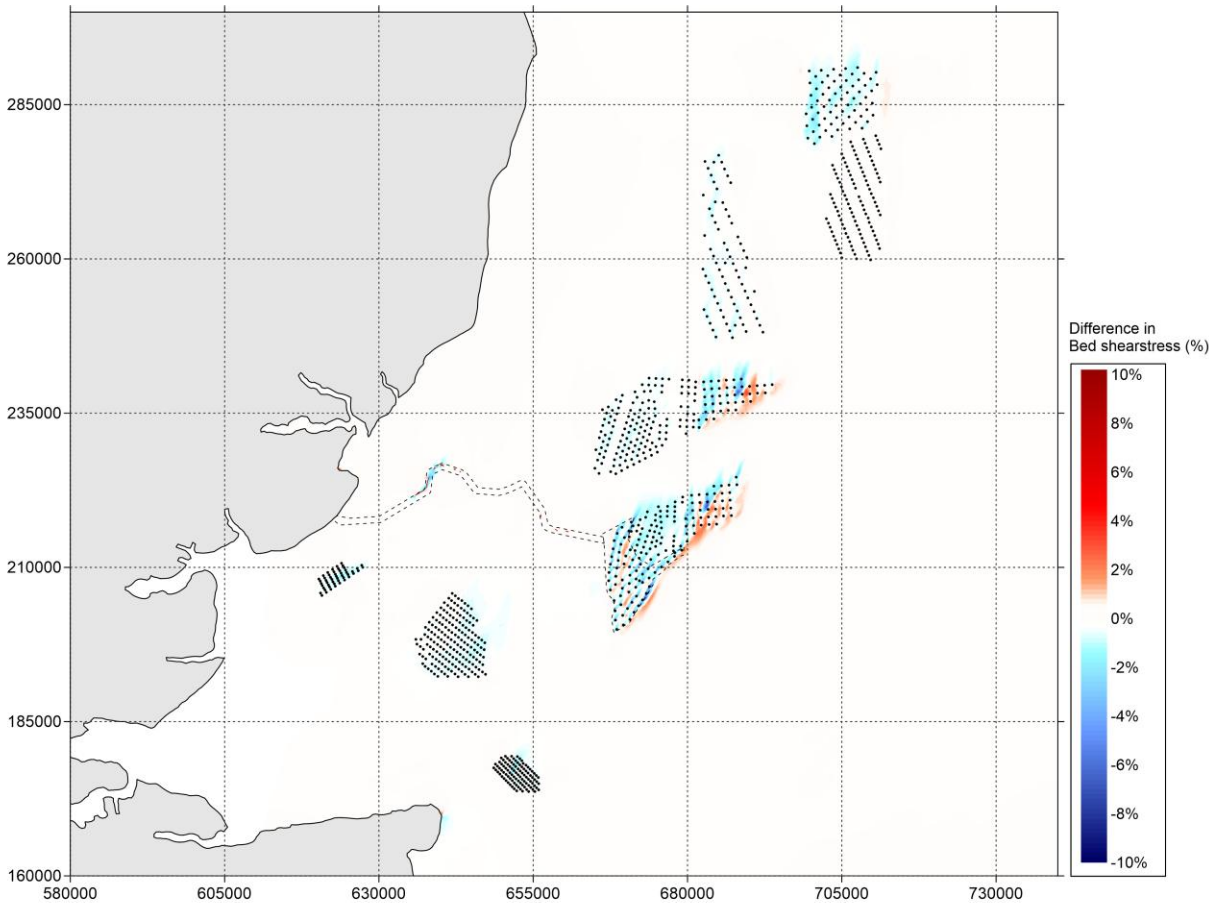


Figure 5-83~~5-835.83~~ Difference in bed shear stress (in percent) between 'Baseline' and 'Cumulative' during neap tide (positive means increase of bed shear stress by option and vice versa) – peak ebb.

5.5 Discussion on Model Results

5.5.1 The difference in current speed between the 'Baseline' and 'Option' scenarios (Section 5.3) during spring tides as well as neap tides for peak flood and peak ebb are less than 2 percent across all cable protection sections. At the array area, the majority of change is less than 3 percent, apart from small, localized areas on the eastern edge of the array which reach up to 4 percent.

5.5.2 The difference in bed shear stress between the 'Baseline' and 'Option' during spring tides for peak flood are located around all cable protection sections. At cable protection sections 1 – 3 (see Figure 5-18), the bed shear stress is up to 3 percent lower close to the protection itself and confined to the offshore cable corridor, lower by less than 2 percent for approx. 2-2.5km southwards of the protection. At the immediate location of the cable protection there is a small region of higher bed shear stress by up to 10. This is in response to an increase in local current speed over the structure as due to a reduction in water depth. Where cable protection sections are located close together (2-3, 3-4, 4-5 and 7-8) the increase in bed shear stress between the structures is less than 1 percent. Throughout the wind farm array, the change in bed shear stress is less than 5 percent.

5.5.3 The difference in bed shear stress between the 'Baseline' and 'Option' during spring tides for peak ebb are located around the cable protection sections 1 to 8. The bed shear stress is lowered by between 2 to 4 percent close to cable protection section 1 (see Figure 5-18), whilst the cable protection sections 2, 3 and 4 (see Figure 5-18), show a lowered bed shear stress of up to 2 percent. Similar to flood tide, at the immediate location of the cable protection there is a small region of higher bed shear stress up to 10 percent. Throughout the array area, the change in bed shear stress is less than 5 percent.

5.5.4 The difference in bed shear stress between the 'Baseline' and 'Option' during neap tides for peak flood are less than 2 percent and for peak ebb are less than 3 percent at all cable protection sections. Throughout the majority of the wind farm array the change in bed shear stress is less than 3 percent, with a small, localized area on the eastern edge which reaches up to 5 percent.

5.5.45.5.5 The results of the cumulative assessment of all proposed and constructed windfarms in the area, predicts that the change in current speeds and bed shear stress around each windfarm, in most cases will not have a cumulative effect in addition to the North Falls array. This is shown in the figures by the minimum contour of 0.3% difference in current speed and bed shear stress, where these contours do not overlap between all wind farm arrays, other than the neighbouring Five Estuaries, due to its close proximity. Although these overlapping contours between Five Estuaries and North Falls do not exceed a difference of 5% for both current speed and bed shear stress.

6 DISPERSION MODEL SETUP

6.1 Introduction

6.1.1 This section of the report describes the sediment dispersion modelling exercise that was undertaken to investigate the suspended sediment dispersion and deposition arising from the trenching, levelling, drilling and seabed preparation activities along the indicative offshore export cable route and in the array area of the North Falls Wind Farm.

6.1.2 The sediment dispersion model was built in MIKE3-MT software developed by DHI.

6.1.3 There are ten eleven proposed construction activities that are likely to cause suspended sediment release into the water column, all of which have been simulated in separated dispersion model runs. Table 6-1 summarises these ten eleven simulations (ID1 to ID10, ID13). In addition to the construction activities, two disposal simulations (ID11 and ID12) of different sediment sizes have been run.

Table 6-1 Sediment dispersion model simulations

Id	Location	Activity	Array Layout
1	Offshore Cable Corridor	Levelling through sandwaves (SW) and megaripples (MR) using mass flow excavation (MFE) as a worst case scenario	N/An/a
2	Offshore Cable Corridor	Trenching after levelling through sandwaves (SW) and megaripples (MR)	N/An/a
3	Offshore Cable Corridor	Dredging at Sunk DWR	N/An/a
4	Offshore Cable Corridor	Dredging at Trinity DWR	N/An/a
5	Structure Installation in Array	Drilling for WTGs and OCP/OSP	Greater number of smaller WTGs
6	Structure Installation in Array	Drilling for WTGs and OCP/OSP	Fewer larger WTGs
7	Structure Installation in Array	Bed preparation for WTGs and OCP/OSP	Greater number of smaller WTGs

Id	Location	Activity	Array Layout
8	Structure Installation in Array	Bed preparation for WTGs and OCP/OSP using MFE as a worst case scenario	Fewer larger WTGs
9	Array Cable	Levelling through sandwaves (SW) and megaripples (MR) using MFE as a worst case scenario	Greater number of smaller WTGs
10	Array Cable	Trenching after levelling through sandwaves (SW) and megaripples (MR)	Greater number of smaller WTGs
11	Array disposal	Dredged sediment disposal in the array area – sediment size ("Zone 1 & 3")	N/A
12	Array disposal	Dredged sediment disposal in the array area – sediment size ("Sandwaves")	N/A
13	Offshore Cable Corridor	Dredging at Pilot Boarding Area	N/A

6.2 Dispersion Model Setup

6.2.1 For the purpose of the sediment dispersion model the 2D hydrodynamic model described in Section 4 has been developed into a 3D hydrodynamic model in order to simulate the suspended sediment transport throughout the water column.

6.2.2 The sediment dispersion model was then built in MIKE3-MT and is coupled with the 3D hydrodynamic model built in MIKE3-HD. The computational mesh of MIKE3-MT is identical to the MIKE3-HD mesh.

6.2.3 All sediment dispersion model simulations have been run for an 8-week period to cover the full duration of the proposed construction activities and allow the plume to fully disperse after the activities have ended.

6.2.4 Due to the uncertainty of the time when the dredging will take place, the worst scenario in terms of the tidal conditions has been chosen, and the model has been run for the period of October to November 2025. The period includes an equinox tide which has annual largest tidal range during spring tides and annual lowest tidal range during neap tides.

6.2.5 The sediment dispersion model has been set up with 5 vertical layers in order to differentiate between suspended sediment concentrations throughout the water column, e.g. near the seabed and near the water surface.

6.2.6 In order to simulate the sediment dispersion close to natural conditions, wave disturbance effect has been included in the MIKE3-MT model. Wave conditions, based on the 1 in 1-year extreme offshore wave height of 4.24 m, peak wave period of 8.4 sec and wave direction of 0ºN, have been applied to the MIKE3-MT model.

6.2.7 In the model simulation the dredger will release material along a single line along the cable corridor and array cable, or at a single point for WTG and platform construction. This adopted method for material release is a conservative approach. The dredger will in reality move around the dredging area along multiple lines which means the sediment release will be more dispersed and thus the sediment concentration will be less.

6.3 Sediment Properties

6.3.1 Based on the particle size distribution analysis and available seabed sediment map, the offshore cable corridor and the array area have been divided into five particle size distribution zones as shown in Figure 6-1, namely ‘Zone 1’, ‘Sandwaves’, ‘Zone 2’, ‘Zone 3’ and ‘Plain bed’.

6.3.2 The seabed sediment properties can be characterised by five sediment fractions, settling velocities and critical bed shear stresses which have been used in the suspended sediment dispersion modelling. The five fractions are shown in Table 6-2. The critical bed shear stress and fall velocities were calculated using the SandCalc software developed by HR Wallingford.

Table 6-2 Sediment settling velocity and critical bed shear stress

SEDIMENT TYPE	SEDIMENT SIZE (mm)	SETTLING VELOCITY (m/s)	CRITICAL SHEAR STRESS (N/m^2)
Silt/Clay	0.031	0.000554	0.0847
Fine sand	0.13	0.00935	0.1548
Medium Sand	0.3	0.0372	0.2025
Coarse Sand	1.3	0.135	0.657
Gravel	2	0.1734	1.166

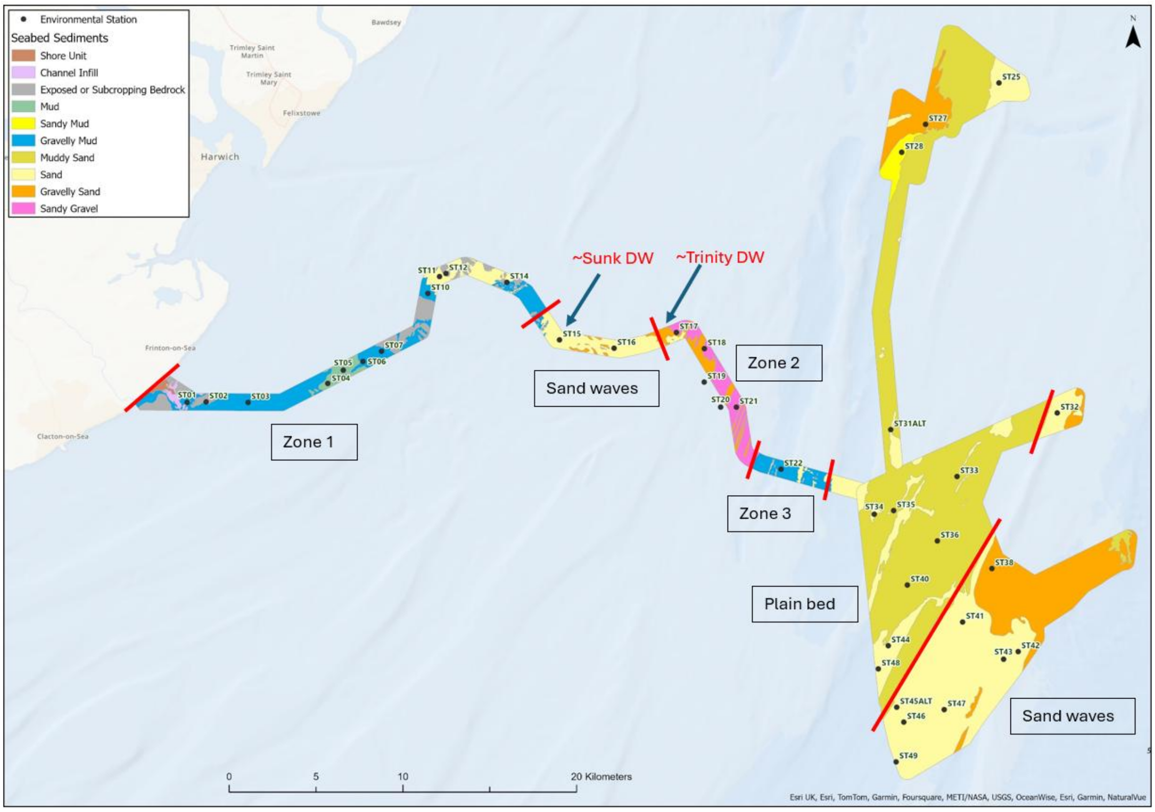


Figure 6-1 Sediment particle size distribution zones. Note: Shows PEIR boundaries including Northern Array now removed from the Project.

6.3.3 The particle size distribution for each of the five zones is shown in Table 6-3 to Table 6-6.

Table 6-3 Particle size distribution for Zone 1 and Zone 3

Sediment Category	Sediment Size (Mm)	Percentage (%)
Silt/Clay	0.031	28.79
Fine Sand	0.13	19.60
Medium Sand	0.3	24.16
Coarse Sand	1.3	7.58
Gravel/Cobble	2	19.87

Table 6-4 Particle size distribution for Zone 2

Sediment Category	Sediment Size (Mm)	Percentage (%)
Silt/Clay	0.031	14.66
Fine Sand	0.13	6.63
Medium Sand	0.3	13.95
Coarse Sand	1.3	11.57
Gravel/Cobble	2	53.19

Table 6-5 Particle size distribution for zone 'Sandwaves'

Sediment Category	Sediment Size (Mm)	Percentage (%)
Silt/Clay	0.031	0.92
Fine Sand	0.13	1.29
Medium Sand	0.3	65.30
Coarse Sand	1.3	27.82
Gravel/Cobble	2	4.67

Table 6-6 Particle size distribution for zone 'Plain bed'

Sediment Category	Sediment Size (Mm)	Percentage (%)
Silt/Clay	0.031	13.48
Fine Sand	0.13	1.96
Medium Sand	0.3	25.80
Coarse Sand	1.3	20.16
Gravel/Cobble	2	38.60

6.4 Summary of Sediment Release for Simulation

6.4.1 Table 6-7 and Table 6-8 summarise the construction method, duration and sediment release rates for all ten proposed construction activities.

6.4.2 The lengths presented in Table 6-7 are for single cable and sediment release from single cable installation was modelled. Two parallel cables are proposed but it is assumed that two cables are installed simultaneously.

Table 6-7 Summary of offshore cable corridor / array cable construction activities

Activity	Length (Km)	Volume (M^3)	Method	Prodcution Rate (M^3/S)	Duration (Days)	Sediment Release Rate (Kg/S)
Offshore Cable Corridor Levelling	20.1 (MR) 4.9 (SW)	450,800 (MR) 1,187,687 (SW)	MFE	12.5	1.5	21,250
Offshore Cable Corridor Trenching	62.7	75,441	MFE	0.042	21.8	71.90
Dredging at Sunk DWR	1.04	68,215	SHD	0.39	2.0	5.89
Dredging at Trinity DWR	2.19	86,599	SHD	0.39	2.6	5.89
Dredging at Pilot Boarding Area	1.1	68,219	SHD	0.39	2.0	5.89
Array Cable Levelling	9.98 (MR) 48.94 (SW)	1,756,480 (MR) 20,212,220 (SW)	MFE	12.5	20.3	21,250
Array Cable Trenching	98.2	117,798	MFE	0.04	34.1	68.0

Note: The above table presents information for one cable and two parallel cables are proposed.

Table 6-8 Summary of structure construction activities

Activity	Number Of Structures	Volume (M^3)	Method	Prodcution Rate (M^3/S)	Duration (Days)	Sediment Release Rate (Kg/S)
Drilling (DR) for smaller WTGs structures	5 WTG, 1 OCP/OSP	20,145 (WTG) 11,451 (OCP/OSP)	DR	1.0	0.18	6.0
Drilling (DR) for larger WTGs structures	3 WTG 1 OCP/OSP	34,728 (WTG) 11,451 (OCP/OSP)	DR	1.0	0.3	6.0
Seabed preparation for smaller WTGs structures	37 WTG 1 OCP/OSP	28,125 (WTG) 38,485 (OCP/OSP)	MFE	12.5	0.06	21,250
Seabed preparation for larger WTGs structures	24 WTG 1 OCP/OSP	35,280 (WTG) 38,485 (OCP/OSP)	MFE	12.5	0.07	21,250

6.5 Simulation 1 –Offshore Export Cable Levelling

6.5.1 Levelling is expected to be required through areas where sandwaves (SW) and megaripples (MR) are present along the export cables. Table 6-2 indicates the levelling areas considered in the modelling exercise from close to the shore, where the first megaripples areas are located and then progress along the indicative cable route to the next area of megaripples/sandwaves and so on.

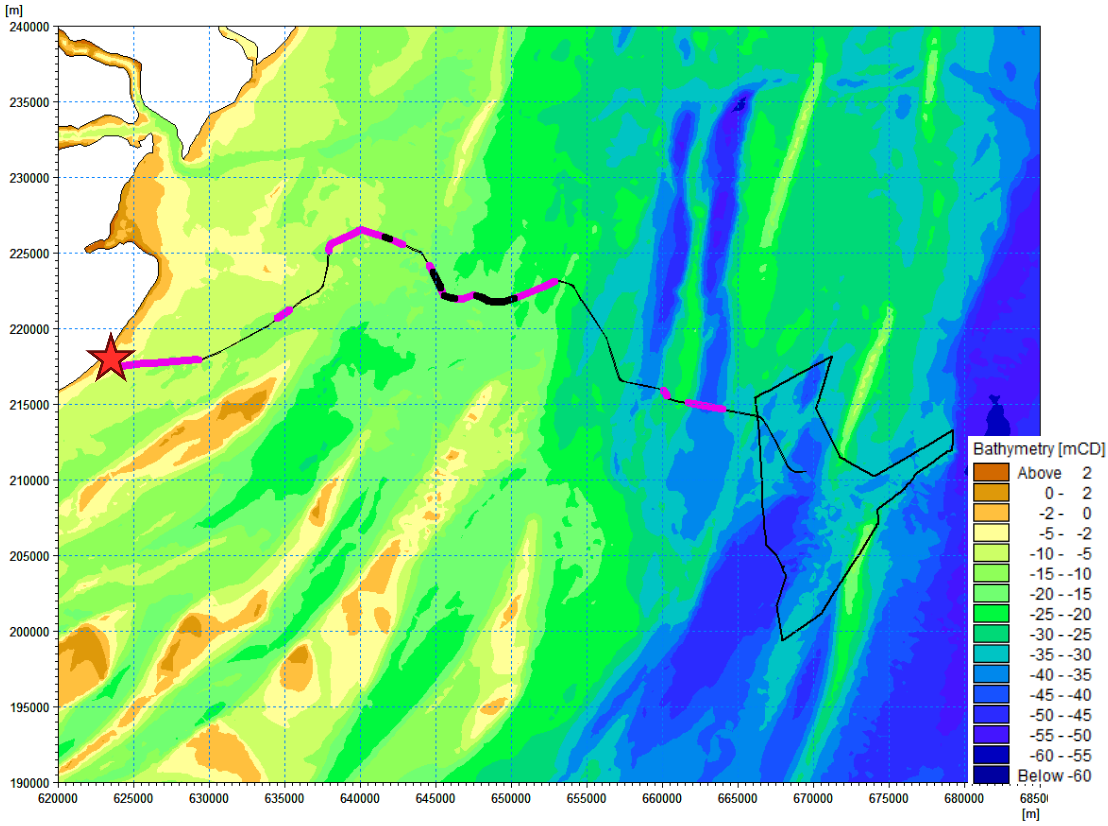


Figure 6-2 Shows where the offshore export cable levelling is expected to be required; where areas through megaripples are shown as thick purple lines and areas through sandwaves are shown as thick black lines. Red star indicates approximate start of export cable levelling.

6.5.2 The modelling of the offshore export cable levelling considers:

- The estimated total length of levelling through megaripples is 20.1km per cable, and for sandwaves the length is 4.9km per cable.
- A worst case scenario total of 450,800 m^3 and 1,187,686.5 m^3 per cable of seabed material will be removed during levelling activities for megaripples and sandwaves respectively.
- The total dredging period for levelling both bedforms is 1.5 days per cable using MFE.
- The sediment release rate of MFE is 21,250 kg/s in levelling and the material is released near the seabed.

6.5.3 The details of the sediment distribution zones and the particle size distribution are given in Section 5.3.

6.6 Simulation 2 –Offshore Export Cable Trenching

6.6.1 The modelling considered that trenching through sandwaves (after levelling) along the export cable route is expected from a point close to the shore and will progress along the export cable route (indicated by the red line in Figure 6-3). The trenching activity will prepare the seabed for two cables which are placed 50m apart. Figure 6-3 shows where the indicative offshore export cable trenching is required by a red line.

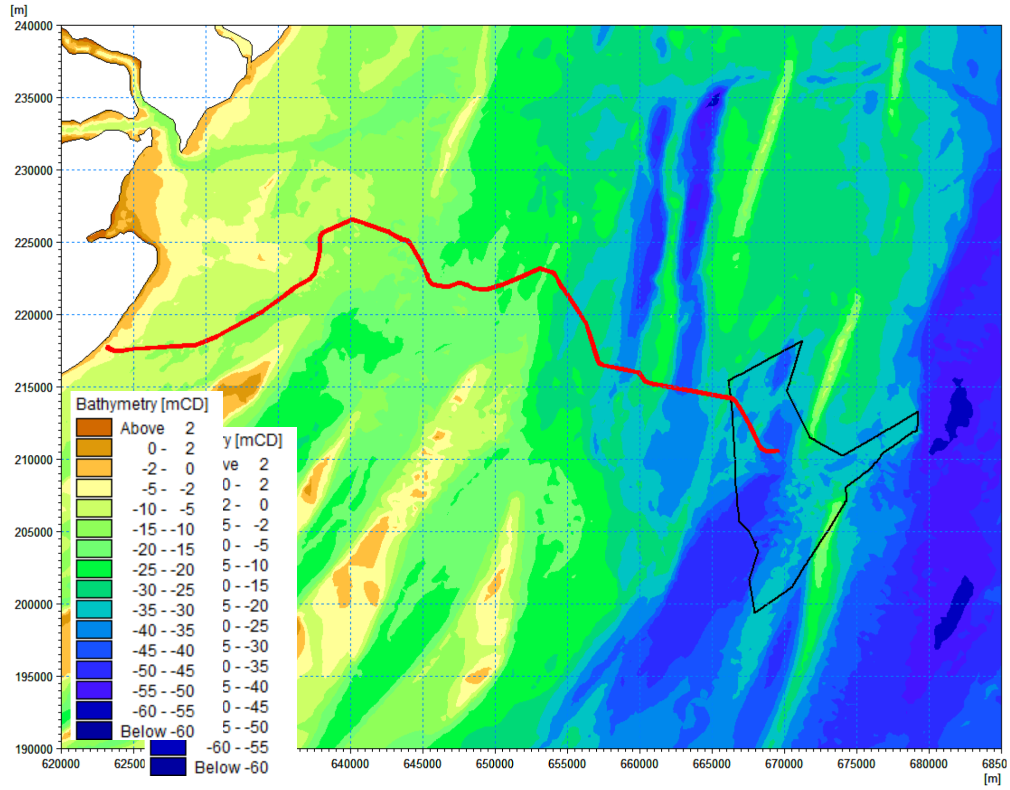


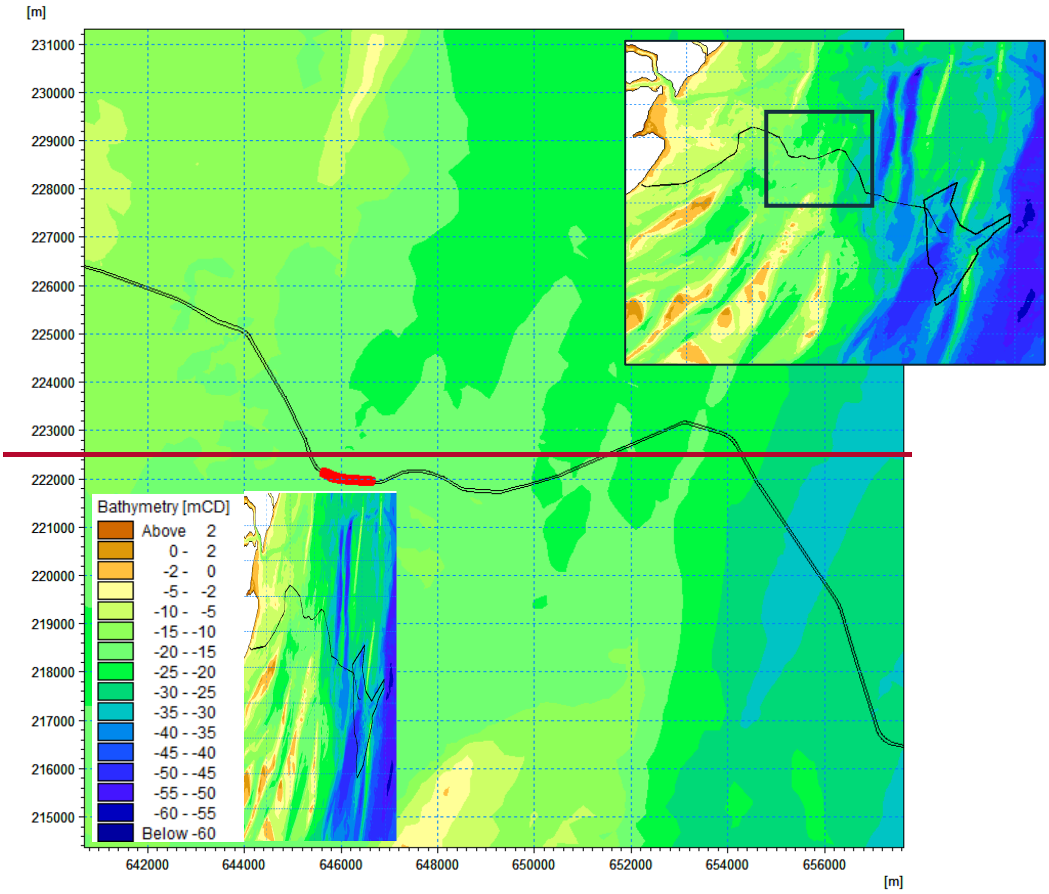
Figure 6-3 Location of indicative offshore export cable trenching activity (red line)

6.6.2 The modelling of the offshore export cable trenching considers:

- A total volume of 75,441 m^3 per cable of seabed material will be dredged during trenching activities along the indicative offshore export cable route.
- The total dredging period for export cable trenching is 21.8 days per cable.
- The sediment release rate of MFE in trenching export cable is 71.9 kg/s and the material is released near the seabed.
- The details of the sediment distribution zone and the particle size distribution are given in Section 5.3.

6.7 Simulation 3 – Dredging at Sunk DWR

6.7.1 The indicative dredging at Sunk DWR is required along the export cable for a total length of 1.04 km per cable as indicated by a red line on Figure 6-4.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Bathymetry [mCD]
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0 - 2
-2 - 0
-5 - -2
-10 - -5
-15 - -10
-20 - -15
-25 - -20
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-35 - -30
-40 - -35
-45 - -40
-50 - -45
-55 - -50
-60 - -55
Below -60

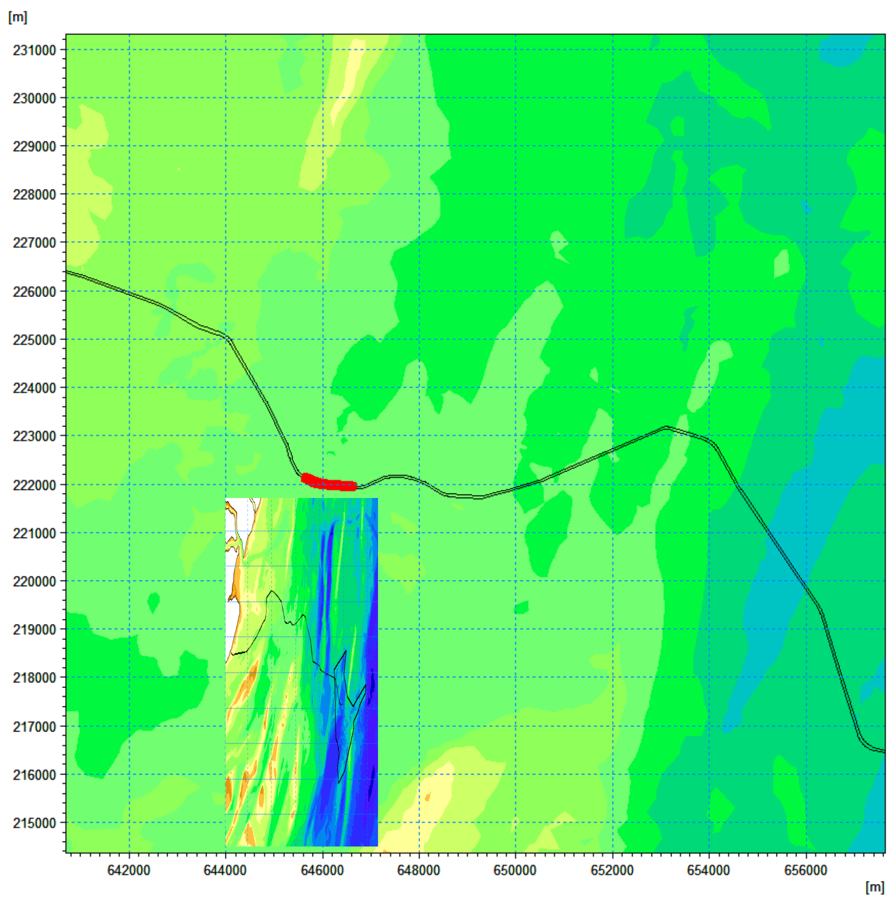


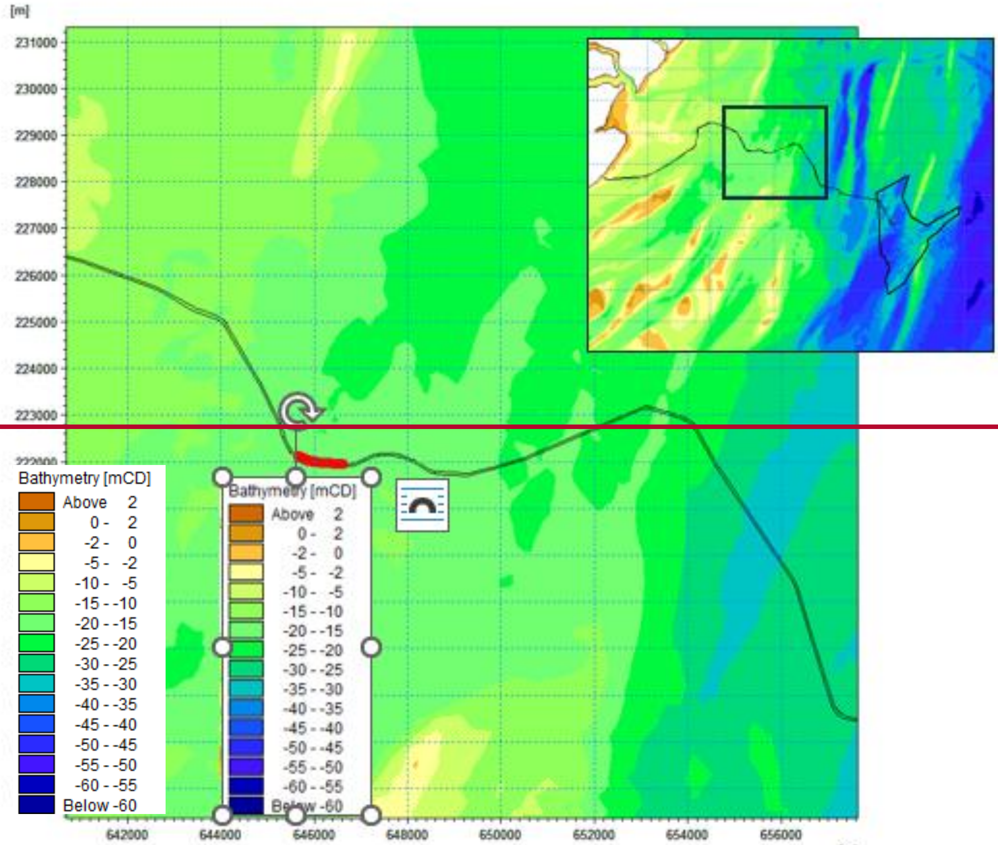
Figure 6-4 Location of dredging at Sunk DWR (red line)

6.7.2 The modelling of the dredging of the Sunk considered:

- A total volume of 68,215 m^3 per cable of seabed material will be dredged during this activity.
- The total dredging period for Sunk dredging is 2 days per cable.
- The sediment release rate of the suction hopper dredger (SHD) is 5.89 kg/s ~~and the material~~.~~a~~ This sediment release rate is ~~released~~based on 15kg sediment loss per cubic metre. Of this volume, 50% is realised near ~~seabed~~the sea bed and 50% at the water surface.
- The dredging activities at Sunk DWR are located in the 'Sandwaves' sediment distribution zone and therefore will be simulated using the sediment composition for this zone. The details of the sediment distribution zones and the particle size distribution are given in Section 5.3.

6.8 Simulation 4 – Dredging at Trinity DWR

6.8.1 The indicative dredging at Trinity DWR is required along the export cable for a total length of 2.19 km per cable as indicated by a red line in Figure 6-5.


[m]
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Bathymetry [mCD]
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-2 - 0
-5 - -2
-10 - -5
-15 - -10
-20 - -15
-25 - -20
-30 - -25
-35 - -30
-40 - -35
-45 - -40
-50 - -45
-55 - -50
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656000
[m]

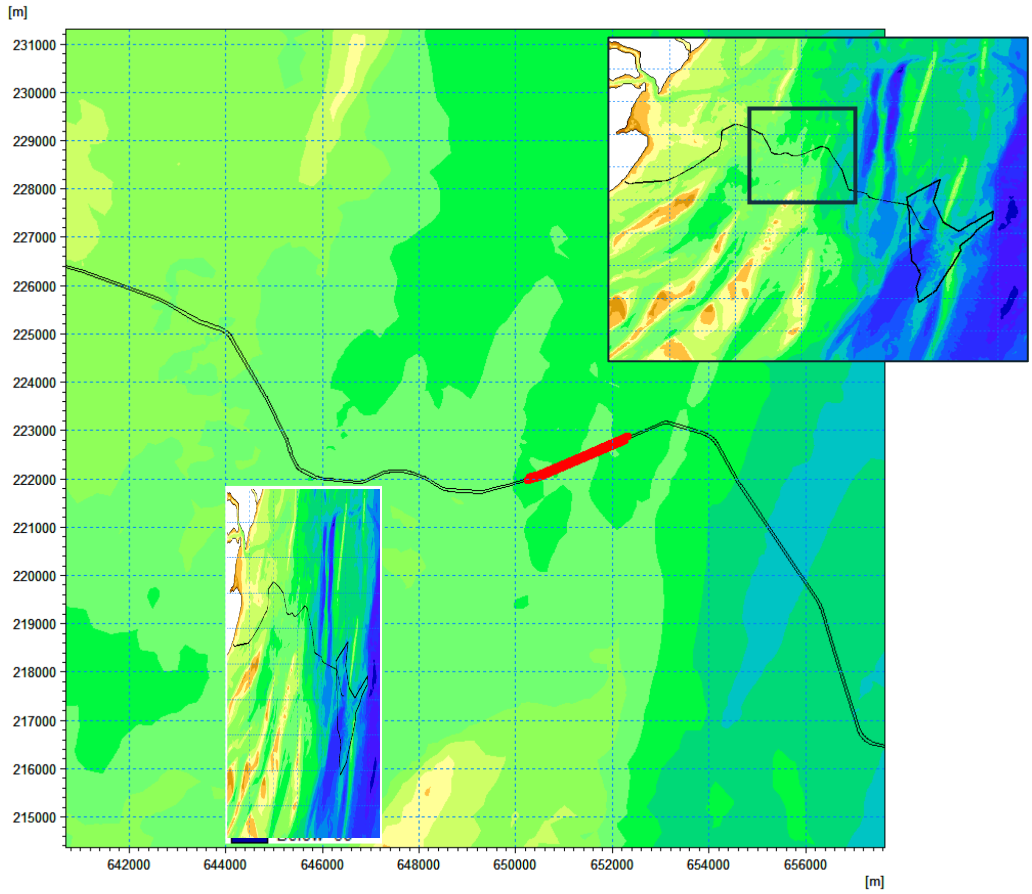


Figure 6-5 Location of dredging at Trinity DWR (red line)

6.8.2 The modelling of the dredging of the Trinity DWR considered:

- An estimated total volume of 86,599 m^3 per cable of seabed material will be dredged during this activity.
- The total dredging period for Trinity dredging is 2.6 days per cable.

6.8.3 The sediment release rate of the suction hopper dredger (SHD) is 5.89 kg/s. This sediment release rate is based on 15kg sediment loss per cubic metre. Of this volume, 50% is realised near the sea bed and 50% at the water surface. The remainer of the dredged material will be stored in the vessel for disposal in other location.

- The dredging activities at Trinity DWR are located in the 'Sandwaves' sediment distribution zone and therefore will be simulated using the sediment composition for this zone. The details of the sediment distribution zones and the particle size distribution are given in Section 5.3.

6.9 Simulation 5 – Drilling for Structures – Smaller WTGs indicative Layout

6.9.1 Up to five of the 57 WTGs and one of the two OCP/OSPs for the smaller WTGs indicative layout might require drilling. For conservative reasons, the 5 WTGs locations closest to the KKE MCZ have been chosen for the simulation. The indicative locations of these WTGs that could require drilling to be installed are shown in Figure 6-6.

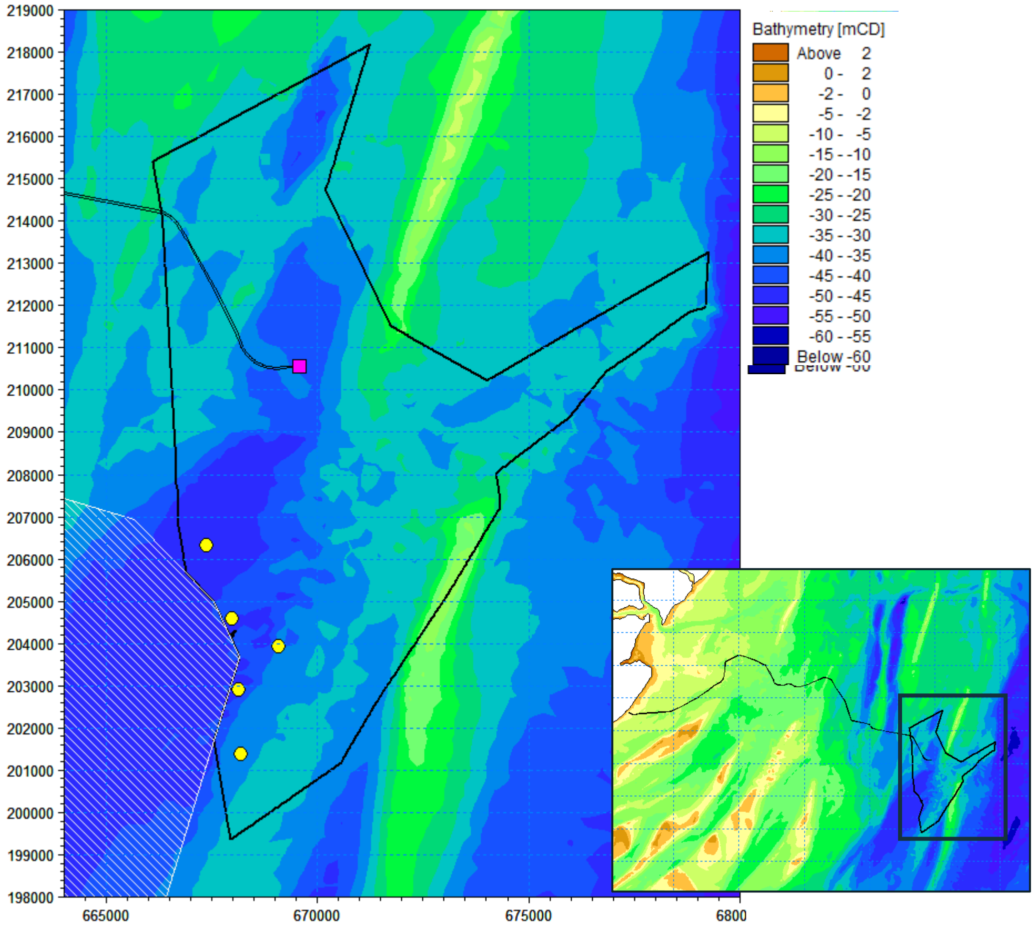


Figure 6-6 Location of drilling activities for array structures – smaller WTGs indicative Layout (purple square = OCP/OSP, yellow dot = WTG, white hatch = MCZ)

6.9.2 A total of 20,145 m^3 of seabed material will be released during the drilling activity for the five WTGs, and 11,451 m^3 for the OCP/OSP.

6.9.3 The total drilling period for the smaller WTGs indicative layout is 0.2 days.

6.9.4 The sediment release rate of the drill is 6.0 kg/s and the material is released evenly throughout the water column.

6.9.5 The drilling activities for the smaller WTGs structures are located in two of the five sediment distribution zones, namely 'Plain bed' and 'Sandwaves'. Therefore the simulation will use the sediment composition for both of these zones. The details of the sediment distribution zones and the particle size distribution are given in Section 5.3.

6.10 Simulation 6 – Drilling for Structures – Larger WTGs Indicative Layout

6.10.1 Up to three of the 34 WTGs and one of the two OCP/OSPs for the larger WTGs indicative layout might require drilling. For conservative reasons, the 3 WTGs locations closest to the MCZ have been chosen in the simulation. The locations of the WTGs that could require drilling activities are shown in Figure 6-7.

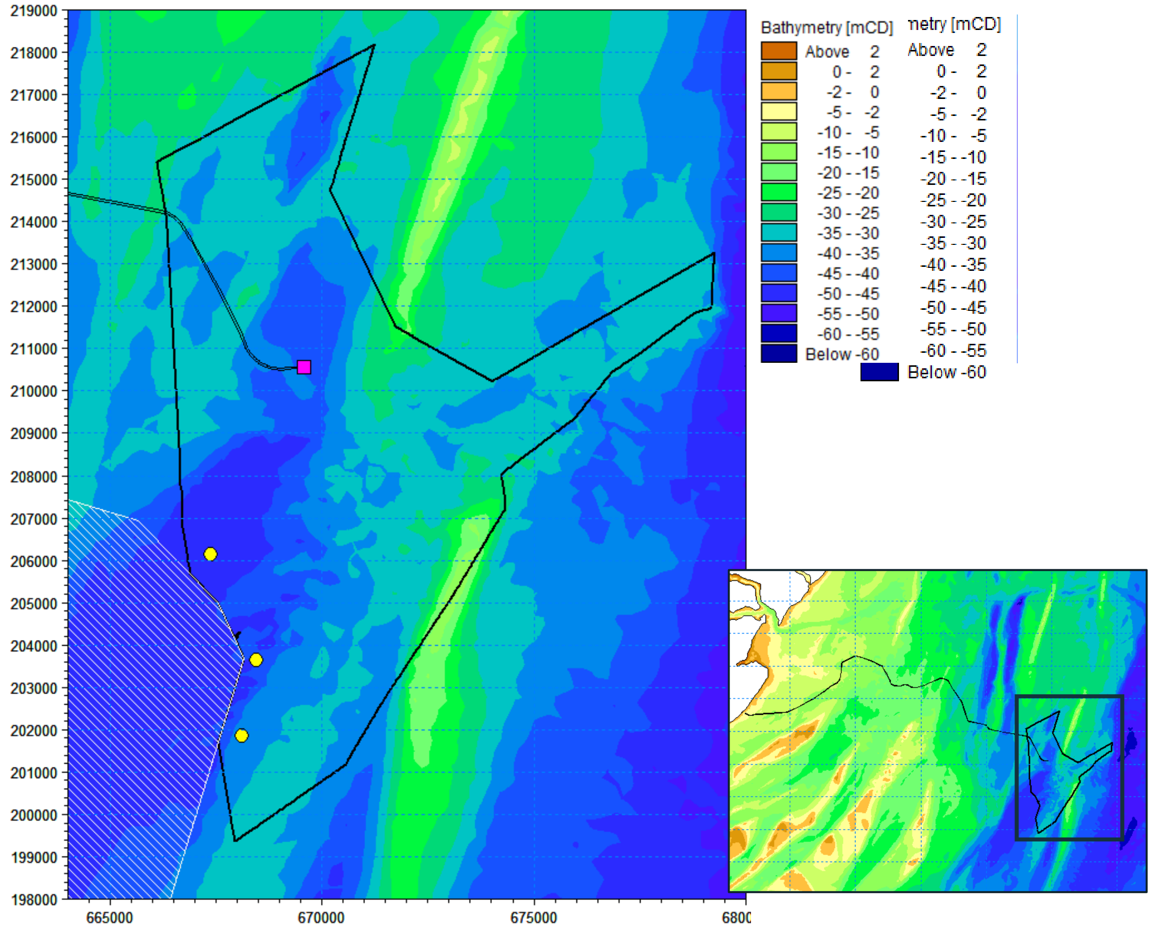


Figure 6-7 Location of drilling activities for array structures – larger WTGs indicative Layout (purple square = OCP/OSP, yellow dot = WTGs, white hatch = MCZ)

6.10.2 A total of 34,728 m^3 of seabed material will be released during the drilling activity for the three WTGs, and 11,451 m^3 for the OCP/OSP.

6.10.3 The total drilling period for the larger WTGs indicative layout is 0.3 days.

6.10.4 The sediment release rate of the drill is 6.0 kg/s and the material is released evenly throughout the water column.

6.10.5 The drilling activities for the larger WTGs structures are located in two of the five sediment distribution zones, namely 'Plain bed' and 'Sandwaves'. Therefore the simulation will use the sediment composition for both of these zones. The details of the sediment distribution zones, and the particle size distribution are given in Section 5.3.

6.11 Simulation 7 – Seabed Preparation for Structures – Smaller WTGs Indicative Layout

6.11.1 Up to 37 of the 57 WTGs and one of the two OCP/OSPs might require seabed preparation. The indicative locations of the WTGs that expected to require ~~se~~ seabed preparation are shown in Figure 6-8.

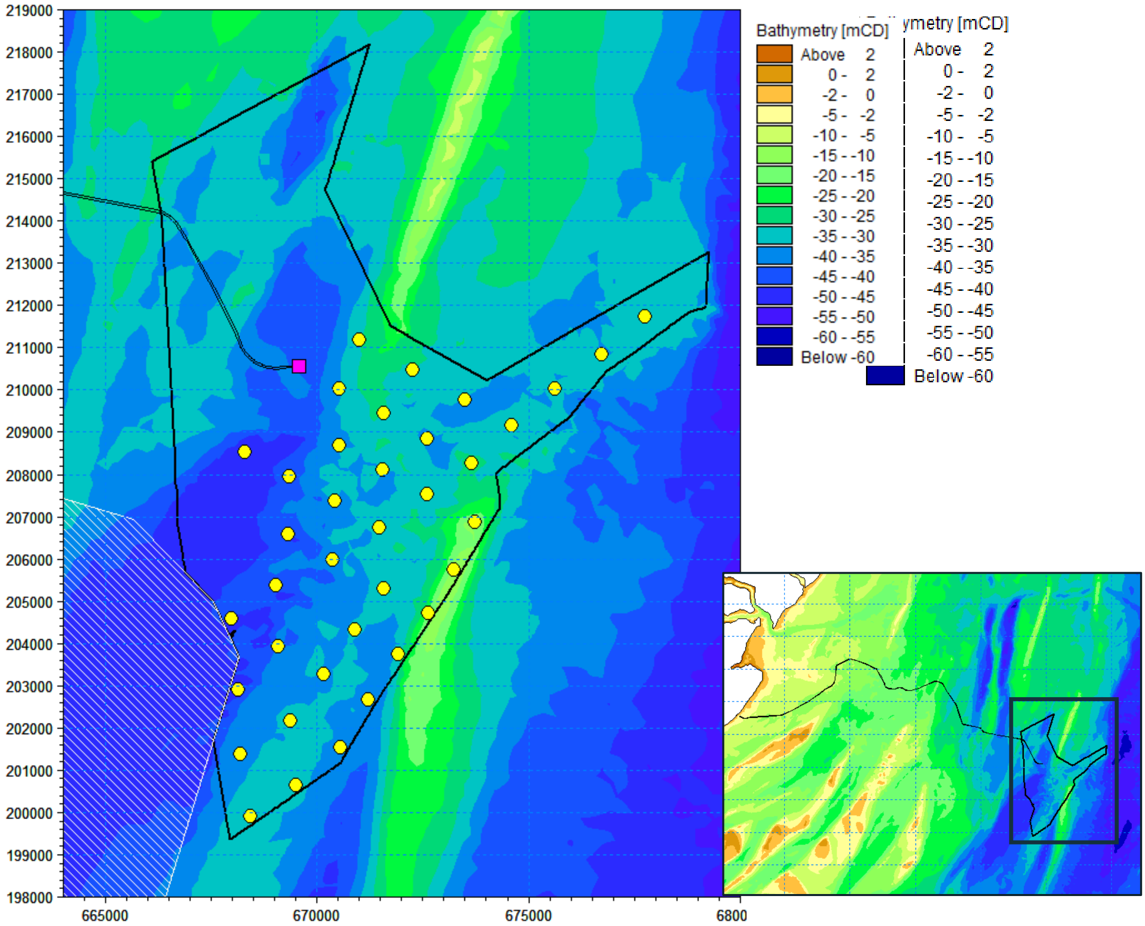


Figure 6-8 Location of seabed preparation activities for array structures – smaller WTGs indicative Layout
(purple square = OCP/OSP, yellow dot = WTGs, white hatch = MCZ)

6.11.2 A total of 28,125 m^3 of seabed material will be released during the seabed preparation activity for the 37 WTGs, and 38,485 m^3 for the OCP/OSP.

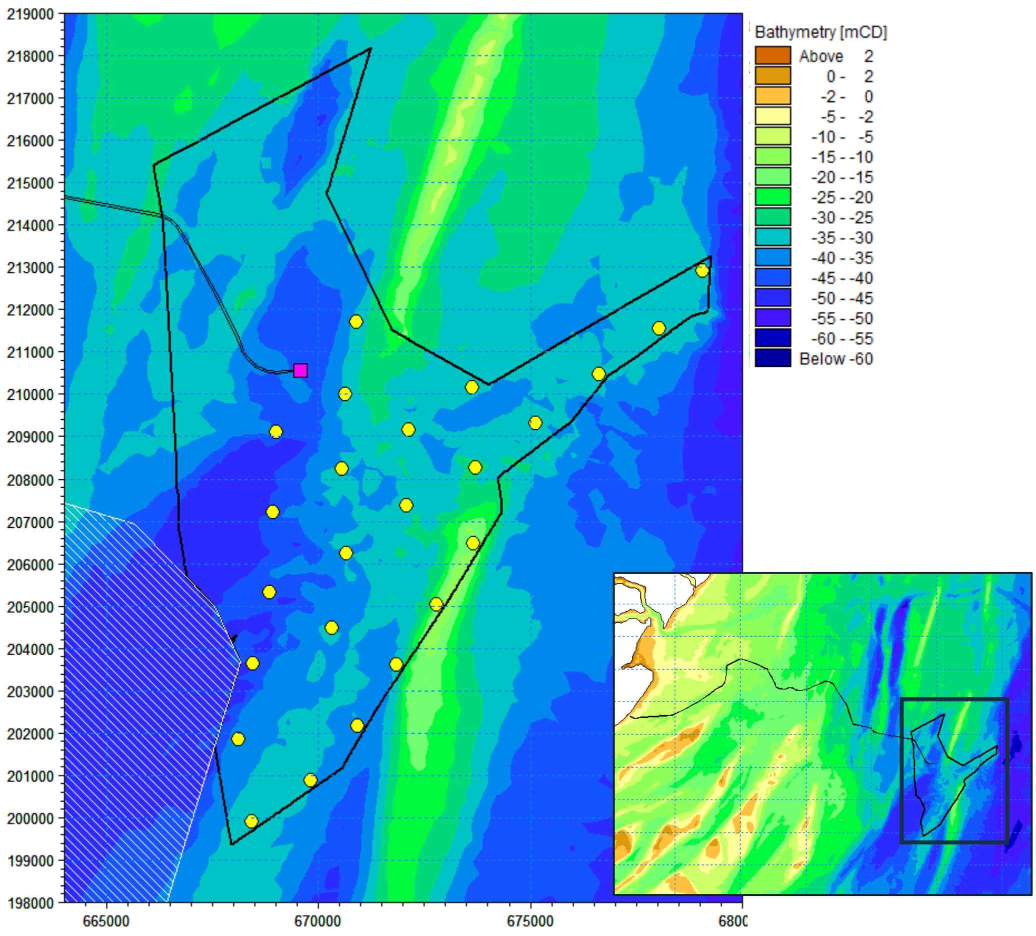
6.11.3 The total seabed preparation period for the smaller WTGs indicative layout is 0.1 days.

6.11.4 The sediment release rate of the mass flow excavator (MFE) is 21,250 kg/s and the material is released near the seabed.

6.11.5 The seabed preparation activities for the smaller WTGs structures are located in two of the five sediment distribution zones, namely 'Plain bed' and 'Sandwaves'. Therefore, the simulation will use the sediment composition for both of these zones. The details of the sediment distribution zones and the particle size distribution are given in Section 5.3.

6.12 Simulation 8 – Seabed Preparation for Structures – Larger WTGs Indicative Layout

6.12.1 Up to 24 of the 34 WTGs and one of the two OCP/OSPs for the larger WTGs indicative layout might require seabed preparation. The indicative locations of the WTGs expected to require seabed preparation are shown in Figure 6-9.


Bathymetry [mCD]
Above 2
0 - 2
-2 - 0
-5 - -2
-10 - -5
-15 - -10
-20 - -15
-25 - -20
-30 - -25
-35 - -30
-40 - -35
-45 - -40
-50 - -45
-55 - -50
-60 - -55
Below -60
219000
218000
217000
216000
215000
214000
213000
212000
211000
210000
209000
208000
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665000
670000
675000
6800

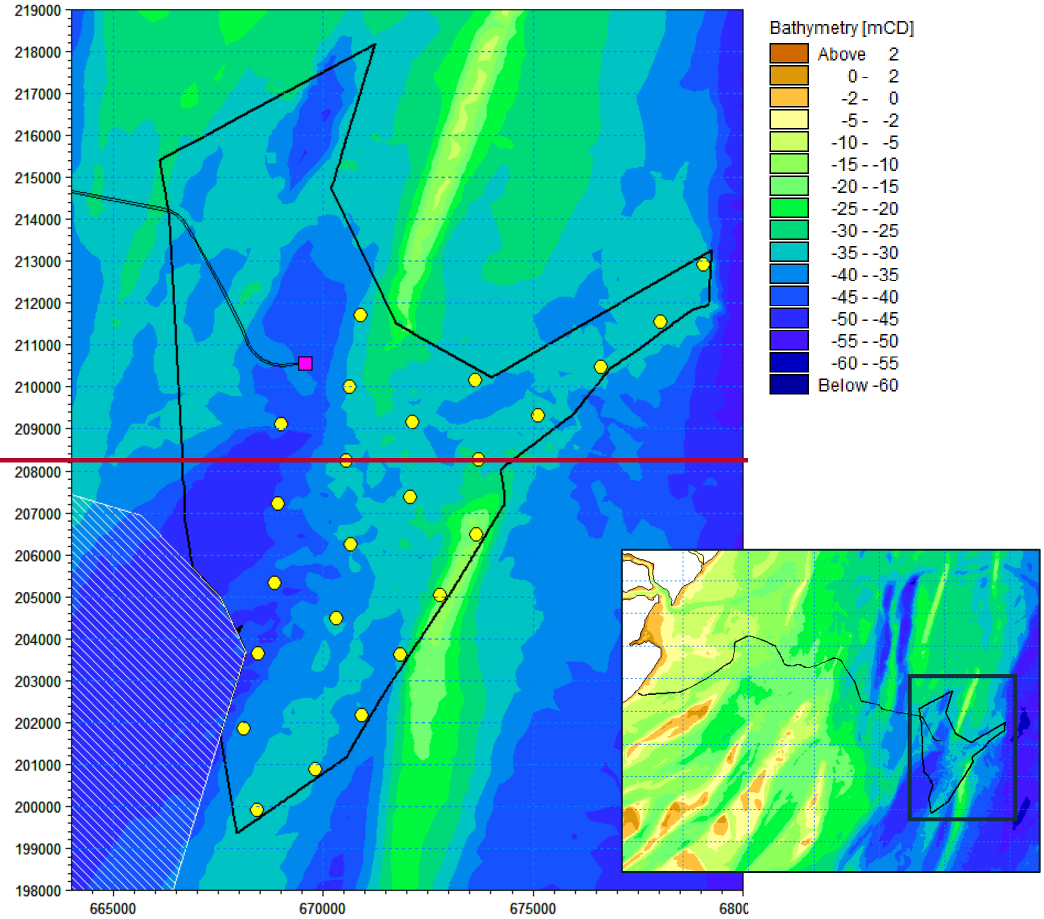

Figure 6-9. Location of seabed preparation activities for array structures – larger WTGs indicative Layout
(purple square = OCP/OSP, yellow dot = WTGs, white hatch = MCZ)

6.12.2 A total of 35,280 m^3 of seabed material will be released during the seabed preparation activity for the 24 WTGs, and 38,485 m^3 for the OCP/OSP.

6.12.3 The total seabed preparation period for the larger WTGs indicative layout is 0.1 days.

6.12.4 The sediment release rate of the mass flow excavator (MFE) is 21,250 kg/s and the material is released near the seabed.

6.12.5 The seabed preparation activities for the larger WTGs structures are located in two of the five sediment distribution zones, namely ‘Plain bed’ and ‘Sandwaves’. Therefore, the simulation will use the sediment composition for both of these zones. The details of the sediment distribution zones, and the particle size distribution are given in Section 5.3.

6.13 Simulation 9 –Array Cable Levelling

6.13.1 Levelling through sandwaves (SW) and megaripples (MR) along the array cables could be required from the OCP/OSP location along each of the 12 WTGs lines. Figure 6-10Figure 6-10 shows indicative locations where array cable levelling activity might be required; where areas through megaripples are shown as thick purple lines and areas through sandwaves are shown as thick black lines.

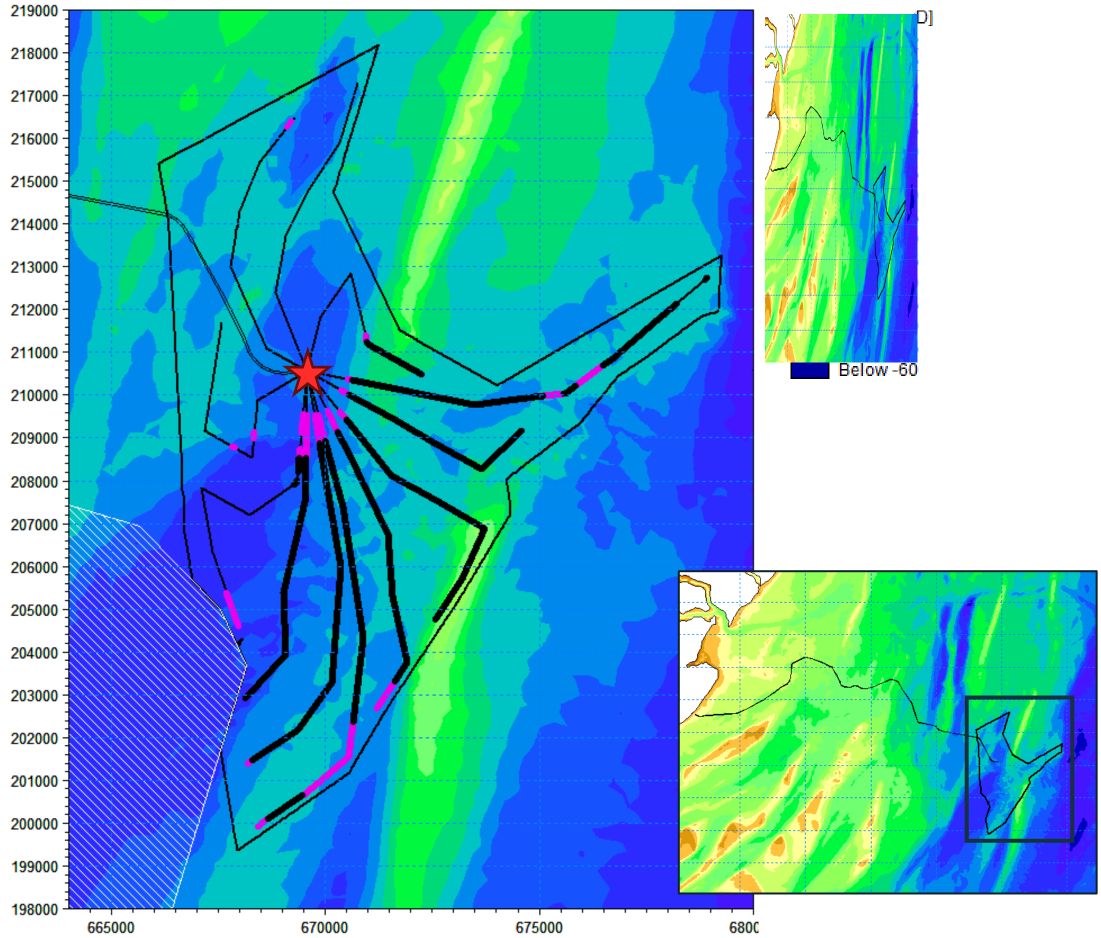

Figure 6-10 Location of array cable levelling activity
(thick purple line = MR, thick black line = SW, red star = OCP/OSP location, white hatch = MCZ)

6.13.2 A total length of 9.98km of levelling through megaripples, and 48.9km levelling through sandwaves are estimated for one cable.

6.13.3 For a single cable the total of 1,756,480 m^3 of seabed material will be dredged during levelling activities for megaripples, and 20,212,220 m^3 for sandwaves.

6.13.4 The total dredging period for levelling both bedforms is 20.3 days using a mass flow excavator (MFE).

6.13.5 The sediment release rate of the mass flow excavator (MFE) is 21,250 kg/s and the material is released near the seabed.

6.13.6 The array cable levelling activities are located in two of the five sediment distribution zones, namely 'Plain bed' and 'Sandwaves'. Therefore the simulation will use the sediment composition for both of these zones. The details of the sediment distribution zones and the particle size distribution are given in Section 5.3.

6.14 Simulation 10 –Array Cable Trenching

6.14.1 The required total length of array cable trenching is 170 km as shown in Figure 6-11.

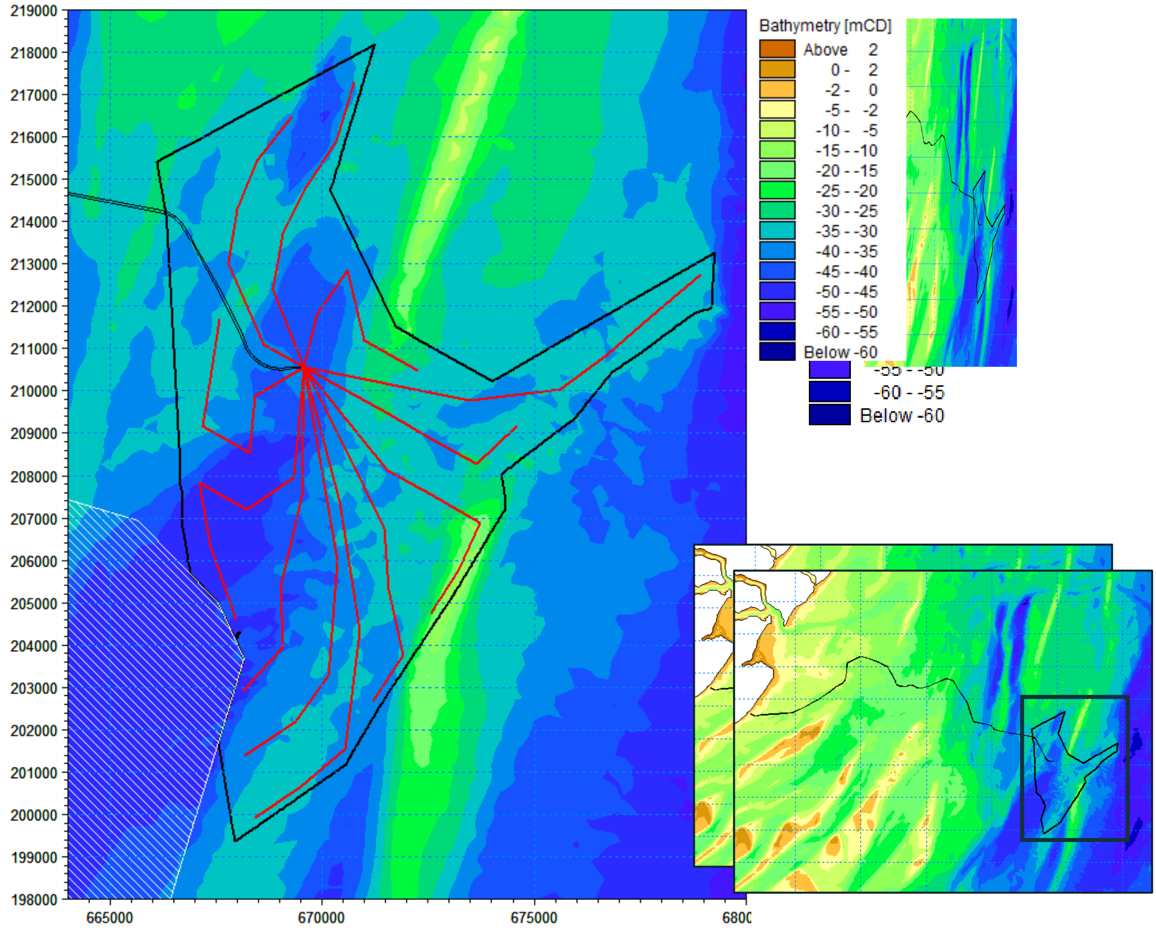

Figure 6-11 Location of array cable trenching activity (red line) white hatch = MCZ

6.14.2 The modelling considers that for a single cable a worst case volume of 117,798 m^3 of seabed material would be dredged during trenching activities.

6.14.3 The total dredging period for trenching of two cables is 34.1 days.

6.14.4 The sediment release rate of the mass flow excavator (MFE) is 68.0 kg/s and the material is released near the seabed.

6.14.5 The array cable trenching activities are located in two of the five sediment distribution zones, namely 'Plain bed' and 'Sandwaves'. Therefore the simulation will use the sediment composition for both of these zones. The details of the sediment distribution zones and the particle size distribution are given in Section 5.3.

6.15 Simulation 11 and 12 –Array Disposal

6.15.1 The setup for simulations 11 and 12 is the same apart from the sediment distribution used in the model. Simulation 11 uses the sediment composition of ‘Zone 1 & 3’ (dominated by finer material) and simulation 12 uses the sediment composition of ‘Sandwaves’ (dominated by medium sand) as specified in Section 5.3.

6.15.2 A total volume of 28,400m^3 is released at a worst case location for sediment dispersal (shallow location) at the northern end of the array area as shown by a red point in Figure 6-12.

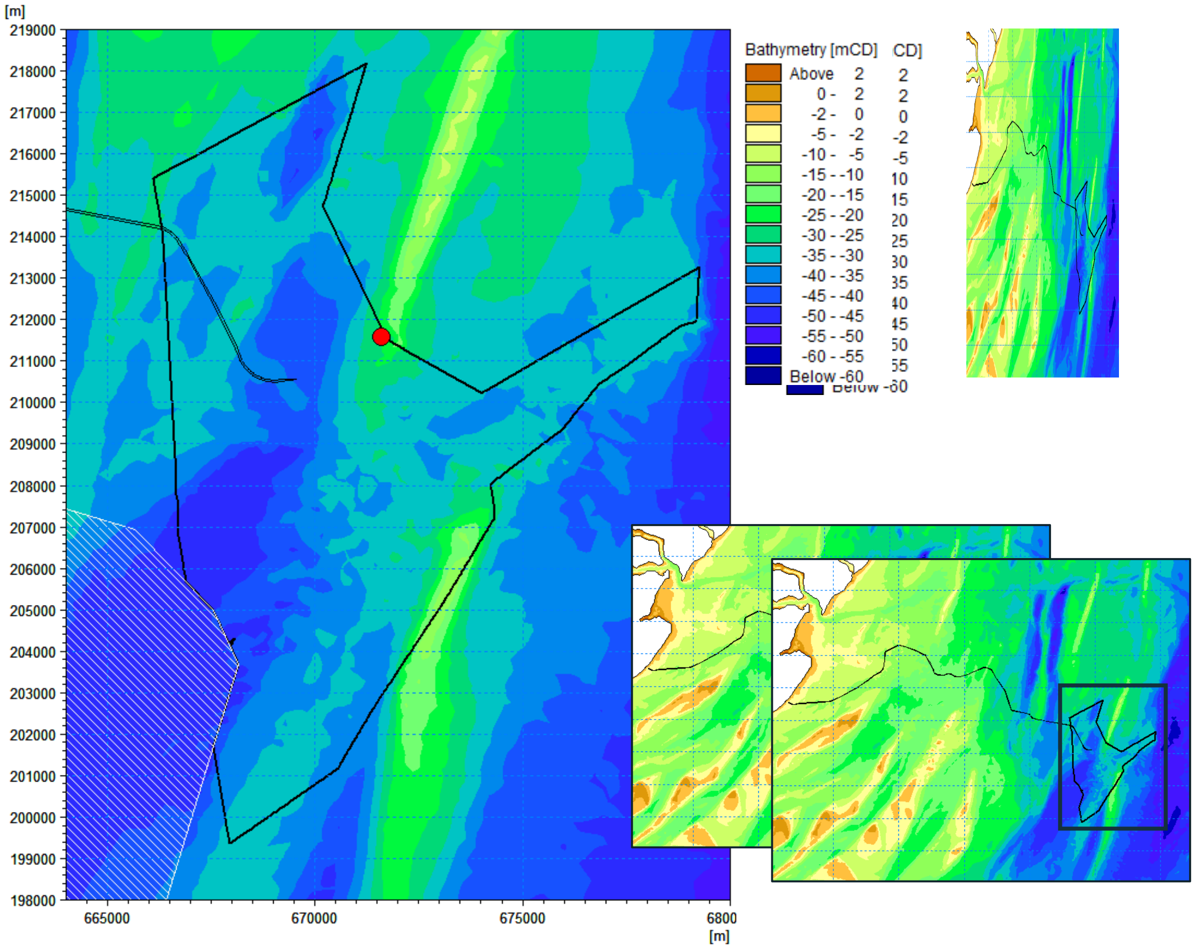

Figure 6-12 Location of sediment disposal (white hatched area = KKE MCZ)

6.15.3 Figure 6-13 and Figure 6-14 present:

- Slack water near high water during neap tide,
- Slack water near low water during neap tide,
- Peak flood during spring tide,
- Peak ebb during spring tide.

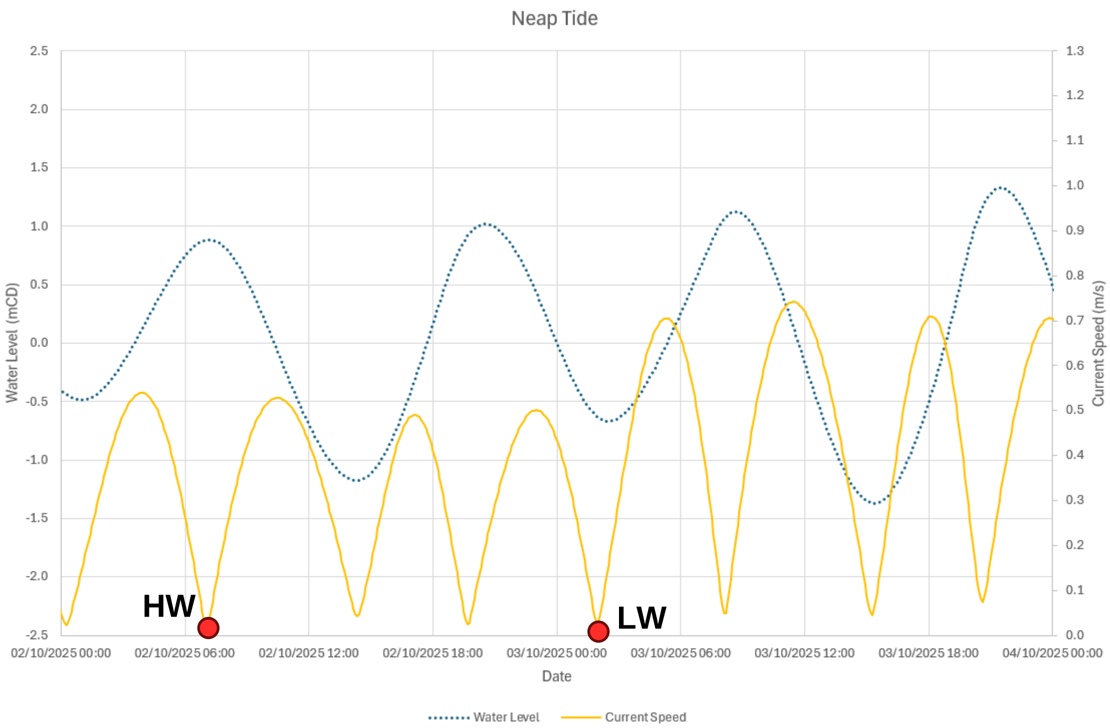

Figure 6-13. Slack water near high water (HW) and low water (LW) during neap tide indicated by red point

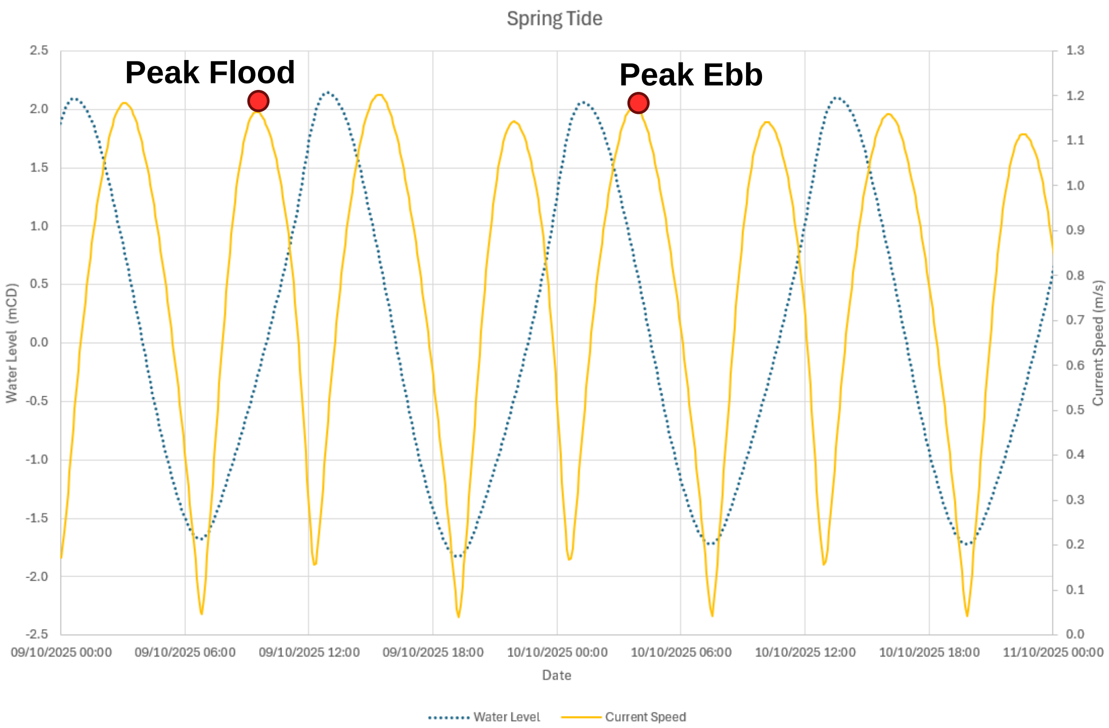

Figure 6-14 Peak flood and peak ebb during spring tide indicated by red point

6.15.4 The total release time for each tide moment is 10 minutes.

6.15.5 The sediment release rate of the disposing dredger is 80,466.67 kg/s and the material is released at the water surface.

6.16 Simulation 13 – Dredging at Pilot Boarding Area

6.16.1 The indicative dredging at the Pilot Boarding Area is required along the Offshore export cable for a total length of 1.1 km per cable as indicated by a red line on Figure 6-15-.

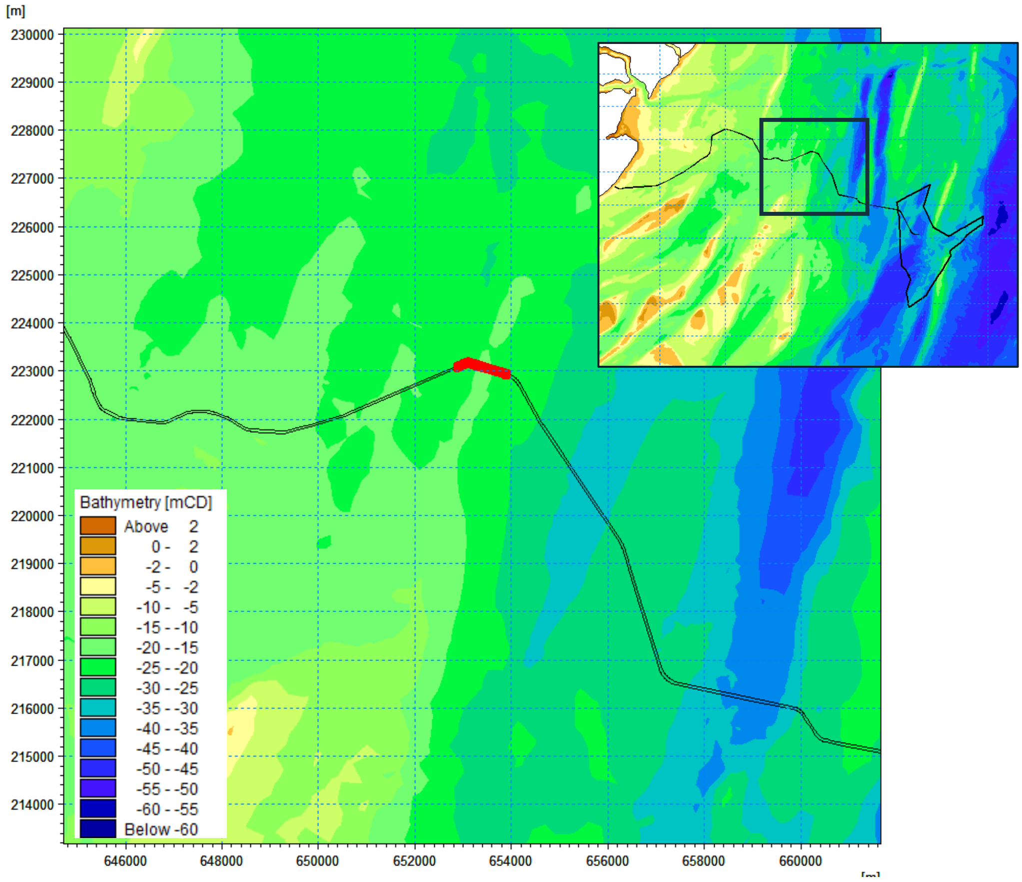

Figure 6-15 **Location of dredging at Pilot Boarding Area (red line)**

6.16.2 The modelling of the dredging of the Pilot Boarding Area considered:

- A total volume of 68,219 m^3 per cable of seabed material will be dredged during this activity.
- The total dredging period for Pilot Boarding Area dredging is circa 2 days per cable. The size of the dredger vessels and transit time to disposal location will influence the total duration of the works.
- The sediment release rate of the suction hopper dredger (SHD) is 5.89 kg/s and the material is released 50% near seabed and 50% at the water surface.

- The dredging activities at Pilot Boarding Area are located in the 'Zone 2' sediment distribution zone and therefore will be simulated using the sediment composition for this zone. The details of the sediment distribution zones and the particle size distribution are given in Section 5.3.

6.15.6

7 DISPERSION MODEL RESULTS

7.1 Introduction

7.1.1 This section of the report presents the dispersion model results for all ~~ten~~ eleven proposed construction activities and two proposed disposal activities (modelled as separate simulations) that have been described in Section 5. For each simulation the model results are shown as

- maximum suspended sediment concentration contours showing the maximum at any one time during the entire model duration,
- time series of maximum suspended sediment concentration throughout the operational activities at points of interest, and ~~i.e. near the designated sites and/or in areas of higher SSC concentrations, and~~
- total sediment deposition thickness contours at the end of the simulation.

7.1.2 On the maximum suspended sediment concentrations plots, the levels greater than 5 mg/l will be shown. This value has been chosen because it is well below the 15 mg/l ambient level defined in the coastal processes assessment.

7.1.3 On the total sediment deposition thickness plots, levels greater than 5cm will be shown. This value has been chosen because it is the benchmark for a 'light' deposition event as defined by Marine Biological Association (MarLIN).

7.1.4 Each contour plot shows the dispersion model results and for geographical context the following (as relevant to each simulation):

- North Falls OWF array area as black outline,
- North Falls OWF indicative offshore export cable as black lines,
- North Falls OWF WTGs (black circle) and OCP/OSP location (black square) for smaller WTGs or larger WTGs indicatives layouts,
- North Falls OWF array cables for smaller WTGs indicative layout as black lines,
- Proposed construction activities (symbology varies for each simulation, refer to relevant report section for details),
- MLS SAC as vertical hashed area,
- KKE MCZ as horizontal hashed area.

7.2 Simulation 1 Results –Offshore Export Cable Levelling

7.2.1 Figure 7-1 to Figure 7-3 show the maximum suspended sediment concentration (SSC) above 5 mg/l which occurs during offshore export cable levelling activities near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The maximum SSC extends in a north-east to south-west direction from the export cable following the dominant current direction.

7.2.2 Figure 7-1 Figure 7-1 shows the maximum SSC plume near the seabed that extends from the indicative offshore export cable route north-eastwards by between 13 km to 20 km, and south-westwards by between 7 km and 20 km, albeit this extent includes large areas of very low SSC levels. The maximum SSC that is greater than 500 mg/l extends up to 12 km.

7.2.3 Figure 7-2 Figure 7-2 shows the maximum SSC plume in the middle of the water column that extends broadly as far as near the seabed, but maximum SSC greater than 500 mg/l are considerably smaller, extending only by up to 11 km from the export cable.

7.2.4 Figure 7-3 – shows the maximum SSC plume near the water surface that extends broadly as far as near the seabed, but maximum SSC greater than 500 mg/l are further reduced and extending only by up to 10 km in a narrow band from the export cable.

7.2.5 Figure 7-4 and Figure 7-5 - show the time series data of suspended sediment concentration during offshore export cable levelling near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively, that are shown as red points on Figure 7-1 to Figure 7-3-. The peak of the suspended sediment concentration at P1 (~~near~~in relation to the SAC) exceeds 100 mg/l and reach levels just below 400 mg/l for approx. one hour near the seabed, whilst the SSC levels near the water surface stay below 20 mg/l during the peak (lasting less than one hour) and below 10 mg/l during the rest of the model duration. At P2 the SSC exceeds 500 mg/l for approx. 1 to 3 hours near the seabed, whilst the SSC levels near the water surface are below 40 mg/l during the peak which lasts only 20 minutes.

7.2.6 Figure 7-6 - shows the total sediment deposition thickness greater than 5cm which occurs during offshore export cable levelling activities. The sediment deposition occurs mainly along the indicative offshore export cable route itself, localised where the levelling activities have taken place. The maximum thickness of sediment deposition along the indicative offshore export cable route is 1.8 m with only some isolated spots where the thickness is greater than 3.0 m. The average deposition along the cable corridor is between 0.4m and 0.6m. There are a couple of distinct elongated shapes that extend in parallel in a north-eastward and south-westward direction for up to 9km from the cable corridor that show depositions between 5cm and 20cm, likely caused by stronger currents in this area.

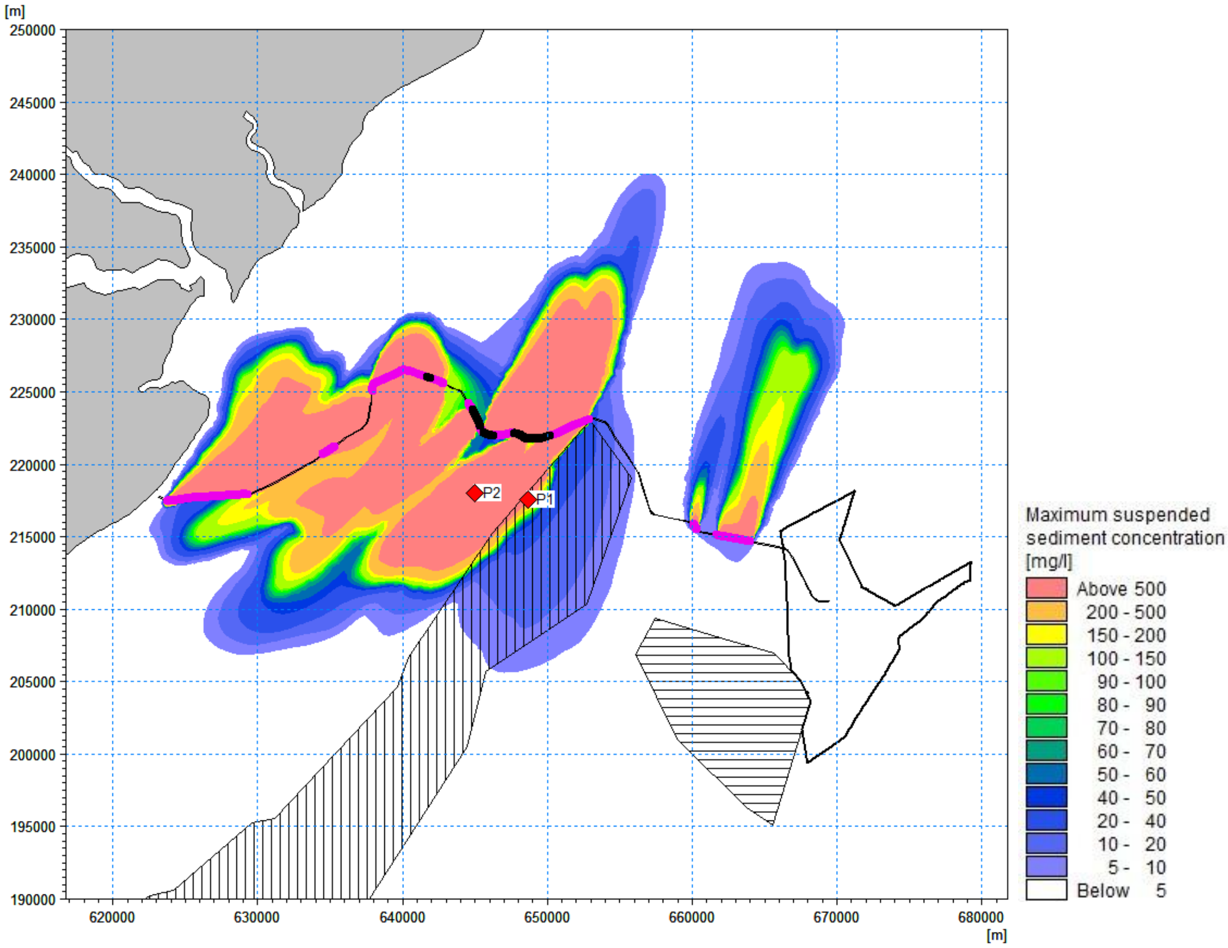

Figure 7-1 Maximum suspended sediment concentration during an indicative offshore export cable levelling near the seabed
(thick purple line = MR, thick black line = SW, red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

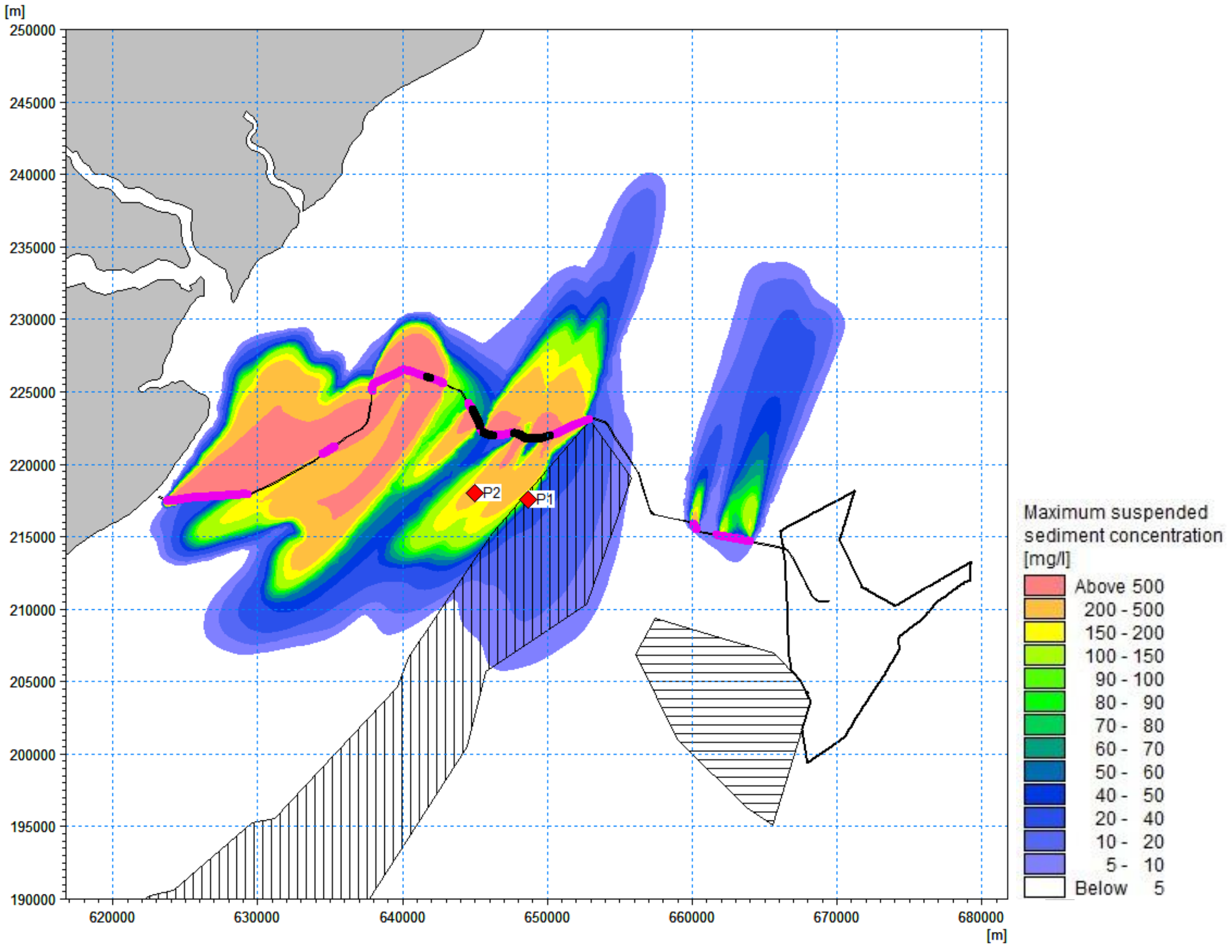

Figure 7-2 Maximum suspended sediment concentration during and indicative offshore export cable levelling in the middle of water column (thick purple line = MR, thick black line = SW, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ))

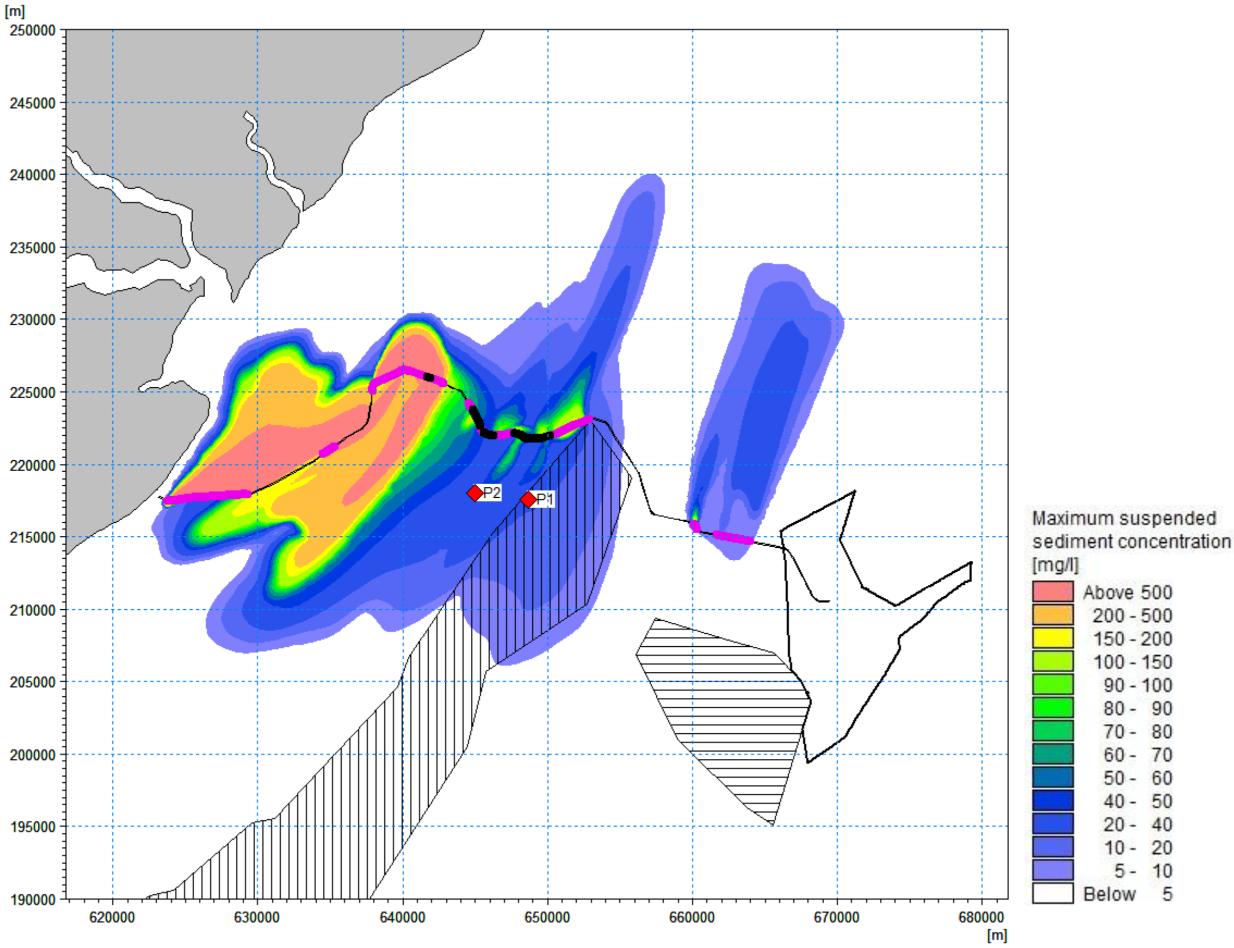

Figure 7-3 Maximum suspended sediment concentration during an indicative offshore export cable levelling near the water surface (thick purple line = MR, thick black line = SW, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ))

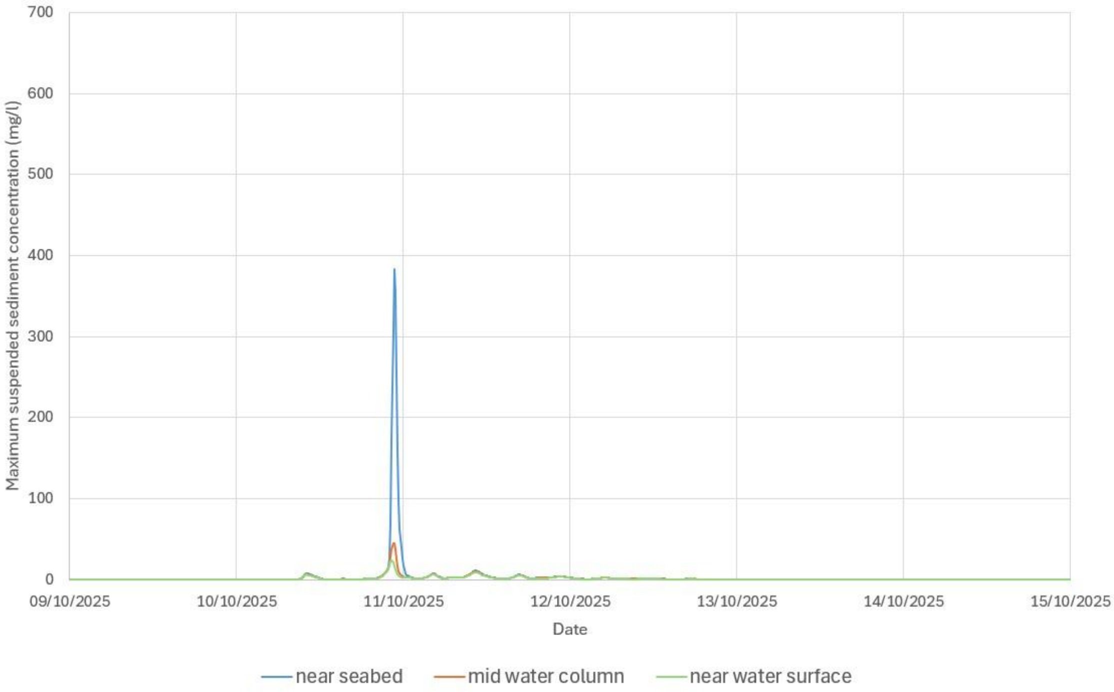

Figure 7-4 Time series of suspended sediment concentration at P1 during indicative offshore export cable levelling for seabed, middle of water column and near water surface (inside SAC)

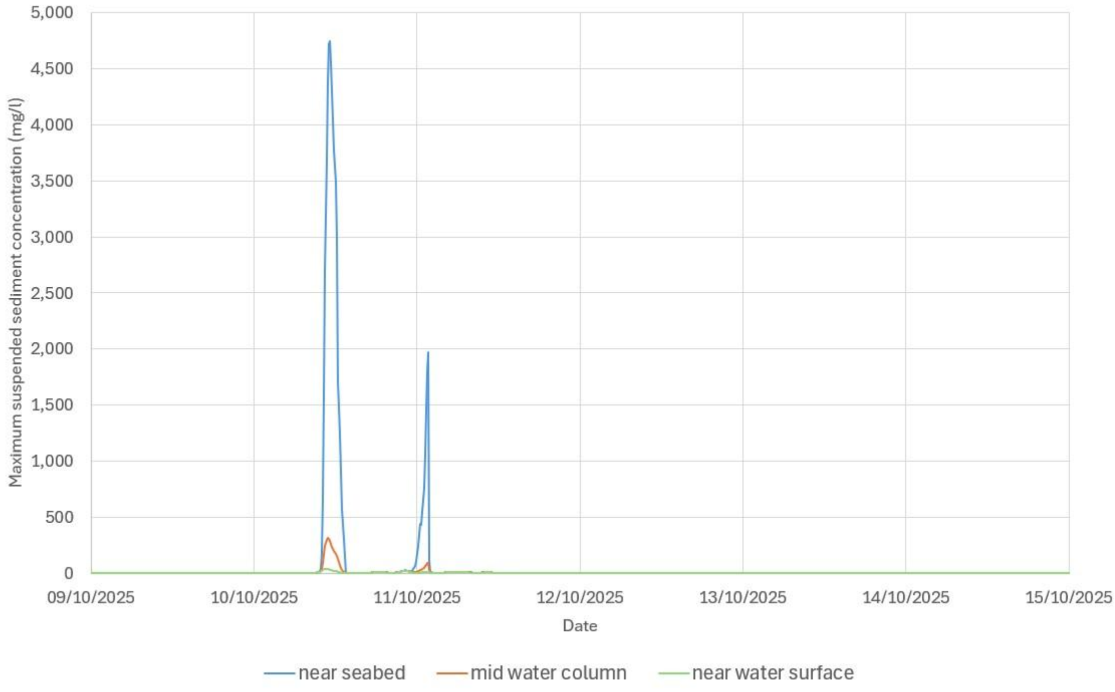

Figure 7-5 Time series of suspended sediment concentration at P2 during indicative offshore export cable levelling near seabed, middle of water column and near water surface

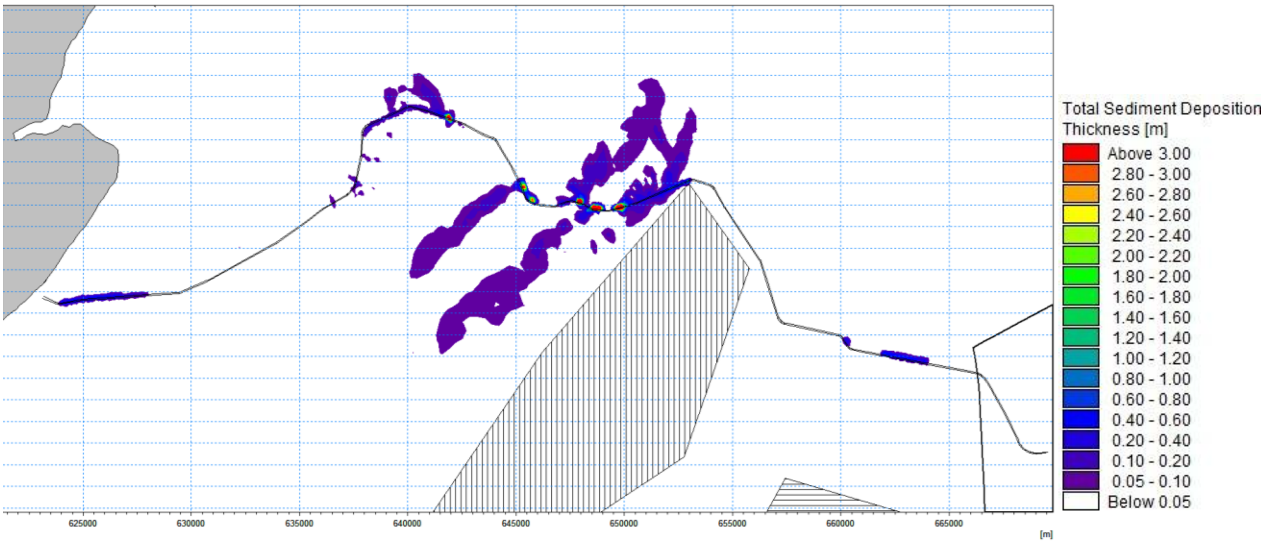

Figure 7-6 Total sediment deposition thickness during export cable levelling operations (vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

7.3 Simulation 2 Results – Offshore Export Cable Trenching

7.3.1 Figure 7-7 to Figure 7-9 –show the maximum suspended sediment concentration above 5 mg/l which occurs during export cable trenching activities near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The maximum SSC extends in a north-east to south-west direction from the export cable following the dominant current direction.

7.3.2 Figure 7-7 shows the maximum SSC plume near the seabed that extends from the export cable by up to 7 km either side, albeit this extent includes large areas of SSC levels below 30 mg/l. The maximum SSC that is greater than 500 mg/l is confined to a couple of very small spots along the offshore cable corridor. The SSC levels along the cable corridor are between 100 and <500 mg/l.

7.3.3 Figure 7-8 shows the maximum SSC plume in the middle of the water column that is considerably reduced in size compared to that near the seabed and occurs predominantly from the nearshore zone to halfway along the length of the export cable. The maximum SSC on average is less than 40 mg/l.

7.3.4 Figure 7-9 shows the maximum SSC plume near the water surface that is not only reduced in size similar to the extent in the middle of the water column but also shows maximum SSC levels of less than 10 mg/l to 20 mg/l.

7.3.5 Figure 7-10 –and –Figure 7-11 show the time series data of suspended sediment concentration during export cable trenching near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively, that are shown as red points on Figure 7-7 -to . The SSC at P1 (near the SAC) is below 25 mg/l throughout the water column and lasts less than two hours, SSC levels near the water surface are below 5 mg/l. The SSC at P2 only exceeds 15 mg/l near the seabed for approx. 8 hours with peak SSC levels at approx. 390 mg/l (1 hour), and in the middle of the water column for about 2 hours, SSC near the water surface is below 15 mg/l.

7.3.6 Figure 7-12 shows the total sediment deposition thickness greater than 5cm which occurs during export cable trenching activities. All sediment deposition occurs within the export cable corridor and is <5cm.

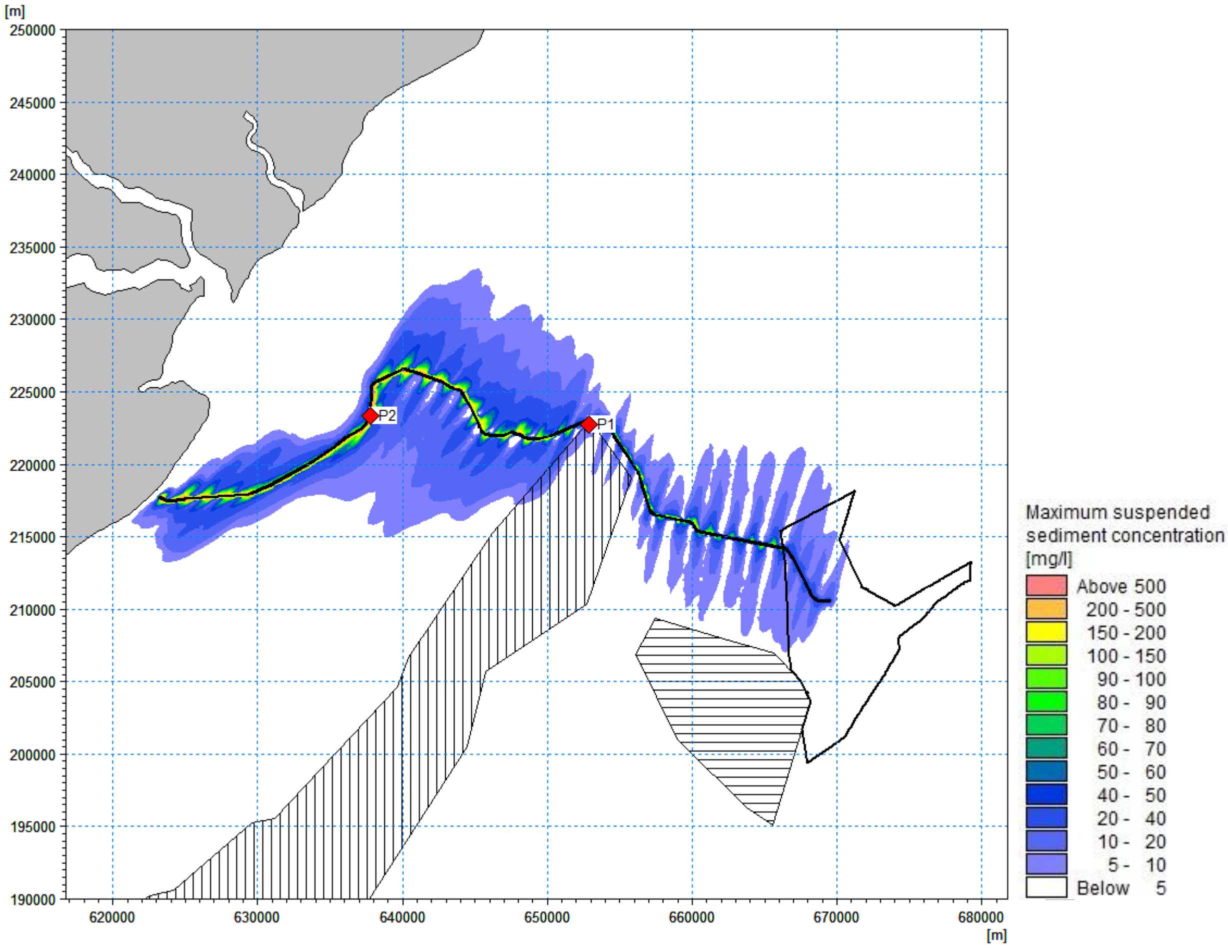

Figure 7-7 Maximum suspended sediment concentration during offshore export cable trenching operations occurring near the seabed (red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

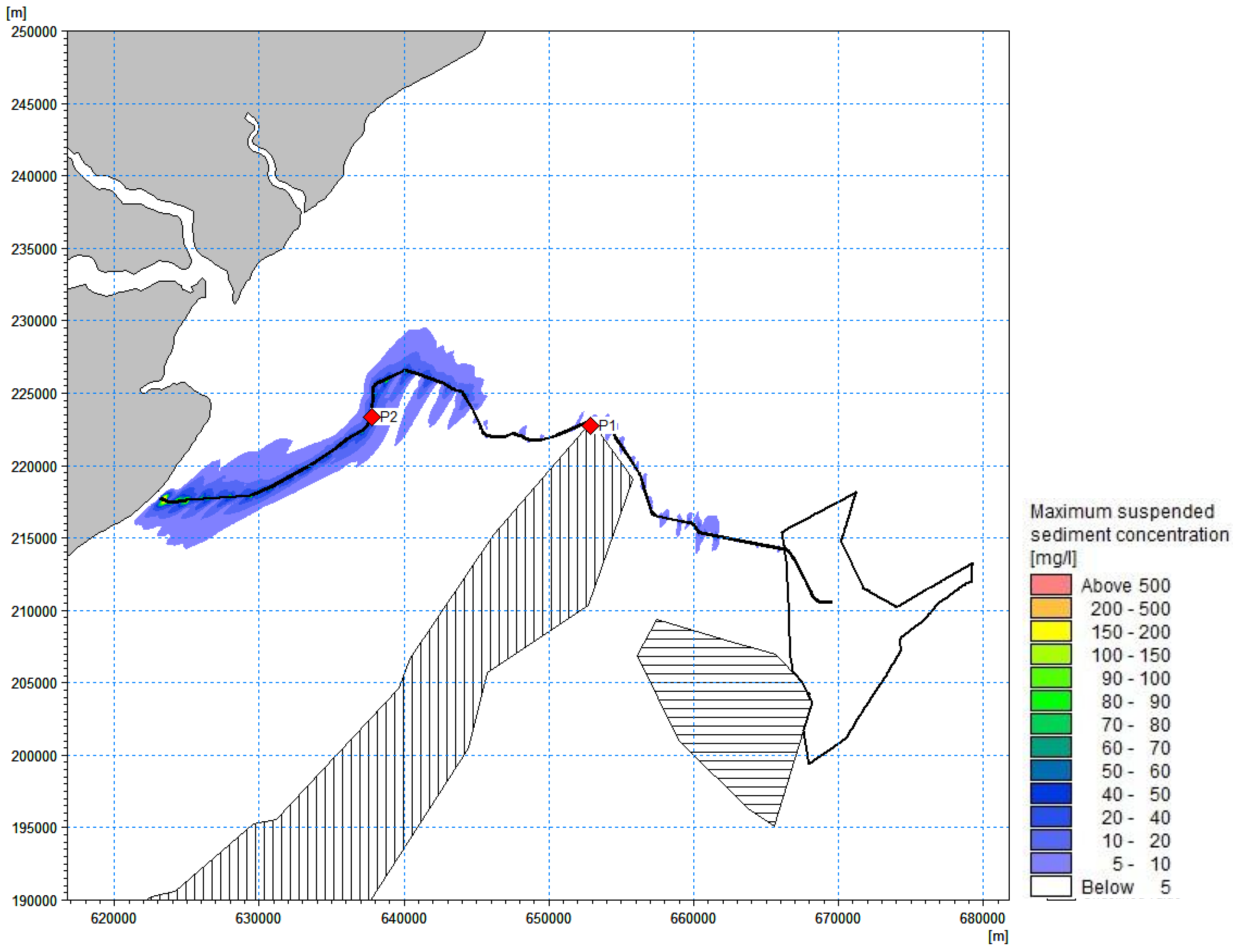

Figure 7-8 Maximum suspended sediment concentration during offshore export cable trenching operations occurring in the middle of water column (red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ))

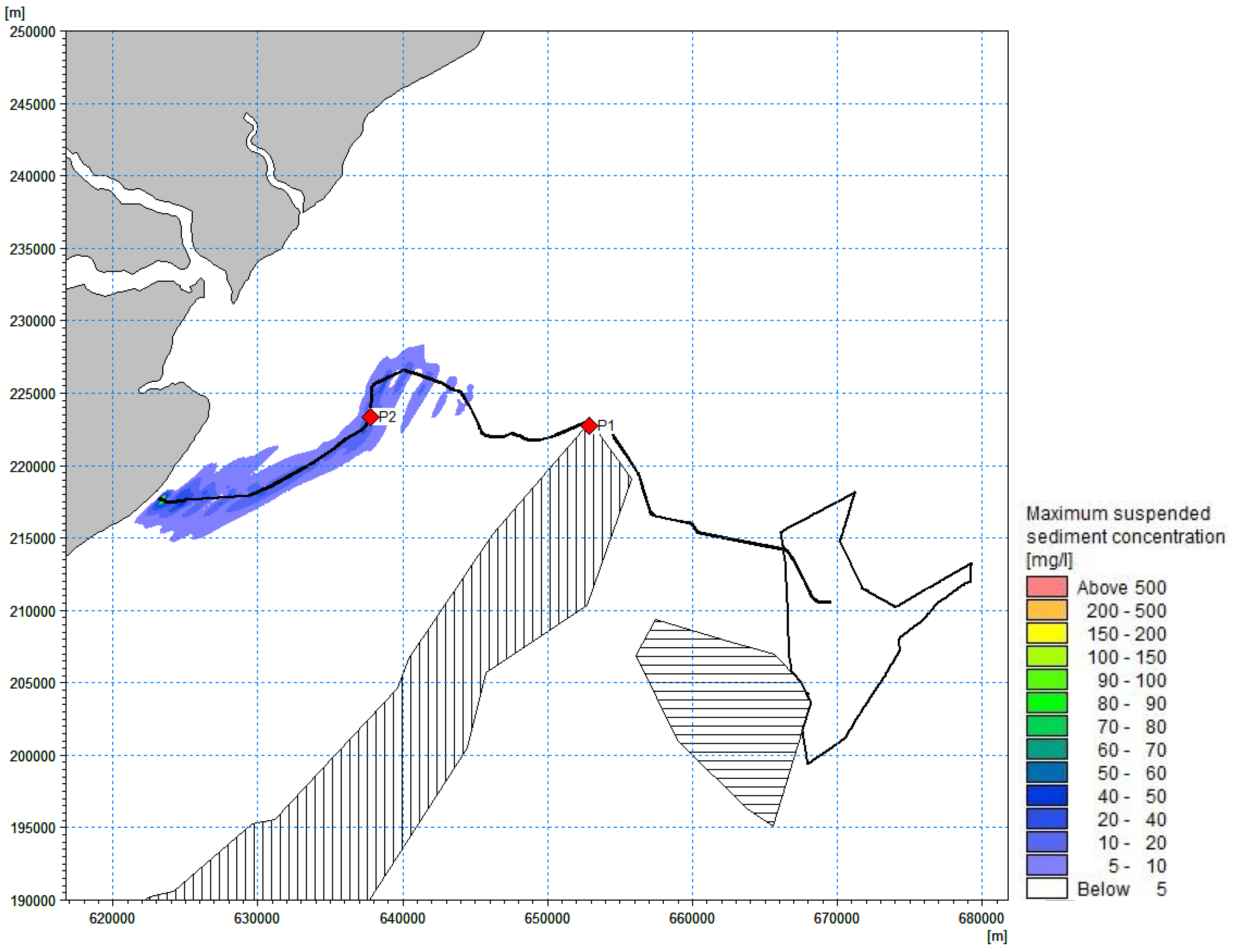

Figure 7-9 Maximum suspended sediment concentration during offshore export cable trenching operations occurring near the water surface
(red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

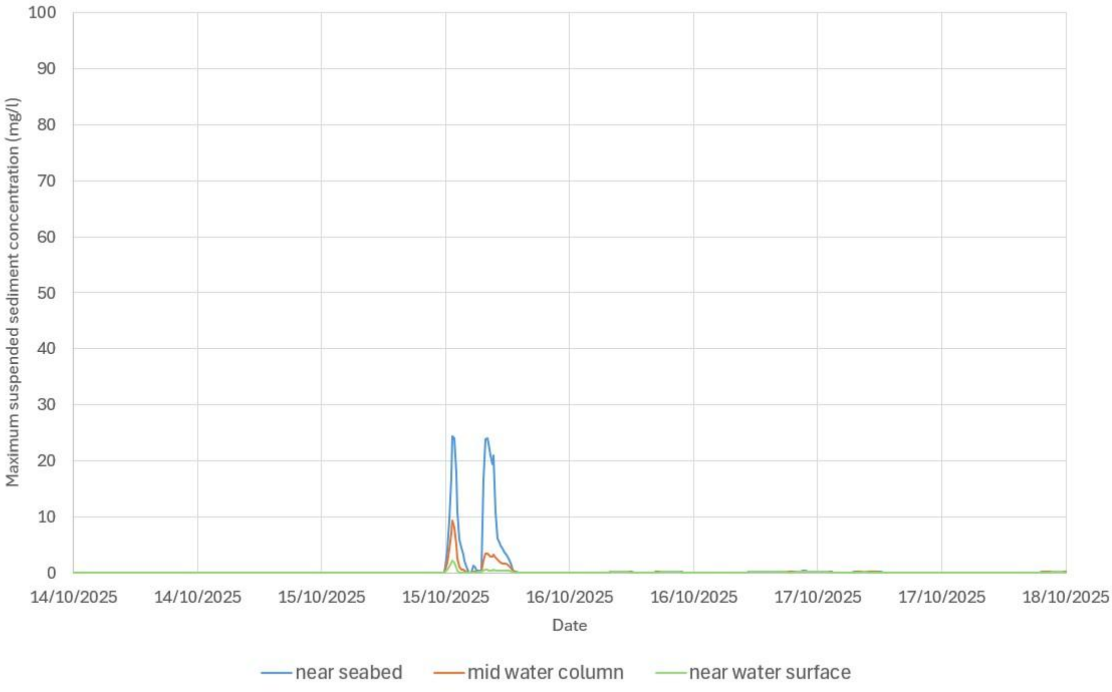

Figure 7-10 Time series of suspended sediment concentration at P1 during offshore export cable trenching near seabed, middle of water column and near water surface (inside SAC)

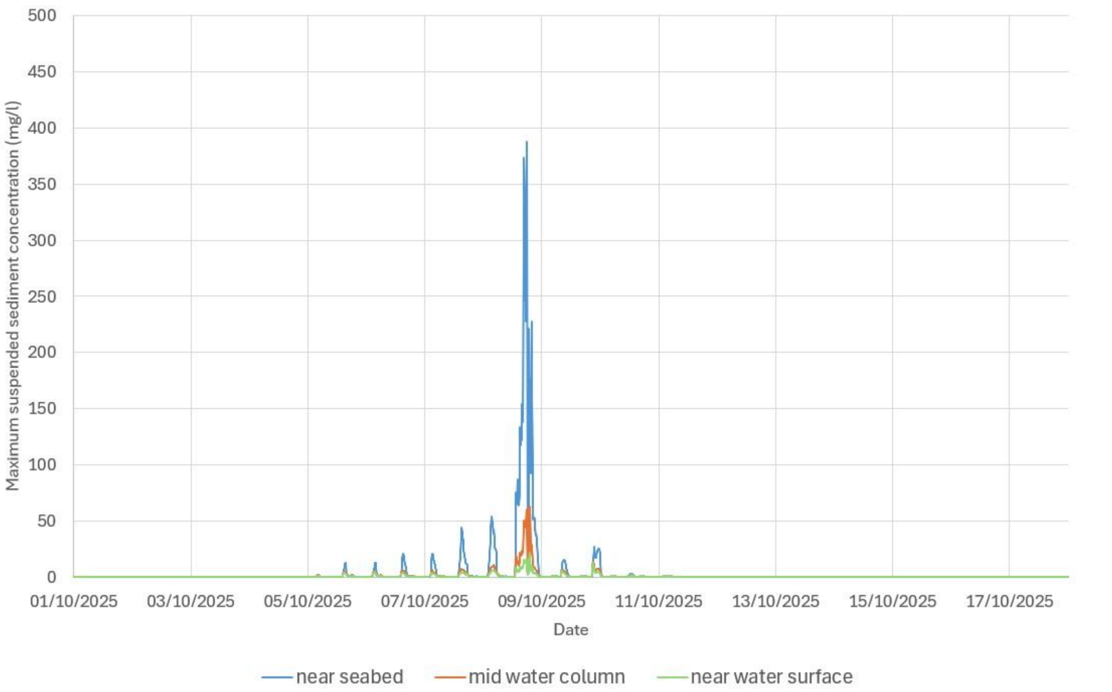

Figure 7-11 Time series of suspended sediment concentration at P2 during offshore export cable trenching near seabed, middle of water column and near water surface (high point along export cable)

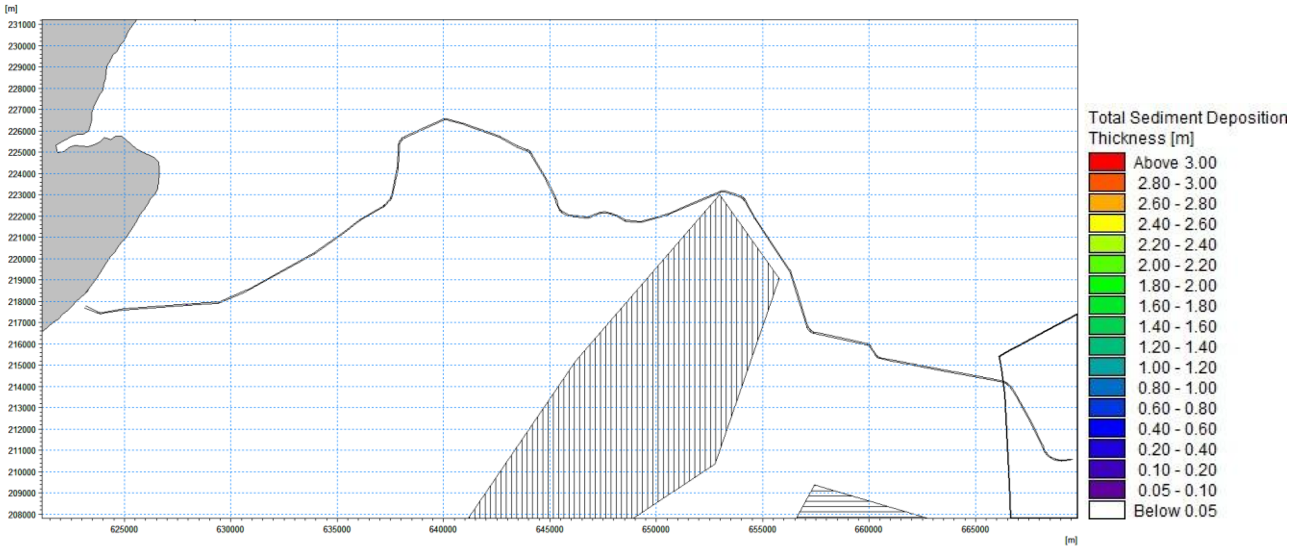

Figure 7-12 Total sediment deposition thickness during offshore export cable levelling operations. (vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

7.4 Simulation 3 Results – Dredging at Sunk ~~DW~~DWR

7.4.1 Figure 7-13 ~~–~~to Figure 7-15 ~~–~~show the maximum suspended sediment concentration above 5 mg/l which occurs during dredging activities at Sunk DWR near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The maximum SSC extends in a north-east to south-west direction following the dominant current direction from the dredging location at the Sunk DWR.

7.4.2 Figure 7-13 ~~-~~shows that the maximum SSC plume near the seabed extends from the Sunk DWR by up to 800 m with SSC levels below 20 mg/l.

7.4.3 Figure 7-14 shows that the maximum SSC plume in the middle of the water column is reduced to less than 5 mg/l. This is likely due to the sediment release occurring near the seabed and the water surface.

7.4.4 Figure 7-15 shows the maximum SSC plume near the water surface ~~that~~ less than 150 m in width at the Sunk DWR with maximum SSC levels of less than 10 mg/l.

7.4.5 Figure 7-16 shows the time series data of suspended sediment concentration during dredging at Sunk DWR near the seabed, the middle of the water column and near the water surface for location P1 shown as a red point on Figure 7-13 to~~-~~ Figure 7-15.

7.4.6 Figure 7-17~~-~~shows the total sediment deposition thickness greater than 5cm which occurs during dredging activities at Sunk DWR. All sediment deposition occurs within the cable corridor near the Sunk DWR and is <1cm.

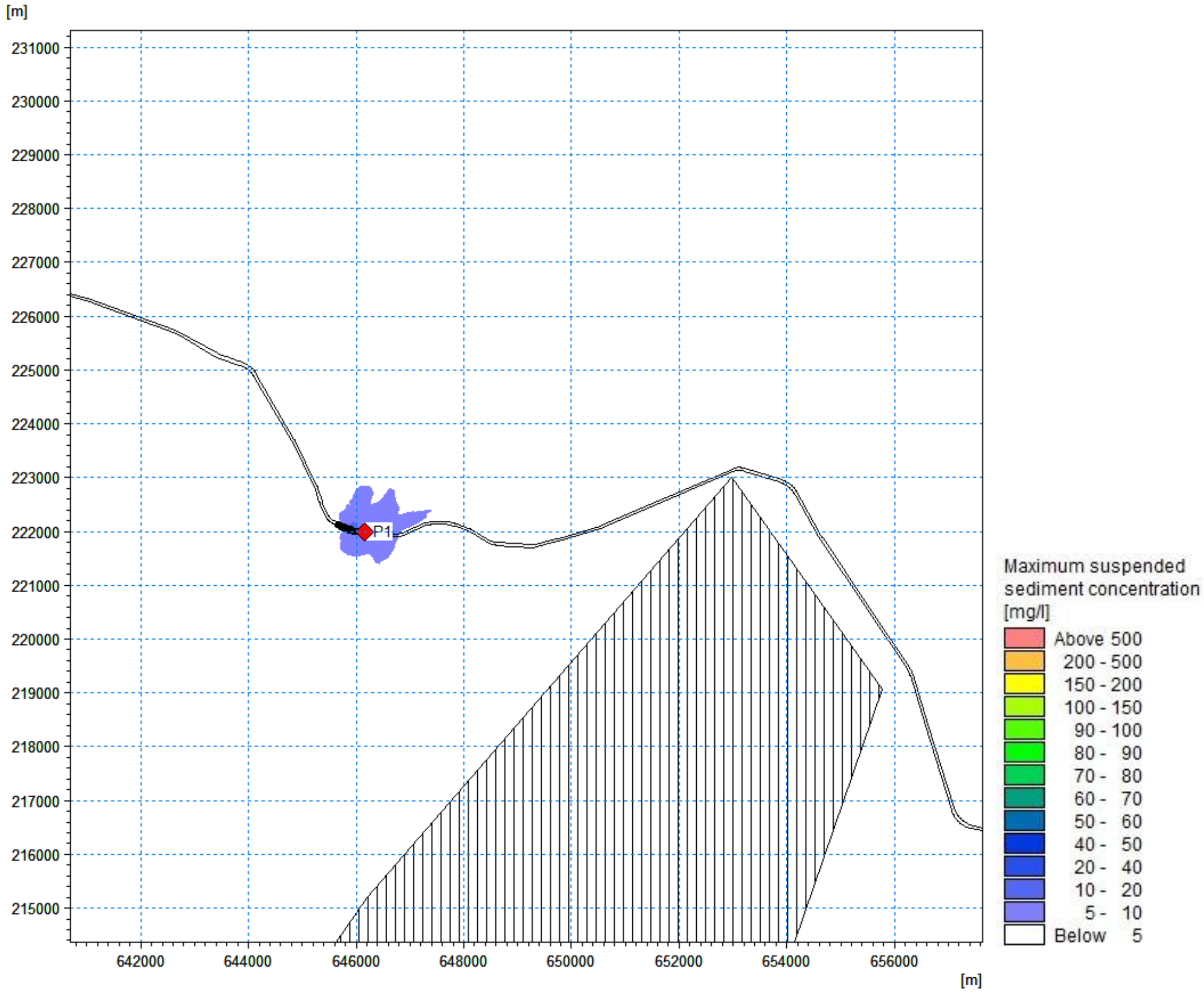

Figure 7-13 Maximum suspended sediment concentration during dredging operations at Sunk DWR occurring near the seabed
(red points = time series extraction points, vertical hashed area = MLS SAC~~, horizontal hashed area = KKE MCZ~~)

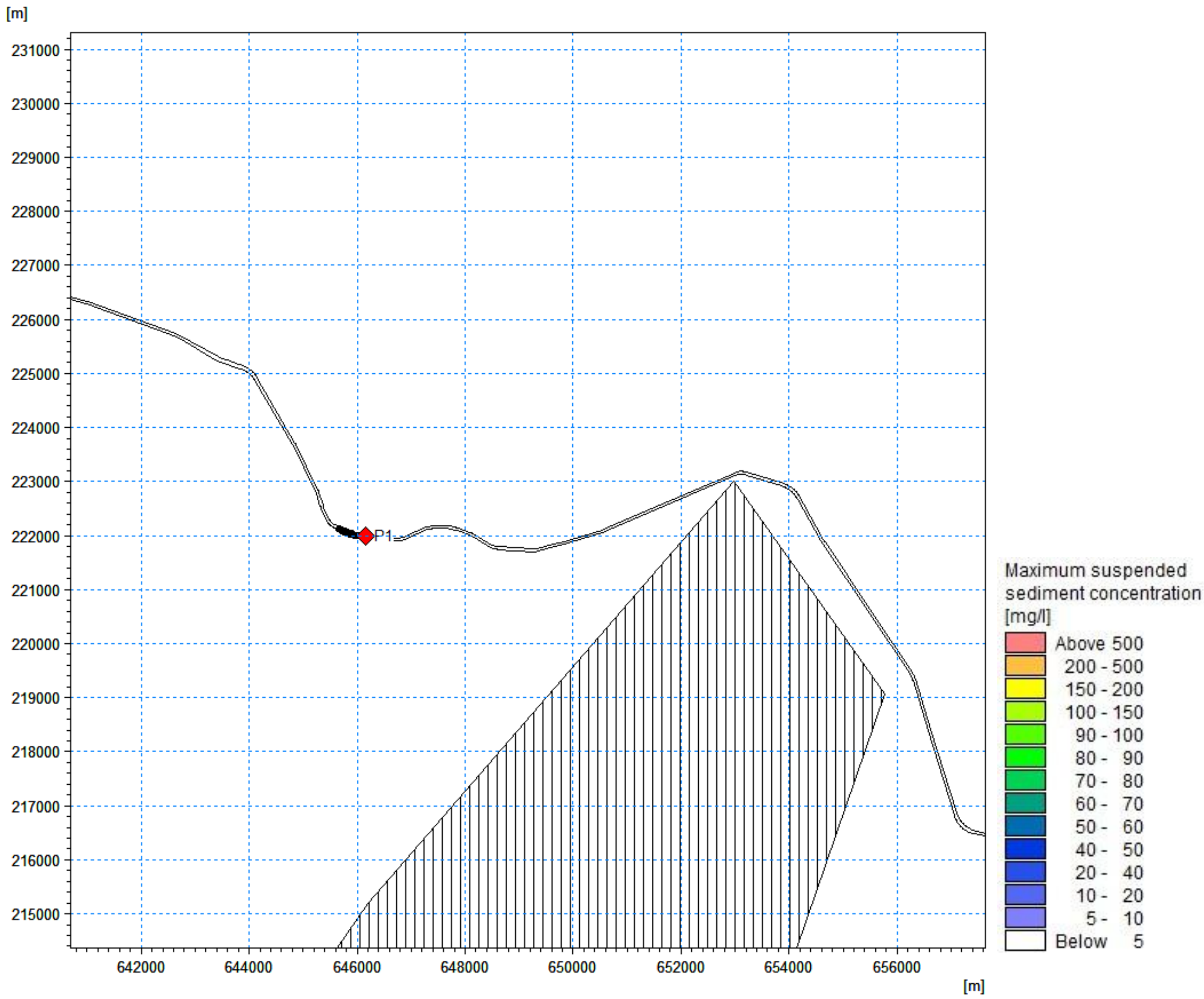

Figure 7-14 Maximum suspended sediment concentration during dredging operations at Sunk DWR occurring in the middle of water column (vertical hashed area = MLS SAC ~~MCZ~~)

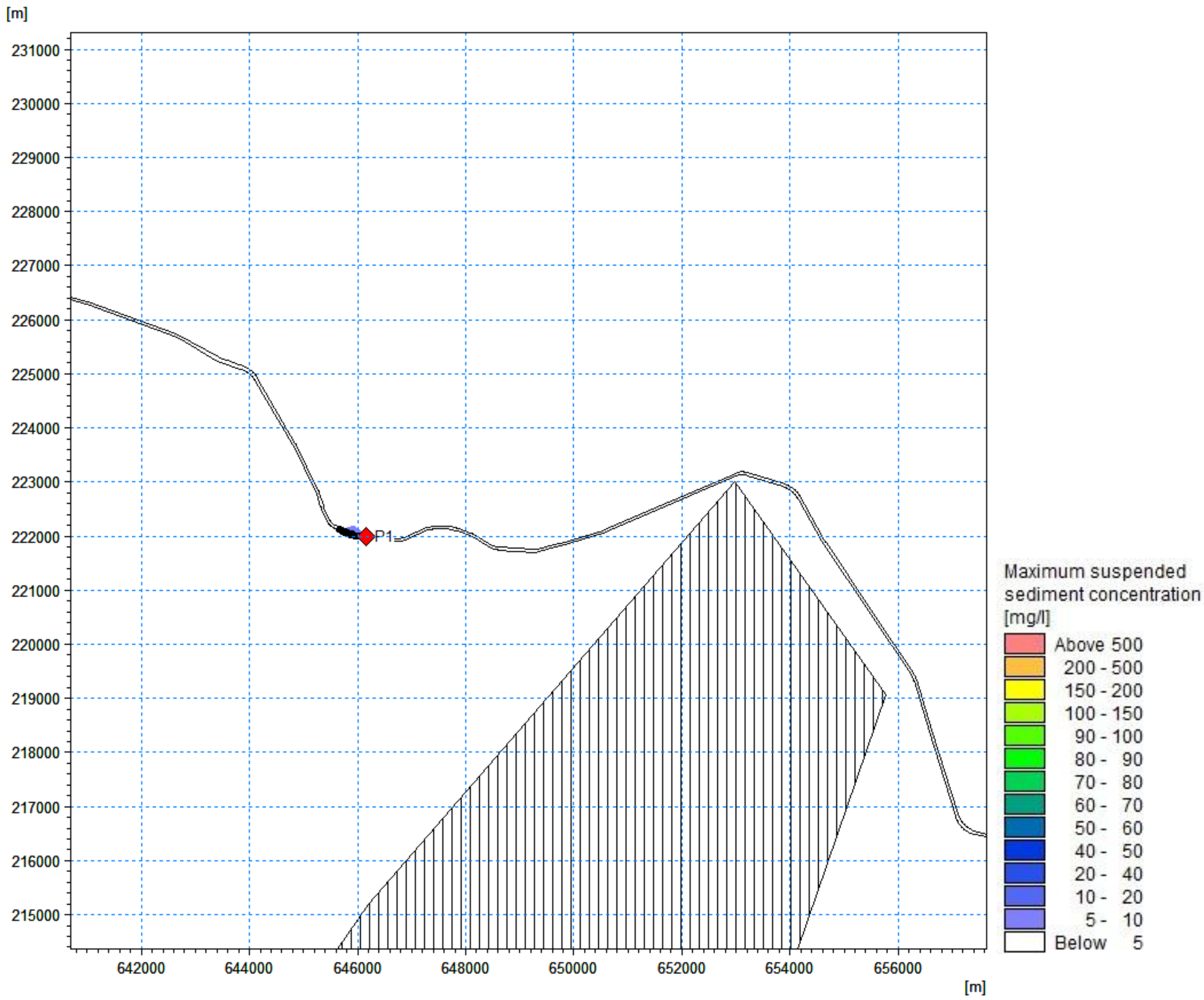

Figure 7-15 Maximum suspended sediment concentration during dredging operations at Sunk DWR occurring near the water surface (vertical hashed area = MLS SAC)

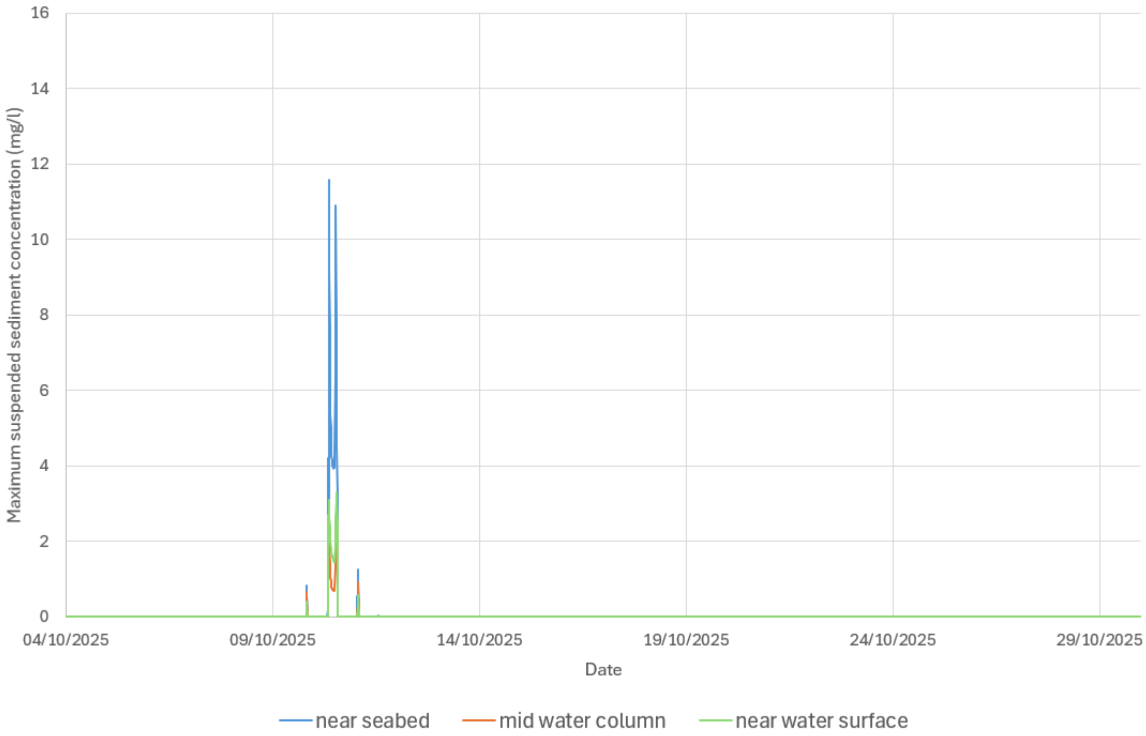

Figure 7-16 Time series of suspended sediment concentration at P1 during dredging at Sunk DWR near seabed, middle of water column and near water surface

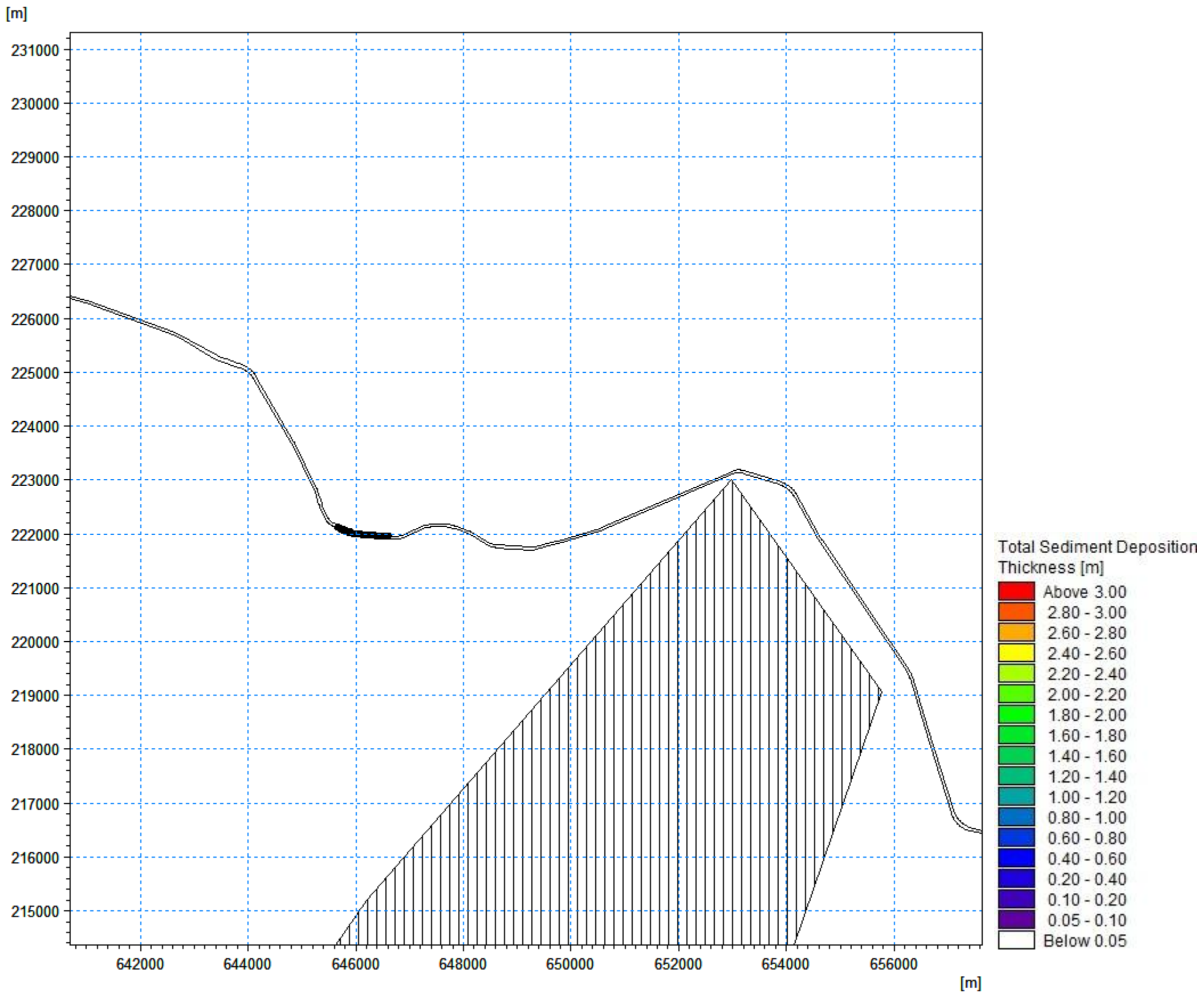

Figure 7-17 Total sediment deposition thickness during dredging operations at Sunk DWR (vertical hashed area = MLS SAC)

7.5 Simulation 4 Results – Dredging at Trinity DWR

7.5.1 Figure 7-18 to Figure 7-20 show the maximum suspended sediment concentration above 5 mg/l which occurs during dredging activities at Trinity DWR near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The maximum SSC extends in a north-east to south-west direction following the dominant current direction from the dredging location at the Trinity DWR.

7.5.2 Figure 7-18 shows that the maximum SSC plume near the seabed extends from the Trinity DWR by up to 500 m with SSC levels below 20 mg/l.

7.5.3 Figure 7-19 shows that the maximum SSC plume in the middle of the water column is reduced to less than 5 mg/l. This is likely due to the sediment release occurring near the seabed and the water surface.

7.5.4 Figure 7-20 shows the maxi mum SSC plume near the water surface that is less than 150 m in size and occurs localised along the dredger path near the Trinity DWR with maximum SSC levels of less than 10 mg/l.

7.5.5 Figure 7-21 shows the time series data of suspended sediment concentration during the dredging at Trinity DWR near the seabed, the middle of the water column and near the water surface for location P1 as shown as red point on Figure 7-18 -to Figure 7-20Figure 7-20.

7.5.6 Figure 7-22 -shows the total sediment deposition thickness greater than 5cm which occurs during dredging activities at Trinity DWR. All sediment deposition occurs within the cable corridor near the Trinity DWR and is <1cm.

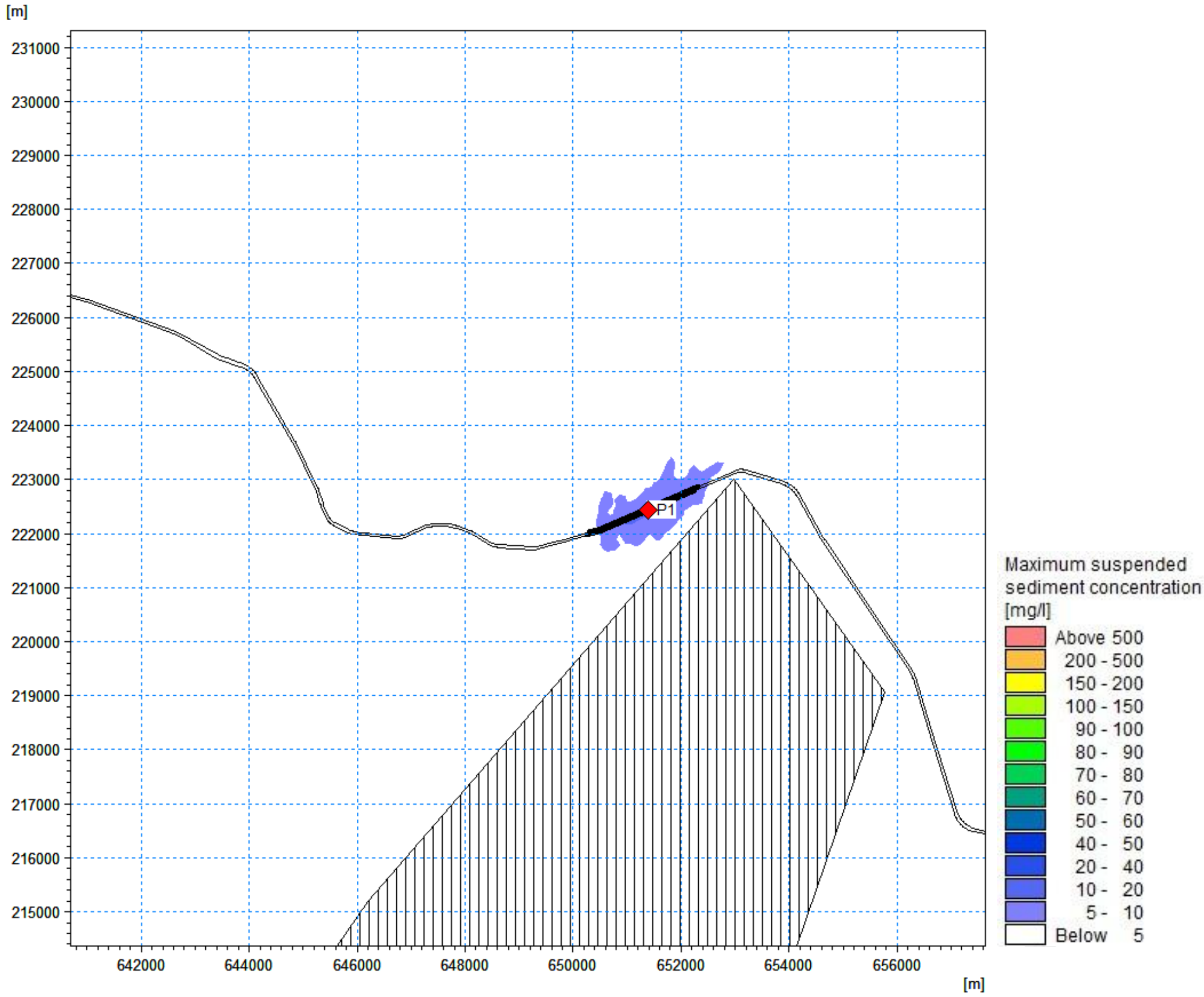

Figure 7-18 Maximum suspended sediment concentration during dredging operations at Trinity DWR occurring near the seabed
(red points = time series extraction points, vertical hashed area = MLS SAC)

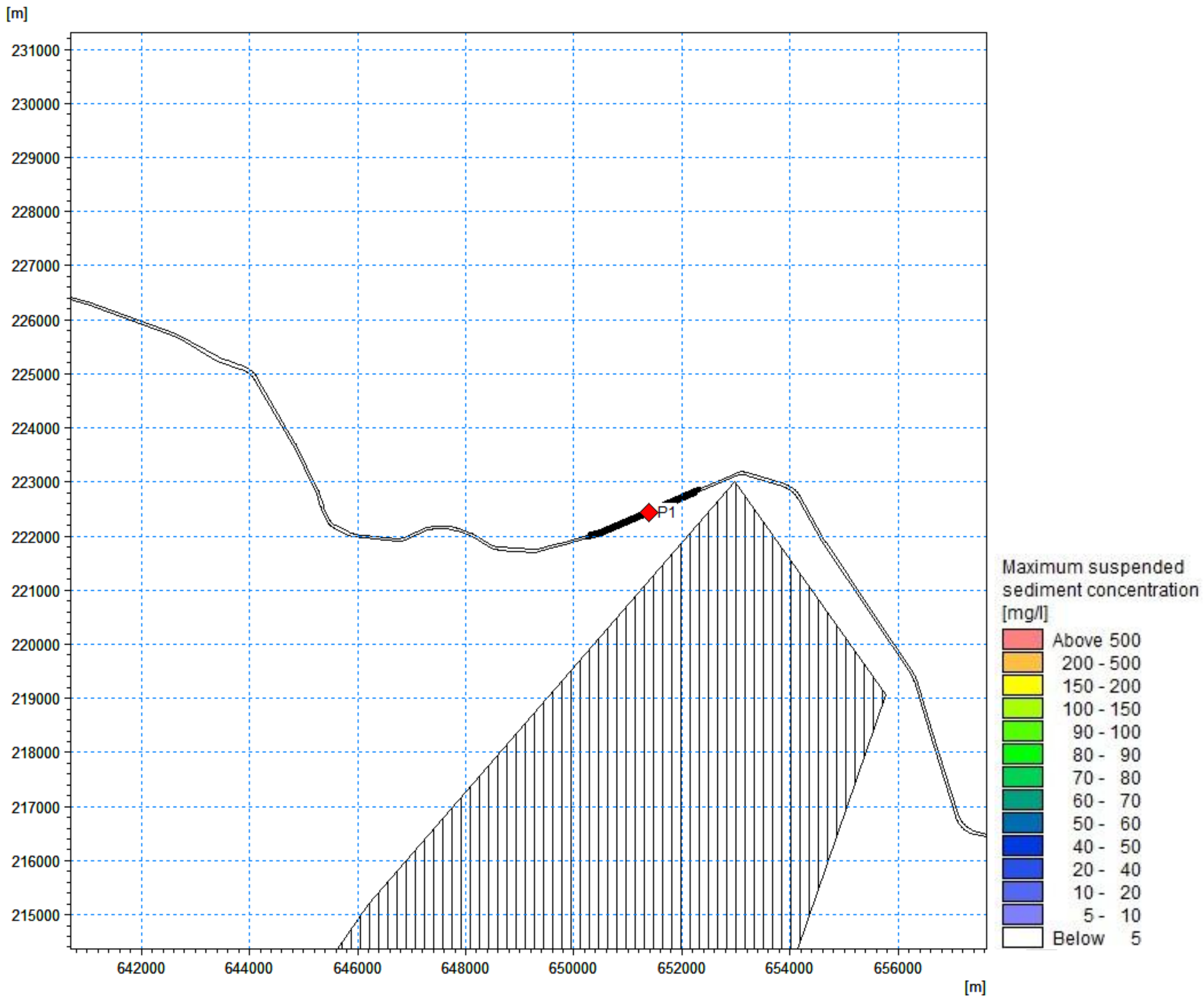

Figure 7-19 Maximum suspended sediment concentration during dredging operations at Trinity DWR occurring in the middle of water column (vertical hashed area = MLS SAC)

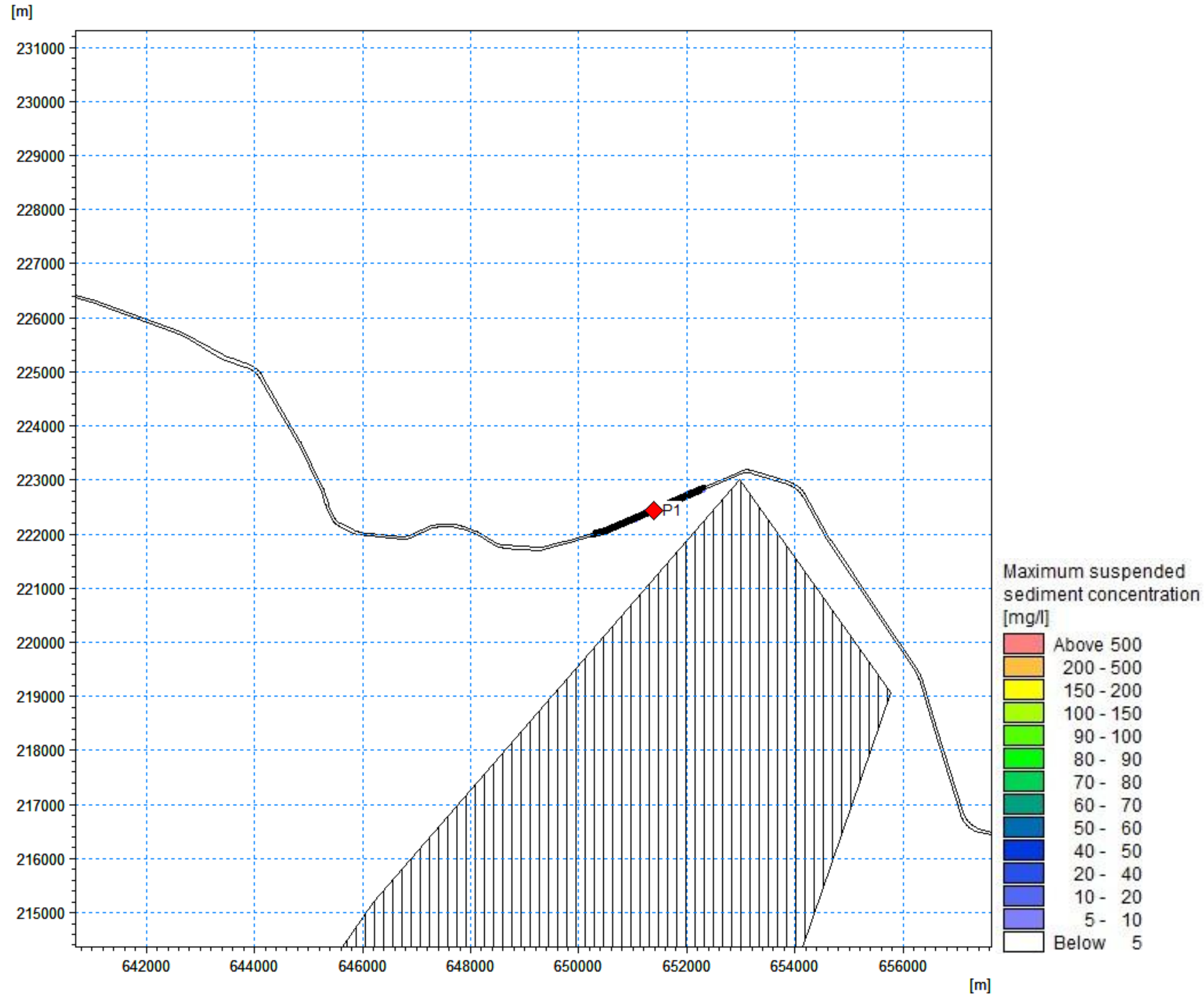

Figure 7-20 Maximum suspended sediment concentration during dredging operations at Trinity DWR occurring near the water surface (vertical hashed area = MLS SAC)

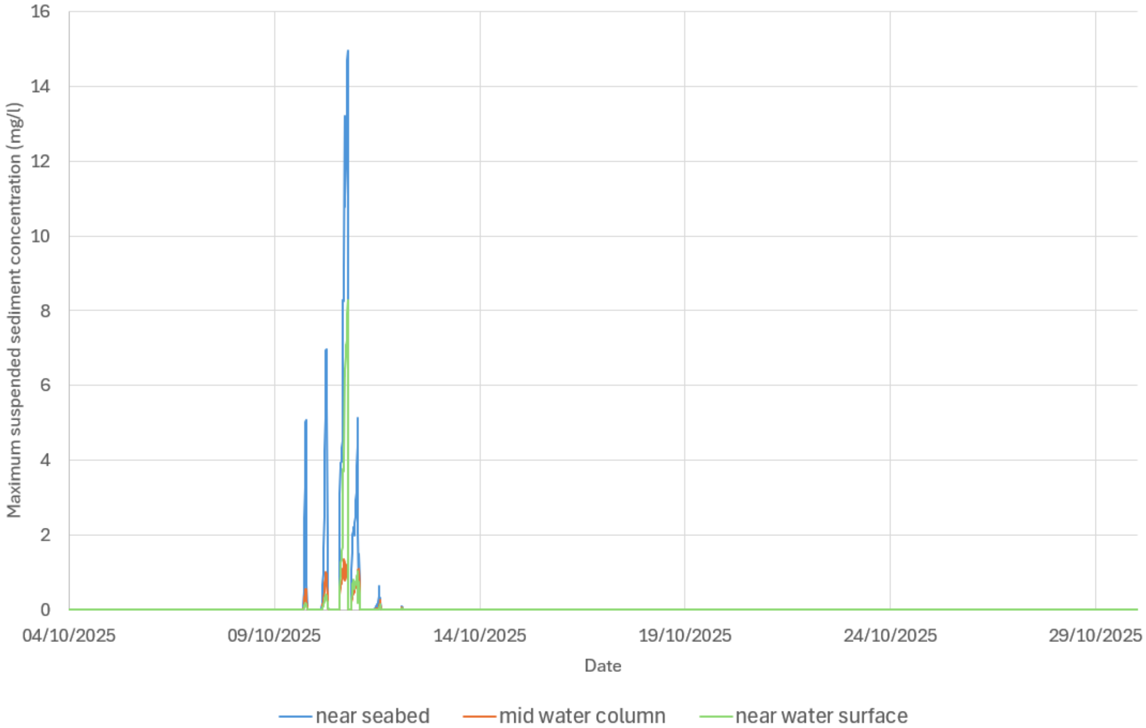

Figure 7-21 Time series of suspended sediment concentration at P1 during dredging at Trinity DWR for near seabed, middle of water column and near water surface

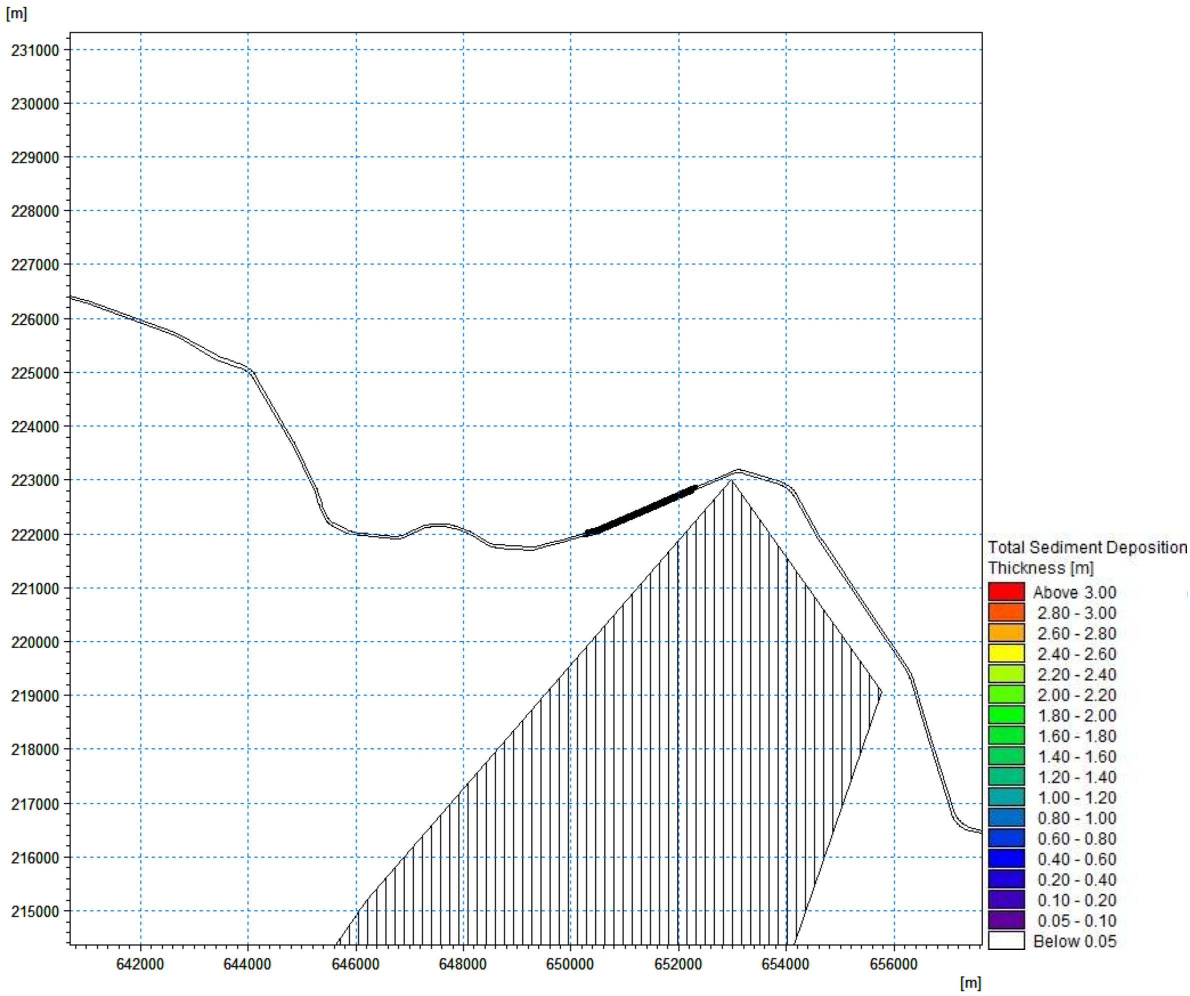

Figure 7-22 Total sediment deposition thickness during dredging operations at Trinity DWR (vertical hashed area = MLS SAC)

7.6 Simulation 5 Results – Drilling for Structures – Smaller WTGs Indicative Layout

7.6.1 Figure 7-23 to Figure 7-25 show the maximum suspended sediment concentration which occurs during drilling activities for smaller WTGs array indicative layout structures near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration throughout the water column is below 5 mg/l.

7.6.2 There are no time series data plots due to the very low suspended sediment concentrations during this activity.

7.6.3 Figure 7-26 shows the total sediment deposition thickness greater than 5cm which occurs during drilling activities for smaller WTGs indicative layout structures. All sediment deposition occurs within the array area near the structures that require drilling and is <0.5cm.

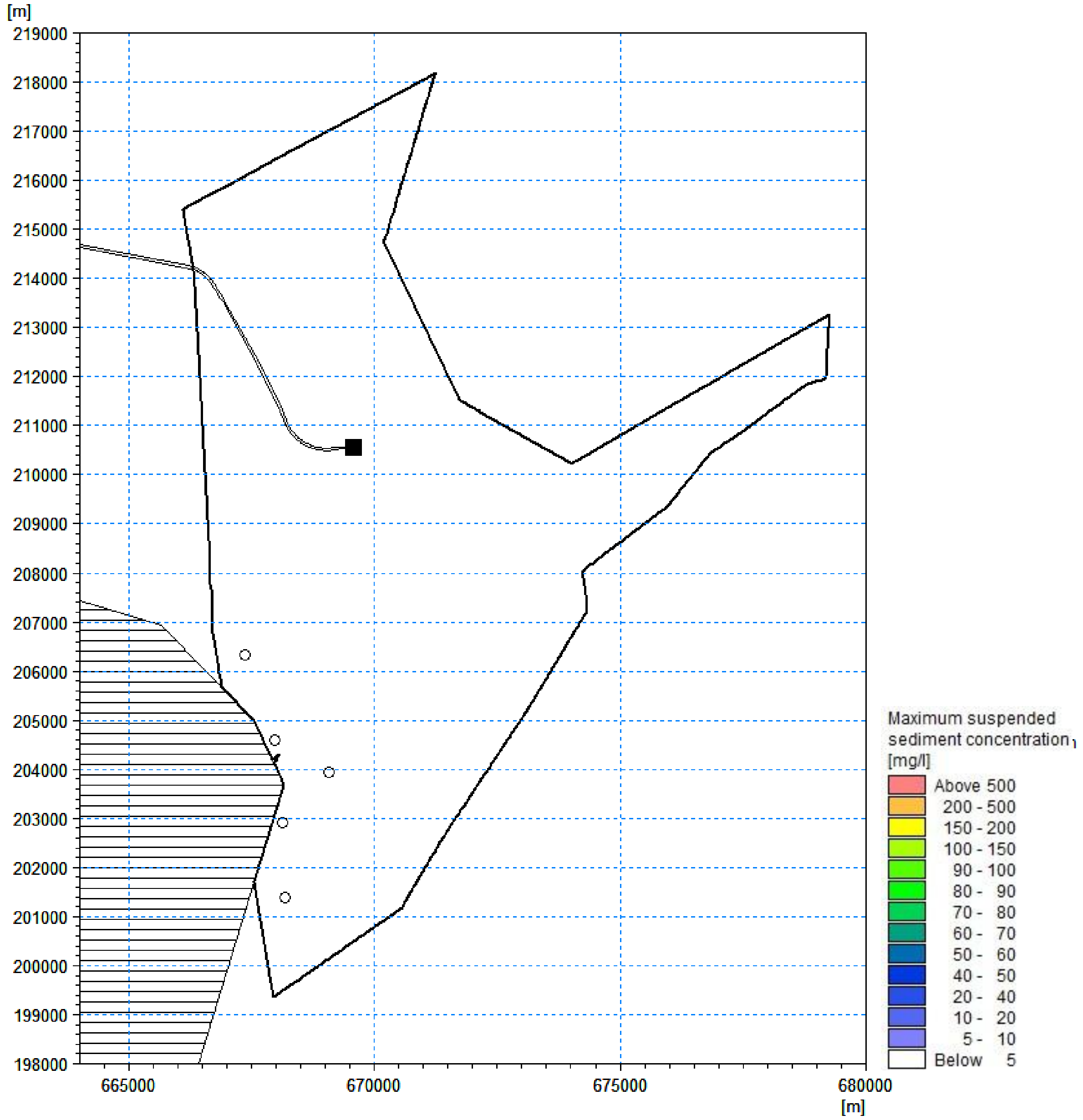

Figure 7-23 Maximum suspended sediment concentration during drilling operations for smaller WTGs indicative layout structures occurring near the seabed (horizontal hashed area = KKE MCZ).

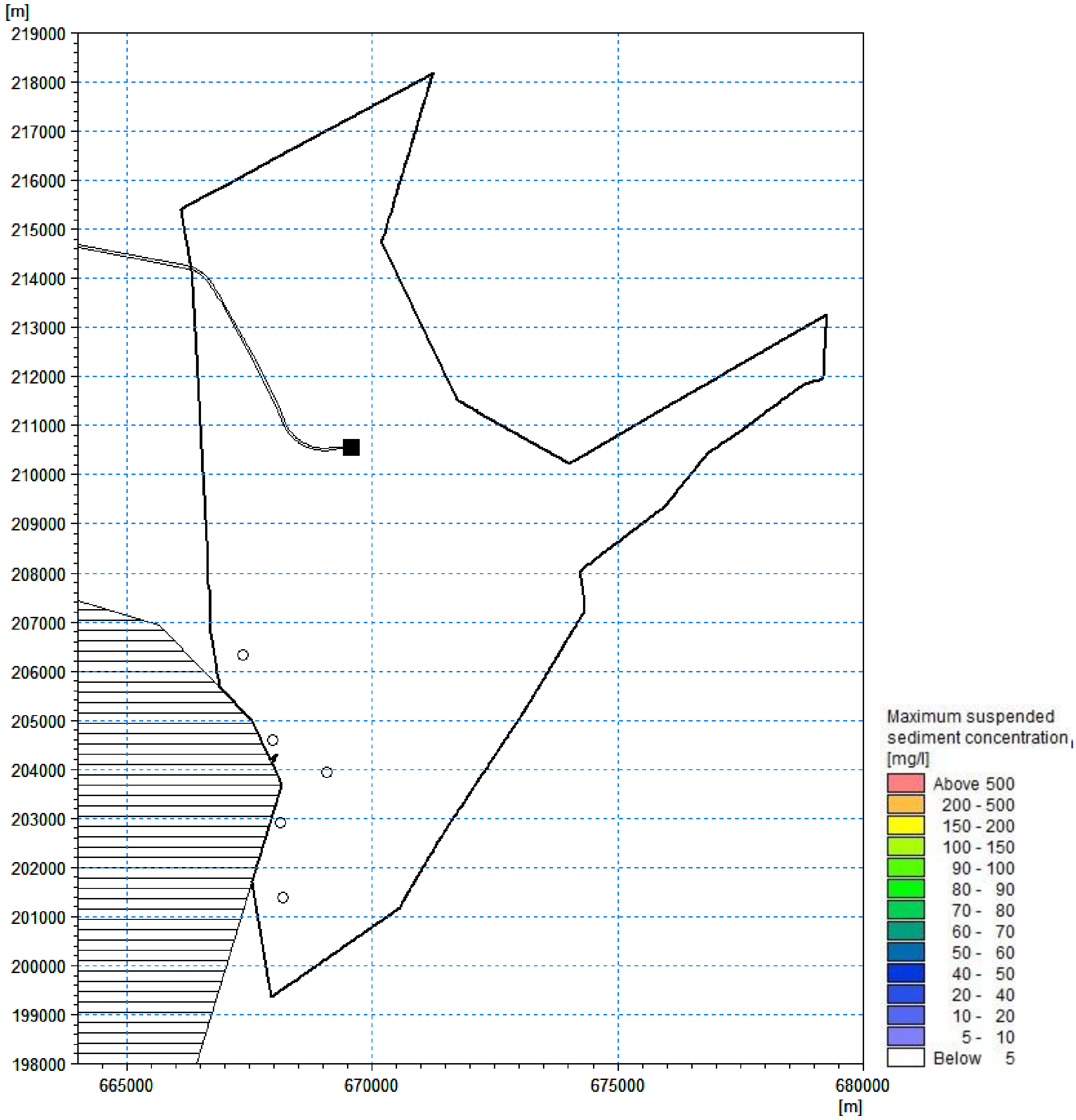

Figure 7-24 Maximum suspended sediment concentration during drilling operations for smaller WTGs layout structures occurring in the middle of water column (horizontal hashed area = KKE MCZ)

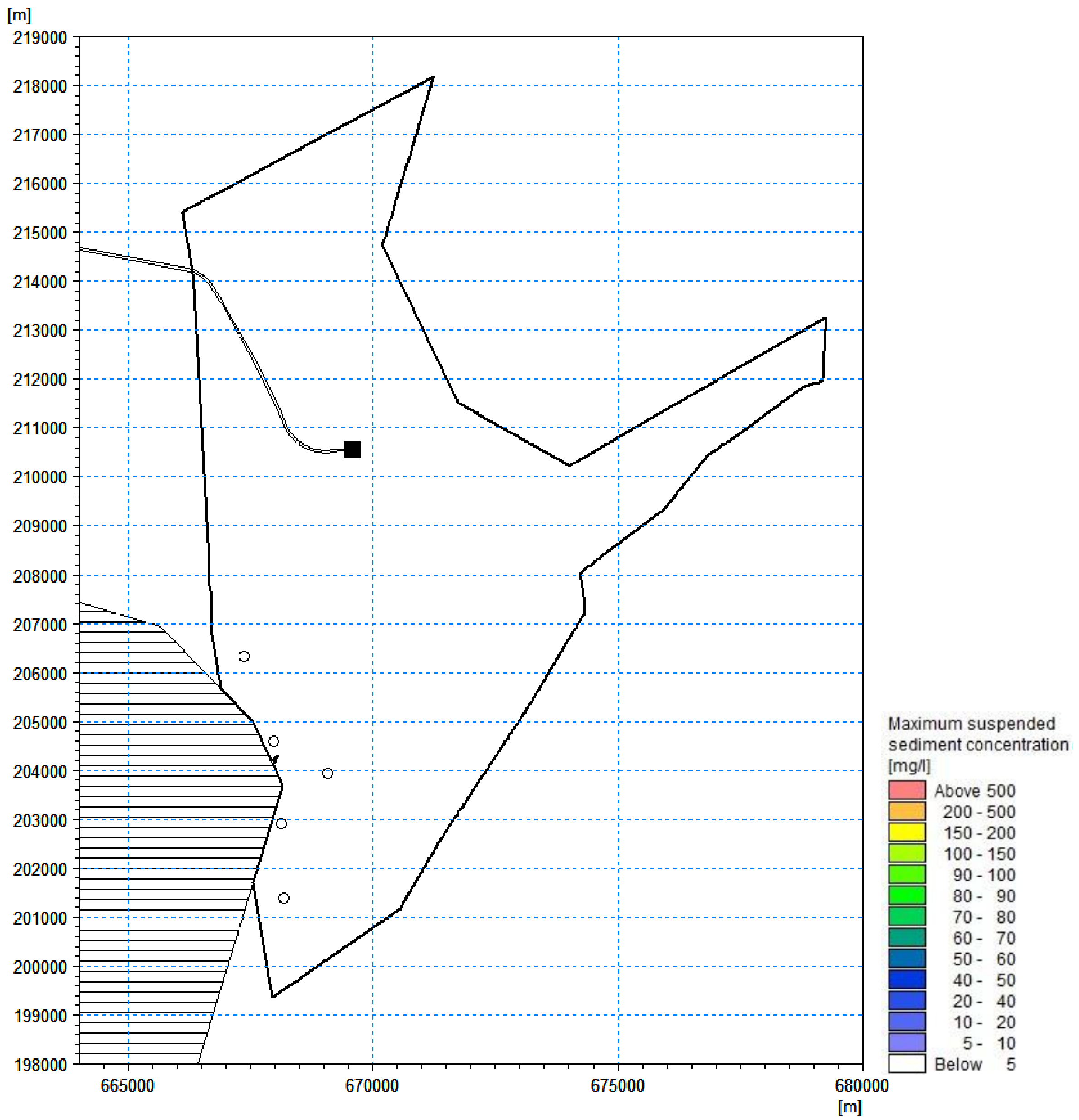

Figure 7-25 Maximum suspended sediment concentration during drilling operations for smaller WTGs layout structures occurring near the water surface (horizontal hashed area = KKE MCZ)

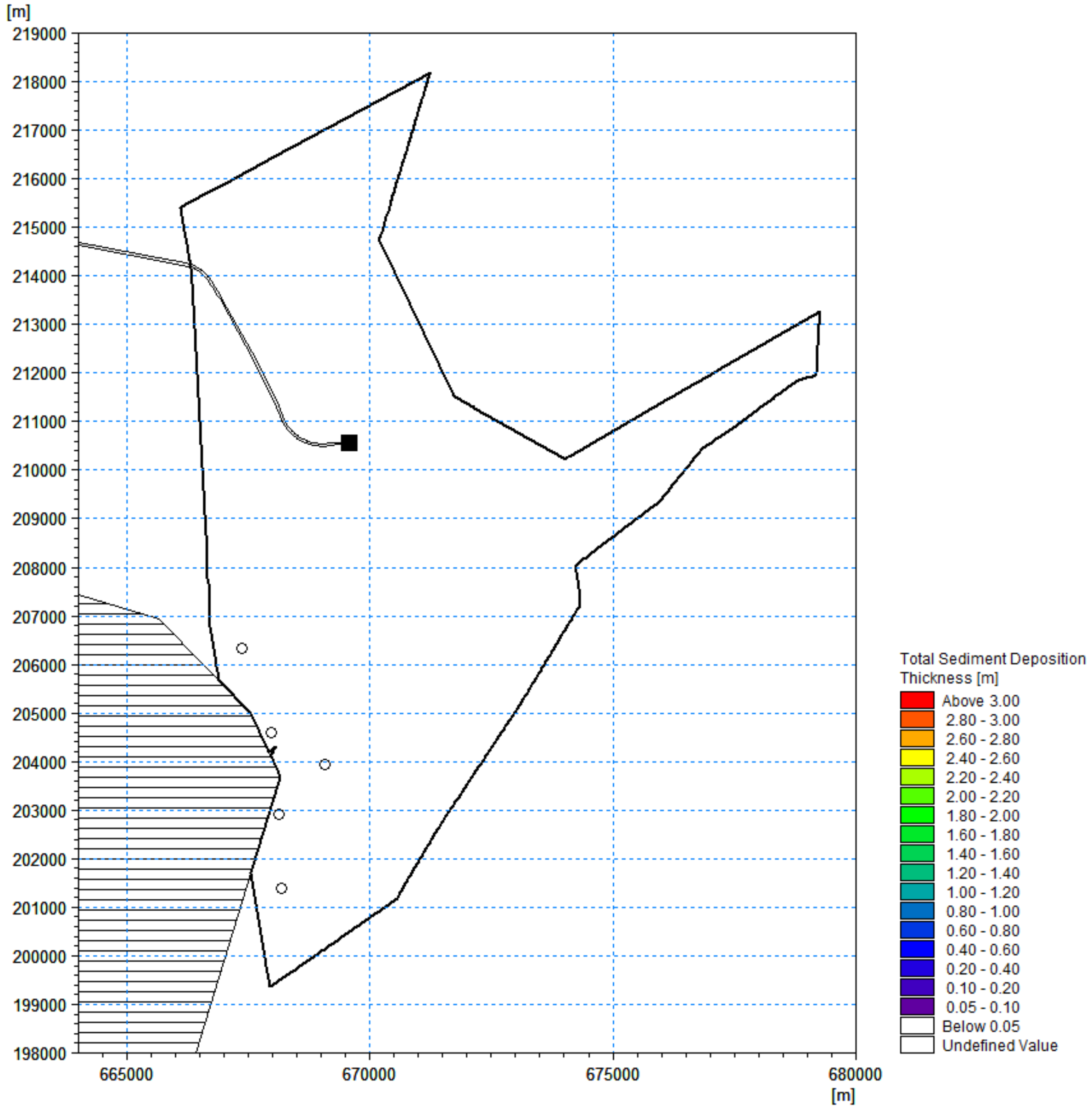

Figure 7-26 Total sediment deposition thickness during drilling operations for smaller WTGs layout structures (horizontal hashed area = KKE MCZ)

7.7 Simulation 6 Results – Drilling for Structures – Larger WTGs Layout

7.7.1 Figure 7-27 – to Figure 7-29 – show the maximum suspended sediment concentration which occurs during drilling activities for larger WTGs array layout structures near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration throughout the water column is below 5 mg/l.

7.7.2 There are no time series data plots due to the very low suspended sediment concentrations during this activity.

7.7.3 Figure 7-30 shows the total sediment deposition thickness greater than 5cm which occurs during drilling activities for larger WTGs layout structures. All sediment deposition occurs within the array area near the structures that require drilling and is <0.5cm.

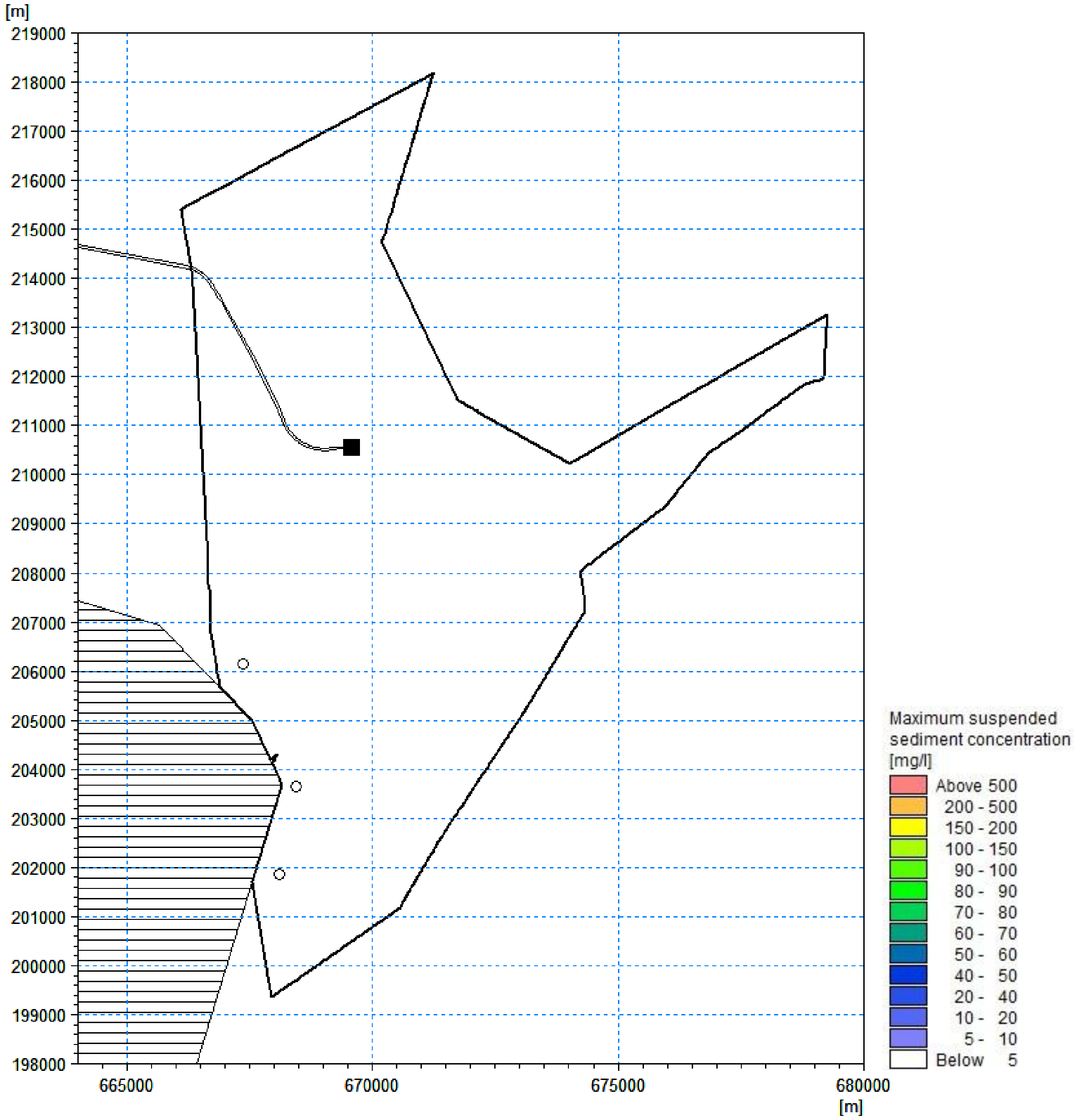

Figure 7-27 Maximum suspended sediment concentration during drilling operations for larger WTGs layout structures occurring near the seabed (horizontal hashed area = KKE MCZ)

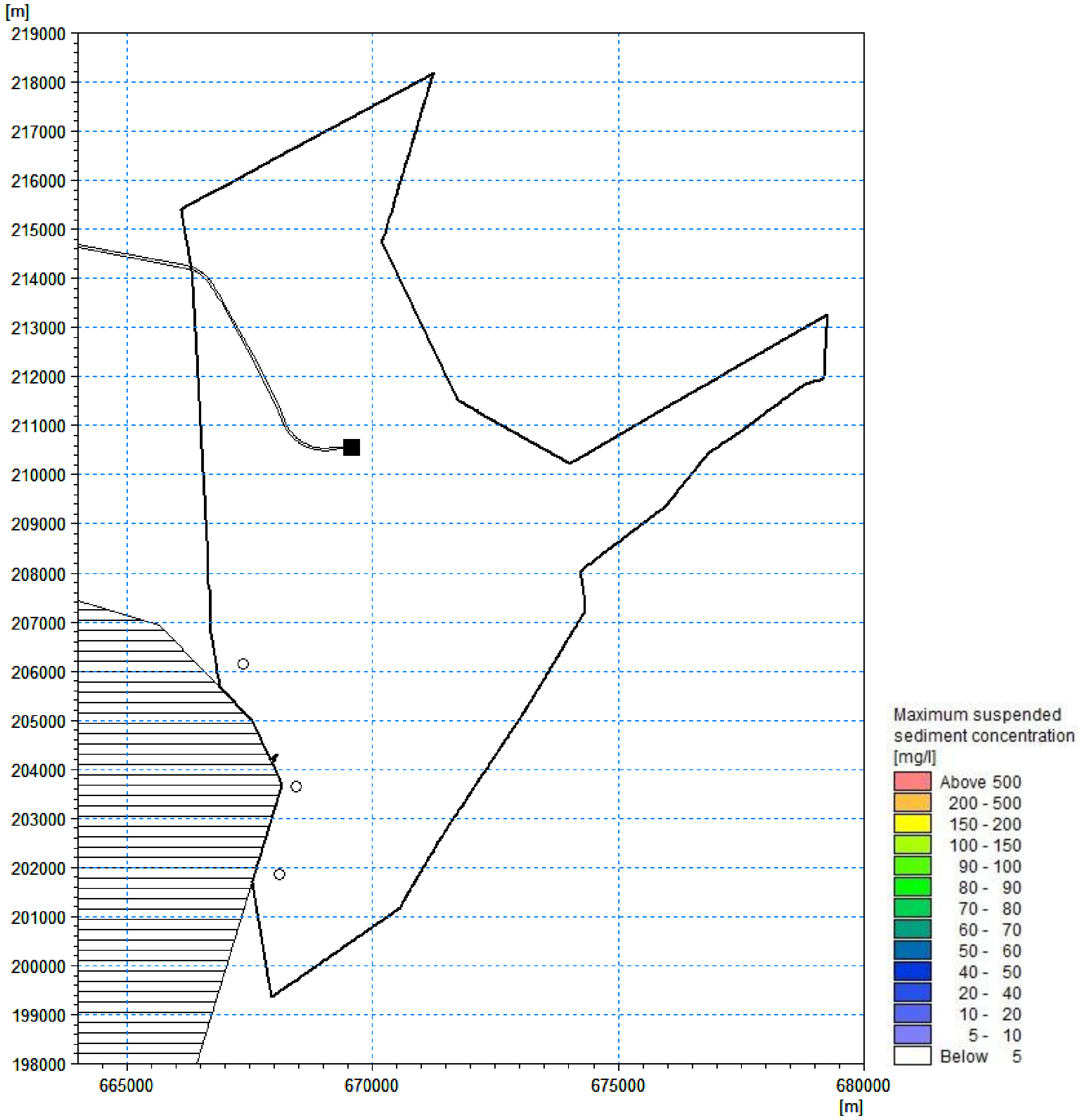

Figure 7-28 Maximum suspended sediment concentration during drilling operations for larger WTGs layout structures occurring in the middle of water column (horizontal hashed area = KKE MCZ)

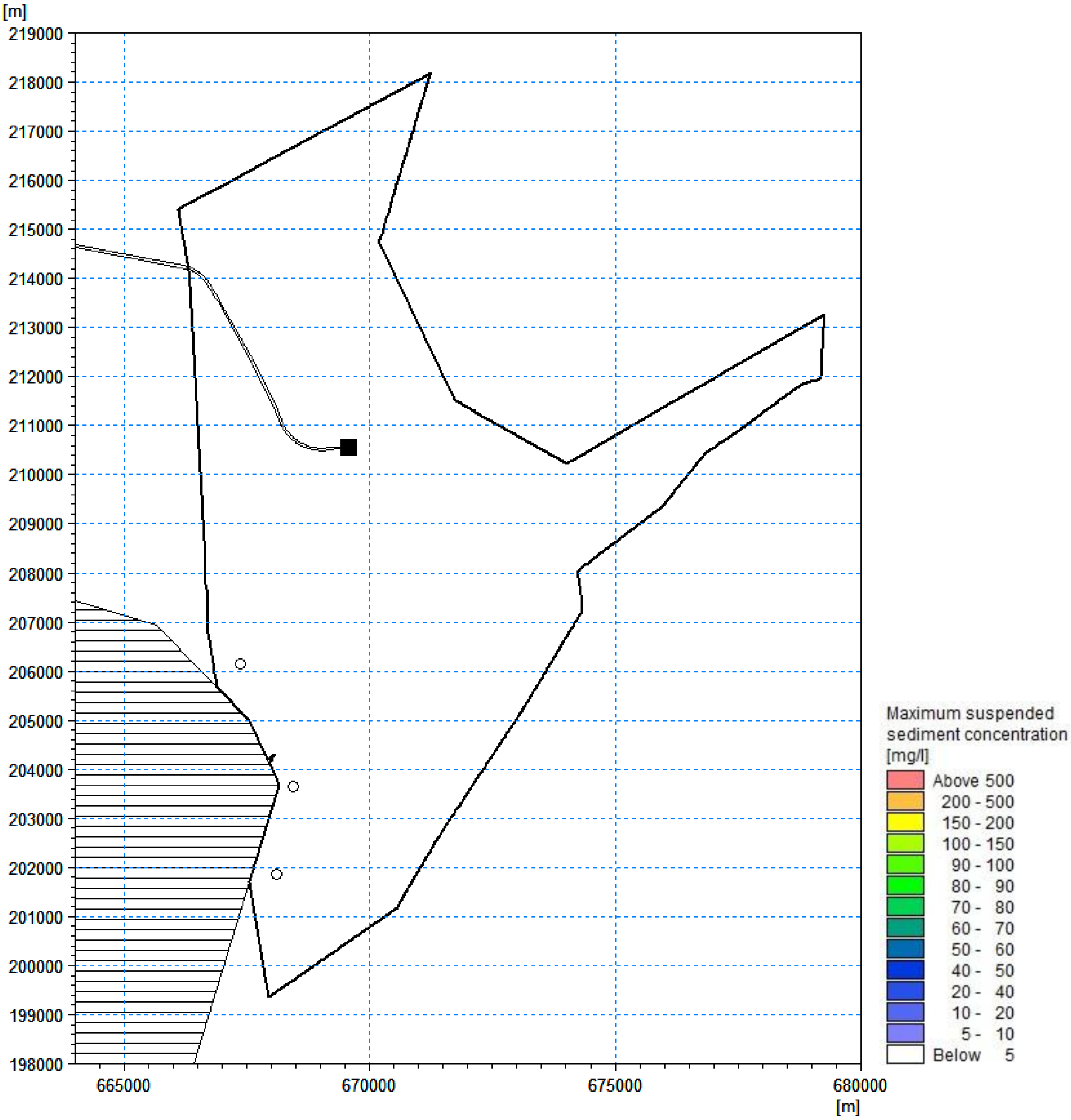

Figure 7-29 Maximum suspended sediment concentration during drilling operations for larger WTGs layout structures occurring near the water surface (horizontal hashed area = KKE MCZ)

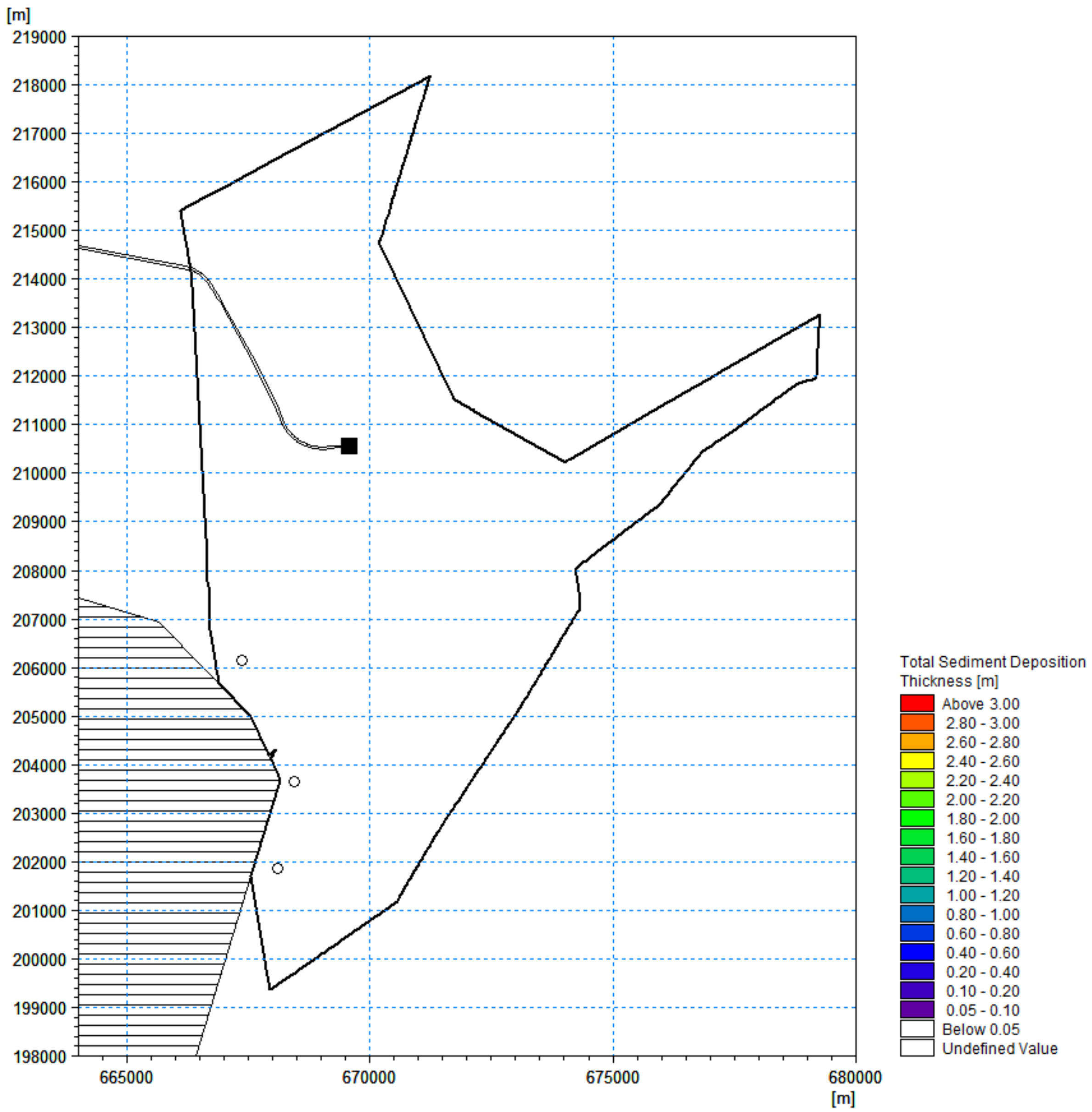

Figure 7-30 Total sediment deposition thickness during drilling operations for larger WTGs layout structures (horizontal hashed area = KKE MCZ)

7.8 Simulation 7 Results – Seabed Preparation for Structures – Smaller WTGs Layout

7.8.1 Figure 7-31 to Figure 7-33 show the maximum suspended sediment concentration above 5 mg/l which occurs during seabed preparation activities for smaller WTGs layout structures near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The maximum SSC extends in a north-east to south-west direction from the smaller WTGs array layout structures that require seabed preparation following the dominant current direction.

7.8.2 Figure 7-31 -shows the maximum SSC plume near the seabed which covers the whole of the array area and extends beyond its boundary north-eastwards by about 25 km, and south-westwards by about 11 km, albeit this extent includes large areas of lower SSC levels of below 50 mg/l. The maximum SSC that is greater than 500 mg/l extends -up to 11 km but covers most of the array area.

7.8.3 Figure 7-32 -shows the maximum SSC plume in the middle of the water column that extends broadly as far as near the seabed, but maximum SSC greater than 500 mg/l show only as small spots inside the array area, whilst the SSC levels inside the array have dropped to between 200 mg/l to <500 mg/l and the plume of the same SSC levels only extends up to 5 km beyond the array boundary.

7.8.4 Figure 7-33 –shows the maximum SSC plume near the water surface that extends broadly as far as near the seabed, but the maximum SSC levels are significantly lower, with only a couple of areas reaching SSC levels of 200 mg/l. Inside the array area the SSC levels are mainly around 50 mg/l to 80 mg/l.

7.8.5 Figure 7-34 and Figure 7-35 -show the time series data of suspended sediment concentration during seabed preparation for smaller WTGs array structures near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively, that are shown as red points on Figure 7-31 to Figure 7-33.. The peak of SSC levels at P1 reaches 1,400 mg/l near the seabed and last for approx. one hour, levels near the water surface are below 20 mg/l and the peak lasts less than one hour. The SSC level at P2 peaks at 14,000 mg/l near the seabed and lasts for approx. 1.5 hours. SSC levels near the water surface are below 50 mg/l throughout.

7.8.6 Figure 7-36 shows the total sediment deposition thickness greater than 5cm which occurs during seabed preparation activities for smaller WTGs layout structures. All sediment deposition occurs within the array area near the structures that require seabed preparation. The maximum sediment deposition is 0.6m with the average being around 0.2.

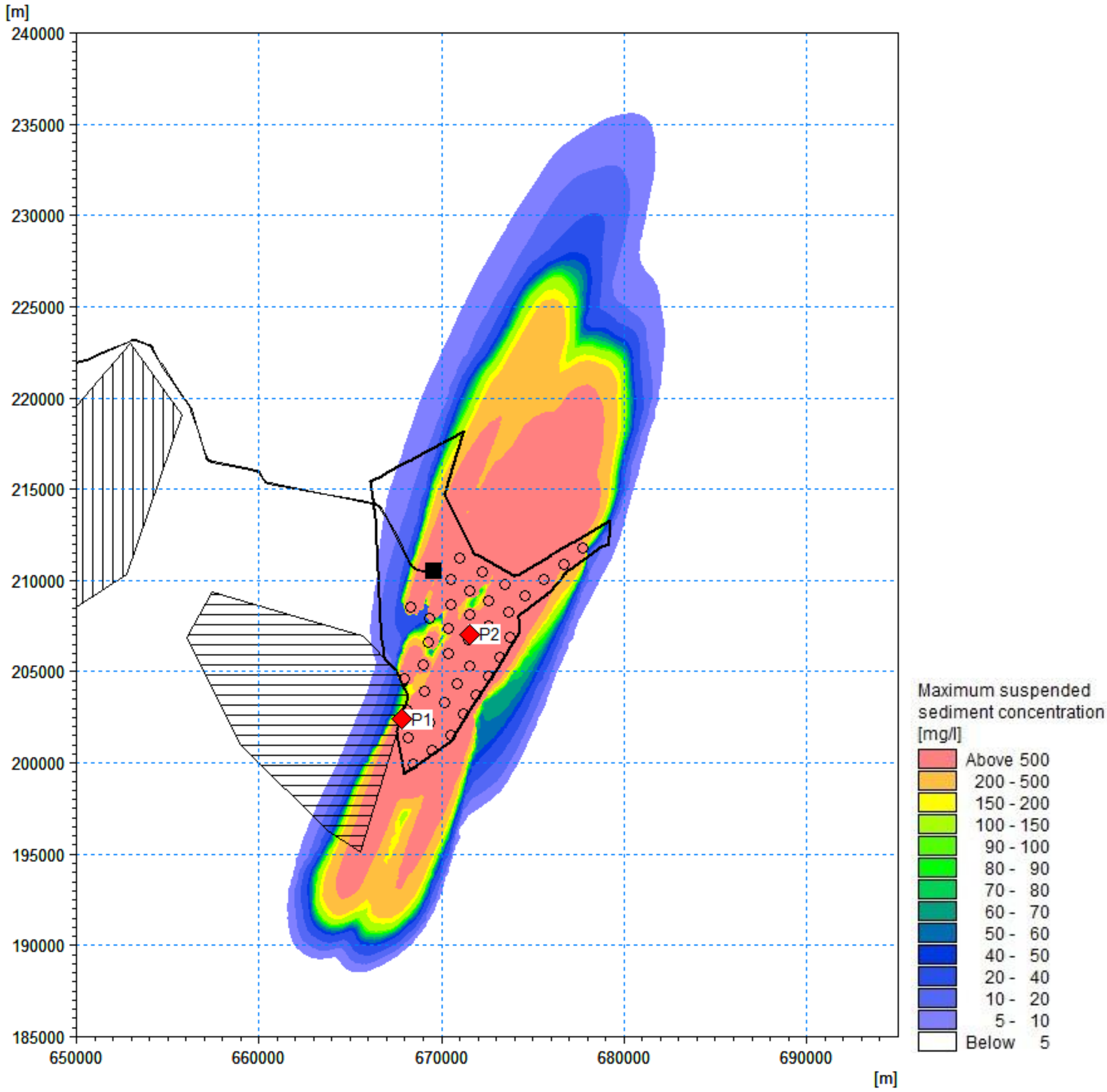

Figure 7-31 Maximum suspended sediment concentration during seabed preparation operations for smaller WTGs layout structures occurring near the seabed (red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

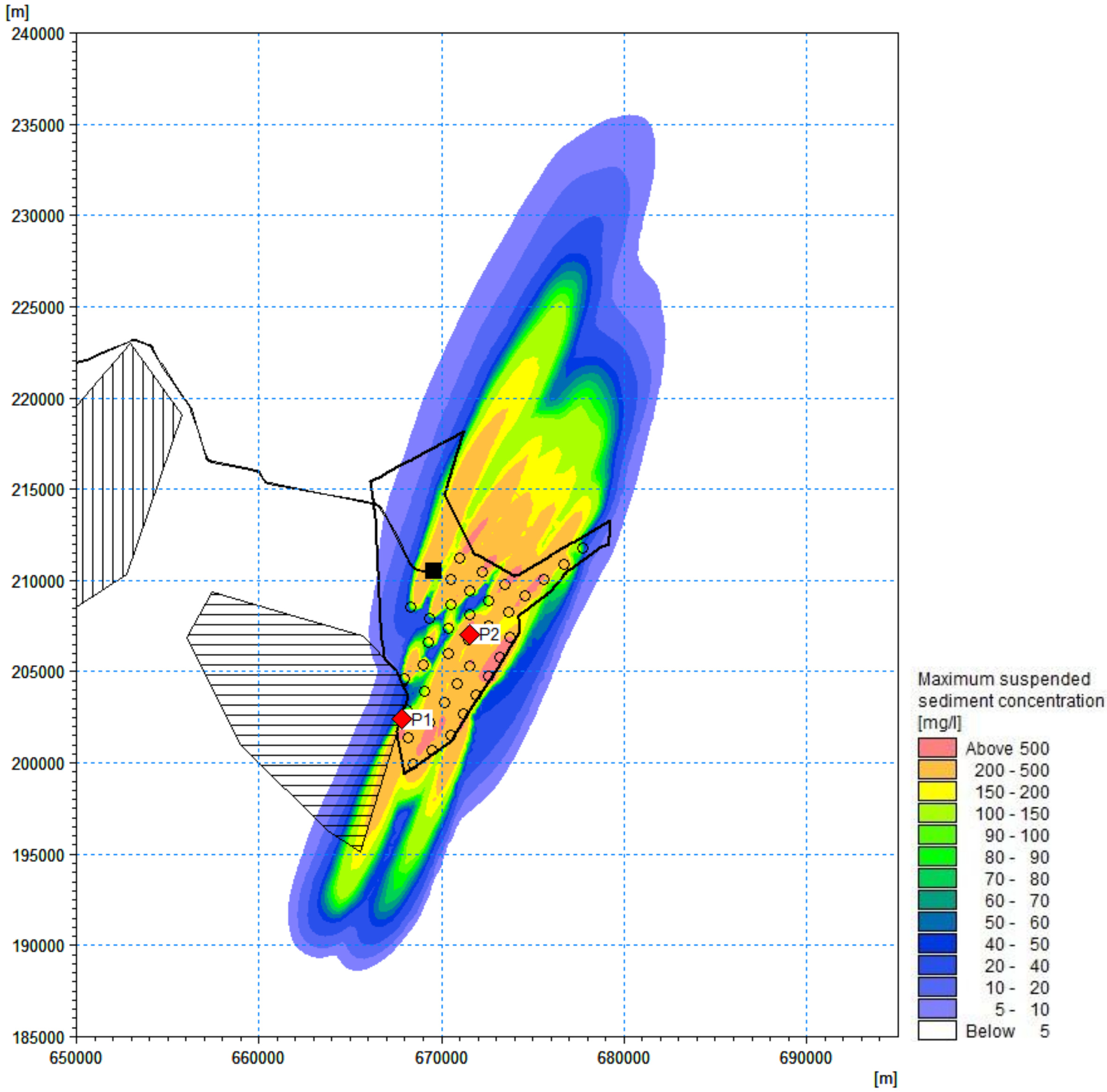

Figure 7-32 Maximum suspended sediment concentration during seabed preparation operations for smaller WTGs layout structures occurring in the middle of water column (red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

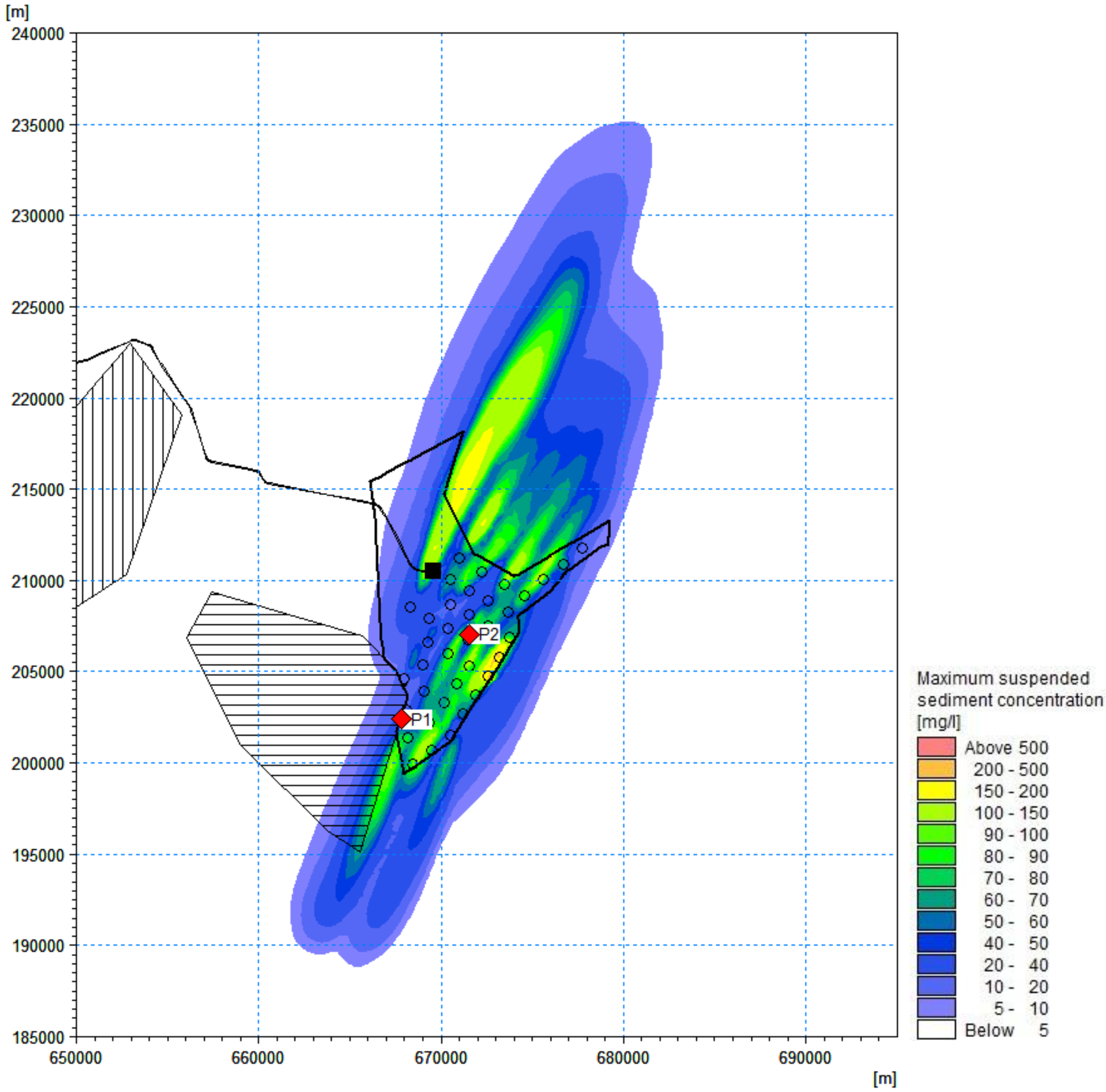

Figure 7-33 Maximum suspended sediment concentration during seabed preparation operations for smaller WTGs layout structures occurring near the water surface (red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

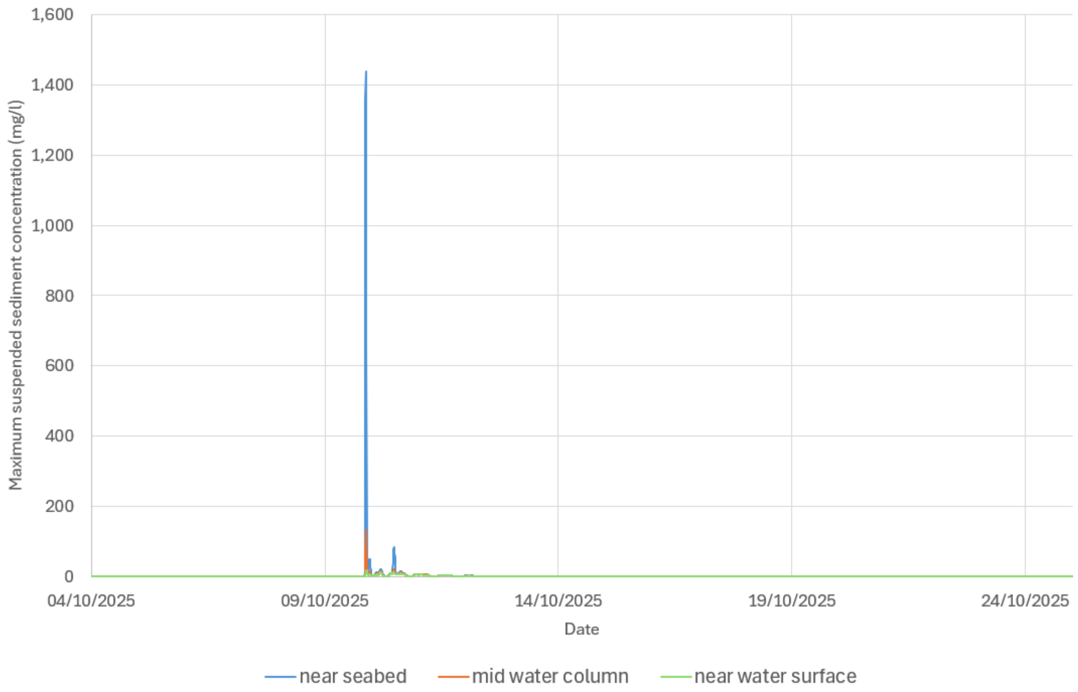

Figure 7-34 Time series of suspended sediment concentration at P1 during seabed preparation for array structures (smaller WTGs) near seabed, middle of water column and near water surface (near MCZ)

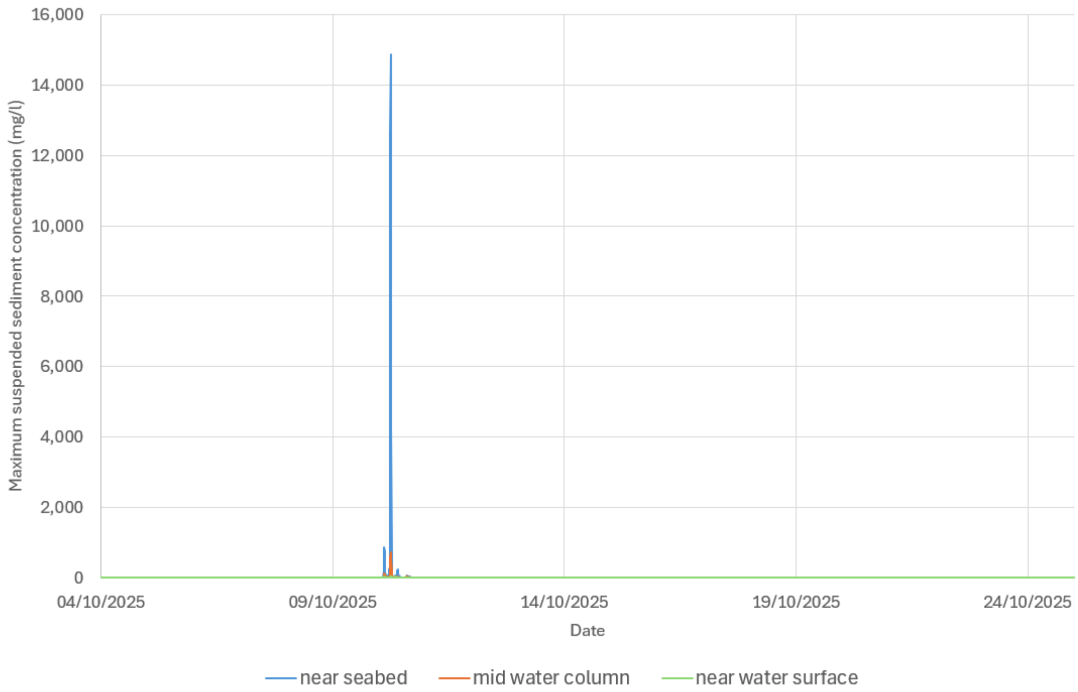

Figure 7-35 Time series of suspended sediment concentration at P2 during seabed preparation for array structures (smaller WTGs) near seabed, middle of water column and near water surface (array centre)

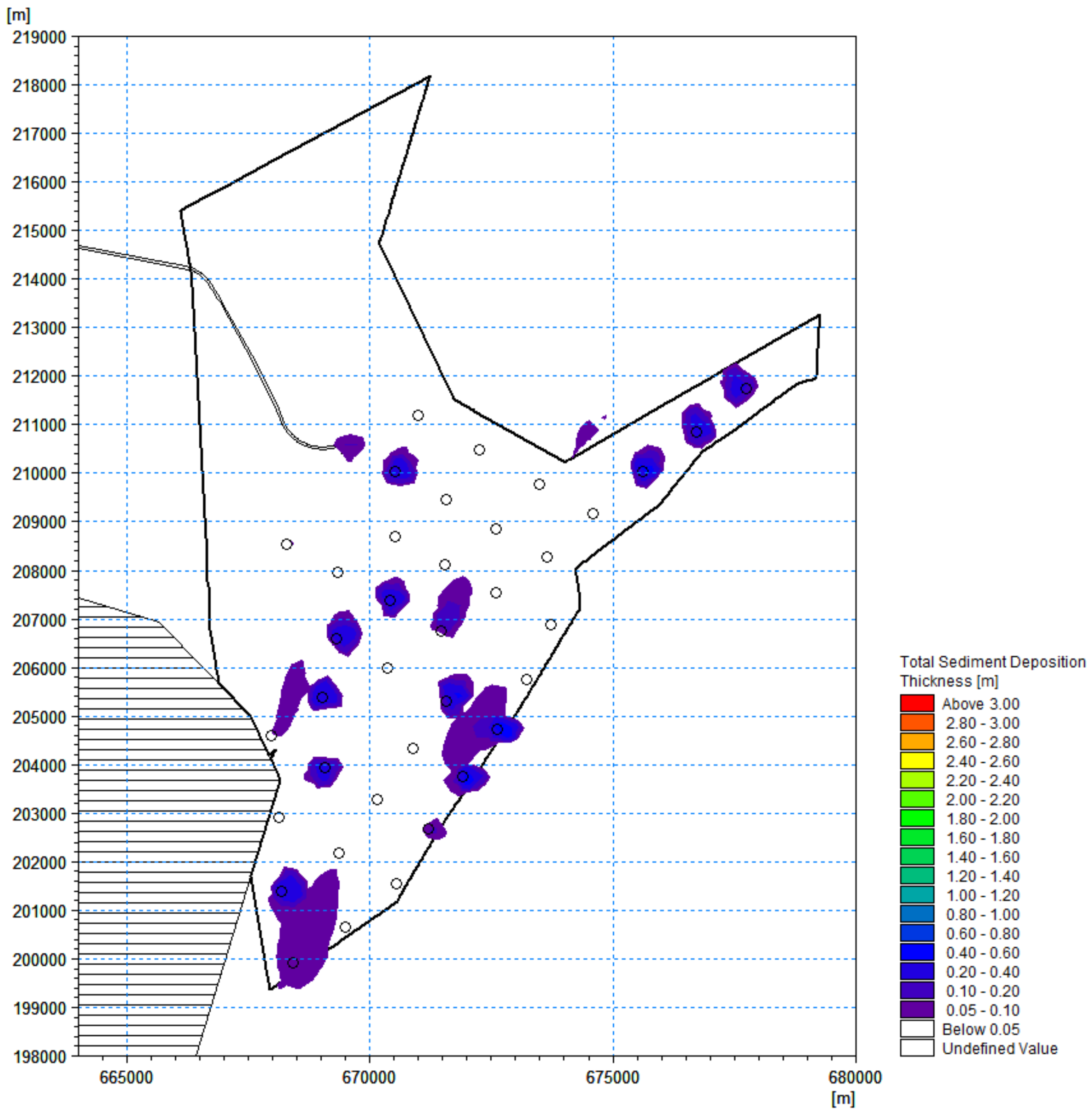

Figure 7-36 Total sediment deposition thickness during seabed preparation operations for smaller WTGs layout structures (horizontal hashed area = KKE MCZ)

7.9 Simulation 8 Results – Seabed Preparation for Structures – Larger WTGs Layout

7.9.1 Figure 7-37 – to Figure 7-39 show the maximum suspended sediment concentration above 5 mg/l which occurs during seabed preparation activities for larger WTGs layout structures near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The maximum SSC extends in a north-east to south-west direction from the larger WTGs array layout structures that require seabed preparation following the dominant current direction.

7.9.2 Figure 7-37 shows the maximum SSC plume near the seabed which covers the whole of the array area and extends beyond its boundary north-eastwards by about 25 km, and south-westwards by between about 10 km, albeit this extent includes large areas where the SSC levels are below 50 mg/l. The maximum SSC that is greater than 500 mg/l covers the whole of the array area and extends up to 7 km outside.

7.9.3 Figure 7-38 shows the maximum SSC plume in the middle of the water column that extends broadly as far as near the seabed, but maximum SSC greater than 500 mg/l show only as small spots inside the array area, whilst the SSC levels inside the array have dropped to between 200 mg/l to <500 mg/l and the plume of the same SSC levels only extends up to 5 km beyond the array boundary.

7.9.4 Figure 7-39 shows the maximum SSC plume near the water surface that extends broadly as far as near the seabed, but the maximum SSC levels are significantly lower, with only a couple of areas reaching SSC levels of 200 mg/l. Inside the array area the SSC levels are mainly around 50 mg/l to 80 mg/l.

7.9.5 Figure 7-40 and Figure 7-41 show the time series data of suspended sediment concentration during seabed preparation for larger WTGs array structures near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively, that are shown as red points on Figure 7-37 to Figure 7-39. The SSC level at P1 peaks at 460 mg/l near the seabed and lasts for just over an hour. The SSC levels at P2 peaks at 2,500 mg/l and last for approx. 2 hours.

7.9.6 Figure 7-42 shows the total sediment deposition thickness greater than 5cm which occurs during seabed preparation activities for larger WTGs layout structures. Most sediment deposition occurs within the array area near the structures that require seabed preparation. Only one area of deposition extends about 800m beyond the northern array boundary with deposition levels less than 0.1m. The maximum sediment deposition is 0.6m with the average being around 0.2m.

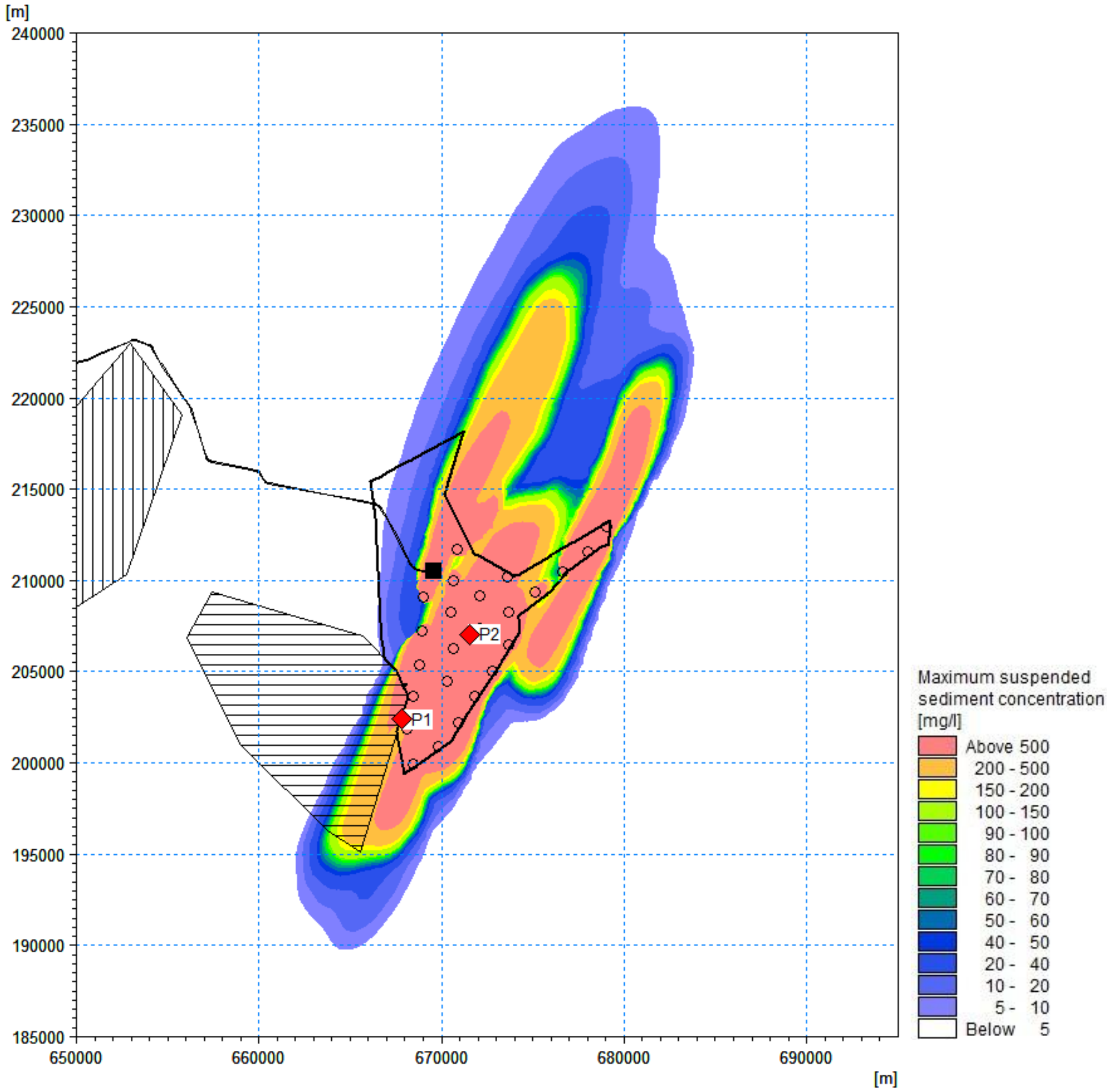

Figure 7-37 Maximum suspended sediment concentration during seabed preparation operations for larger WTGs layout structures occurring near the seabed (red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

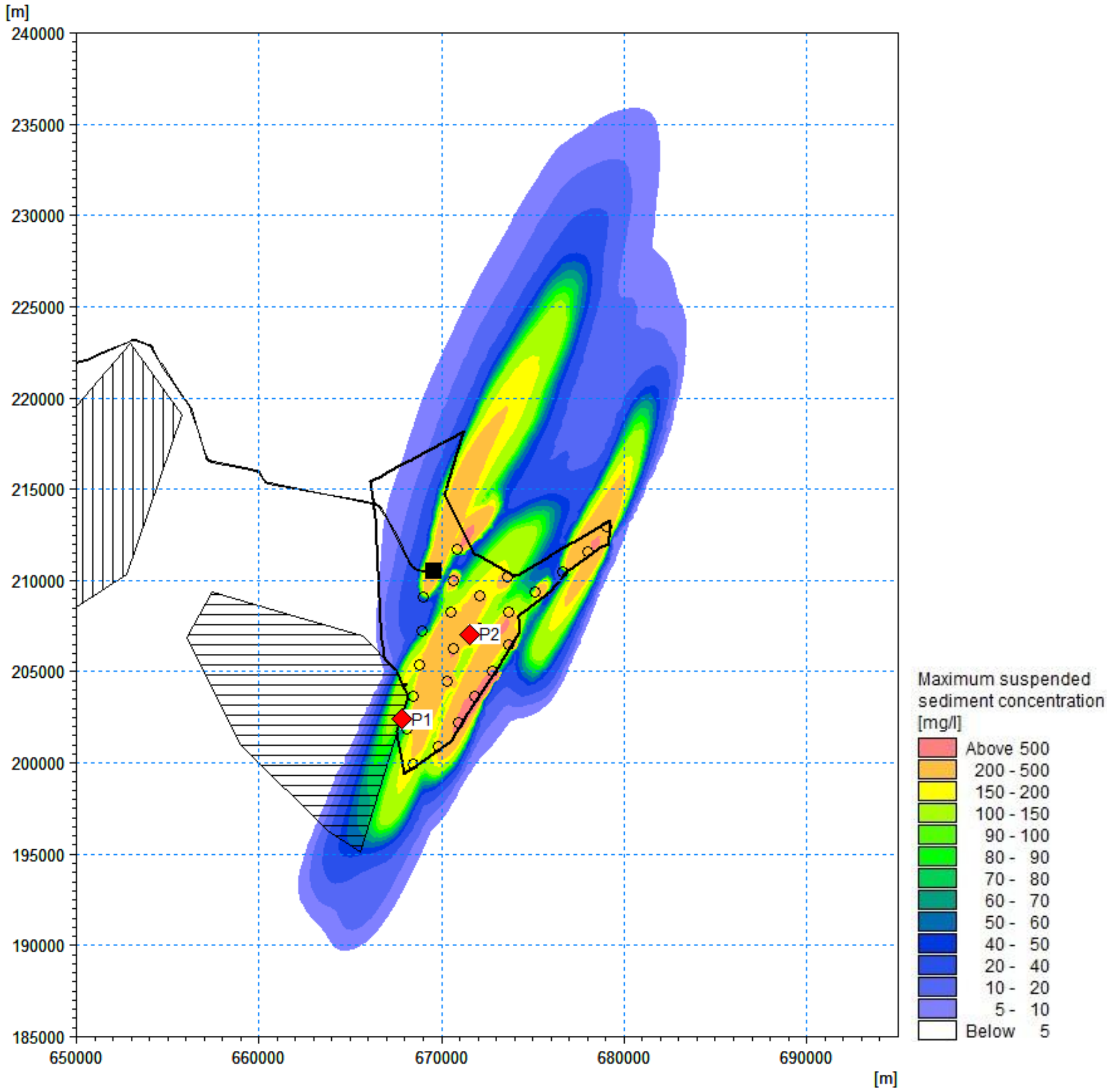

Figure 7-38 Maximum suspended sediment concentration during seabed preparation operations for larger WTGs layout structures occurring in the middle of water column (vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

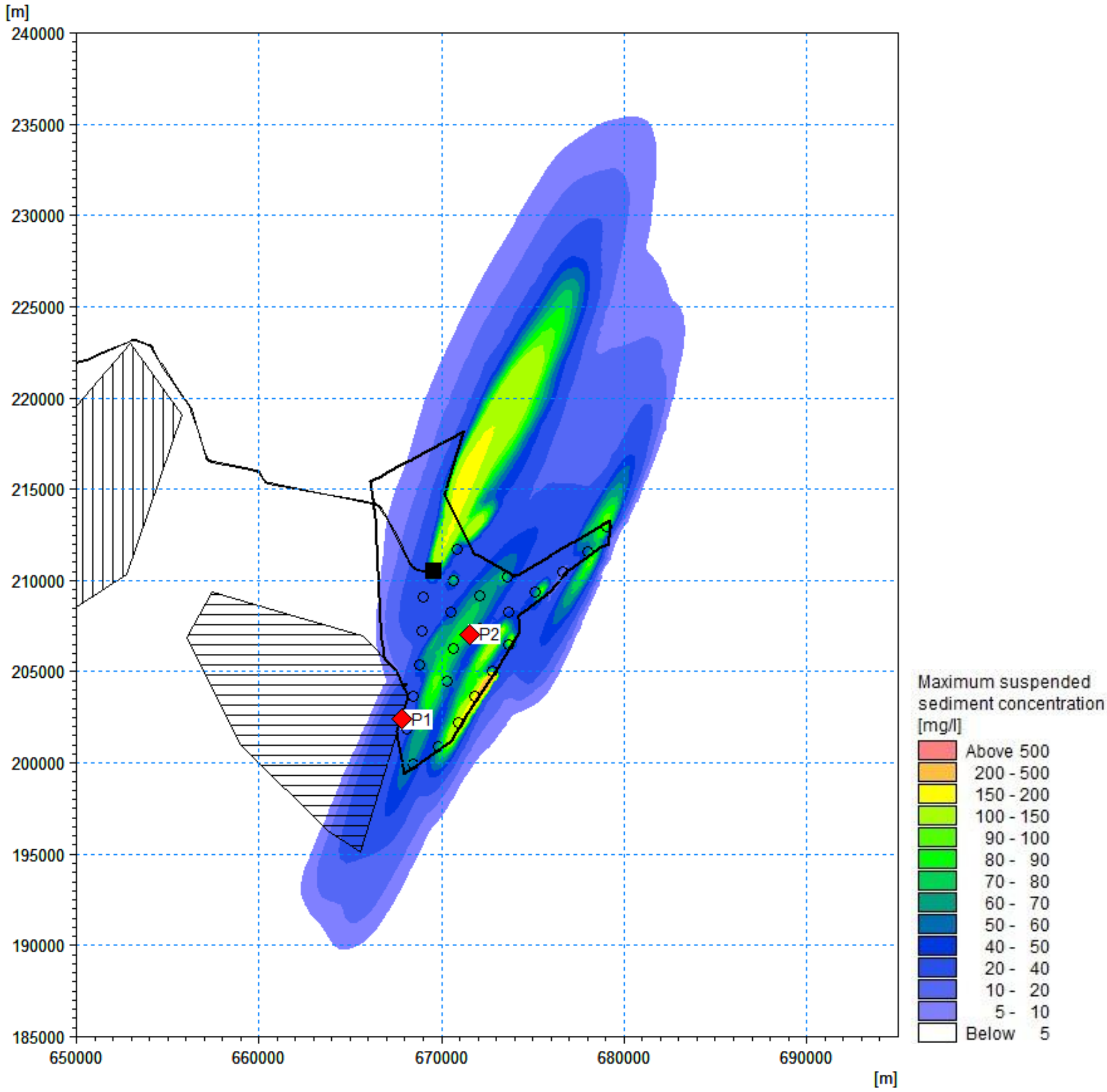

Figure 7-39 Maximum suspended sediment concentration during seabed preparation operations for larger WTGs layout structures occurring near the water surface (vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

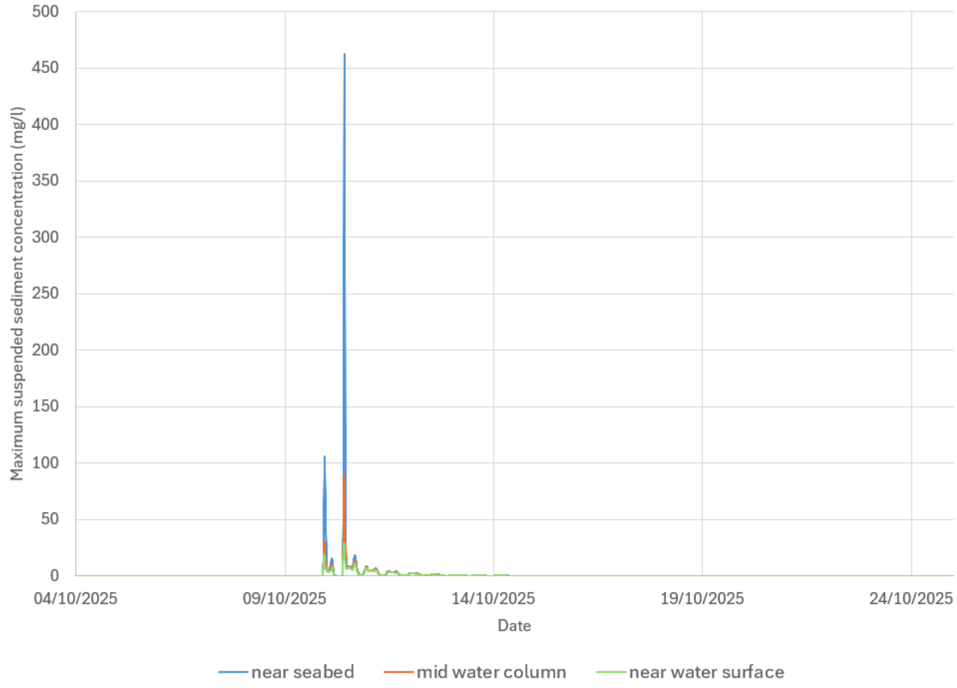

Figure 7-40 Time series of suspended sediment concentration at P1 during seabed preparation for array structures (larger WTGs) near seabed, middle of water column and near water surface

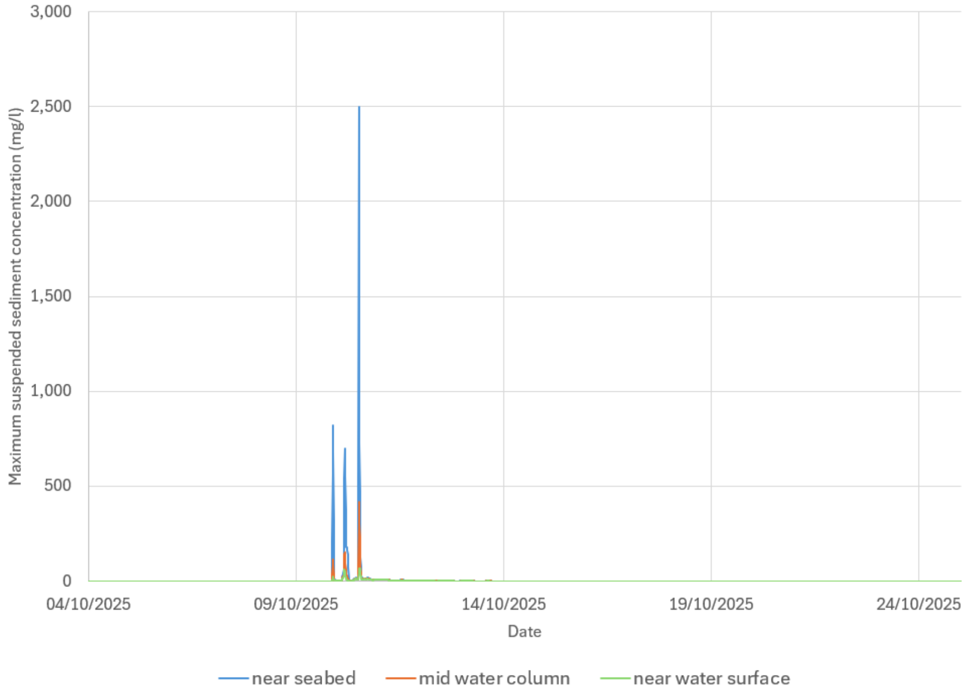

Figure 7-41 Time series of suspended sediment concentration at P2 during seabed preparation for array structures (larger WTGs) near seabed, middle of water column and near water surface

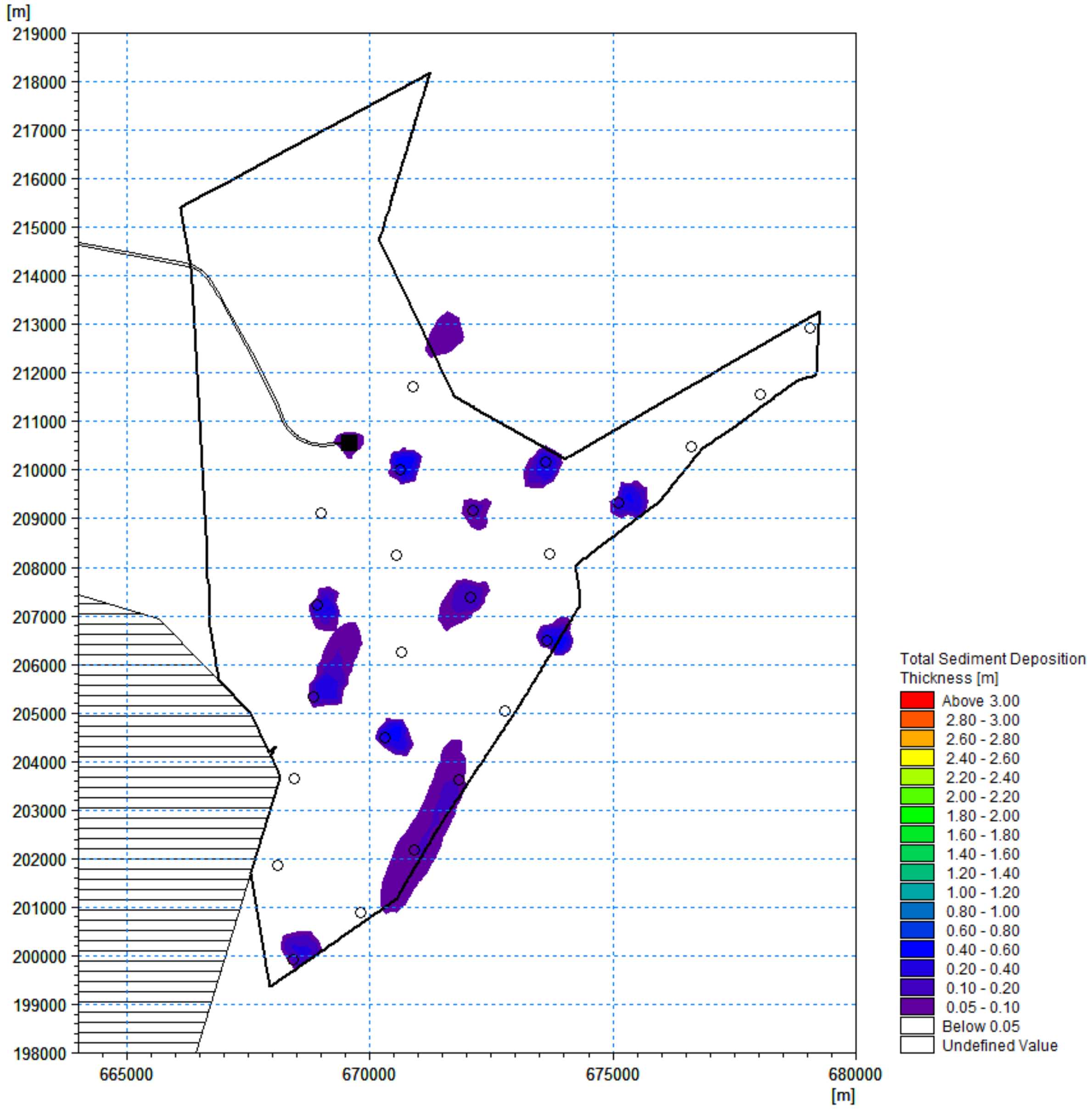

Figure 7-42 Total sediment deposition thickness during seabed preparation operations for larger WTGs layout structures (horizontal hashed area = KKE MCZ)

7.10 Simulation 9 Results – Array Cable Levelling

7.10.1 Figure 7-43 to Figure 7-45 show the maximum suspended sediment concentration above 5 mg/l which occurs during array cable levelling activities near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The maximum SSC extends in a north-east to south-west direction from the array area following the dominant current direction.

7.10.2 Figure 7-43 shows the maximum SSC plume near the seabed that extends from the array area north-eastwards by up to 19 km, and south-westwards by up to 12 km, albeit this extent includes areas of SSC levels less than 50 mg/l. The maximum SSC that is greater than 500 mg/l extends by up to 10 km beyond the array area.

7.10.3 Figure 7-44 shows the maximum SSC plume in the middle of the water column that extends broadly as far as near the seabed, but areas with maximum SSC greater than 500 mg/l only cover a 3.5 km strip along the eastern side of the array. The SSC in the eastern half of the array area is between 200 to 300 mg/l. Maximum SSC levels between 200 and 500 mg/l extend outside the array area by up to 3 km.

7.10.4 Figure 7-45 shows the maximum SSC plume near the water surface that extends broadly as far as near the seabed, but there is only one small area (inside the array area) where the maximum SSC levels are greater than 100 mg/l. Outside the array area the SSC levels are further reduced to levels of less than 40 mg/l for most areas.

7.10.5 Figure 7-46 and Figure 7-47 show the time series data of suspended sediment concentration during array cable levelling near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively, that are shown as red points on Figure 7-43 to Figure 7-45. The largest peak of SSC at P1 only exceeds 15 mg/l for approx. 1 hour near the seabed. The largest peak of SSC at P2 exceeds 15 mg/l for approx. 4 hours near the seabed.

7.10.6 Figure 7-48 shows the total sediment deposition thickness greater than 5cm which occurs during array cable levelling activities. The sediment deposition of higher magnitude occurs inside the array area and along the array cables that require levelling. The deposition close to the cables exceeds 3.0m, especially where the cables are close together near the central OCP/OSP location. The sediment deposition of smaller magnitude extends outside the array area by 11 km north-eastwards and by 9 km south-westwards in the direction of the dominant current direction. The deposition northwards of the array area is between 0.2 – 0.8m for about 7km before the thickness decreases to between 0.05 – 0.2m. The deposition southwards of the array area (near the MCZ) is between 0.05 – 0.6m.

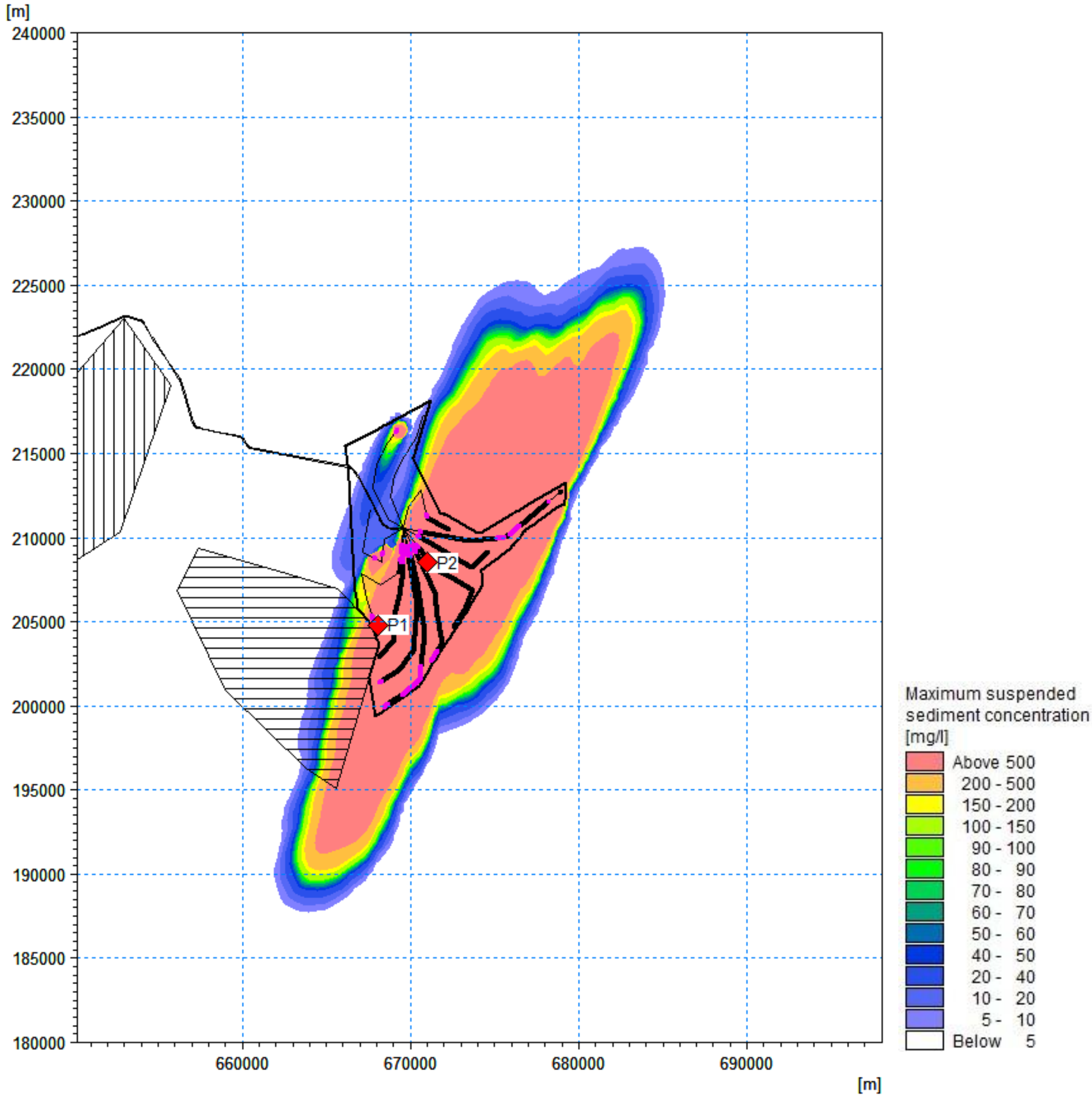

Figure 7-43 Maximum suspended sediment concentration during array cable levelling operations occurring near the seabed
(thick purple line = MR, thick black line = SW, red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

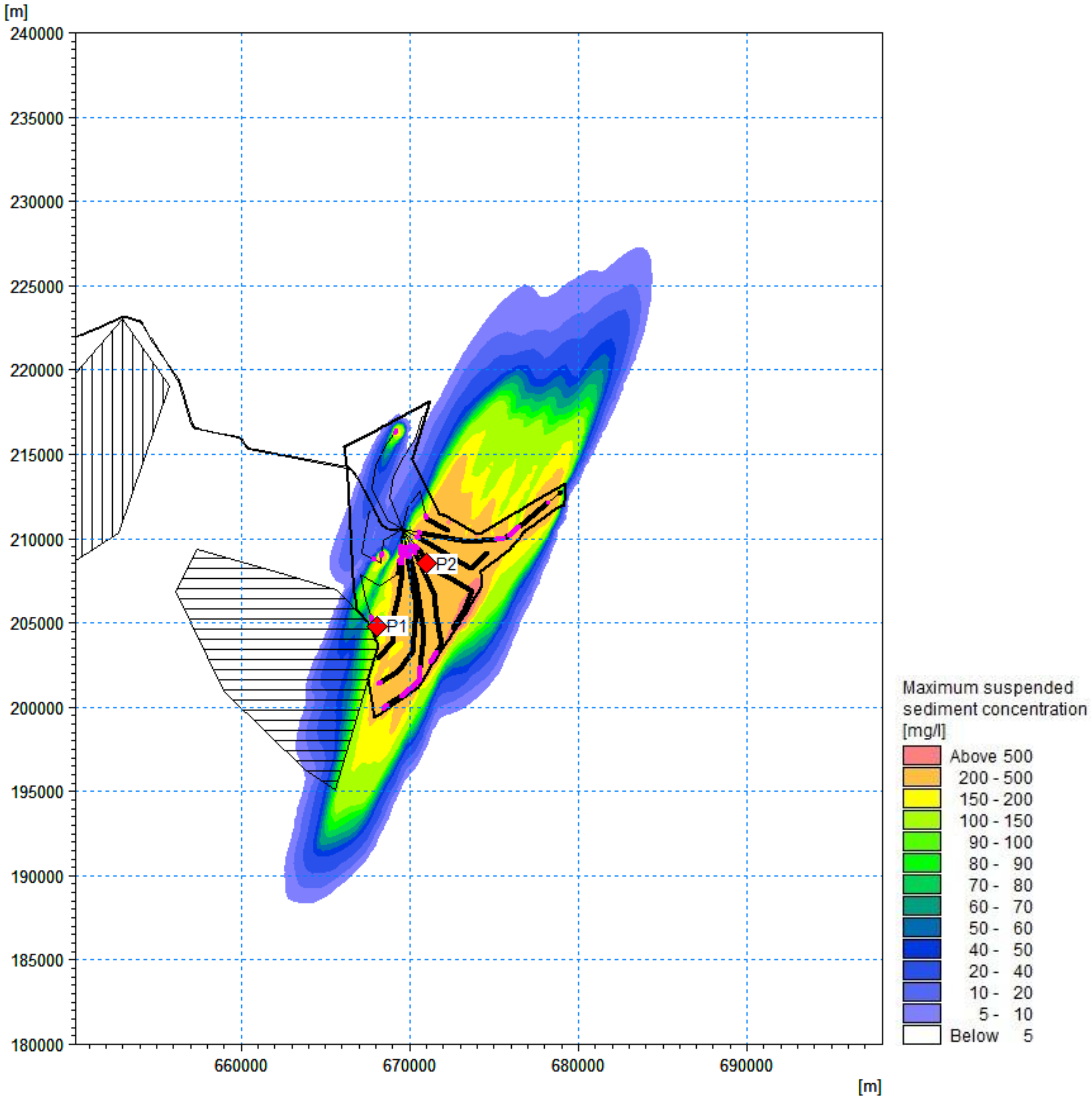

Figure 7-44 Maximum suspended sediment concentration during array cable levelling operations occurring in the middle of water column (thick purple line = MR, thick black line = SW, red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

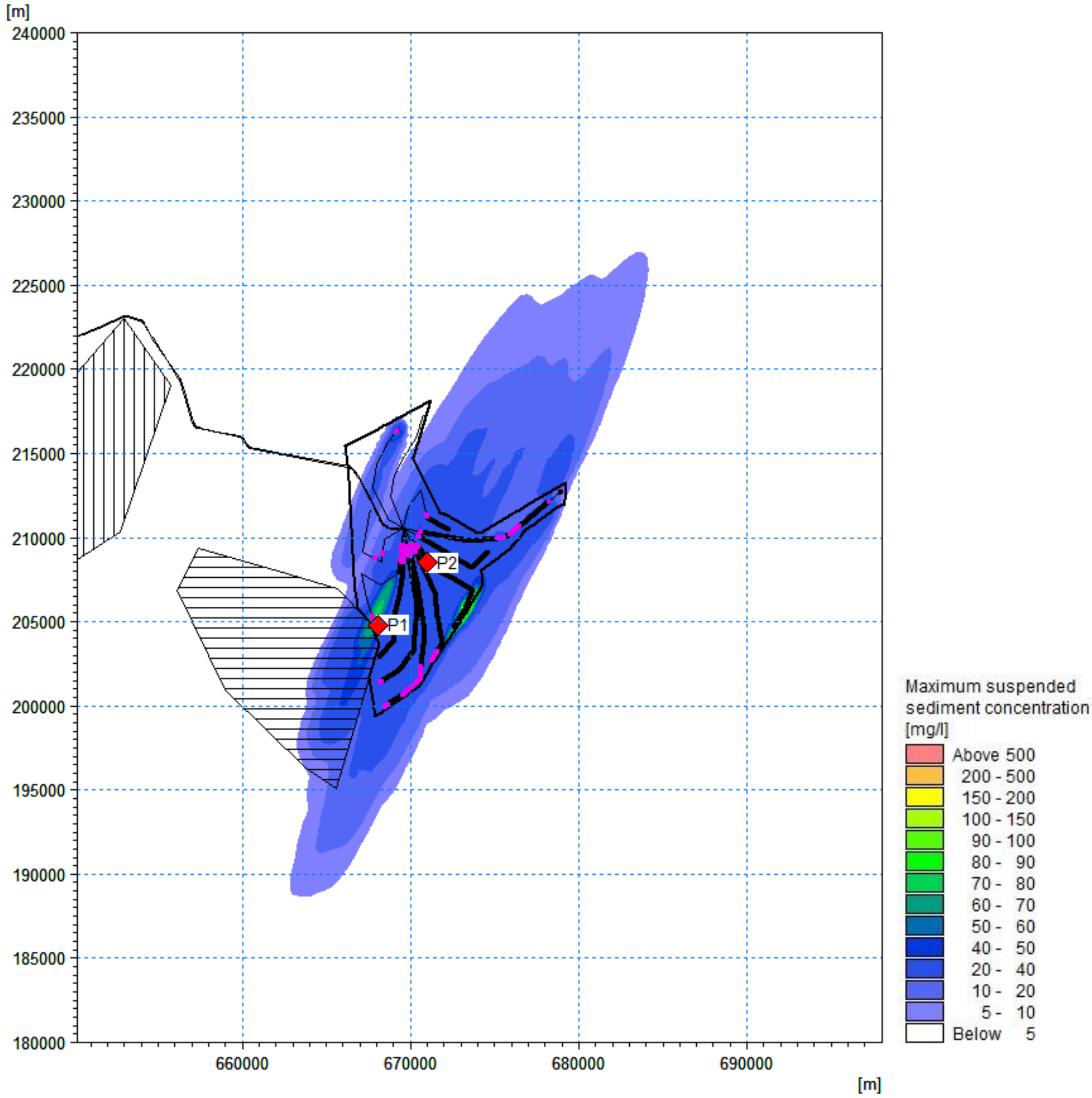

Figure 7-45 Maximum suspended sediment concentration during array cable levelling operations occurring near the water surface (thick purple line = MR, thick black line = SW) (thick purple line = MR, thick black line = SW, red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

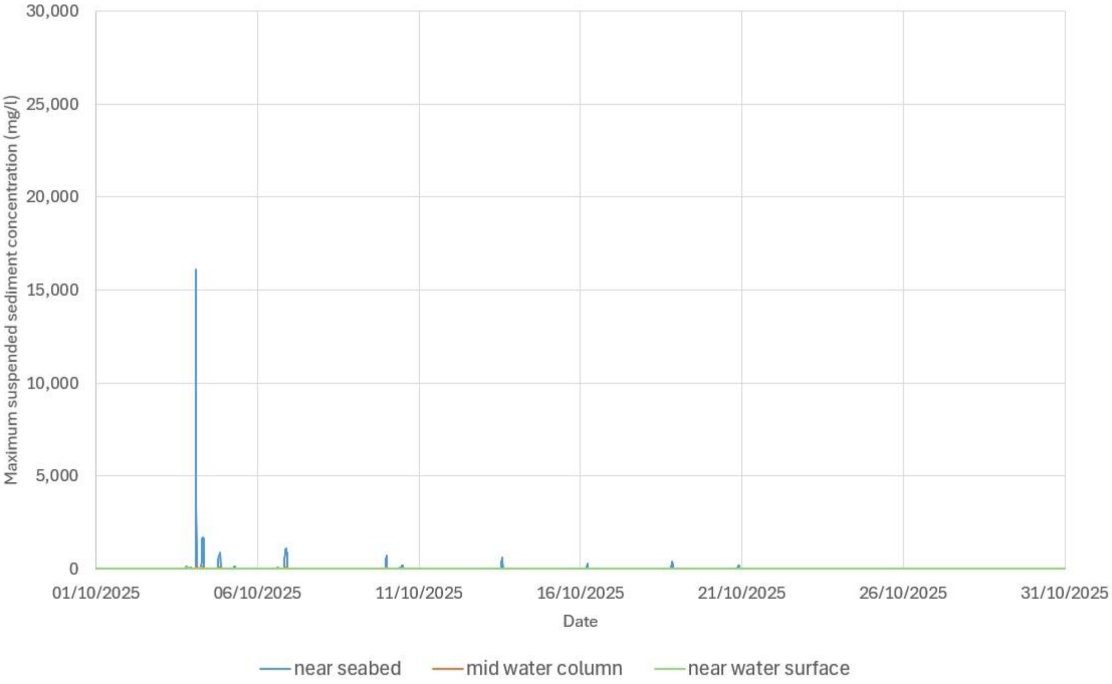

Figure 7-46 Time series of suspended sediment concentration at P1 during array cable levelling near seabed, middle of water column and near water surface (near MCZ)

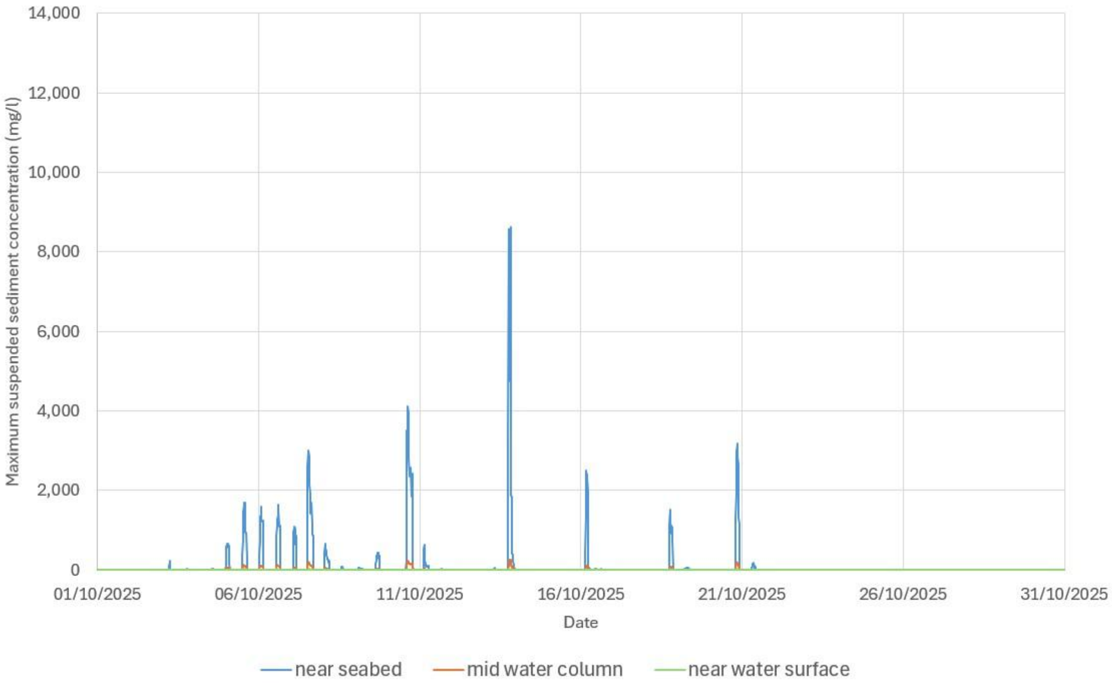

Figure 7-47 Time series of suspended sediment concentration at P2 during array cable levelling near seabed, middle of water column and near water surface (array centre)

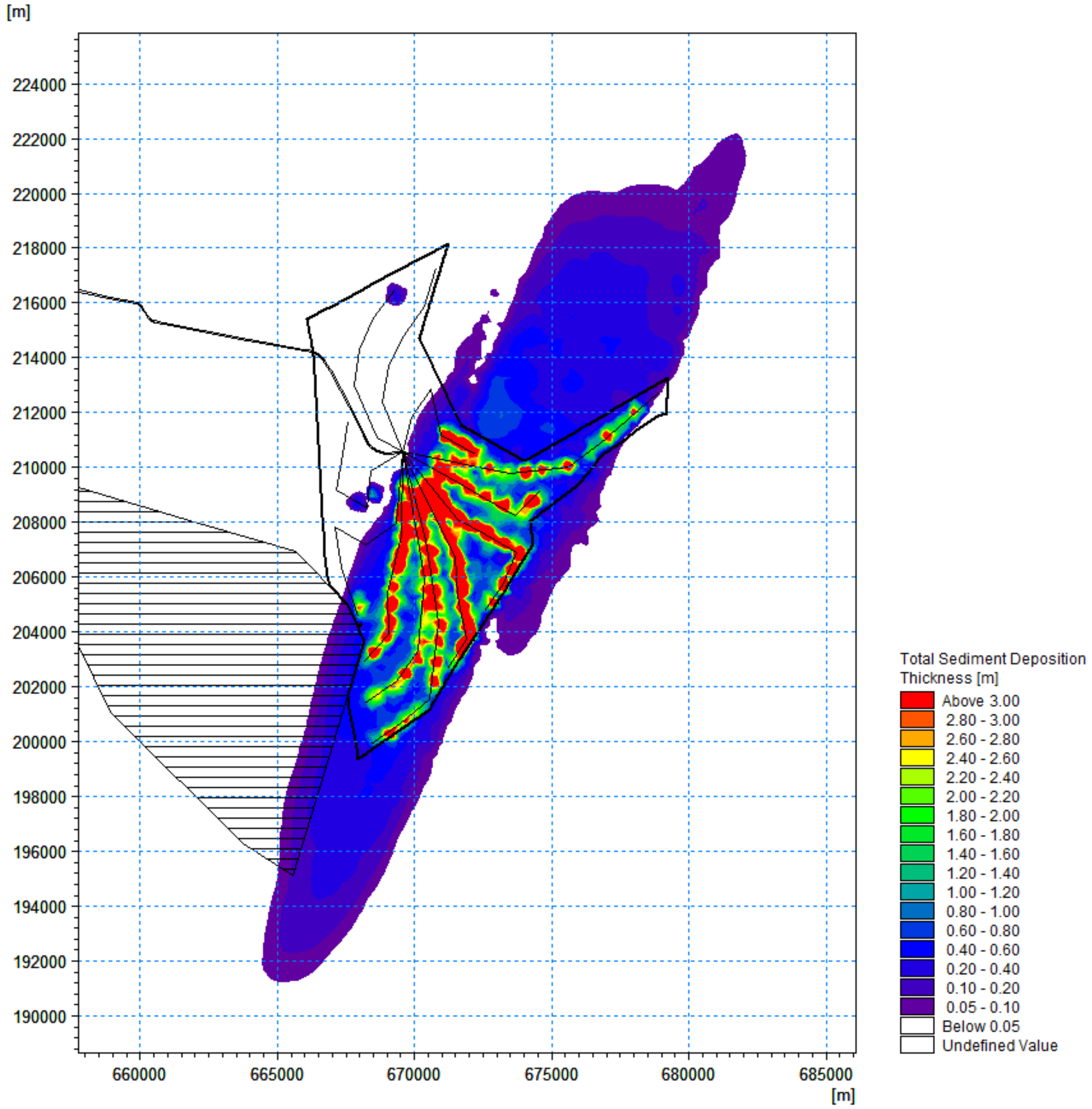

Figure 7-48 Total sediment deposition thickness during array cable levelling operations (horizontal hashed area = KKE MCZ)

7.11 Simulation 10 Results –Array Cable Trenching

7.11.1 Figure 7-49 to Figure 7-51 show the maximum suspended sediment concentration above 5 mg/l which occurs for array cable trenching activities near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The maximum SSC extends in a north-east to south-west direction from the array area following the dominant current direction.

7.11.2 Figure 7-49 shows the maximum SSC plume near the seabed that extends from the array area north-eastwards by up to 7 km, and south-westwards by about 4 km, albeit this extent includes large areas of SSC levels less than 10 mg/l. There are only a couple of areas inside the array area where the maximum SSC levels reach 100 mg/l, the majority of SSC levels close to the array cables are between 20 to 40 mg/l.

7.11.3 Figure 7-50Figure 7-50 shows that the sediment concentration has fully dispersed, i.e. SSC levels are below 5 mg/l, by the time the sediment reaches the middle of the water column.

7.11.4 Figure 7-51 shows that the sediment concentration has fully dispersed, i.e. SSC levels are below 5 mg/l, by the time the sediment reaches the water surface.

7.11.5 Figure 7-52 and Figure 7-53 -show the time series data of suspended sediment concentration during array cable trenching near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively, that are shown as red points on -Figure 7-49 to Figure 7-51-. The SSC near P1 (MCZ) only reaches 25 mg/l near the seabed at its peak and lasts approx. for 1 hour. The SSC near P2 reaches a peak of 80 mg/l and exceeds 15 mg/l for approx. ~~1.5~~1.0 hour near the seabed.

7.11.6 Figure 7-54 -shows the total sediment deposition thickness greater than 5cm which occurs during array cable trenching activities. There is a small area of approx. 500m across located close to the OSP where the deposition thickness is between 0.05 to 0.1m.

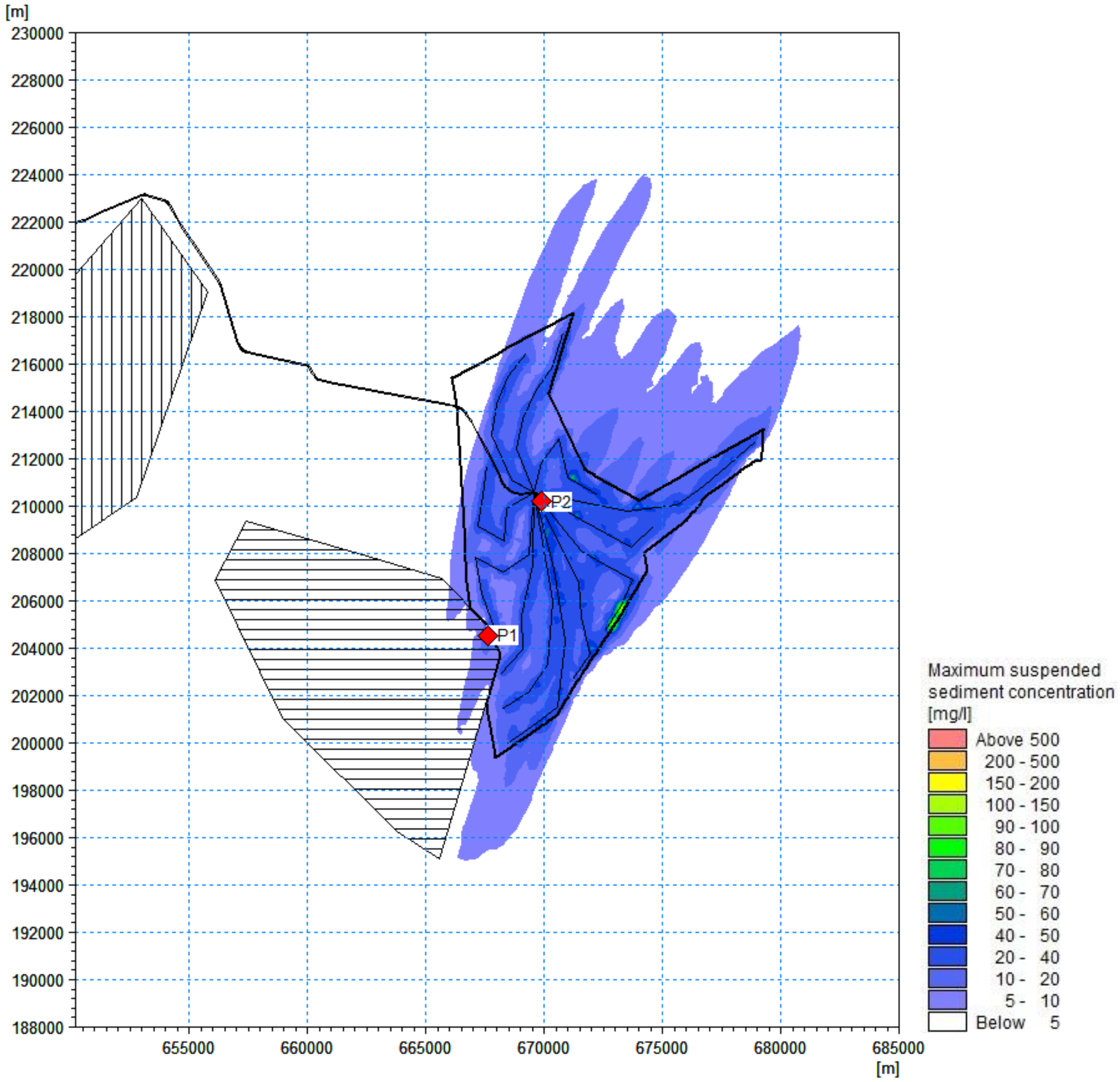

Figure 7-49 Maximum suspended sediment concentration during array cable trenching operations occurring near the seabed
(red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

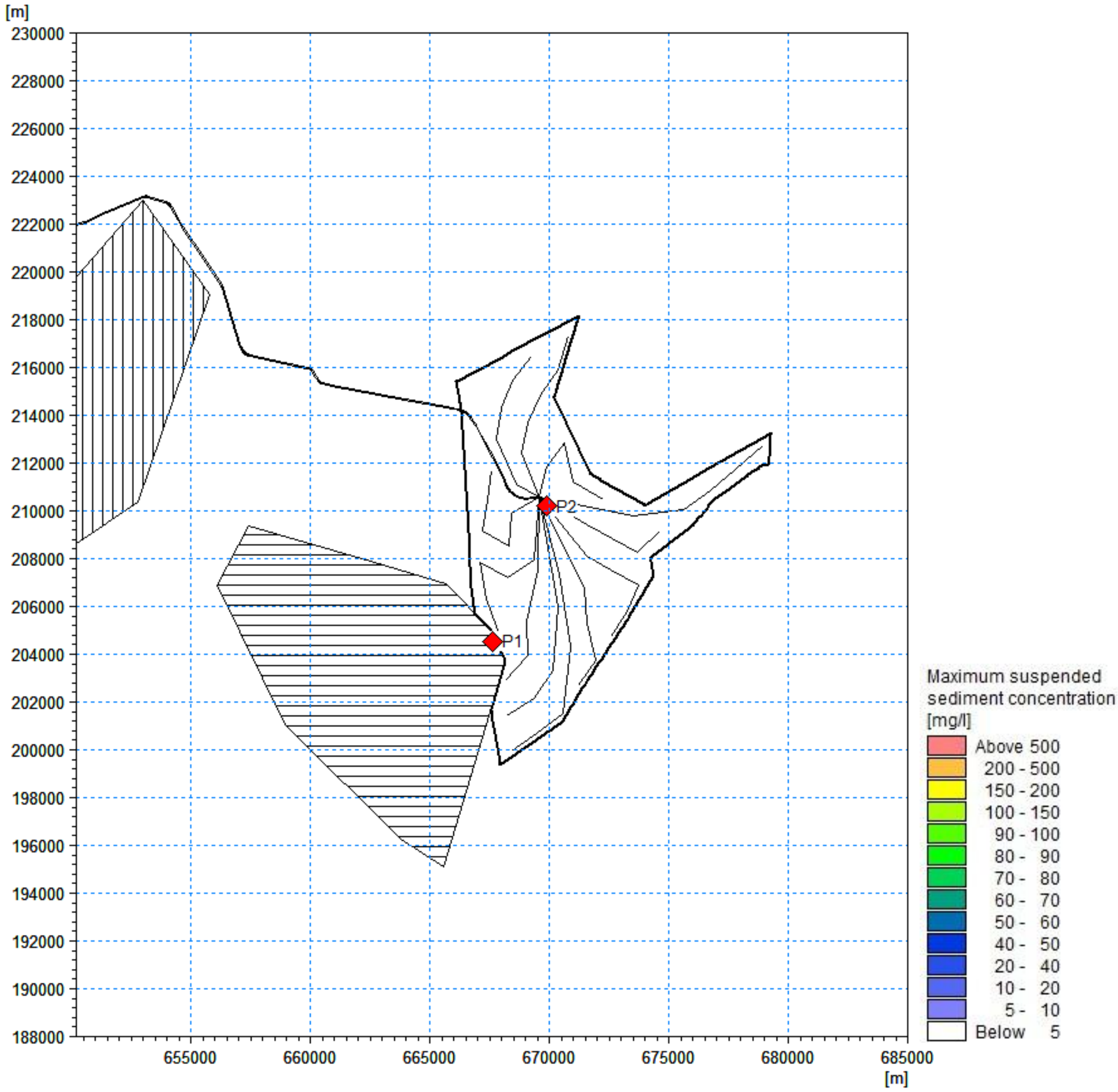

Figure 7-50 Maximum suspended sediment concentration during array cable trenching operations occurring in the middle of water column (red points = time series extraction points vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

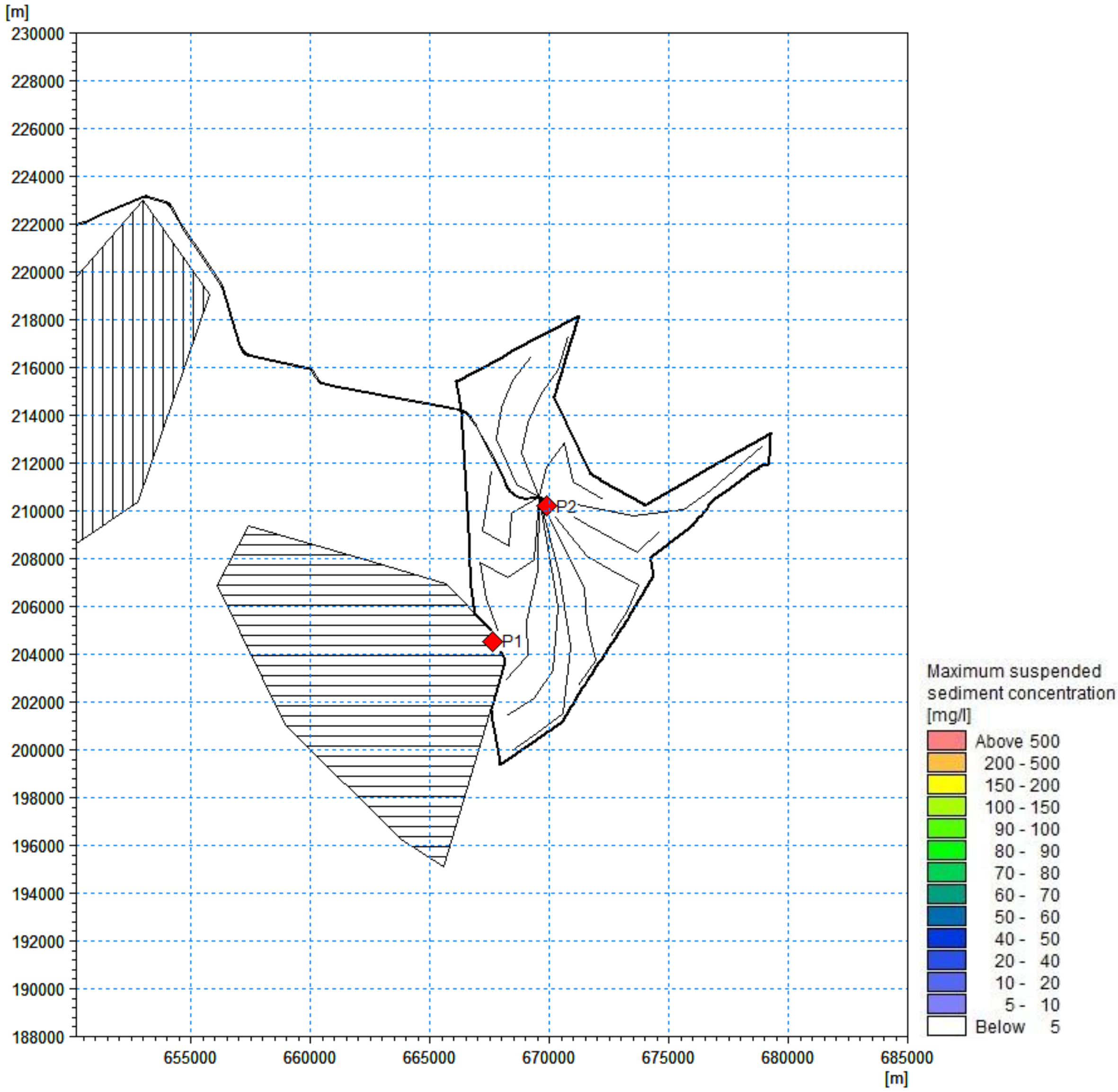

Figure 7-51 Maximum suspended sediment concentration during array cable trenching operations occurring near the water surface
(red points = time series extraction points, vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

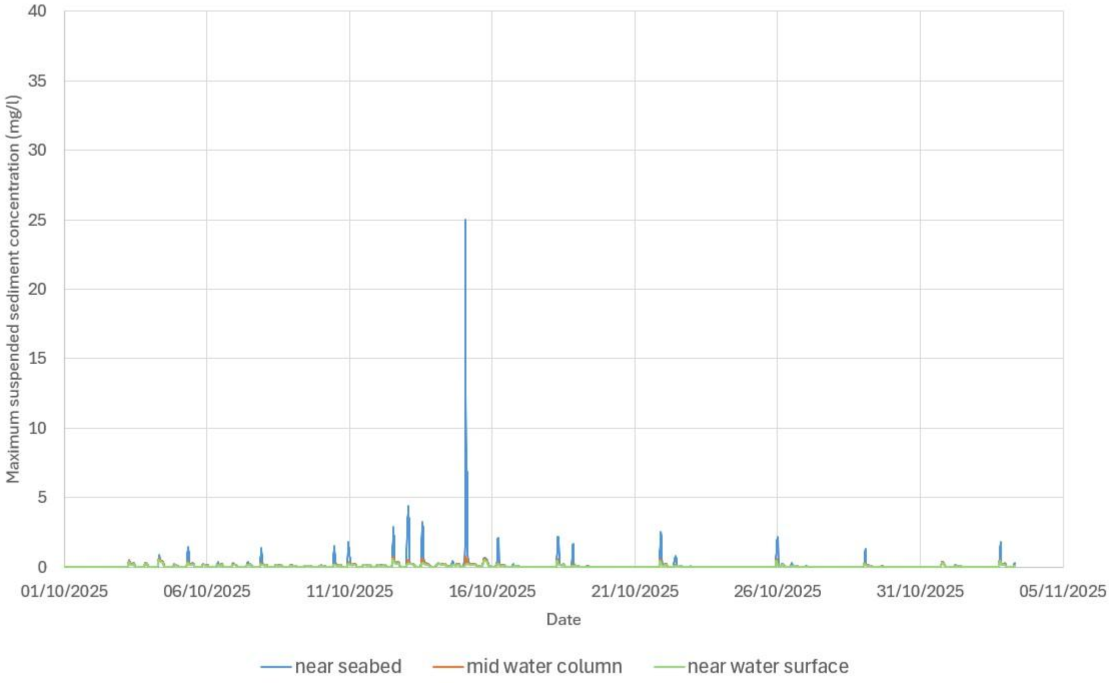

Figure 7-52 Time series of suspended sediment concentration at P1 during array cable trenching near seabed, middle of water column and near water surface (near MCZ)

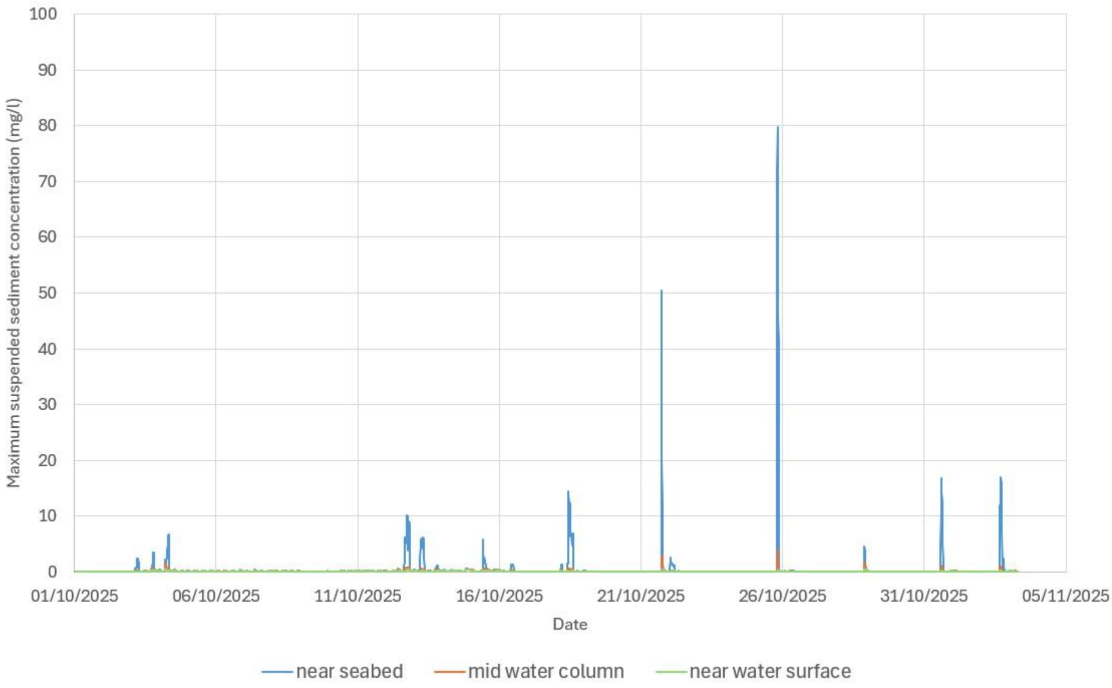

Figure 7-53 Time series of suspended sediment concentration at P2 during array cable trenching near seabed, middle of water column and near water surface

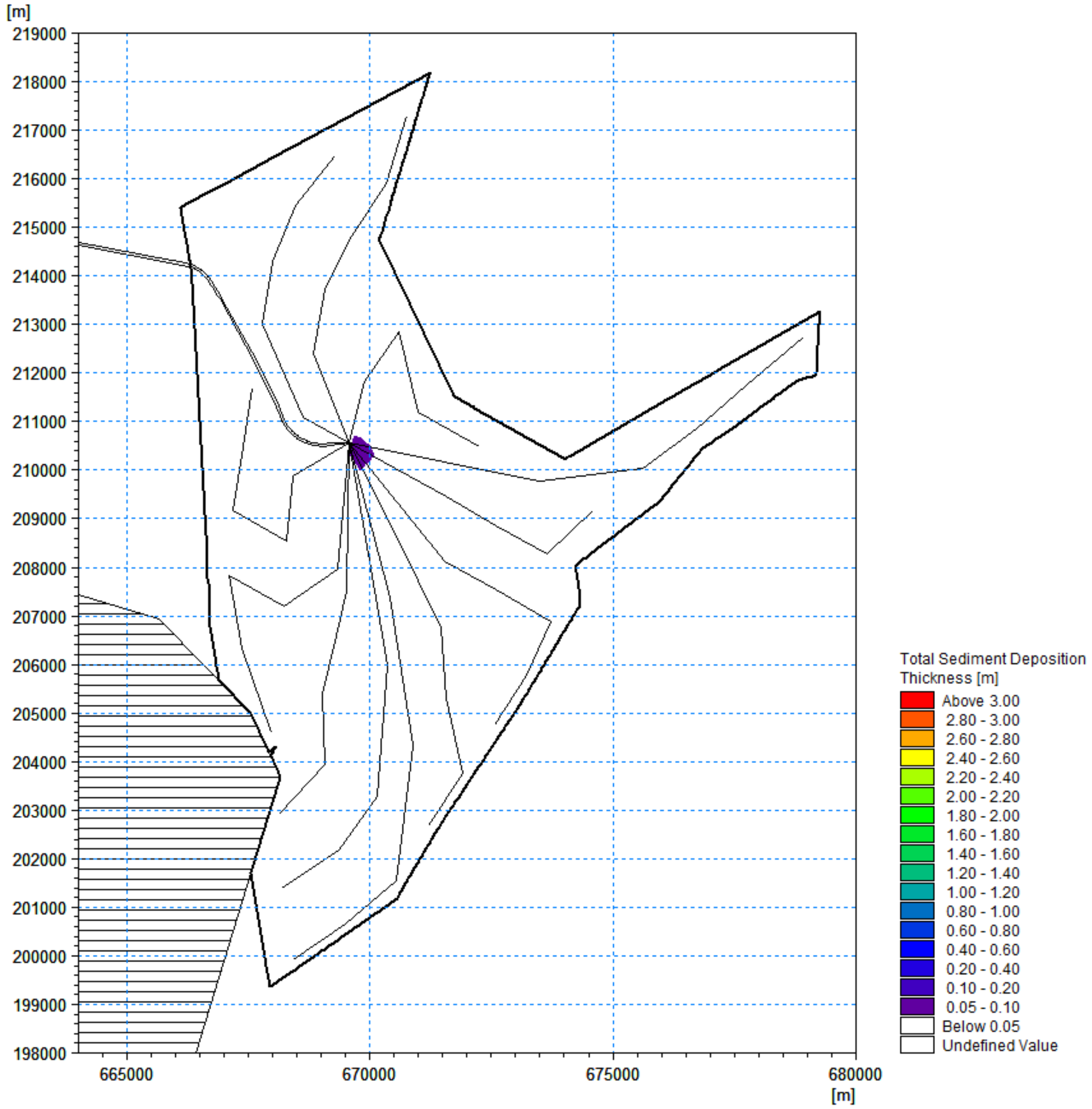

Figure 7-54 Total sediment deposition thickness during array cable trenching operations (vertical hashed area = MLS SAC, horizontal hashed area = KKE MCZ)

7.12 Simulation 11 Results – Array Disposal of ‘Zone 1 & 3’ material

7.12.1 Figure 7-55 to Figure 7-57 show the maximum suspended sediment concentration above 5 mg/l which occurs during sediment disposal during slack water near high water during neap tide near the seabed, in the middle of the water column and near the water surface respectively. The maximum SSC extent is broadly the same throughout the water column. The maximum SSC extends from the release point for approx. 12km in a north-easterly direction and measures approx. 4km in width, albeit this extent includes large areas of SSC levels between 5 mg/l and 50 mg/l.

7.12.2 Figure 7-58 shows the time series data of suspended sediment concentration during sediment disposal during slack water near high water during neap tide near the seabed, the middle of the water column and near the water surface for location P1. The SSC levels for P1 exceed 15 mg/l near the seabed for approx. 1.5 hour with a peak of 800 mg/l, the SSC levels near the water surface peak at 2,200 mg/l within the same duration.

7.12.3 Figure 7-59 shows the total sediment deposition thickness greater than 5cm which occurs during sediment disposal during slack water near high water during neap tide. All sediment depositions are smaller than 0.5m and the area is localised around the release point extending no further than 750m in diameter.

7.12.4 Figure 7-60 to Figure 7-62 show the maximum suspended sediment concentration above 5 mg/l which occurs during sediment disposal during slack water near low water during neap tide near the seabed, in the middle of the water column and near the water surface respectively. The maximum SSC extent is broadly the same throughout the water column. The maximum SSC extends from the release point for approx. 12km in a south-westerly direction and measures approx. 4km in maximum width, albeit this extent includes large areas of SSC levels between 5 mg/l and 50 mg/l. There is a small area of maximum SSC extending north-eastwards by approx. 3km of concentration levels less than 20mg/l.

7.12.5 Figure 7-63 and Figure 7-64 show the time series data of suspended sediment concentration during sediment disposal during slack water near low water during neap tide near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively. The SSC levels for P1 exceed 15 mg/l near the seabed for approx. 1.5 hour with a peak of 1,300 mg/l, the SSC levels near the water surface peak at 4,200 mg/l within the same duration. The SSC levels for P2 exceed 15 mg/l throughout the water column for approx. 3.5 hour with a peak of 45 mg/l.

7.12.6 Figure 7-65 shows the total sediment deposition thickness greater than 5cm which occurs during sediment disposal during slack water near low water during neap tide. All sediment depositions are smaller than 0.5m and the area is localised around the release point extending no further than 700m in diameter.

7.12.7 Figure 7-66 to Figure 7-68 show the maximum suspended sediment concentration above 5 mg/l which occurs during sediment disposal during peak flood during spring tide near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The area of maximum suspended sediment concentration extends from the release point for approx. 9.5km in a south-westerly direction and measures up to 4km in width. The area of maximum suspended sediment concentration above 500mg/l only occurs in a south-westerly direction and is greatest near the seabed (5km) and gradually becomes less when reaching the water surface (2km). The maximum SSC extending north-eastwards by approx. 14km and measures approx. 6km in width, although the maximum SSC levels in this area are below 40mg/l.

7.12.8 Figure 7-69 – and – Figure 7-70 show the time series data of suspended sediment concentration during sediment disposal during peak flood during spring tide near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively. The SSC levels for P1 exceed 15 mg/l near the seabed for approx. 1.5 hour with a peak of 2,800 mg/l, the SSC levels near the water surface peak at 400 mg/l within the same duration. The SSC levels for P2 exceed 15 mg/l throughout the water column for approx. 1.5 hour, with a peak of 45 mg/l.

7.12.9 Figure 7-71 shows the total sediment deposition thickness greater than 5cm which occurs during sediment disposal during peak flood during spring tide. All sediment deposition occurs within the array area and is <5cm.

7.12.10 Figure 7-72 – to – Figure 7-74 show the maximum suspended sediment concentration above 5 mg/l which occurs during sediment disposal during peak ebb during spring tide near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The area of maximum suspended sediment concentration extends from the release point for approx. 16km in a north-easterly direction and measures up to 8km in width. The area of maximum suspended sediment concentration above 500mg/l only occurs in a north-easterly direction and is greatest near the seabed (7km) and gradually becomes less when reaching the water surface (2km). The maximum SSC extending south-westwards by approx. 9km and measures approx. 5.5km in width, although the maximum SSC levels in this area are below 40mg/l.

7.12.11 Figure 7-75 and Figure 7-76 show the time series data of suspended sediment concentration during sediment disposal during peak ebb during spring tide near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively. The SSC levels for P1 exceed 15 mg/l near the seabed for approx. 1.0 hour with a peak of 2,800 mg/l, the SSC levels near the water surface peak at 400 mg/l within the same duration. The SSC levels for P2 exceed 15 mg/l throughout the water column for approx. 1.5 hour, with a peak of 22 mg/l.

7.12.12 Figure 7-77 shows the total sediment deposition thickness greater than 5cm which occurs during sediment disposal during peak ebb during spring tide. All sediment deposition occurs within the array area and is <5cm.

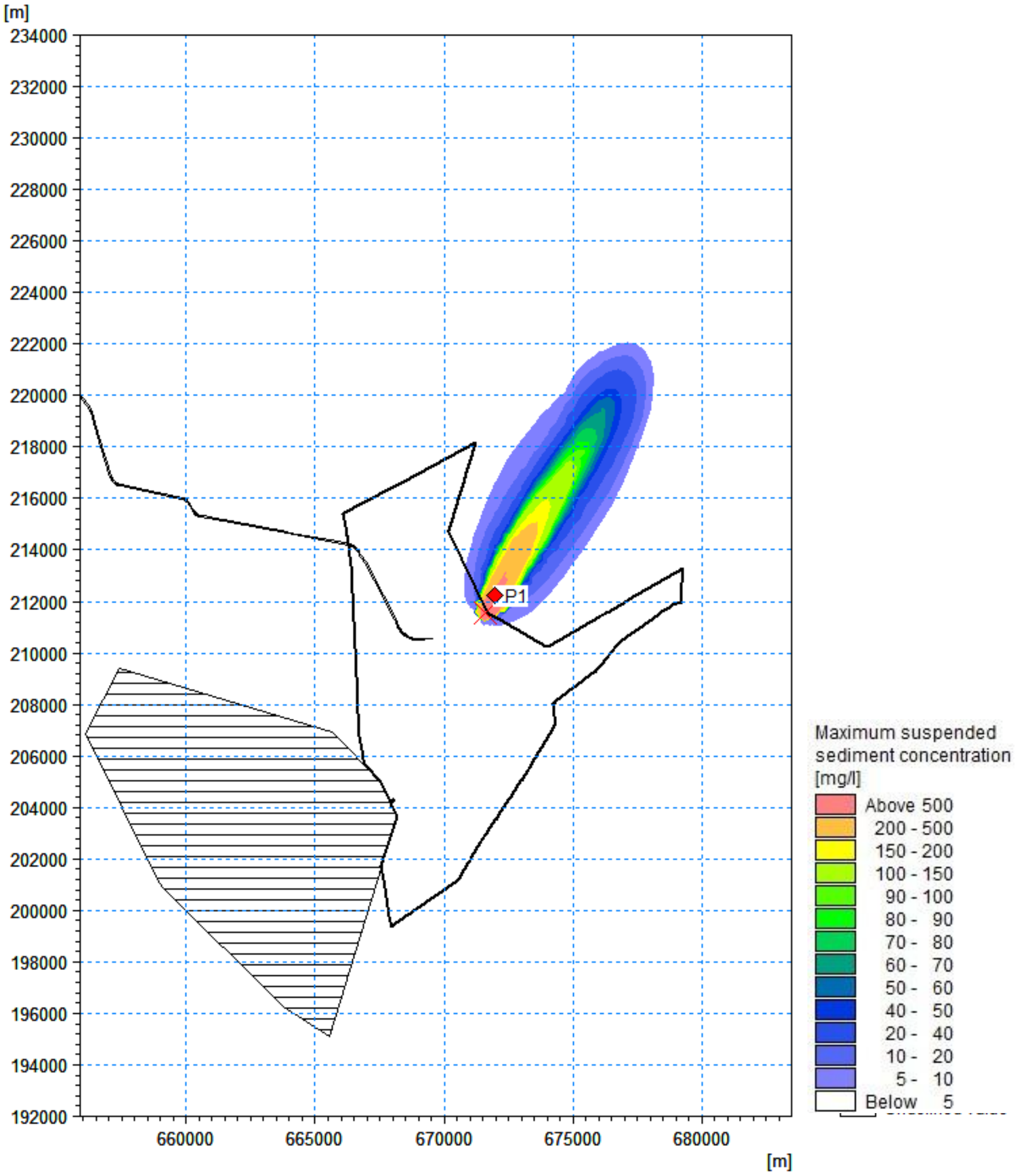

Figure 7-55 Maximum suspended sediment concentration during array disposal occurring near the seabed – Slack water near high water during neap tide ('Zone 1 & 3' material) (red point = time series extraction point)

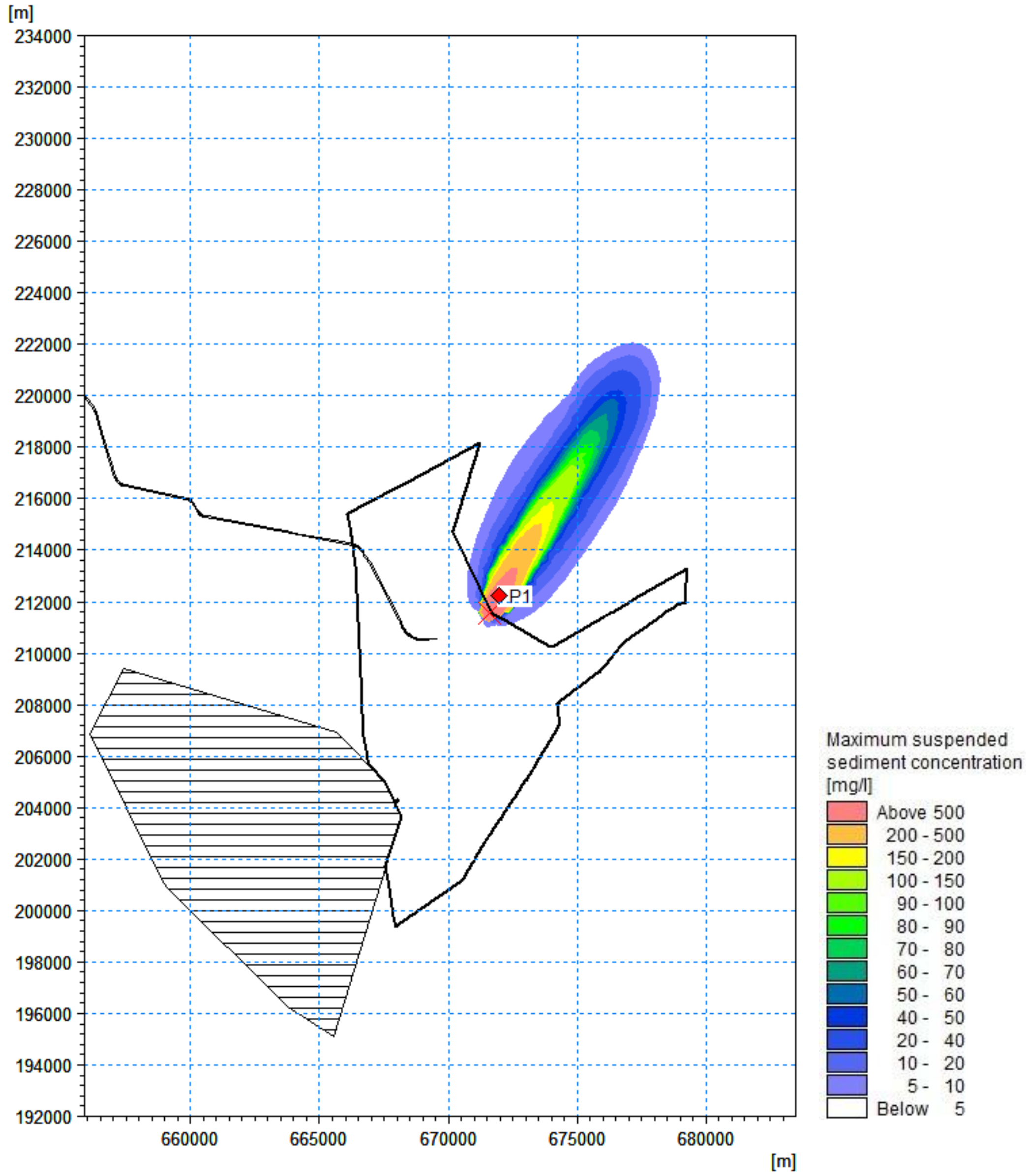

Figure 7-56 Maximum suspended sediment concentration during array disposal occurring near the middle of water column – Slack water near high water during neap tide ('Zone 1 & 3' material) (red point = time series extraction point)

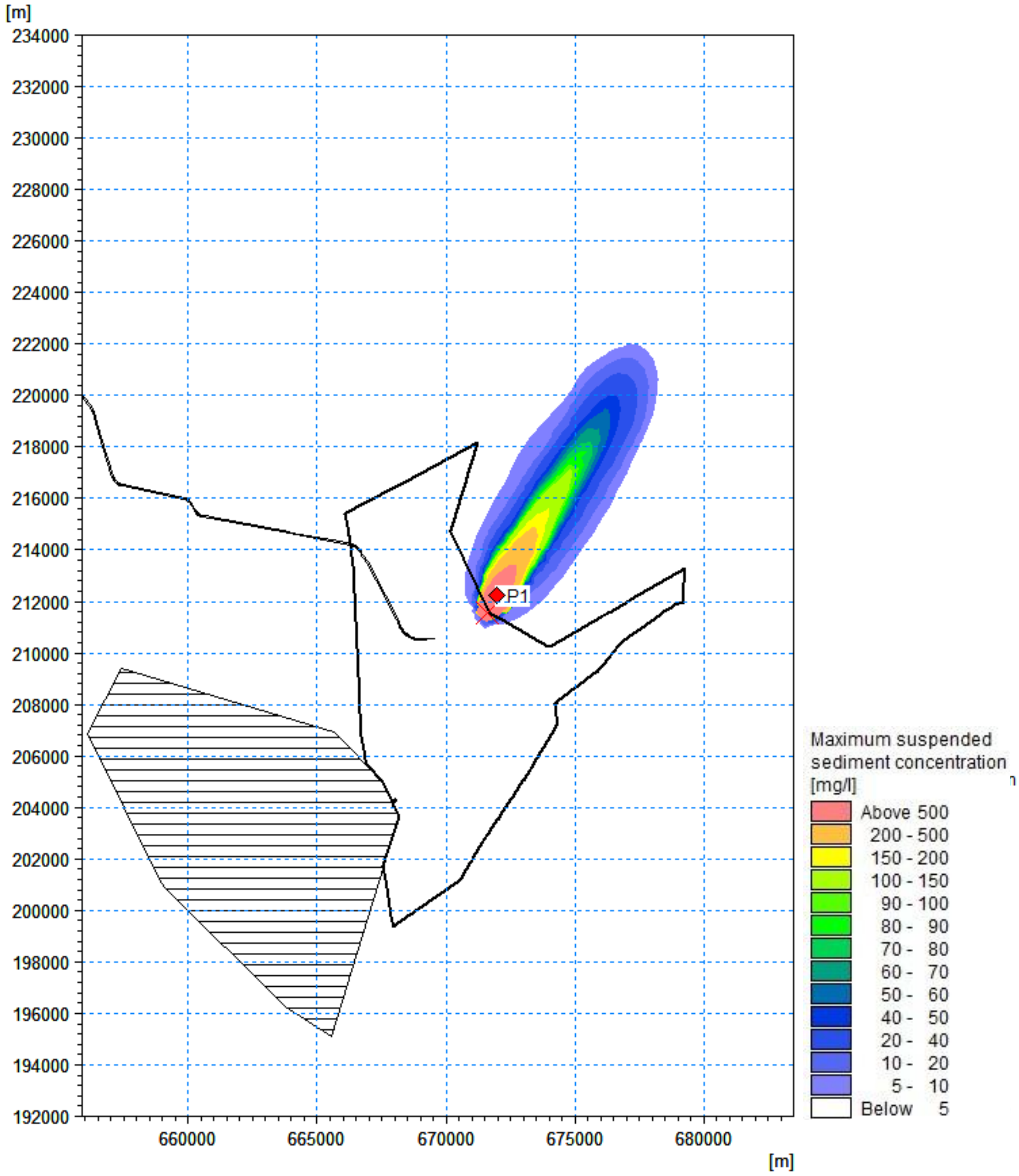

Figure 7-57 Maximum suspended sediment concentration during array disposal occurring near the water surface – Slack water near high water during neap tide ('Zone 1 & 3' material) (red point = time series extraction point)

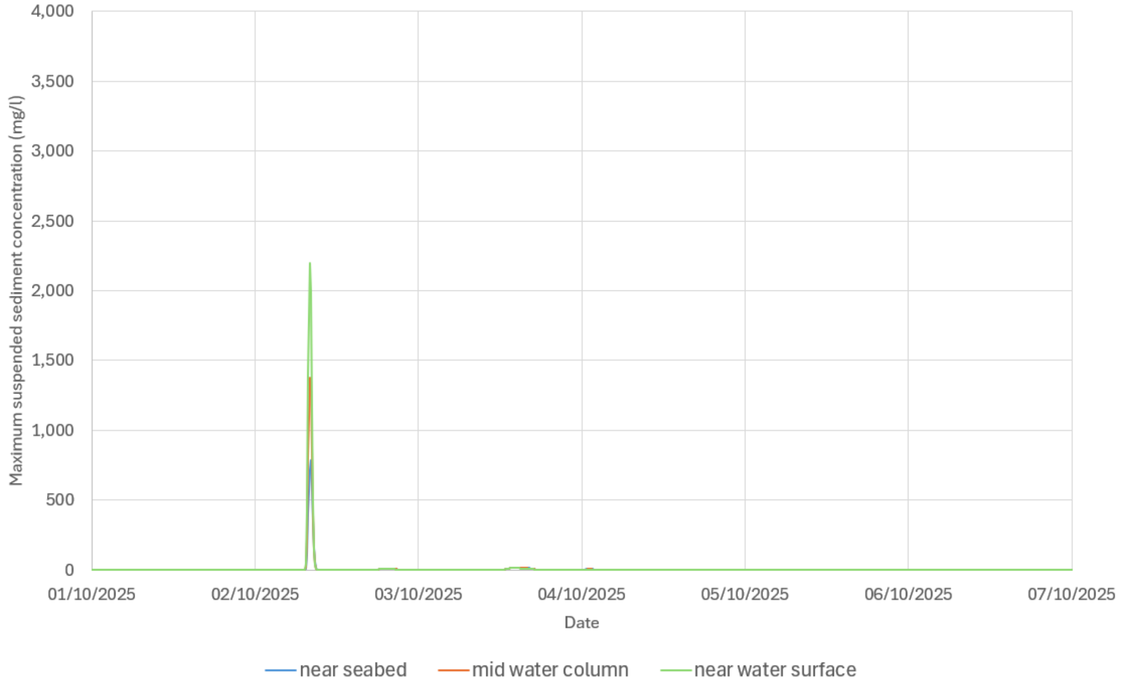

Figure 7-58 Time series of suspended sediment concentration at P1 during sediment disposal near seabed, middle of water column and near water surface - Slack water near high water during neap tide (‘Zone 1 & 3’ material)

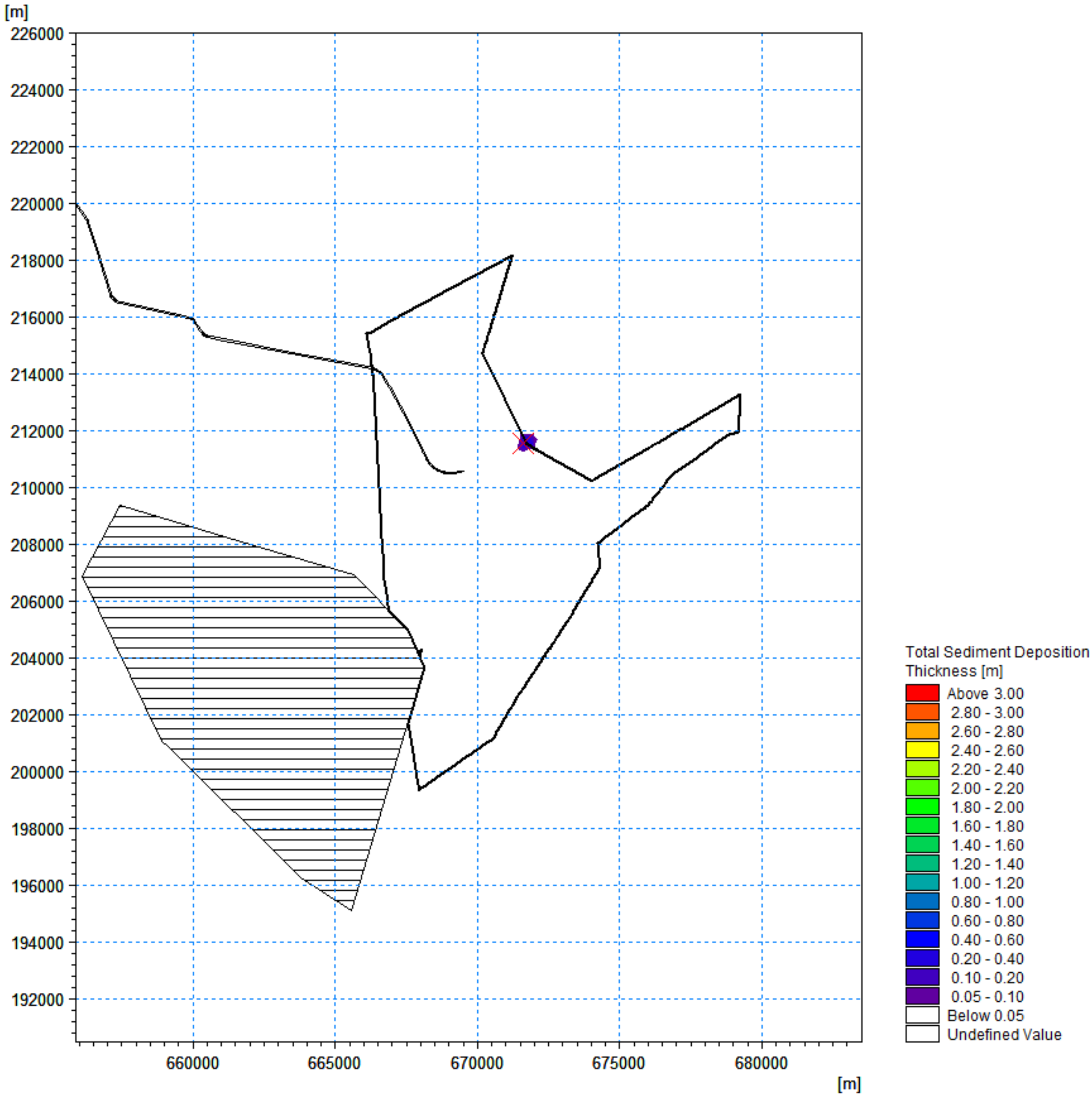

Figure 7-59 Total deposition thickness during sediment disposal - Slack water near high water during neap tide (‘Zone 1 & 3’ material)

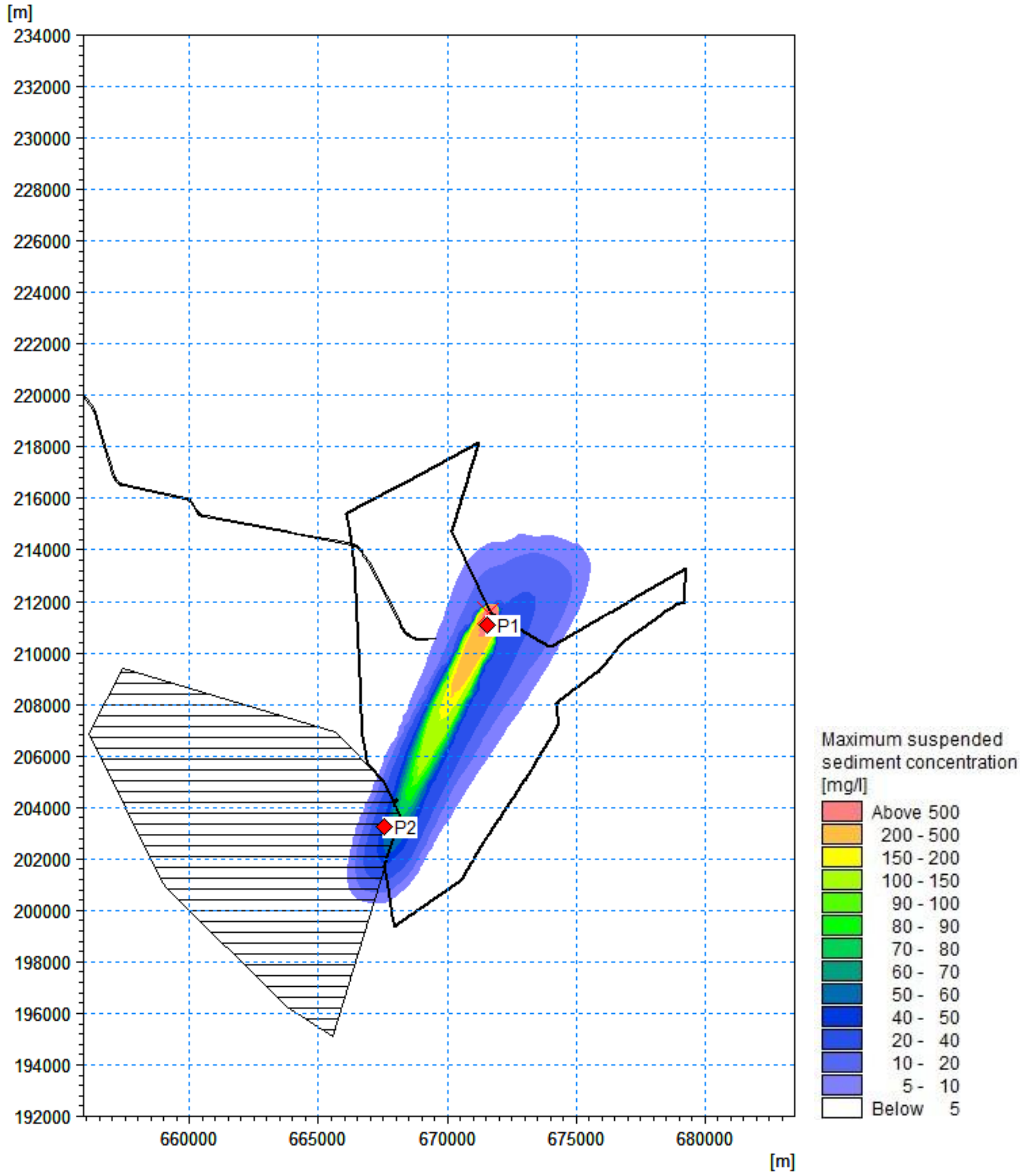

Figure 7-60 Maximum suspended sediment concentration during array disposal occurring near the seabed – Slack water near low water during neap tide (‘Zone 1 & 3’ material) (red point = time series extraction point)

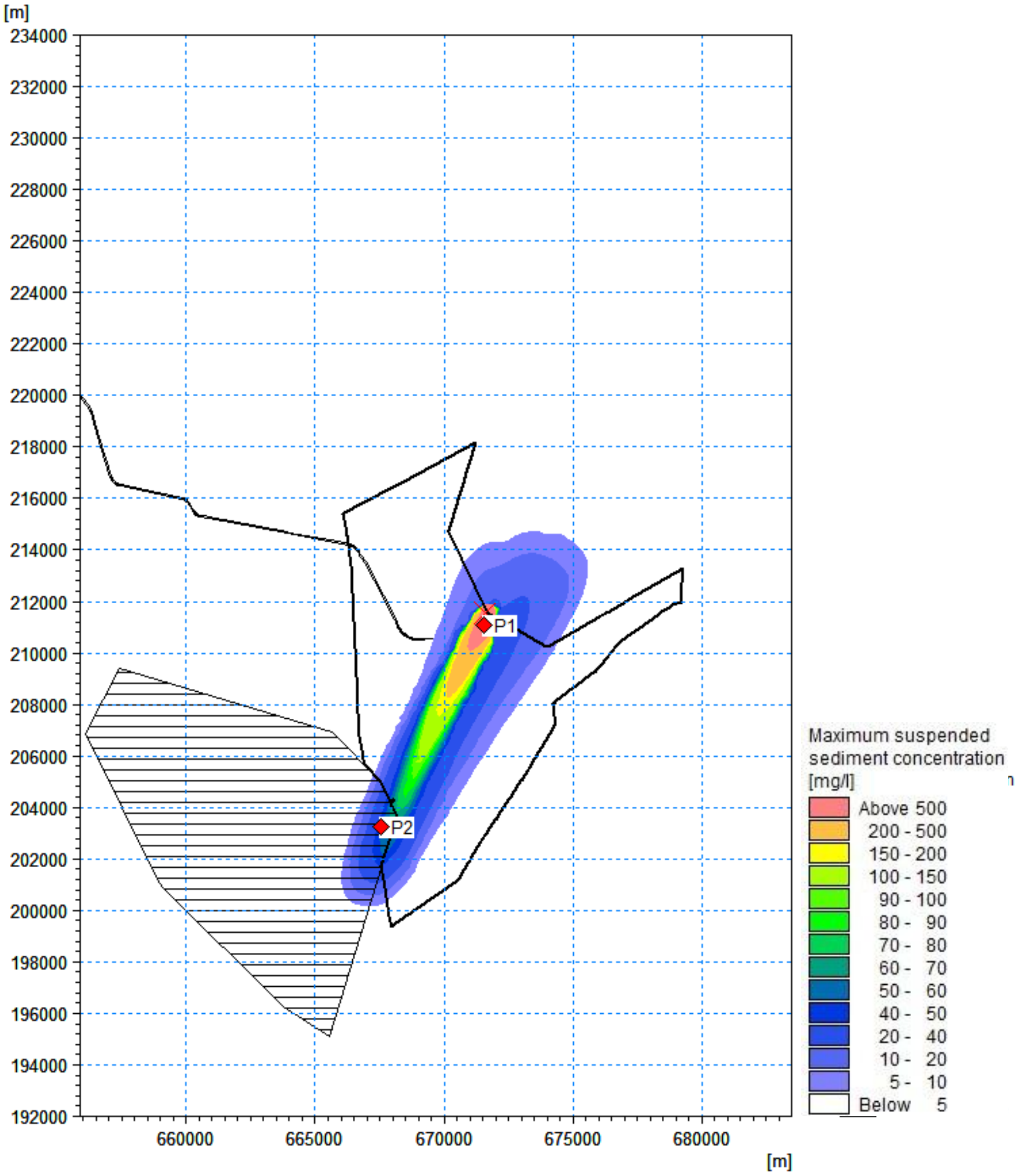

Figure 7-61 Maximum suspended sediment concentration during array disposal occurring near the middle of water column – Slack water near low water during neap tide ('Zone 1 & 3' material) (red point = time series extraction point)

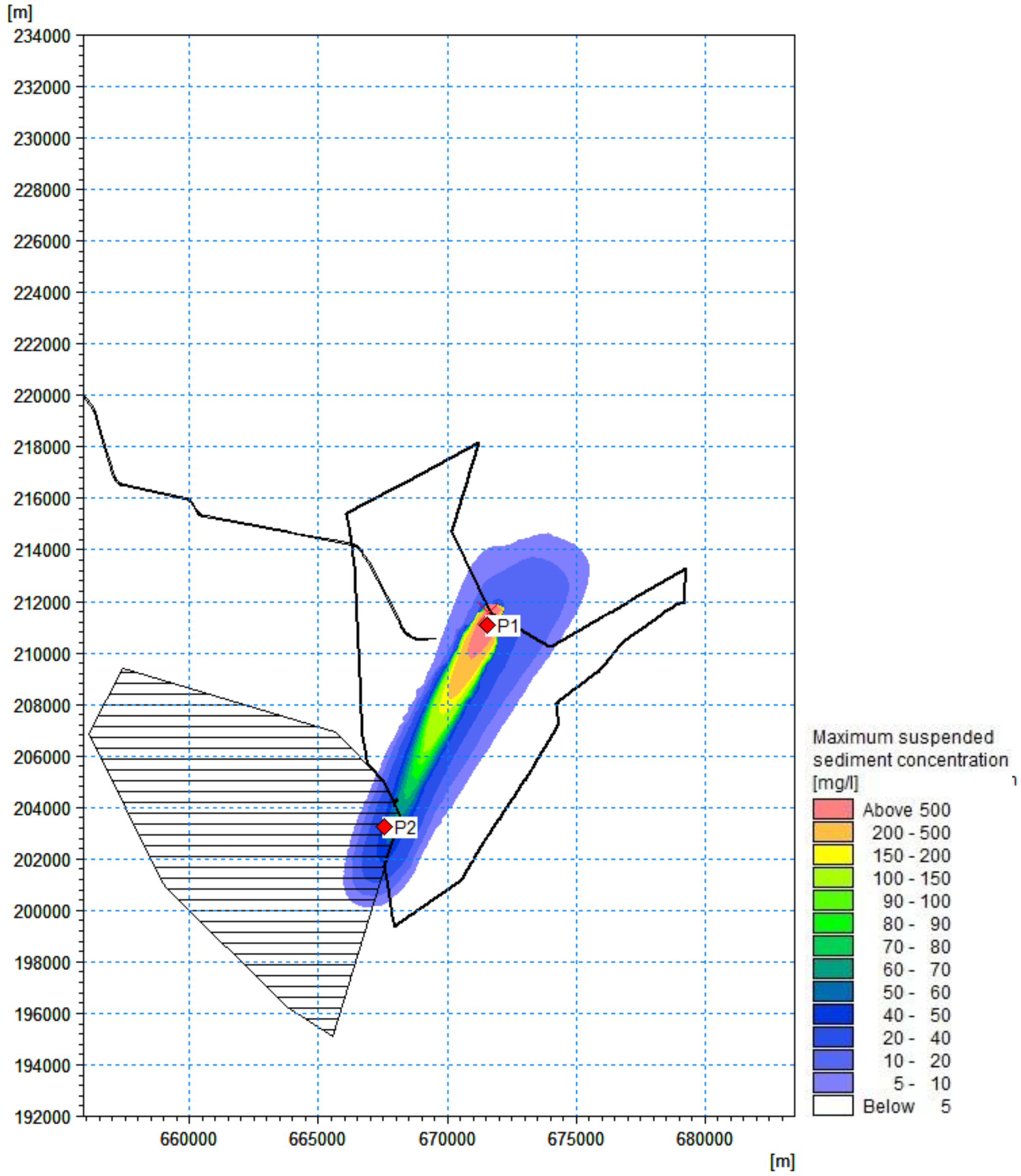

Figure 7-62 Maximum suspended sediment concentration during array disposal occurring near the water surface – Slack water near low water during neap tide ('Zone 1 & 3' material) (red point = time series extraction point)

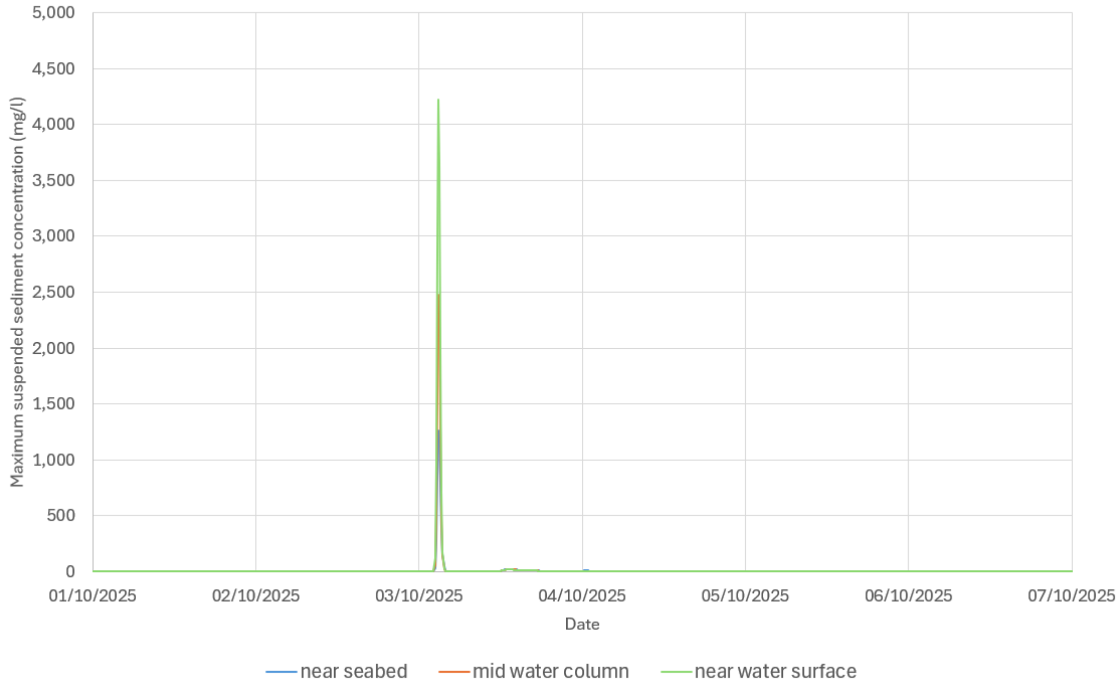

Figure 7-63 Time series of suspended sediment concentration at P1 during sediment disposal near seabed, middle of water column and near water surface - Slack water near low water during neap tide ('Zone 1 & 3' material)

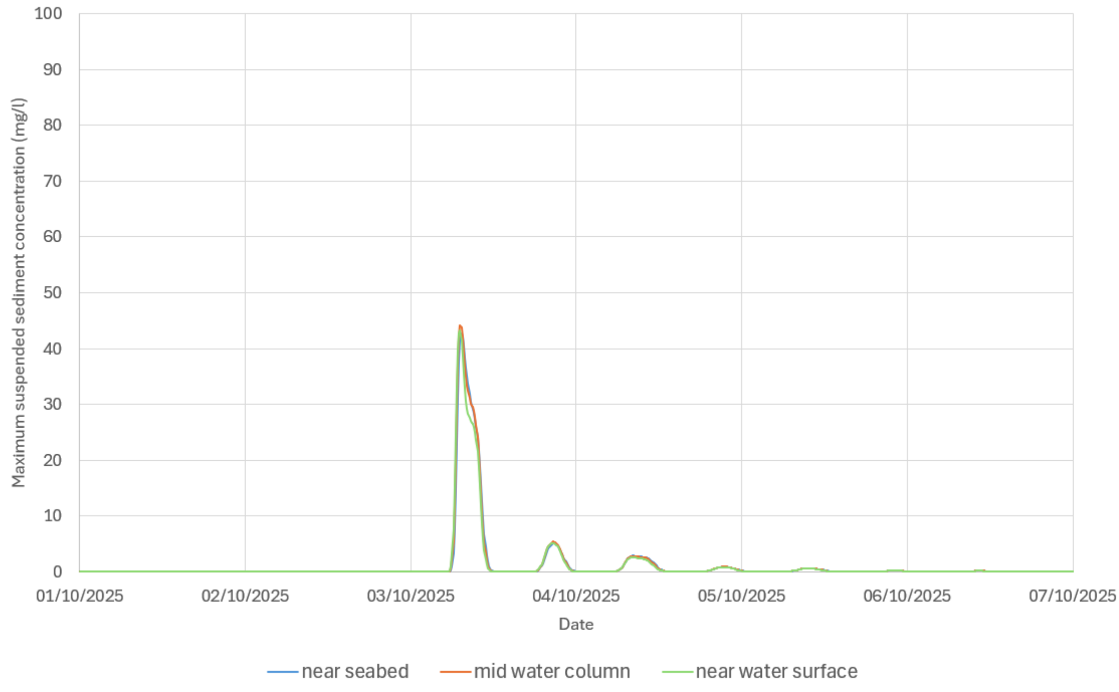

Figure 7-64 Time series of suspended sediment concentration at P2 during sediment disposal near seabed, middle of water column and near water surface - Slack water near low water during neap tide ('Zone 1 & 3' material)

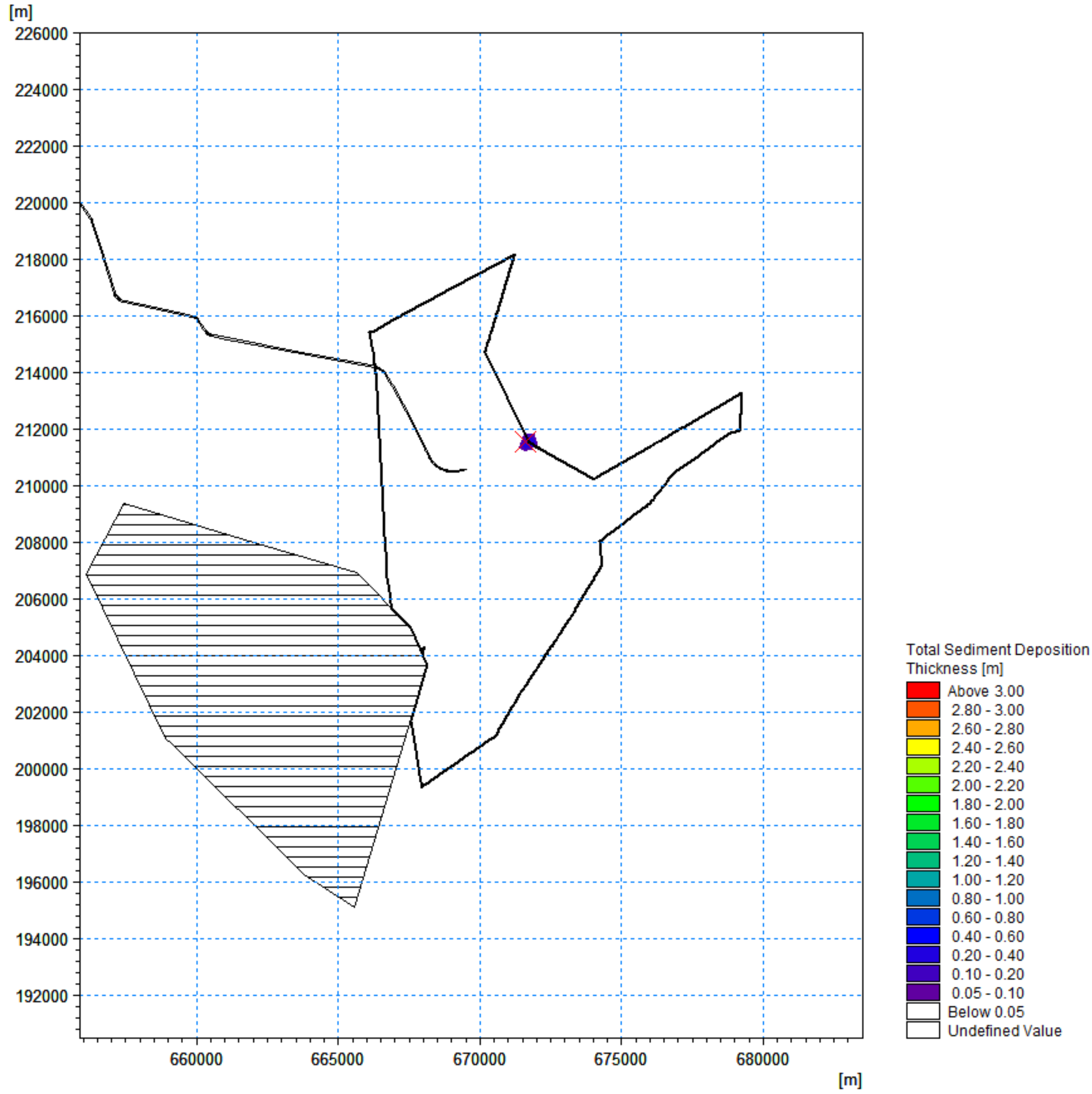

Figure 7-65 Total deposition thickness during sediment disposal - Slack water near low water during neap tide ('Zone 1 & 3' material)

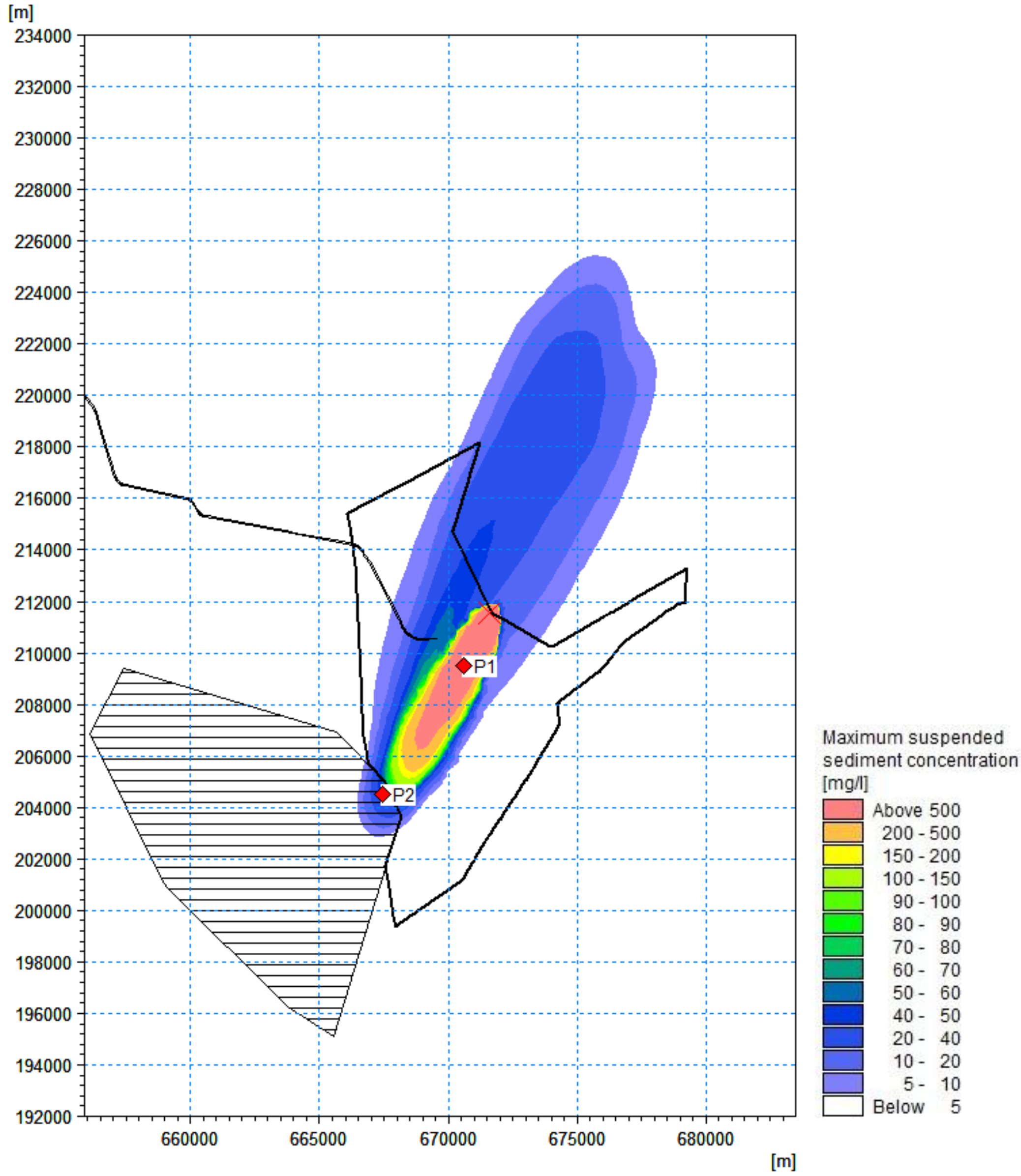

Figure 7-66 Maximum suspended sediment concentration during array disposal occurring near the seabed – Peak flood during spring tide ('Zone 1 & 3' material) (red point = time series extraction point)

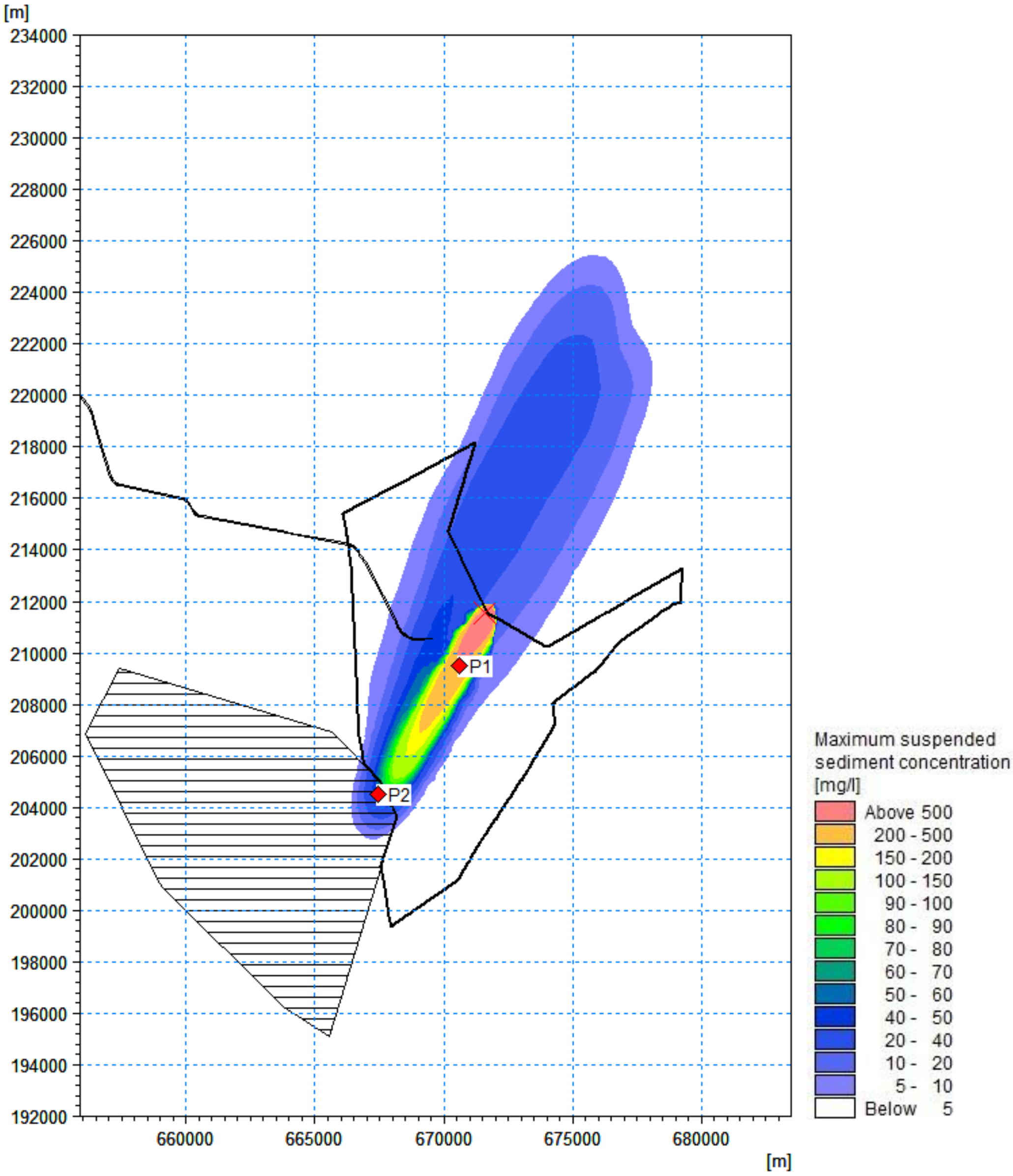

Figure 7-67 Maximum suspended sediment concentration during array disposal occurring near the middle of water column – Peak flood during spring tide ('Zone 1 & 3' material) (red point = time series extraction point)

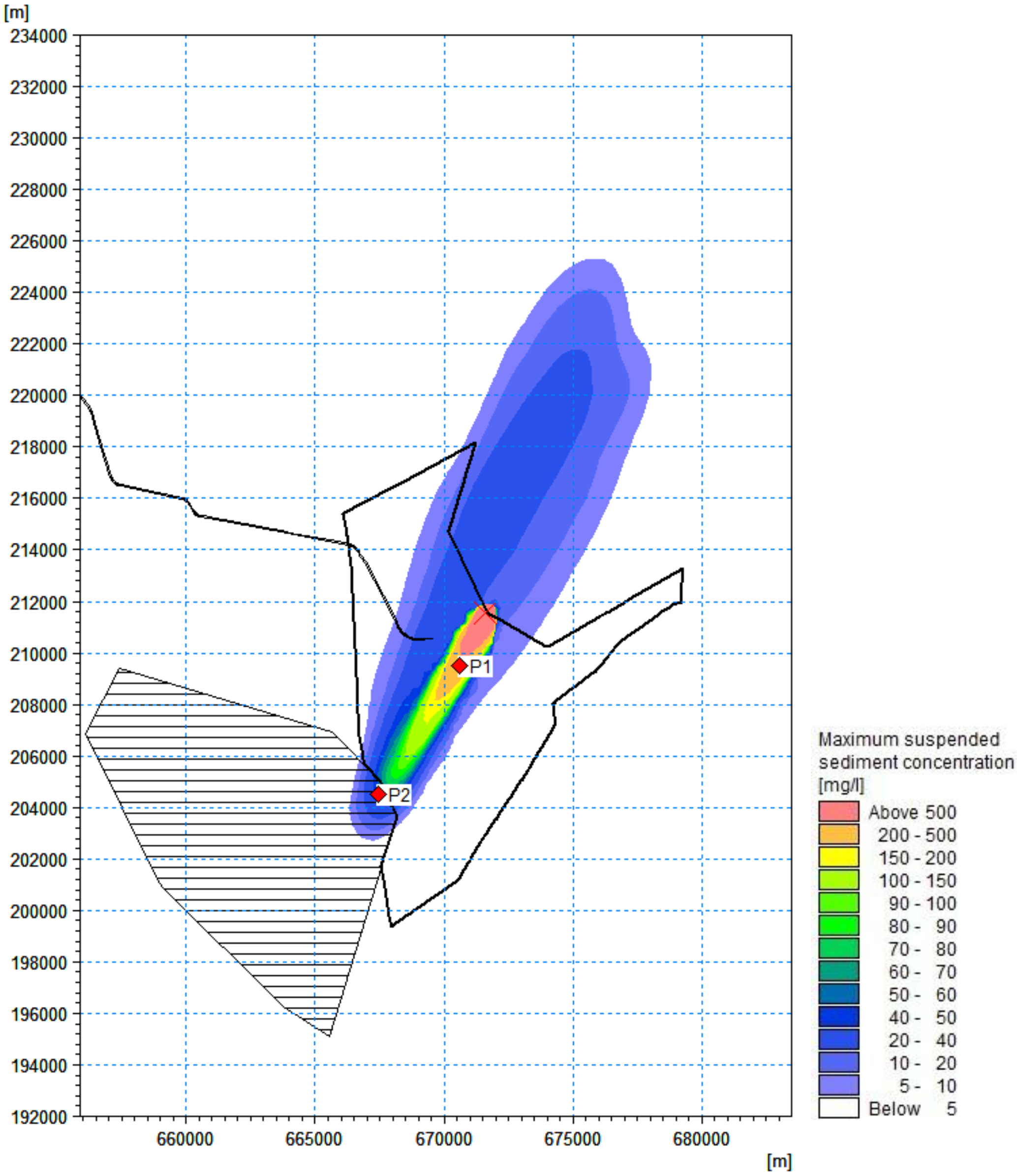

Figure 7-68 Maximum suspended sediment concentration during array disposal occurring near the water surface – Peak flood during spring tide (‘Zone 1 & 3’ material) (red point = time series extraction point)

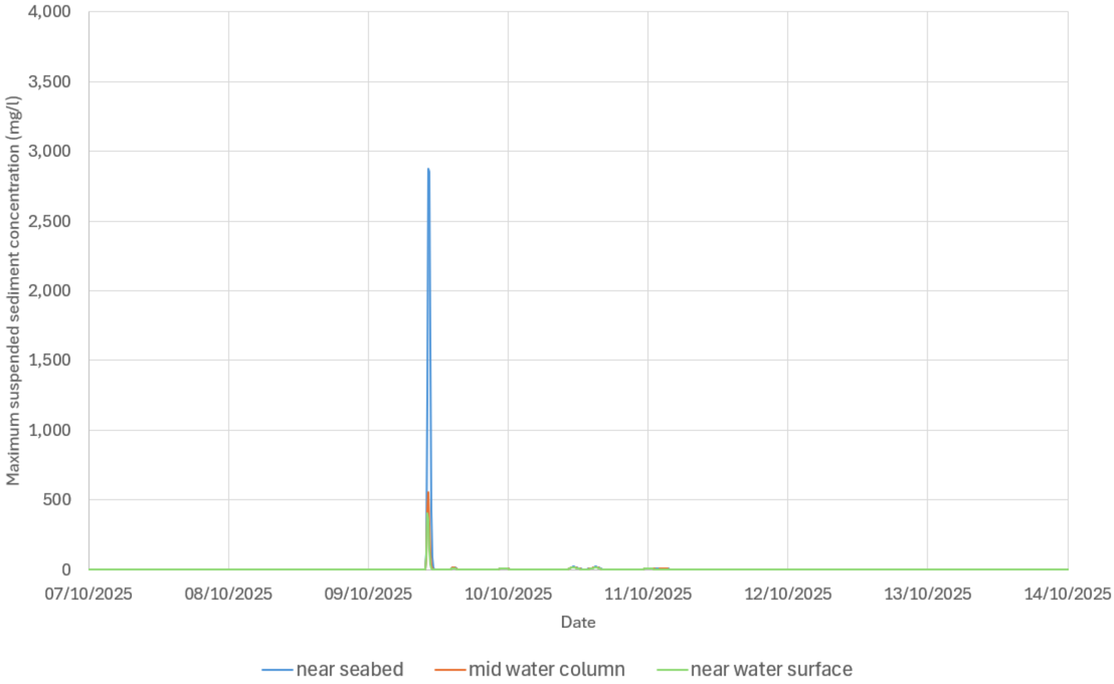

Figure 7-69 Time series of suspended sediment concentration at P1 during sediment disposal near seabed, middle of water column and near water surface – Peak flood during spring tide (‘Zone 1 & 3’ material)

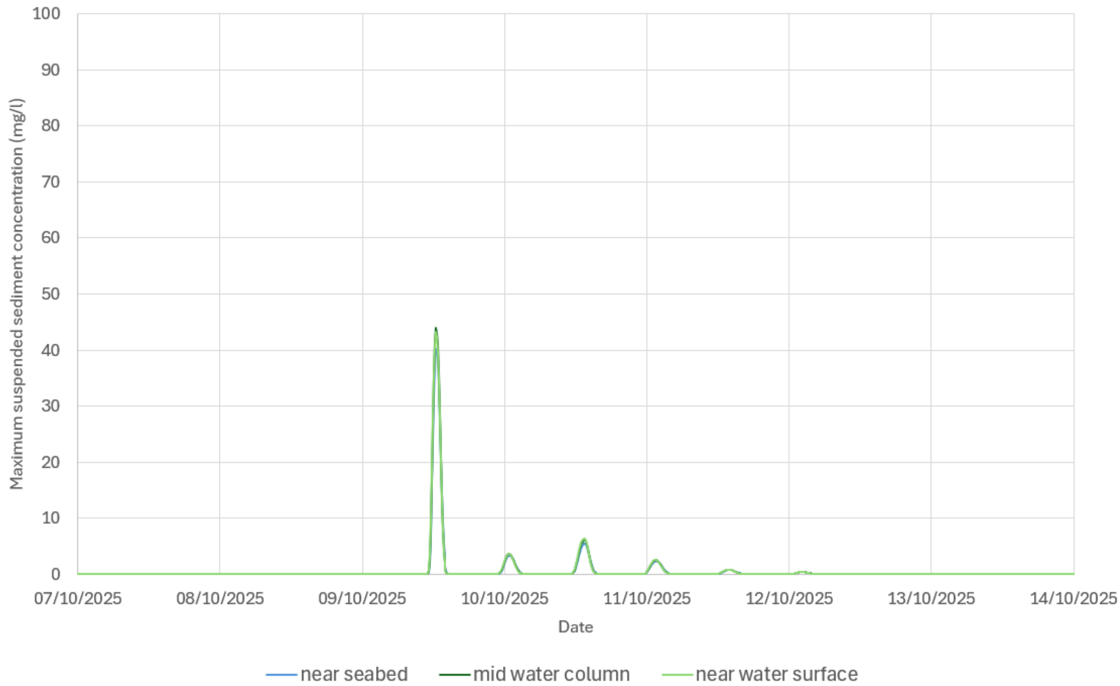

Figure 7-70 Time series of suspended sediment concentration at P2 during sediment disposal near seabed, middle of water column and near water surface - Peak flood during spring tide (‘Zone 1 & 3’ material)

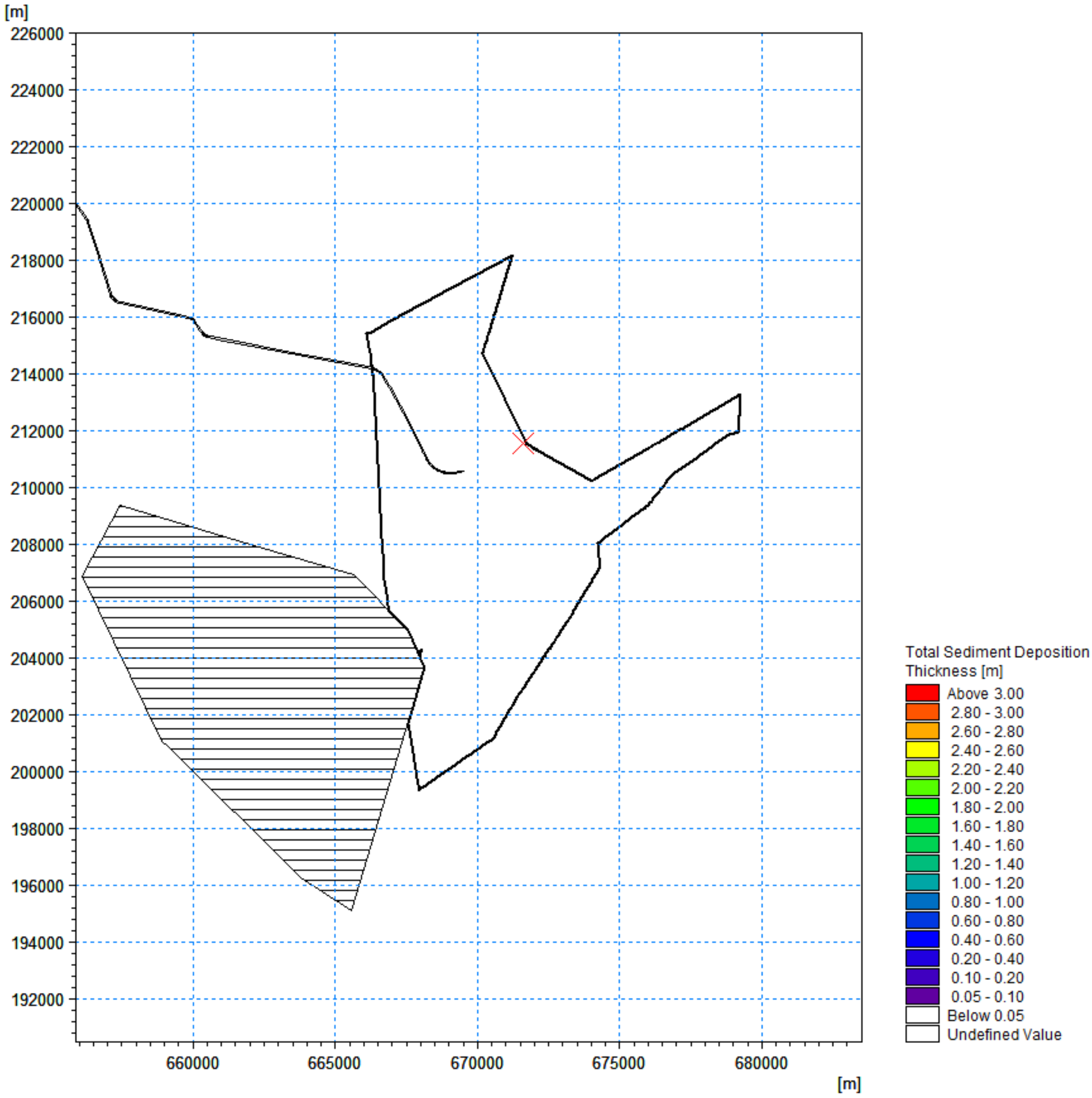

Figure 7-71 Total deposition thickness during sediment disposal - Peak flood during spring tide ('Zone 1 & 3' material)

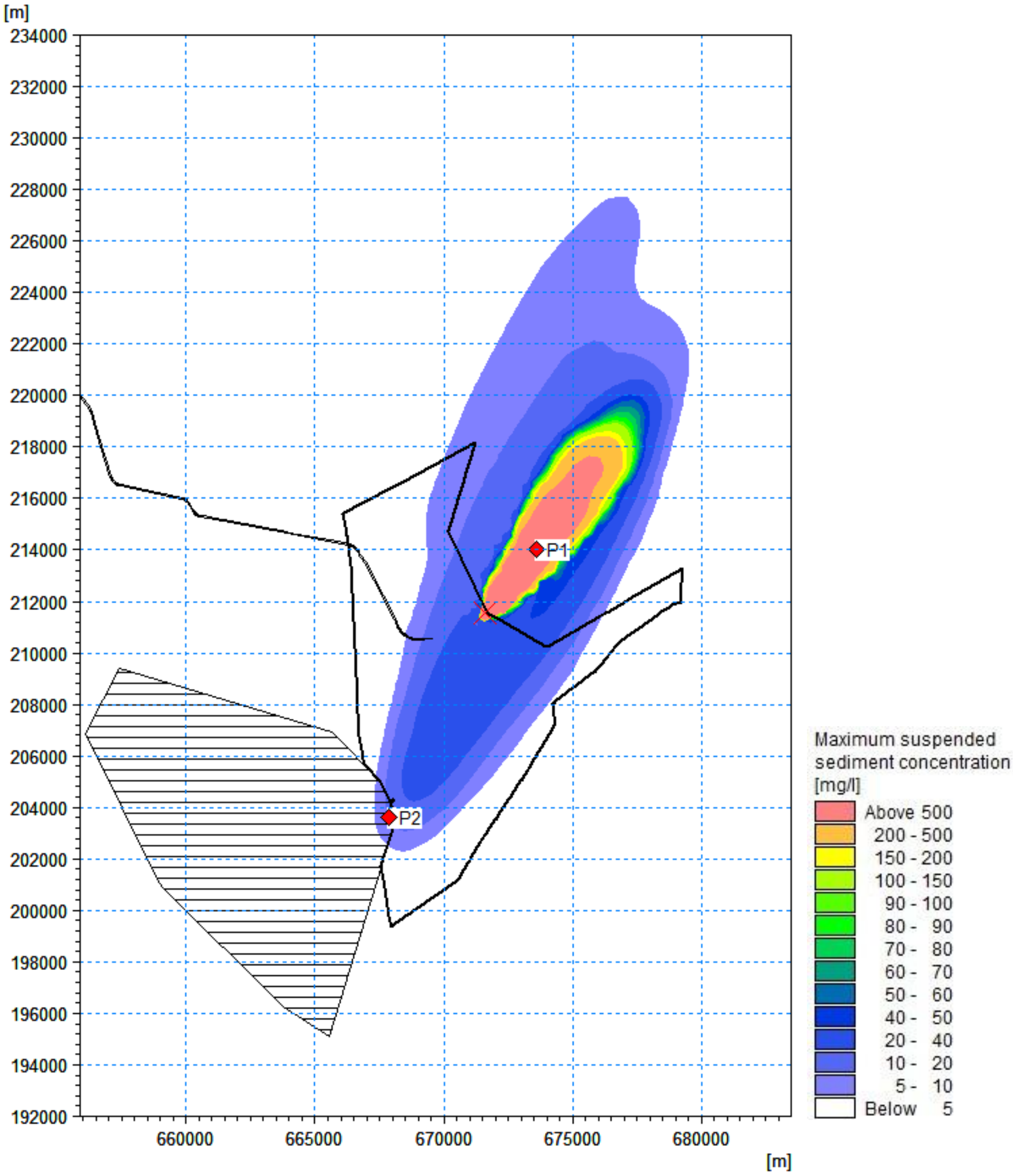

Figure 7-72 Maximum suspended sediment concentration during array disposal occurring near the seabed – Peak ebb during spring tide ('Zone 1 & 3' material) (red point = time series extraction point)

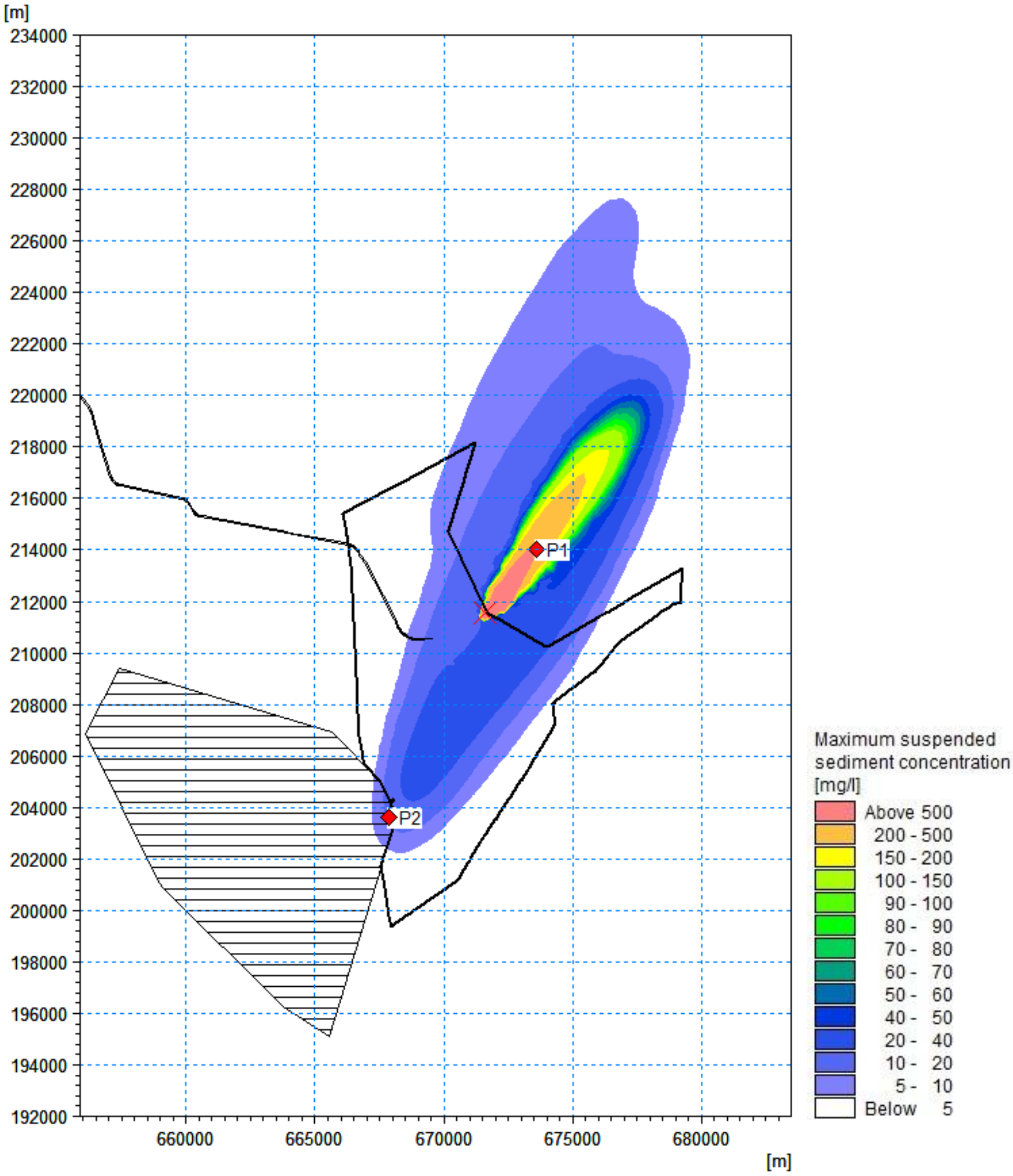

Figure 7-73 Maximum suspended sediment concentration during array disposal occurring near the middle of water column – Peak ebb during spring tide ('Zone 1 & 3' material) (red point = time series extraction point)

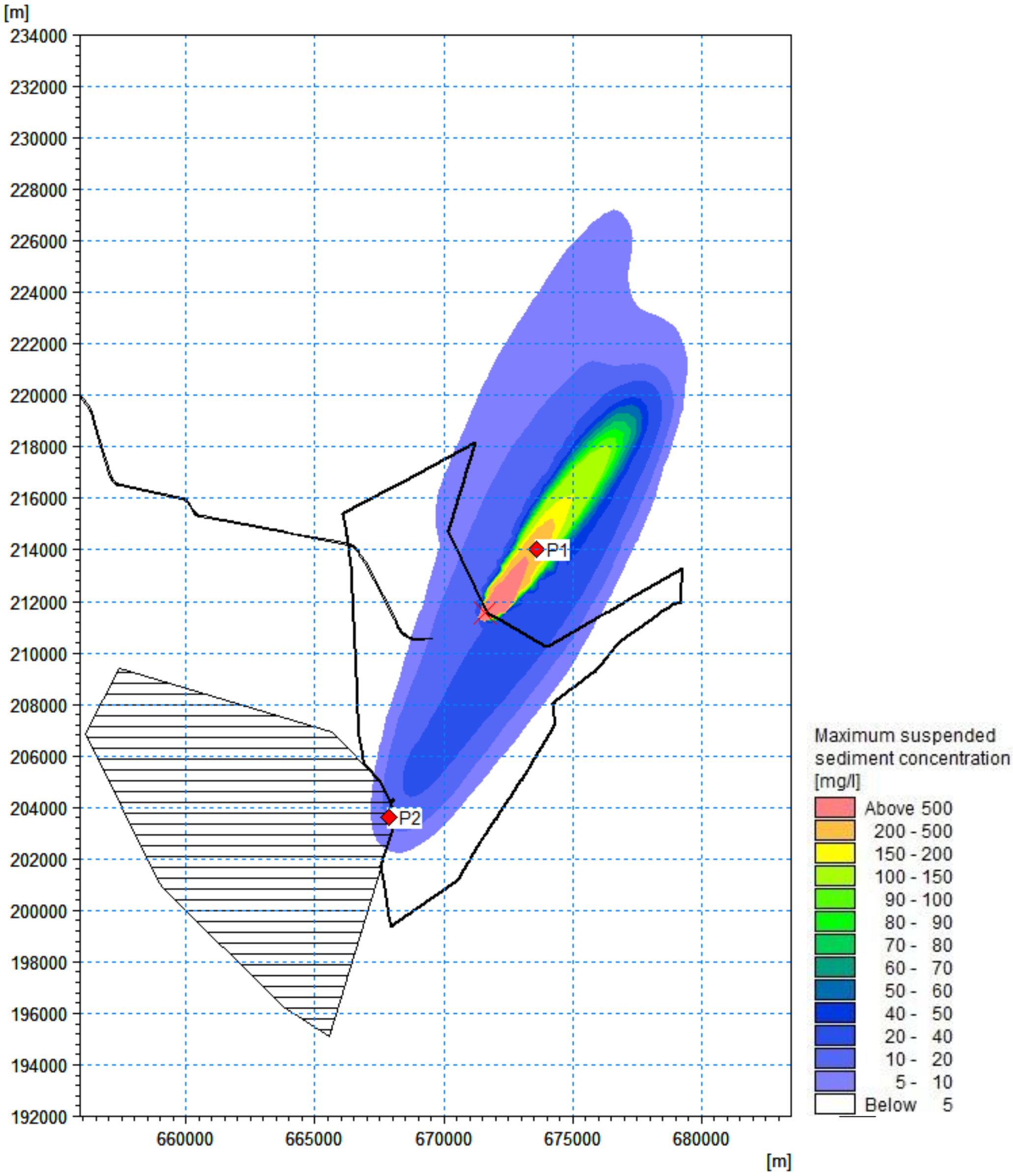

Figure 7-74 Maximum suspended sediment concentration during array disposal occurring near the water surface – Peak ebb during spring tide ('Zone 1 & 3' material) (red point = time series extraction point)

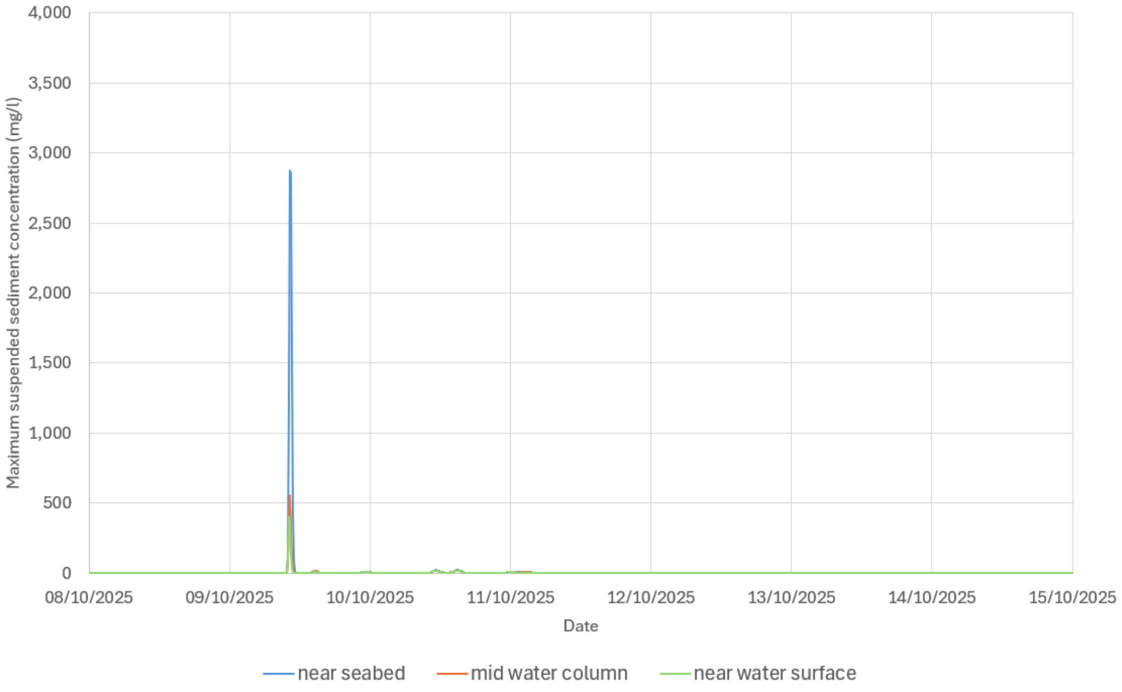

Figure 7-75 Time series of suspended sediment concentration at P1 during sediment disposal near seabed, middle of water column and near water surface – Peak ebb during spring tide (‘Zone 1 & 3’ material)

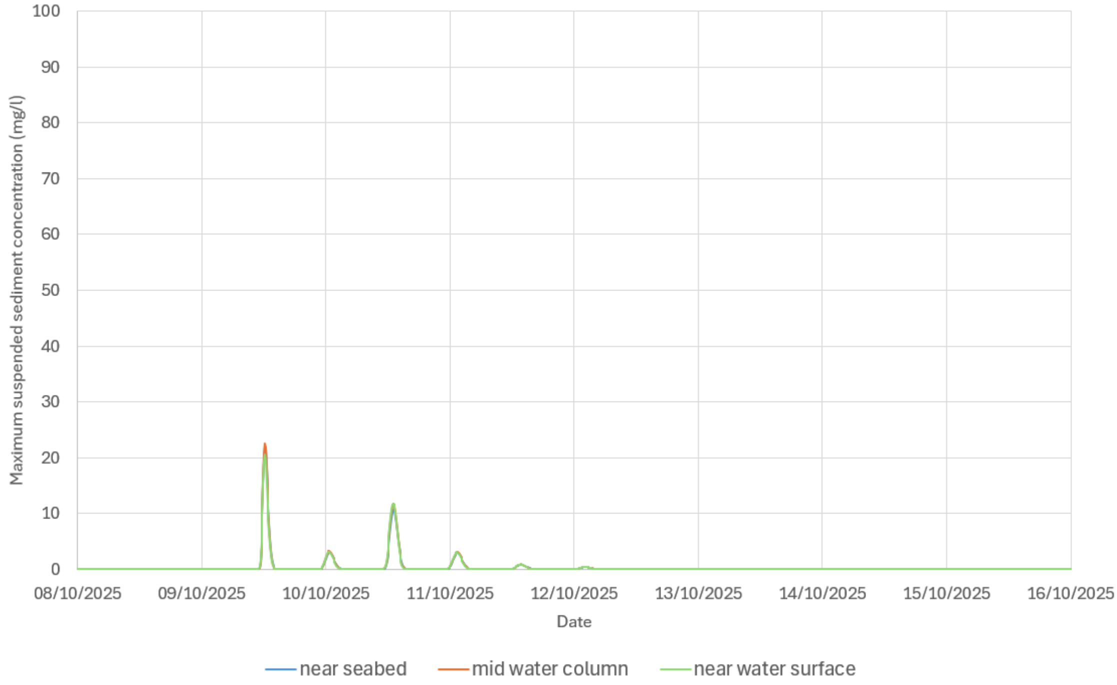

Figure 7-76 Time series of suspended sediment concentration at P2 during sediment disposal near seabed, middle of water column and near water surface - Peak ebb during spring tide (‘Zone 1 & 3’ material)

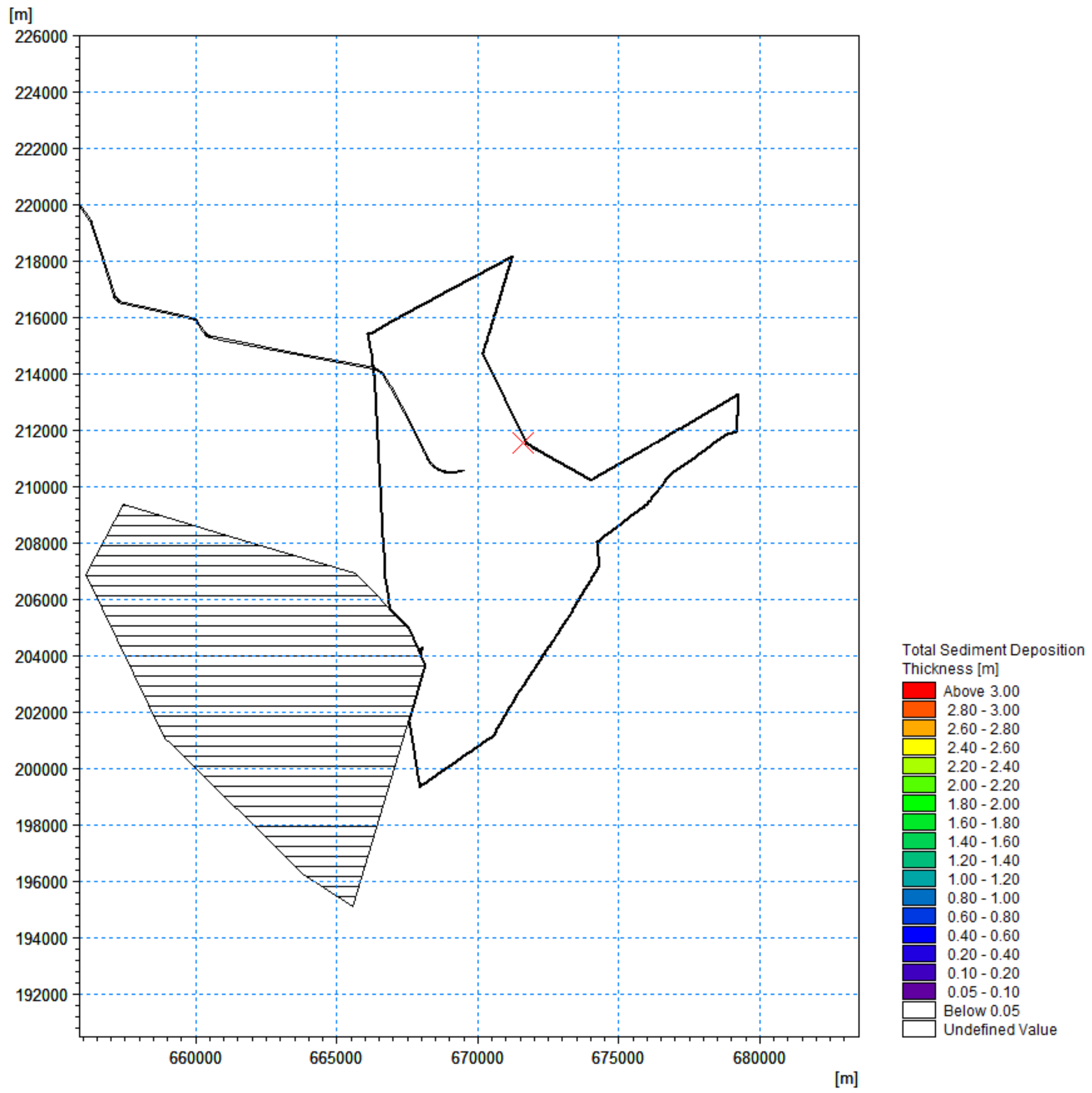

Figure 7-77 Total deposition thickness during sediment disposal - Peak ebb during spring tide ('Zone 1 & 3' material)

7.13 Simulation 12 Results – Array Disposal of 'Sandwaves' material

7.13.1 Figure 7-78 to Figure 7-80 show the maximum suspended sediment concentration above 5 mg/l which occurs during sediment disposal during slack water near high water during neap tide near the seabed, in the middle of the water column and near the water surface respectively. The maximum SSC extent is broadly the same throughout the water column. The sediment plume extends from the release point approx. 10km in a north-easterly direction and measures approx. 2km in width, albeit this extent includes large areas of SSC levels between 5 mg/l and 50 mg/l.

7.13.2 Figure 7-81 shows the time series data of suspended sediment concentration during sediment disposal during slack water near high water during neap tide near the seabed, the middle of the water column and near the water surface for location P1. The SSC levels for P1 exceed 15 mg/l near the seabed for approx. 1 hour, with a peak of 500 mg/l.

7.13.3 Figure 7-82 shows the total sediment deposition thickness greater than 5cm which occurs during sediment disposal during slack water near high water during neap tide. All sediment depositions are smaller than 0.5m and the area is localised around the release point extending no further than 800m.

7.13.4 Figure 7-83 to Figure 7-85 show the maximum suspended sediment concentration above 5 mg/l which occurs during sediment disposal during slack water near low water during neap tide near the seabed, in the middle of the water column and near the water surface respectively. The maximum SSC extent is broadly the same throughout the water column. The sediment plume extends from the release point for approx. 10km in a south-westerly direction and measures approx. 1.5km in width, albeit this extent includes large areas of SSC levels between 5 mg/l and 50 mg/l.

7.13.5 Figure 7-86 and Figure 7-87 show the time series data of suspended sediment concentration during sediment disposal during slack water near low water during neap tide near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively. The SSC levels for P1 exceed 15 mg/l near the seabed for approx. 1 hour, with a peak of 1,000 mg/l.

7.13.6 Figure 7-88 shows the total sediment deposition thickness greater than 5cm which occurs during sediment disposal during slack water near low water during neap tide. All sediment depositions are smaller than 0.5m and the area is localised around the release point extending no further than 800m.

7.13.7 Figure 7-89 to Figure 7-91 show the maximum suspended sediment concentration above 5 mg/l which occurs during sediment disposal during peak flood during spring tide near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The area of maximum suspended sediment concentration extends from the release point for approx. 9km in a south-westerly direction and measures up to 3.5km in width. The area of maximum suspended sediment concentration above 500mg/l only occurs in a south-westerly direction and is greatest near the seabed (6km) and gradually becomes less when reaching the water surface (1km). The maximum SSC extending north-eastwards by between 8 and 12km and measures between 2 and 4km in width, although the maximum SSC levels in this area are below 20mg/l.

7.13.8 Figure 7-92 – and Figure 7-93 – show the time series data of suspended sediment concentration during sediment disposal during peak flood during spring tide near the seabed, the middle of the water column and near the water surface for two locations, namely P1 and P2 respectively. The SSC levels for P1 exceed 15 mg/l near the seabed for approx. 1 hour with a peak of 3,300 mg/l. The SSC levels for P2 exceed 15 mg/l near the seabed for less than 1 hour with a peak of 18 mg/l.

7.13.9 Figure 7-94 shows the total sediment deposition thickness greater than 5cm which occurs during sediment disposal during peak flood during spring tide. All sediment deposition occurs within the array area and is <5cm.

7.13.10 Figure 7-95 – to Figure 7-97 – show the maximum suspended sediment concentration above 5 mg/l which occurs during sediment disposal during peak ebb during spring tide near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The area of maximum suspended sediment concentration extends from the release point for approx. 11km in a north-easterly direction and measures up to 3.5km in width. The area of maximum suspended sediment concentration above 500mg/l only occurs in a north-easterly direction and is greatest near the seabed (8km) and gradually becomes less when reaching the water surface (1.5km). The maximum SSC extending south-westwards by between 2 and 6km and measures up to 1.5km in width, although the maximum SSC levels in this area are below 10mg/l.

7.13.11 -Figure 7-98 shows the time series data of suspended sediment concentration during sediment disposal during peak ebb during spring tide near the seabed, the middle of the water column and near the water surface for locationP1. The SSC levels for P1 exceed 15 mg/l near the seabed for approx. 1 hour with a peak of 3,300 mg/l.

7.13.12 -Figure 7-99 shows the total sediment deposition thickness greater than 5cm which occurs during sediment disposal during peak ebb during spring tide. All sediment deposition occurs within the array area and is <5cm.

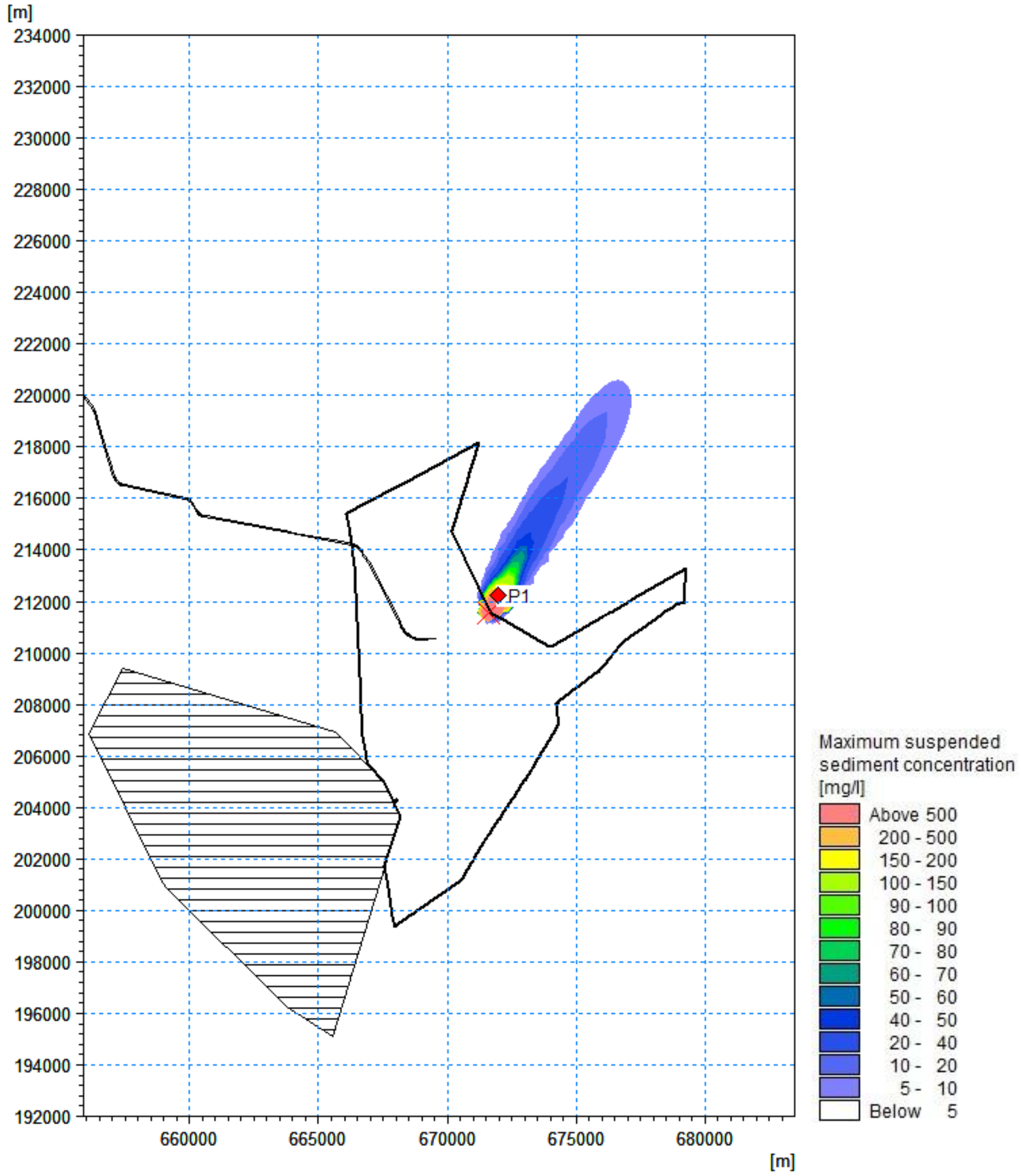

Figure 7-78 Maximum suspended sediment concentration during array disposal occurring near the seabed – Slack water near high water during neap tide (‘Sandwaves’ material) (red point = time series extraction point)

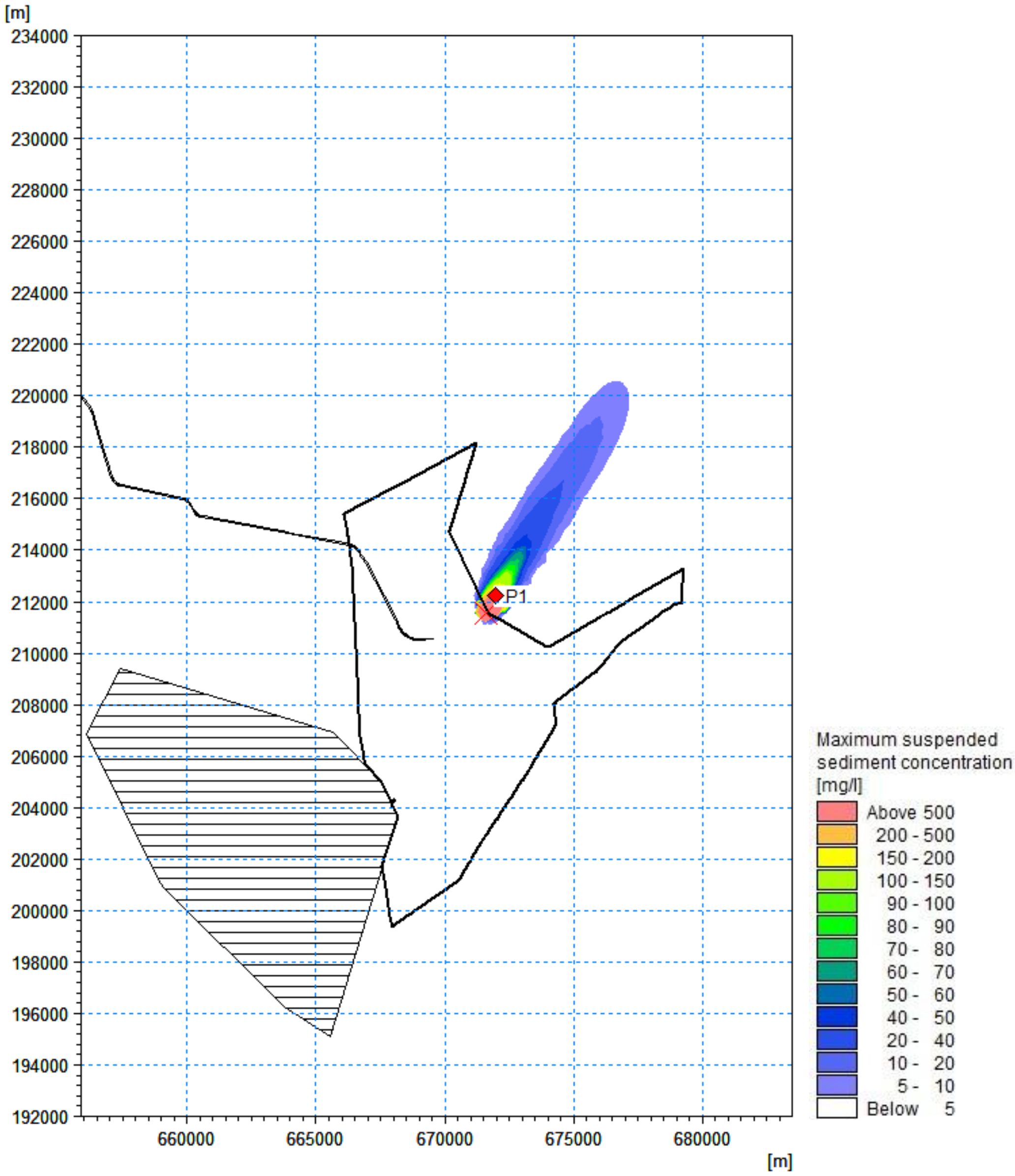

Figure 7-79 Maximum suspended sediment concentration during array disposal occurring near the middle of water column – Slack water near high water during neap tide (‘Sandwaves’ material) (red point = time series extraction point)

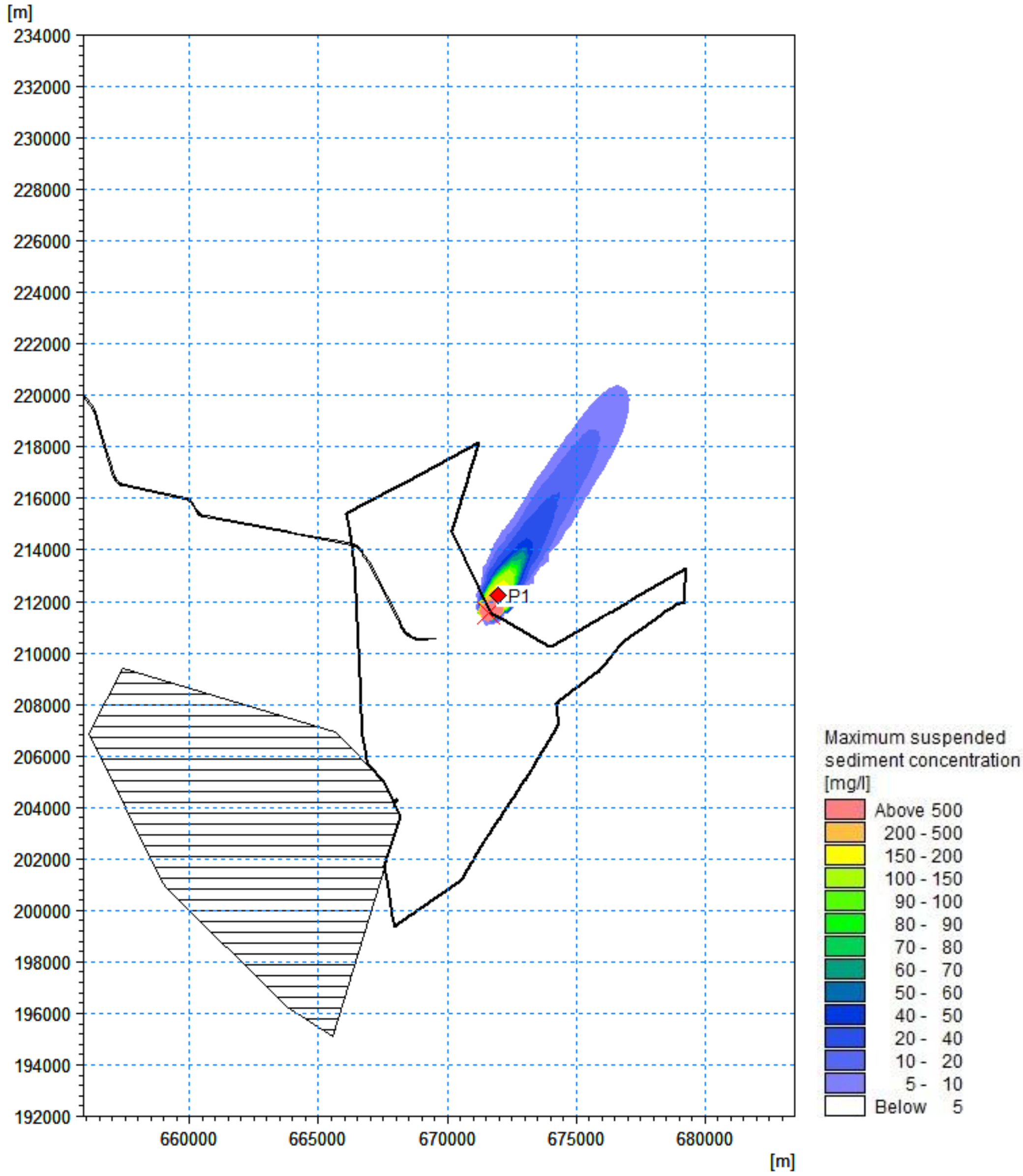

Figure 7-80 Maximum suspended sediment concentration during array disposal occurring near the water surface – Slack water near high water during neap tide ('Sandwaves' material) (red point = time series extraction point)

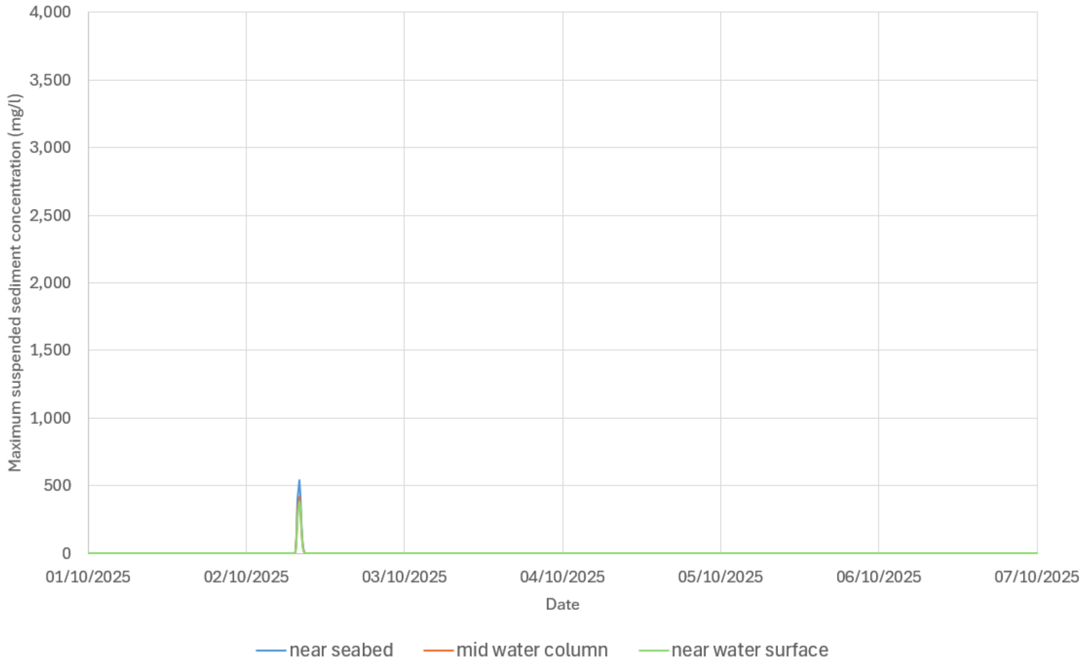

Figure 7-81 Time series of suspended sediment concentration at P1 during sediment disposal near seabed, middle of water column and near water surface - Slack water near high water during neap tide ('Sandwaves' material)

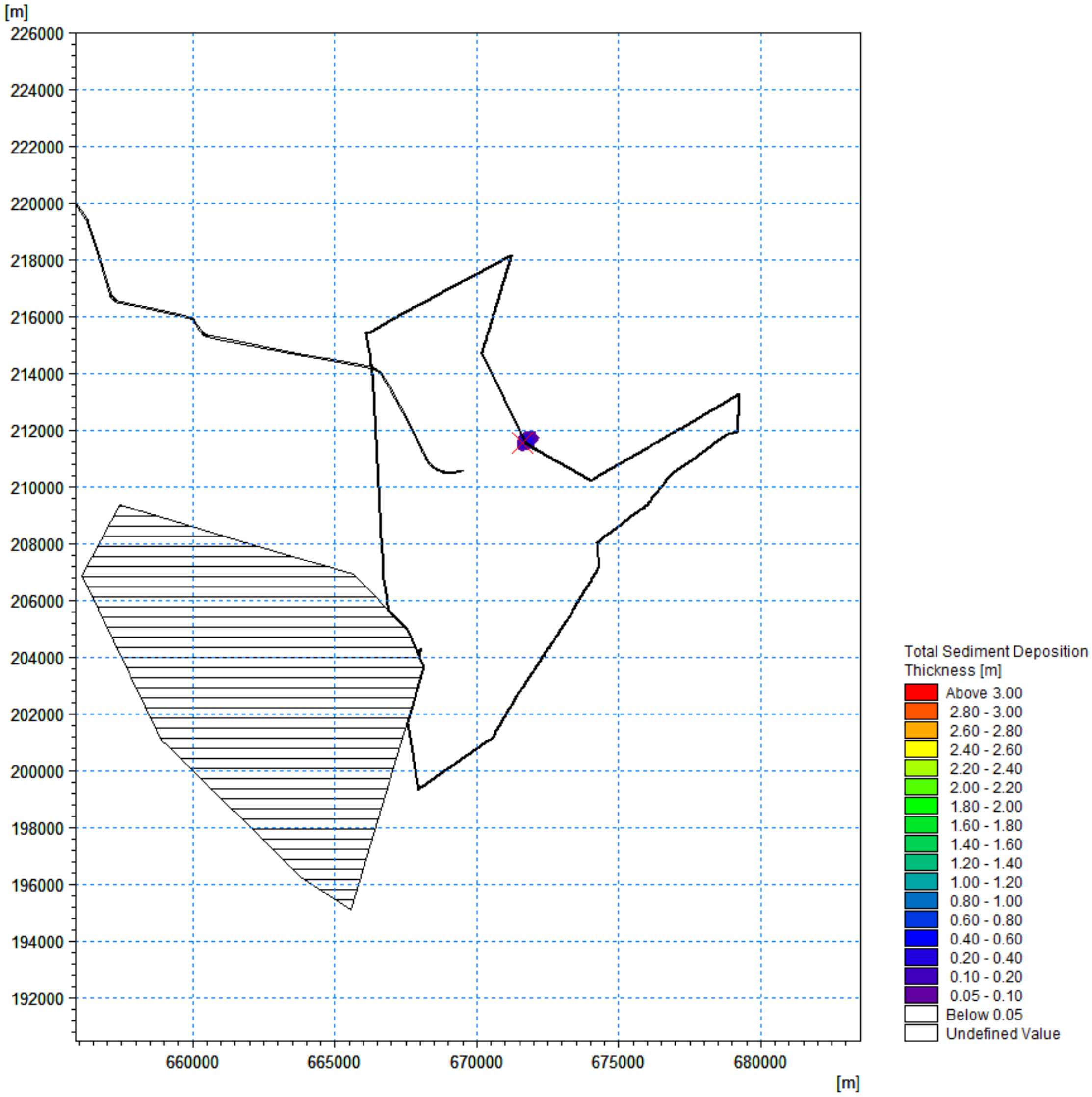

Figure 7-82 Total deposition thickness during sediment disposal - Slack water near high water during neap tide (‘Sandwaves’ material)

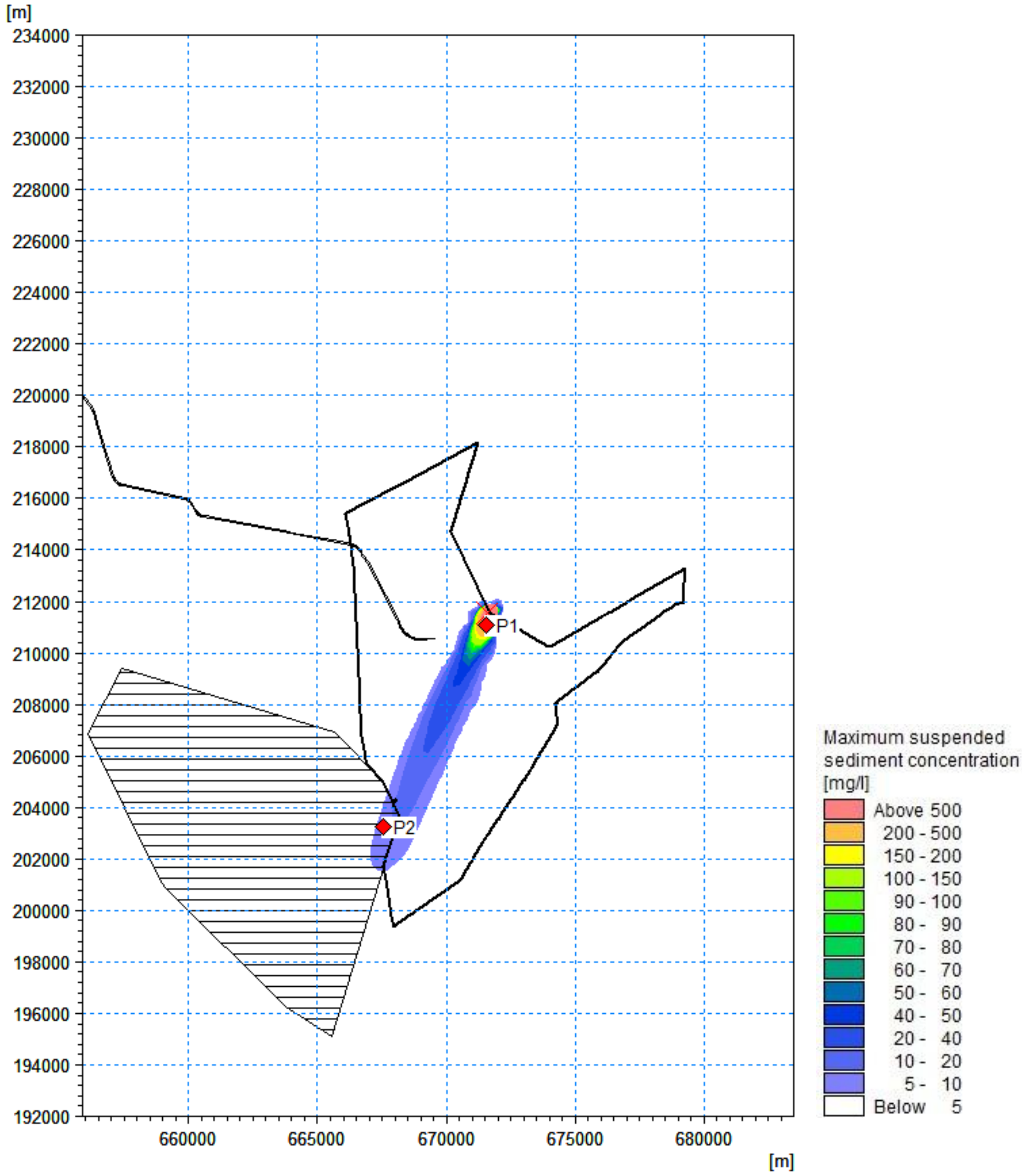

Figure 7-83 Maximum suspended sediment concentration during array disposal occurring near the seabed – Slack water near low water during neap tide (‘Sandwaves’ material) (red point = time series extraction point)

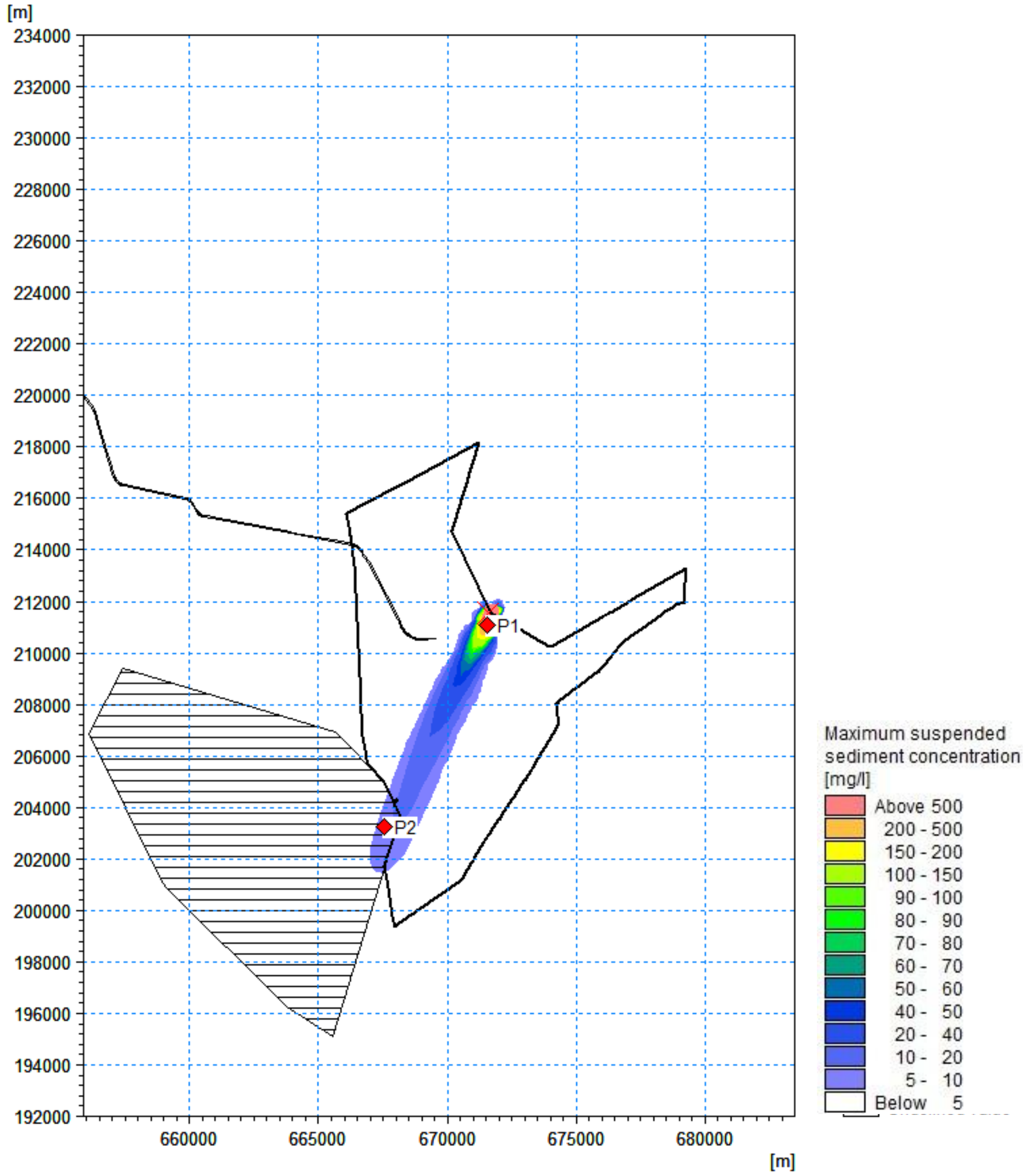

Figure 7-84 Maximum suspended sediment concentration during array disposal occurring near the middle of water column – Slack water near low water during neap tide ('Sandwaves' material) (red point = time series extraction point)

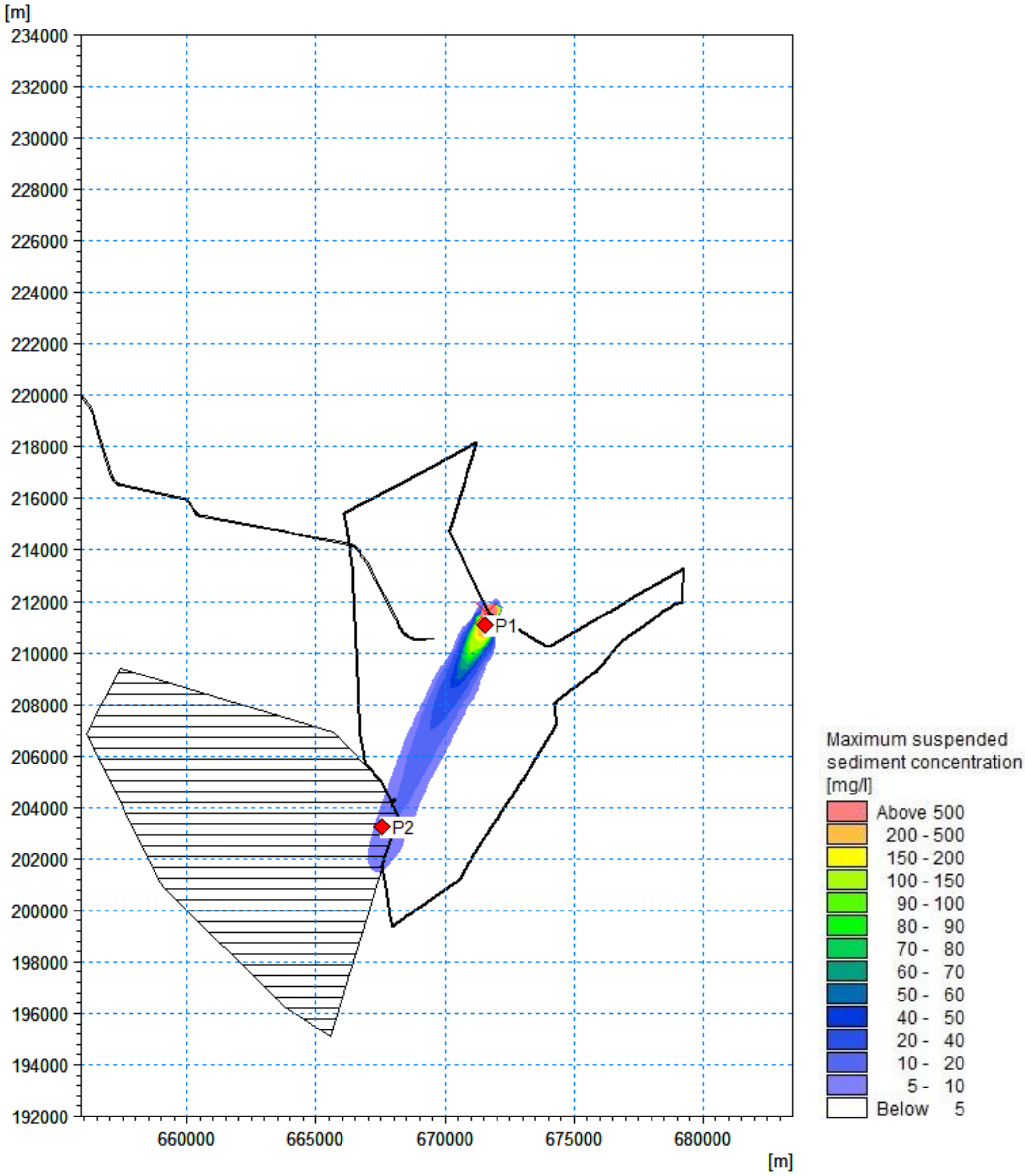

Figure 7-85 Maximum suspended sediment concentration during array disposal occurring near the water surface – Slack water near low water during neap tide ('Sandwaves' material) (red point = time series extraction point)

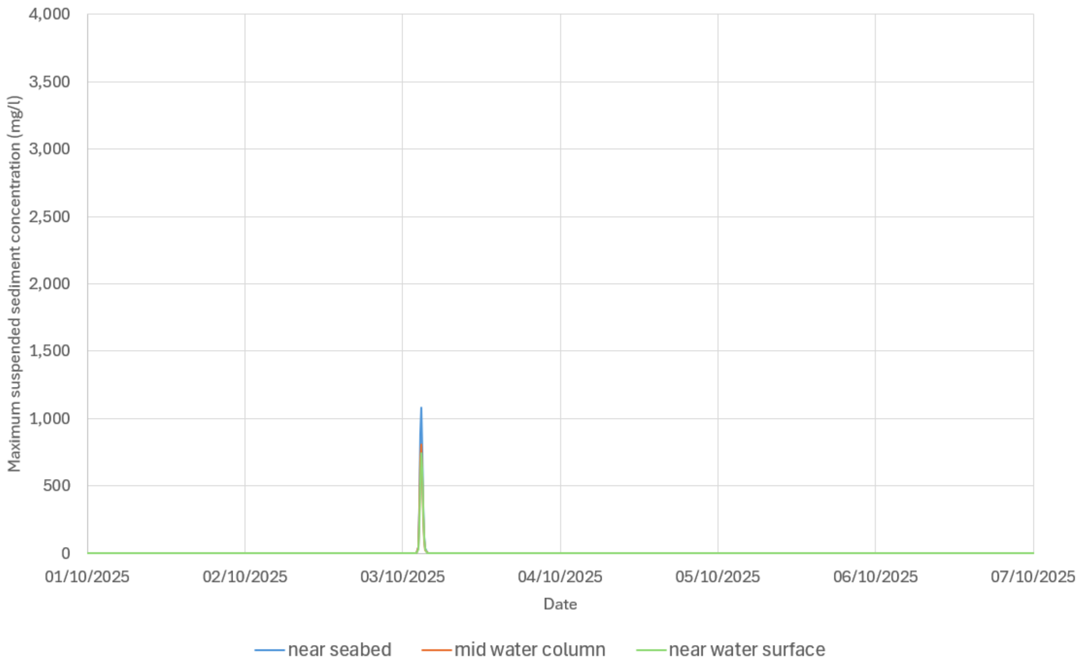

Figure 7-86 Time series of suspended sediment concentration at P1 during sediment disposal near seabed, middle of water column and near water surface - Slack water near low water during neap tide ('Sandwaves' material)

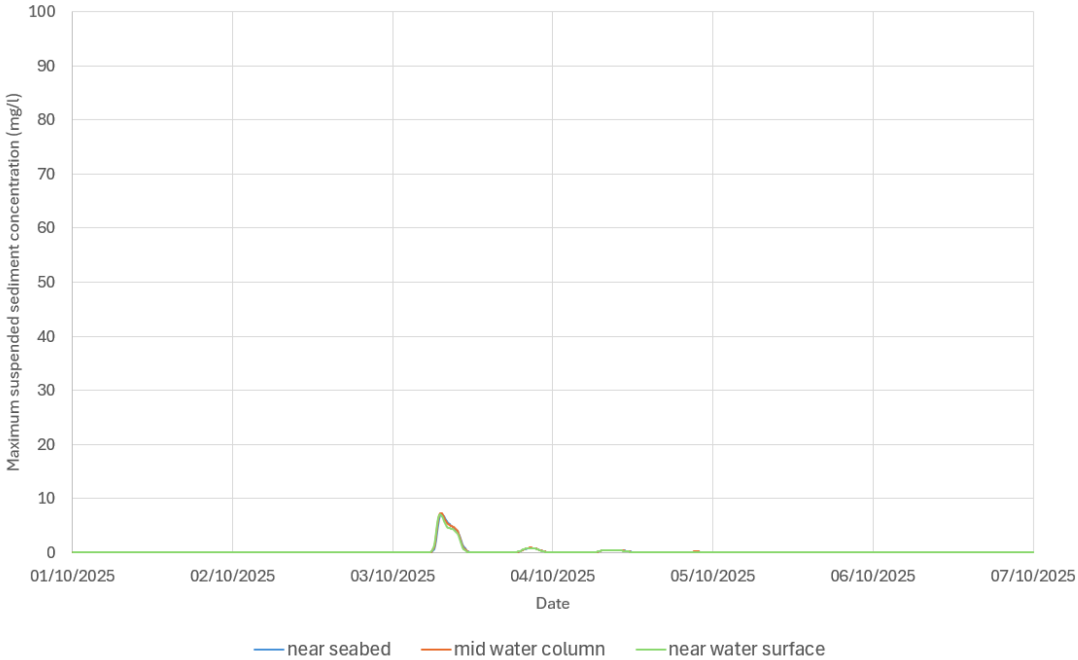

Figure 7-87 Time series of suspended sediment concentration at P2 during sediment disposal near seabed, middle of water column and near water surface - Slack water near low water during neap tide ('Sandwaves' material)

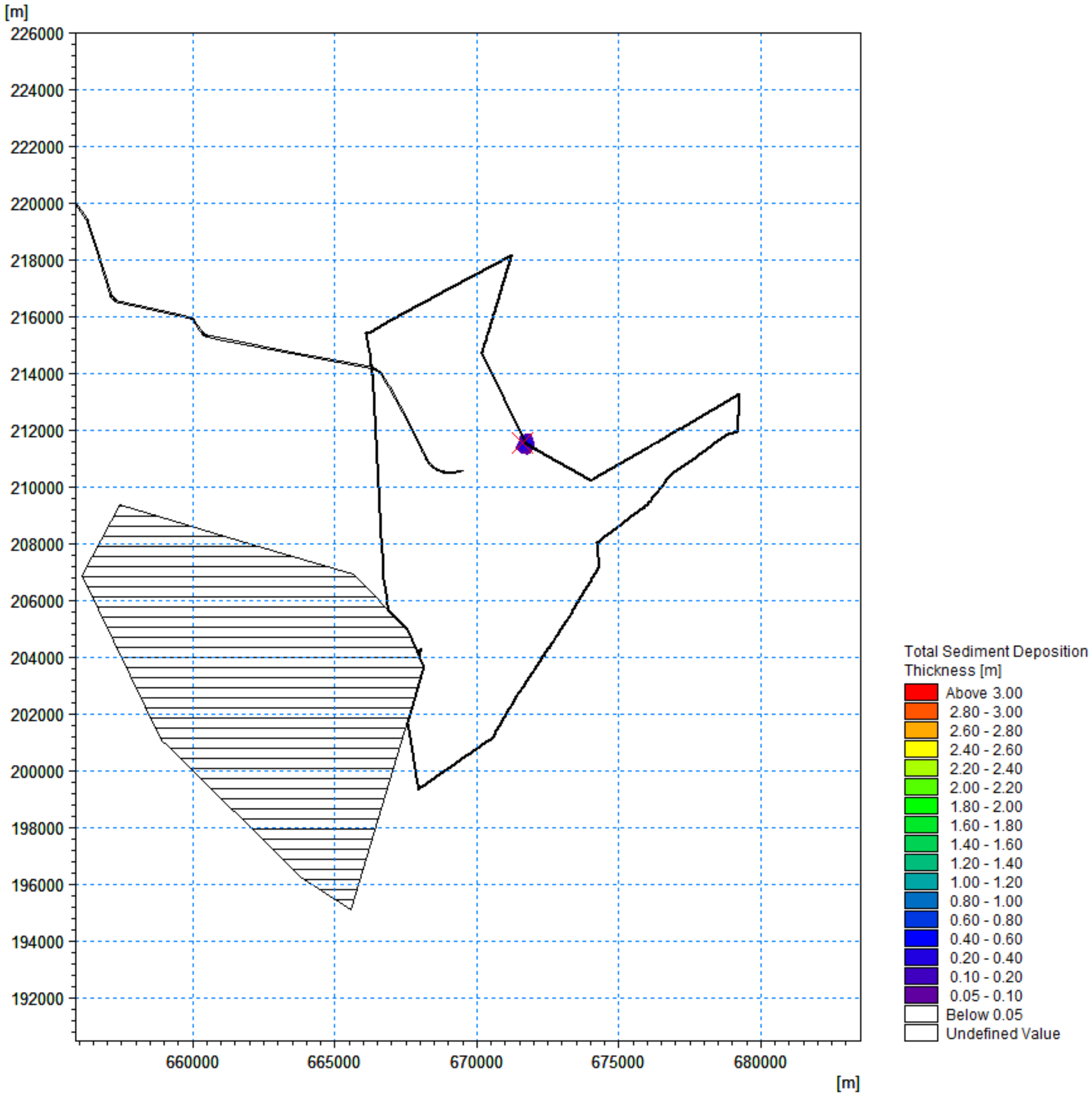

Figure 7-88 Total deposition thickness during sediment disposal - Slack water near low water during neap tide ('Sandwaves' material)

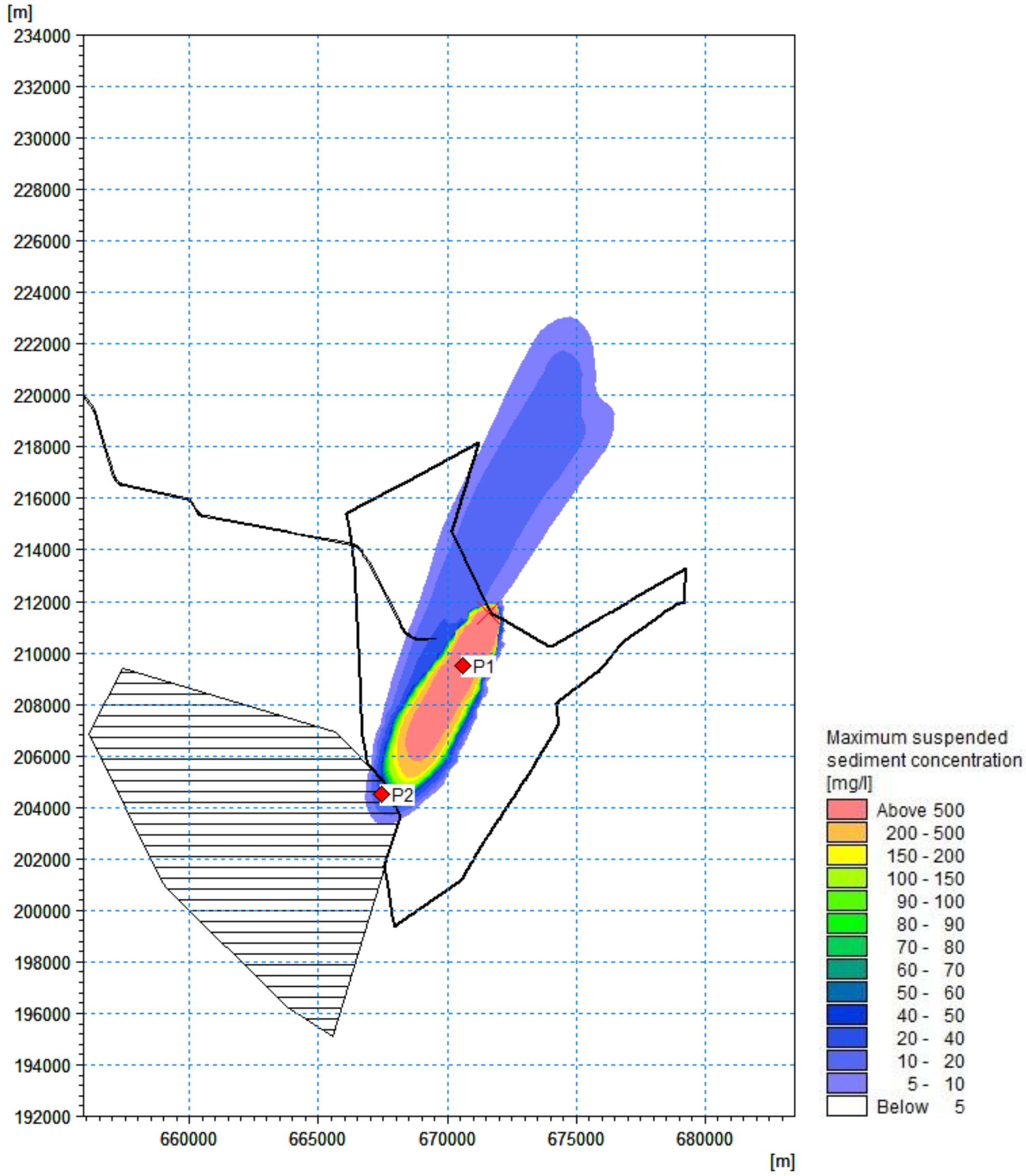

Figure 7-89 Maximum suspended sediment concentration during array disposal occurring near the seabed – Peak flood during spring tide ('Sandwaves' material) (red point = time series extraction point)

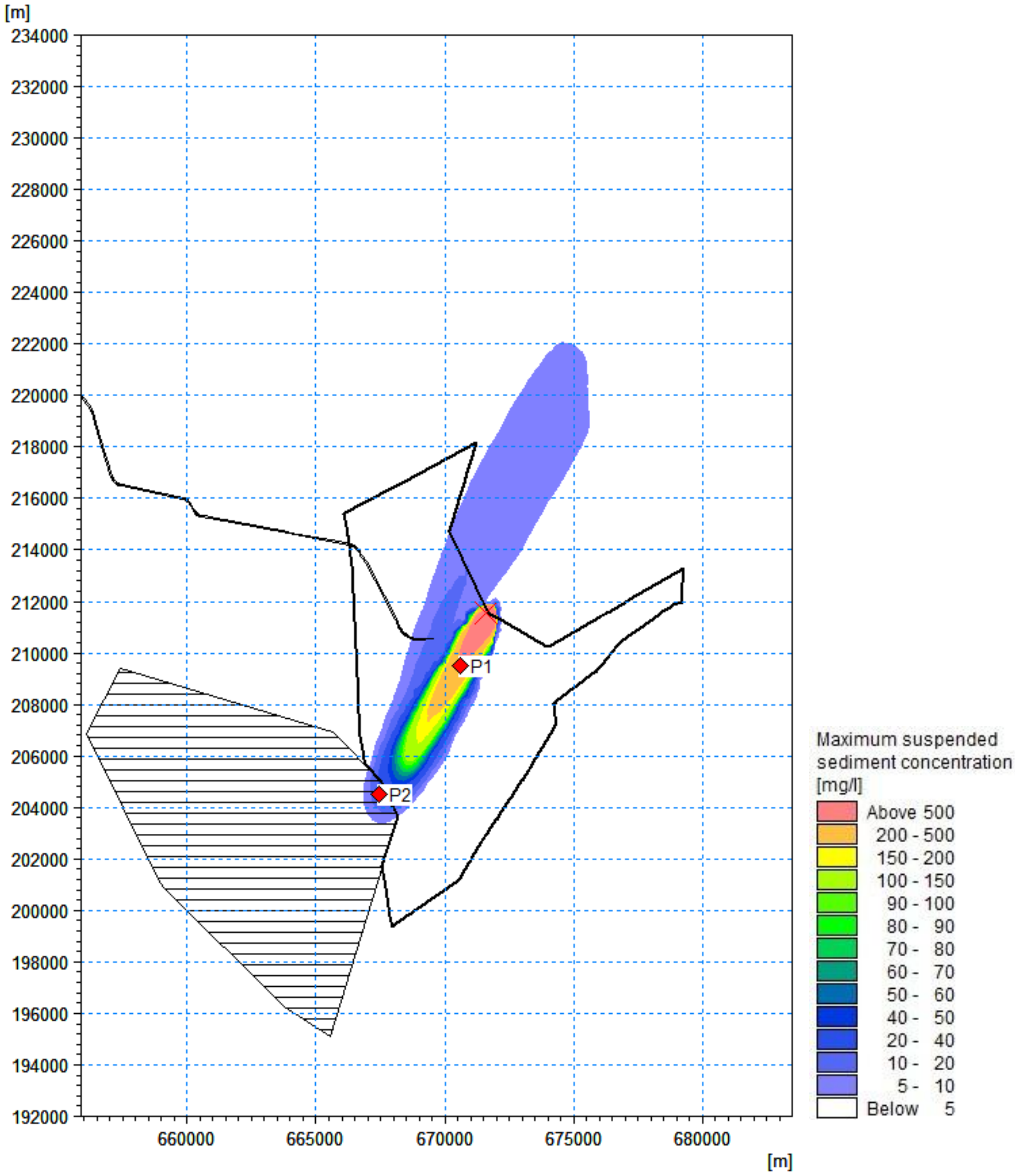

Figure 7-90 Maximum suspended sediment concentration during array disposal occurring near the middle of water column – Peak flood during spring tide ('Sandwaves' material) (red point = time series extraction point)

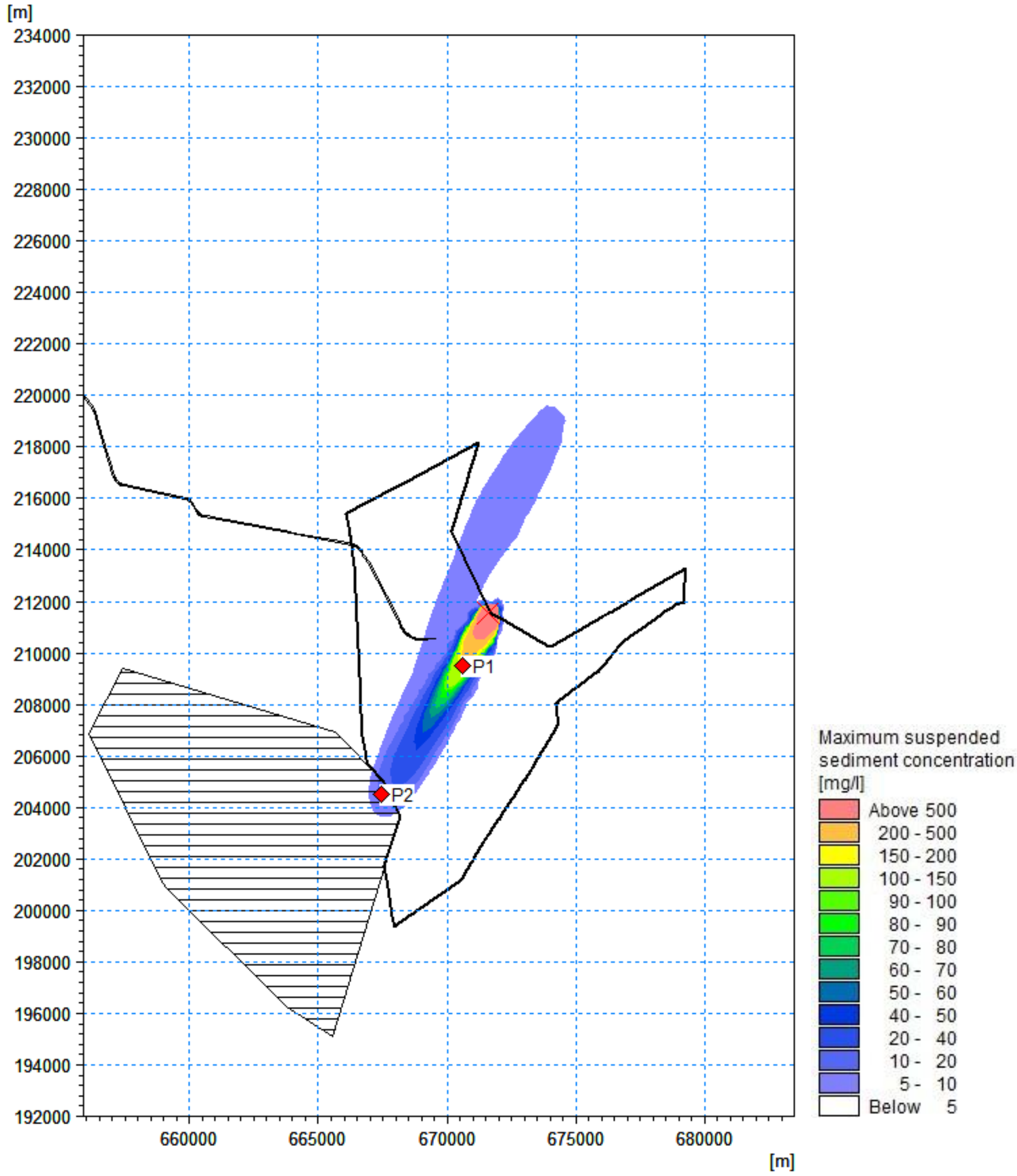

Figure 7-91 Maximum suspended sediment concentration during array disposal occurring near the water surface – Peak flood during spring tide ('Sandwaves' material) (red point = time series extraction point)

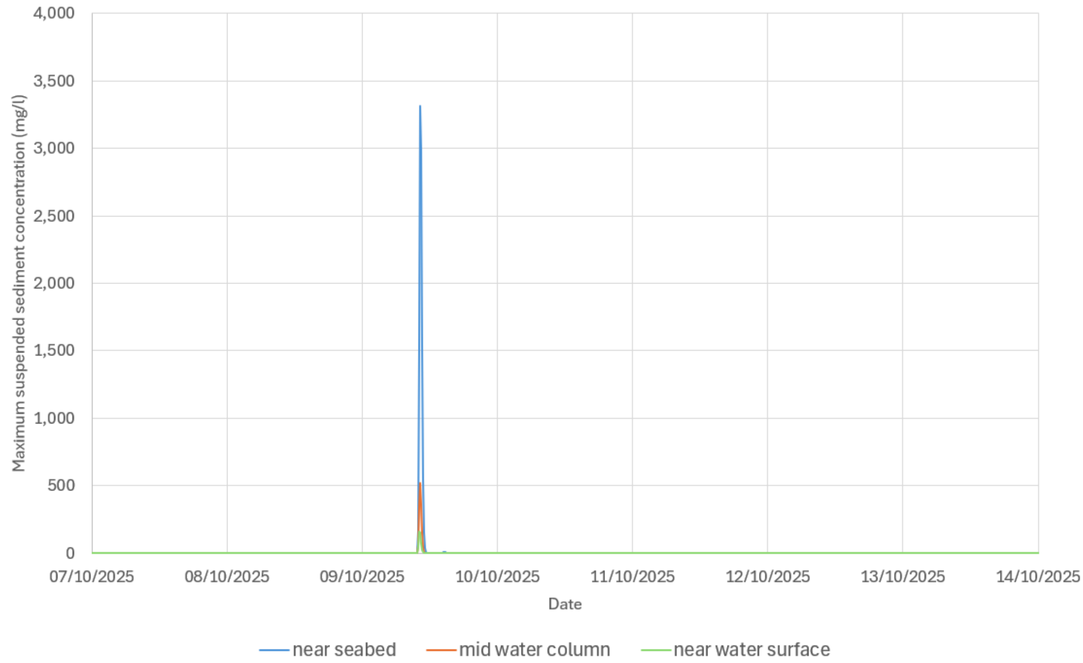

Figure 7-92 Time series of suspended sediment concentration at P1 during sediment disposal near seabed, middle of water column and near water surface – Peak flood during spring tide ('Sandwaves' material)

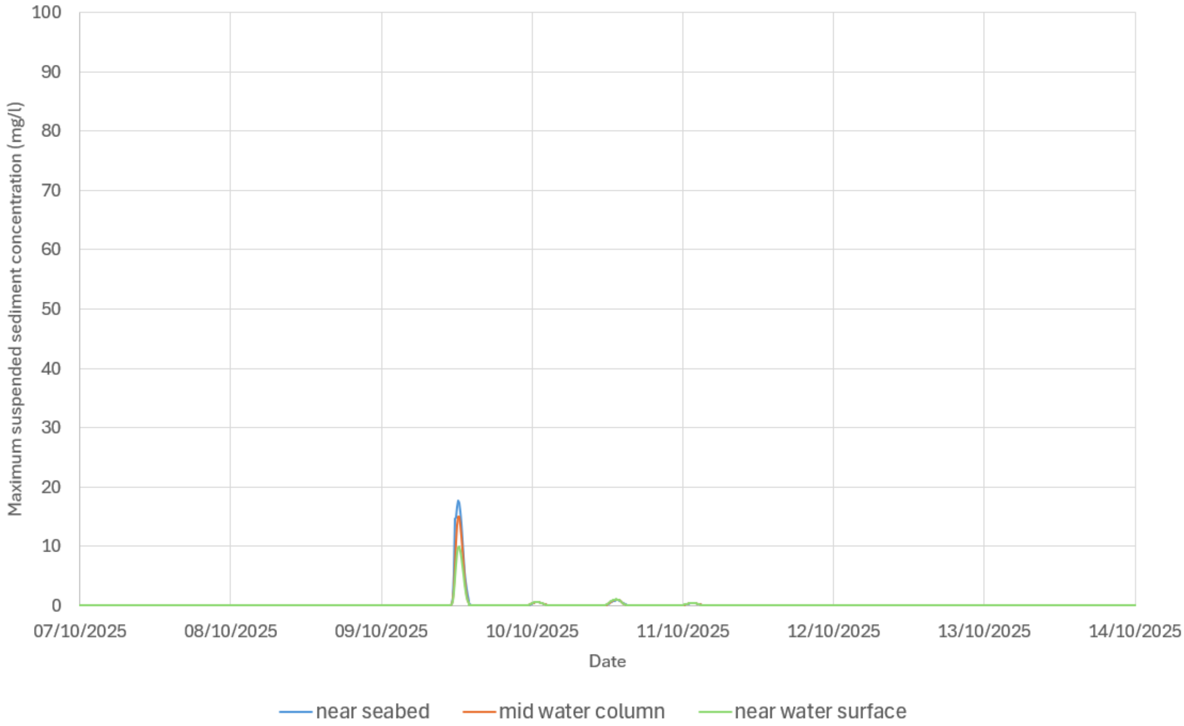

Figure 7-93 Time series of suspended sediment concentration at P2 during sediment disposal near seabed, middle of water column and near water surface - Peak flood during spring tide ('Sandwaves' material)

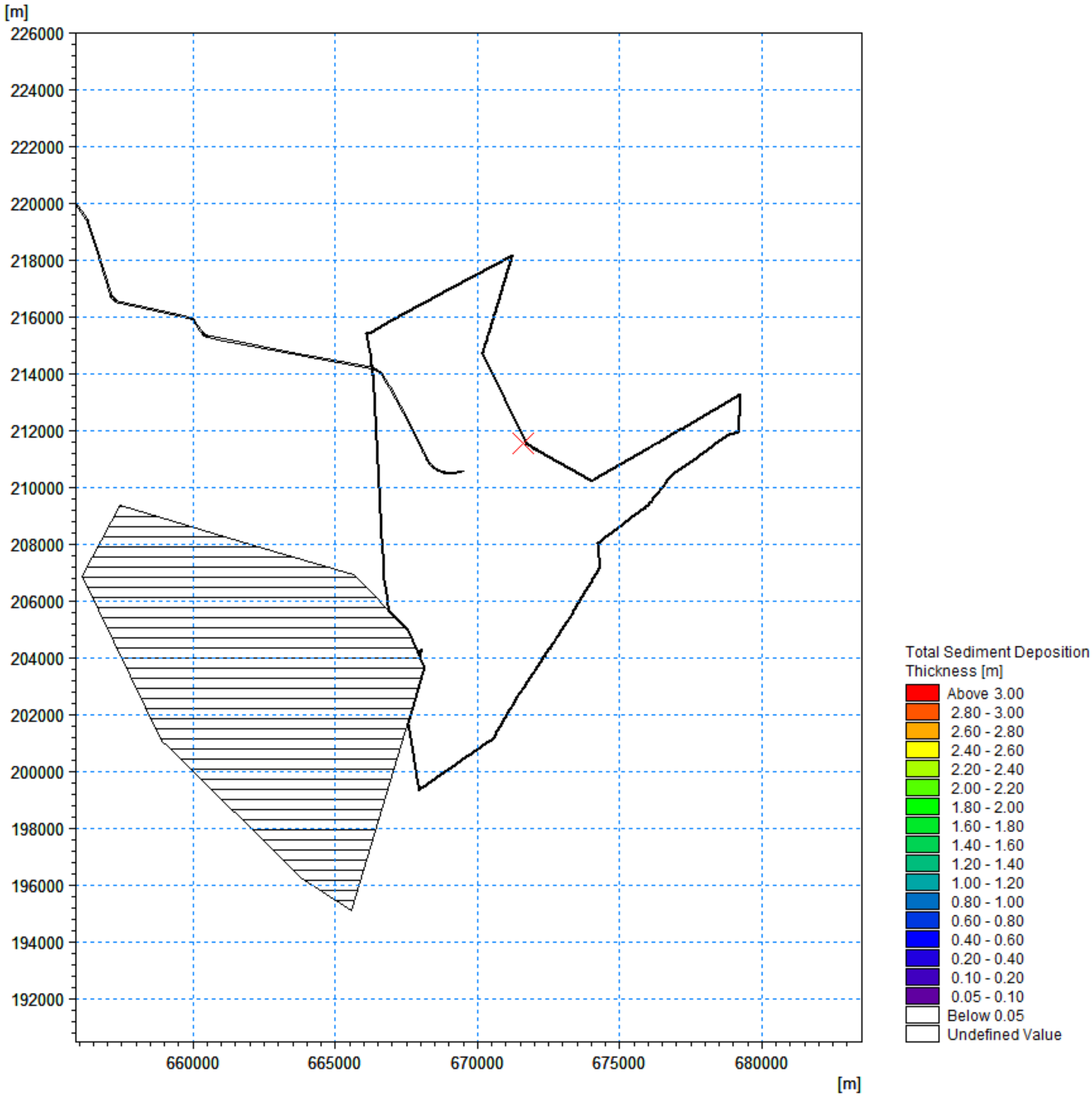

Figure 7-94 Total deposition thickness during sediment disposal - Peak flood during spring tide (‘Sandwaves’ material)

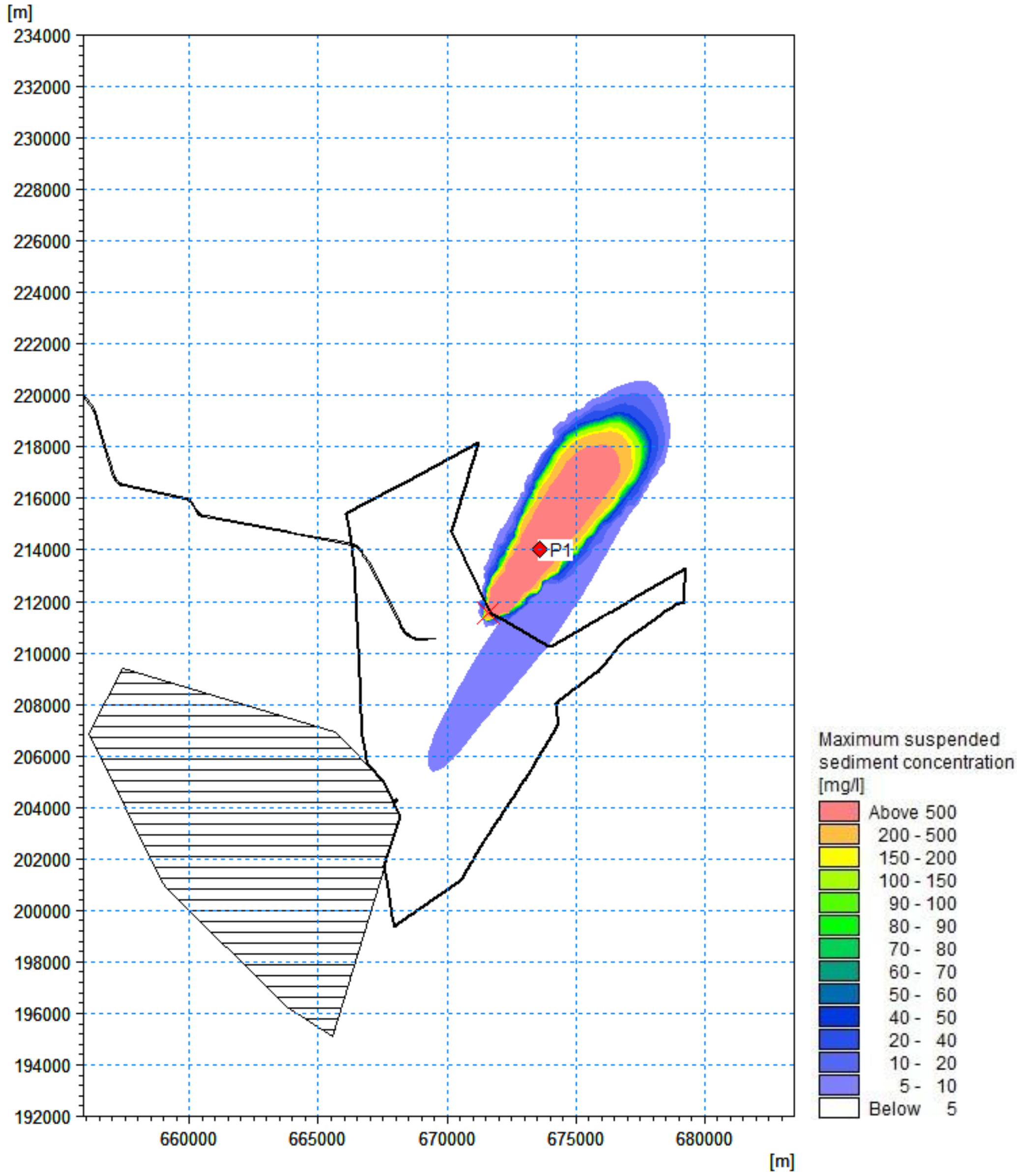

Figure 7-95 Maximum suspended sediment concentration during array disposal occurring near the seabed – Peak ebb during spring tide ('Sandwaves' material) (red point = time series extraction point)

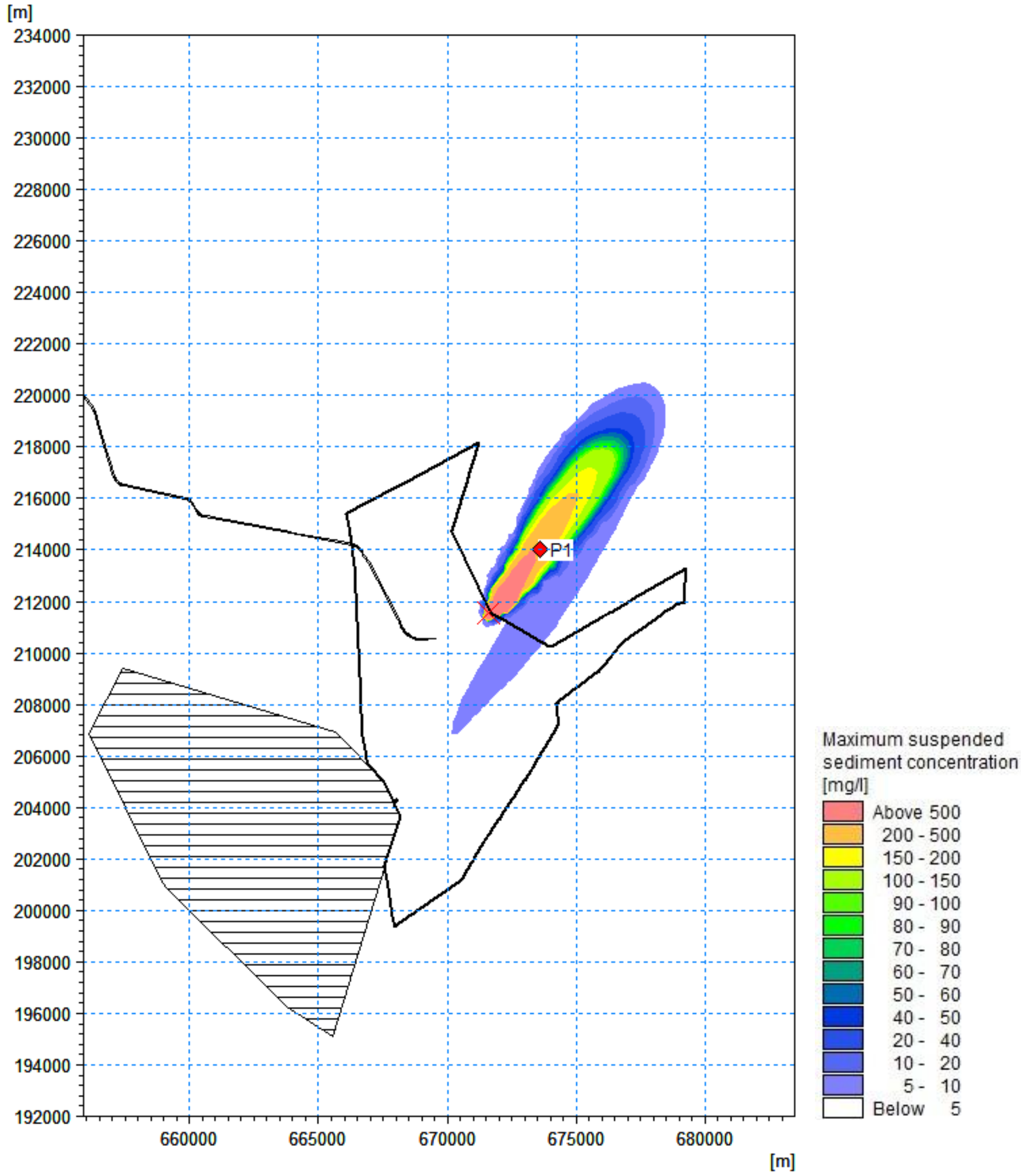

Figure 7-96 Maximum suspended sediment concentration during array disposal occurring near the middle of water column – Peak ebb during spring tide ('Sandwaves' material) (red point = time series extraction point)

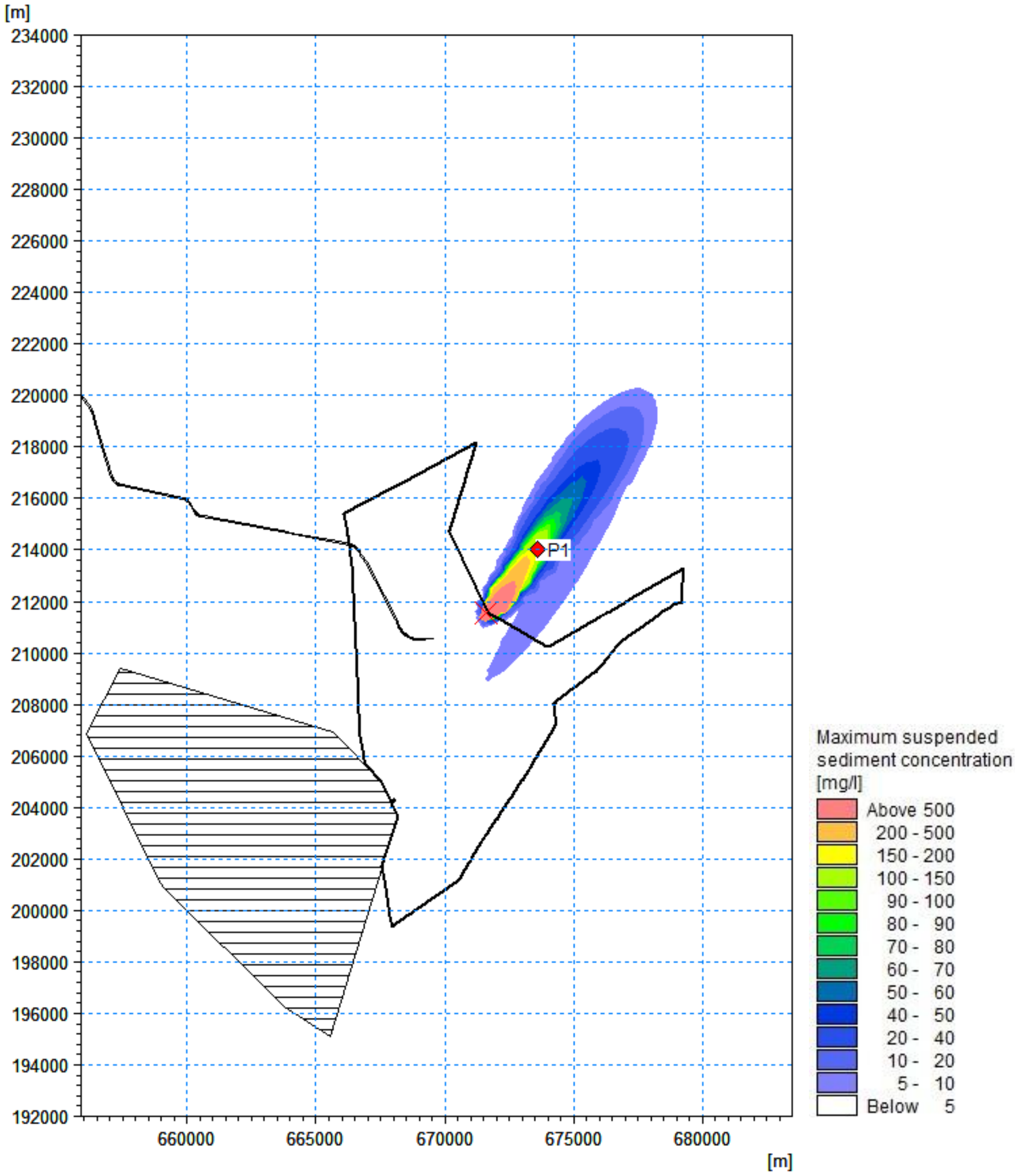

Figure 7-97 Maximum suspended sediment concentration during array disposal occurring near the water surface – Peak ebb during spring tide ('Sandwaves' material)
(red point = time series extraction point)

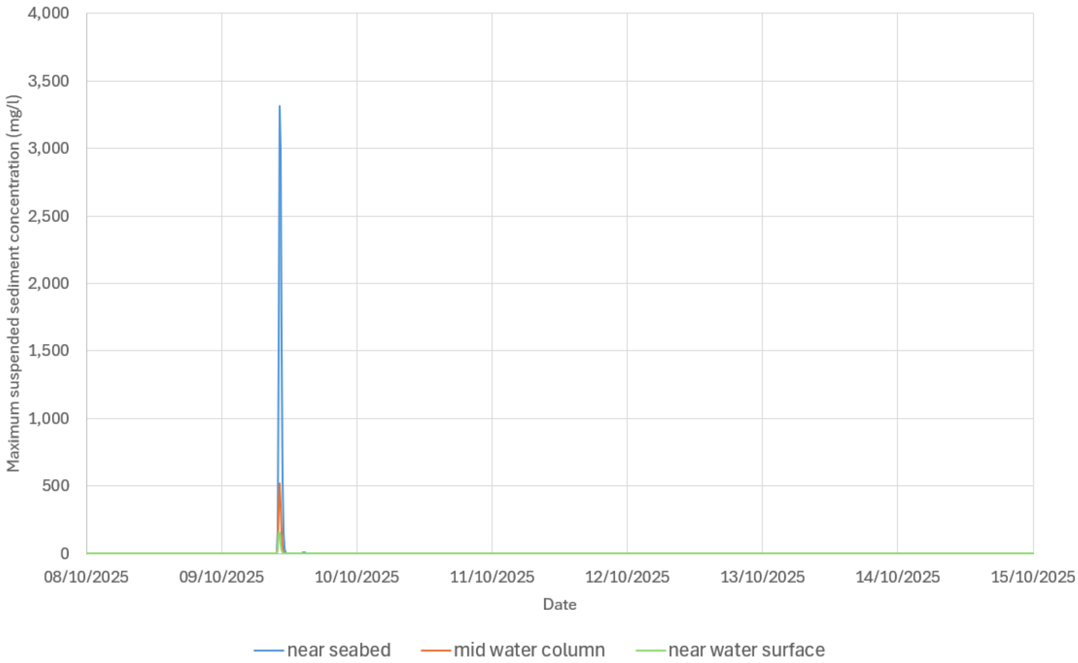

Figure 7-98 Time series of suspended sediment concentration at P1 during sediment disposal near seabed, middle of water column and near water surface – Peak ebb during spring tide (‘Sandwaves’ material)

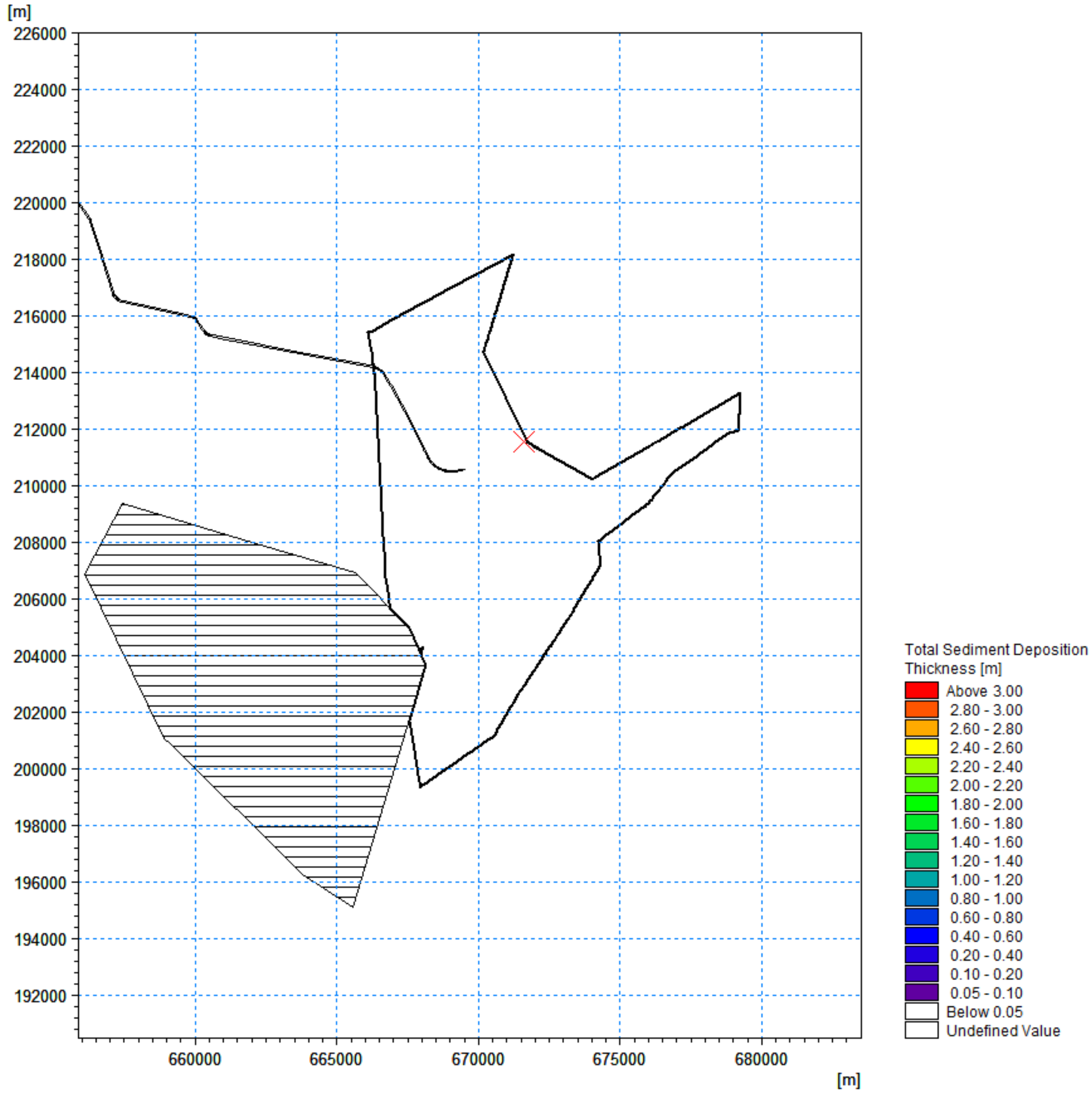

Figure 7-99 Total deposition thickness during sediment disposal - Peak ebb during spring tide ('Sandwaves' material)

7.14 Simulation 13 Results – Dredging at Pilot Boarding Area

7.14.1 Figure 7-100 to Figure 7-102 show the maximum suspended sediment concentration above 5 mg/l which occurs during dredging activities at the Pilot Boarding Area near the seabed, in the middle of the water column and near the water surface respectively. The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface. The maximum SSC extends in a north-east to south-west direction following the dominant current direction from the dredging location at the Pilot Boarding Area.

7.14.2 Figure 7-100 shows that the maximum SSC plume near the seabed extends from the Pilot Boarding Area by up to 800 m with SSC levels below 20 mg/l.

7.14.3 Figure 7-101 shows that the maximum SSC plume in the middle of the water column is reduced to less than 5 mg/l. This is likely due to the sediment release occurring near the seabed and the water surface.

7.14.4 Figure 7-102 shows that the maximum SSC plume near the water surface is less than 100 m in width at the Pilot Boarding Area with maximum SSC levels of less than 10 mg/l.

7.14.5 Figure 7-103 -shows the time series data of suspended sediment concentration during dredging at the Pilot Boarding Area near the seabed, the middle of the water column and near the water surface for location P1 shown as a red point on Figure 7-100 to Figure 7-102

7.14.6 Figure 7-104 shows the total sediment deposition thickness greater than 5cm which occurs during dredging activities at the Pilot Boarding Area. All sediment deposition occurs within the cable corridor near the Pilot Boarding Area and is <1cm.

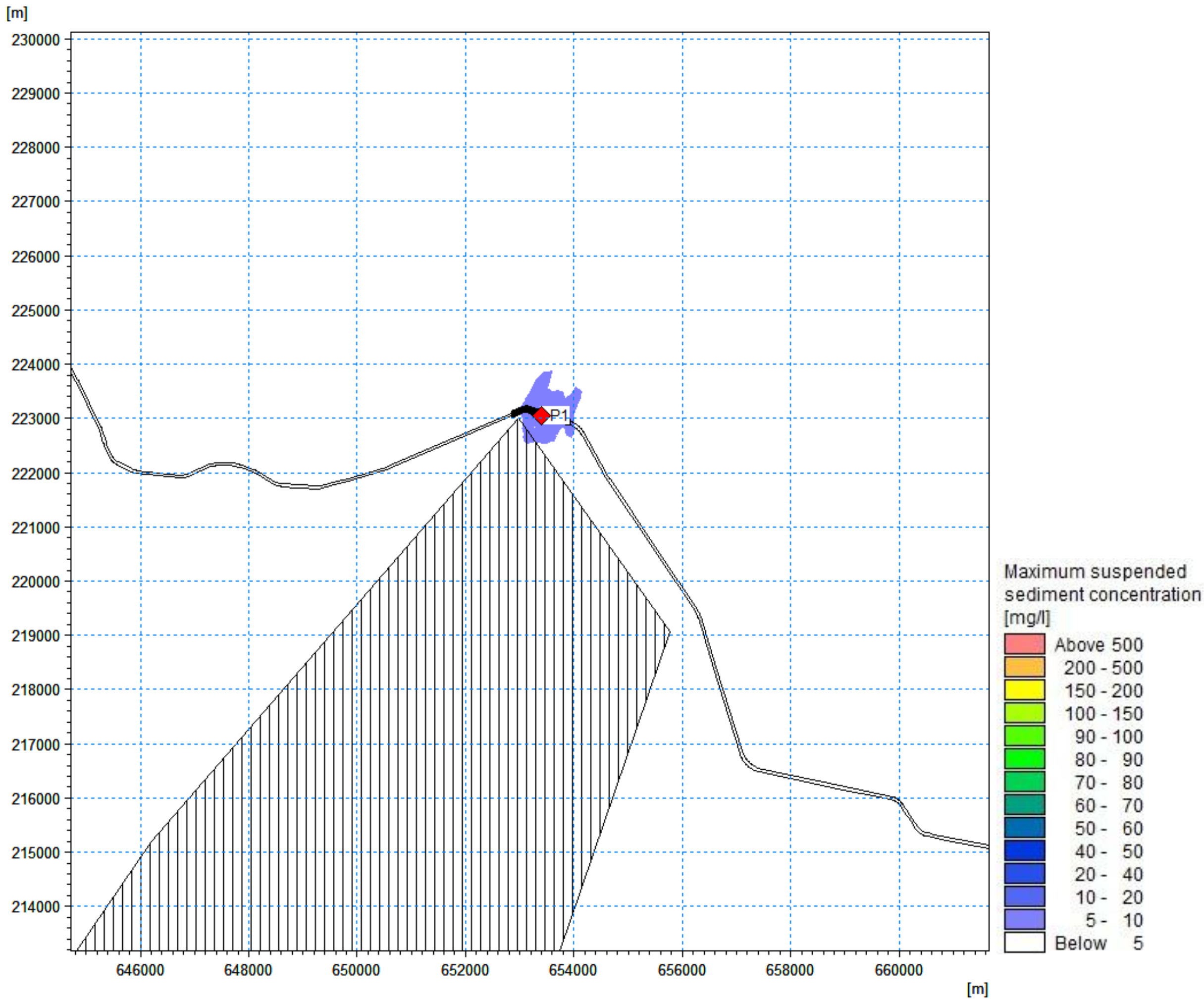

Figure 7-100 Maximum suspended sediment concentration during dredging operations at Pilot Boarding Area occurring near the seabed

(red points = time series extraction point),

(vertical hashed area = MLS SAC)

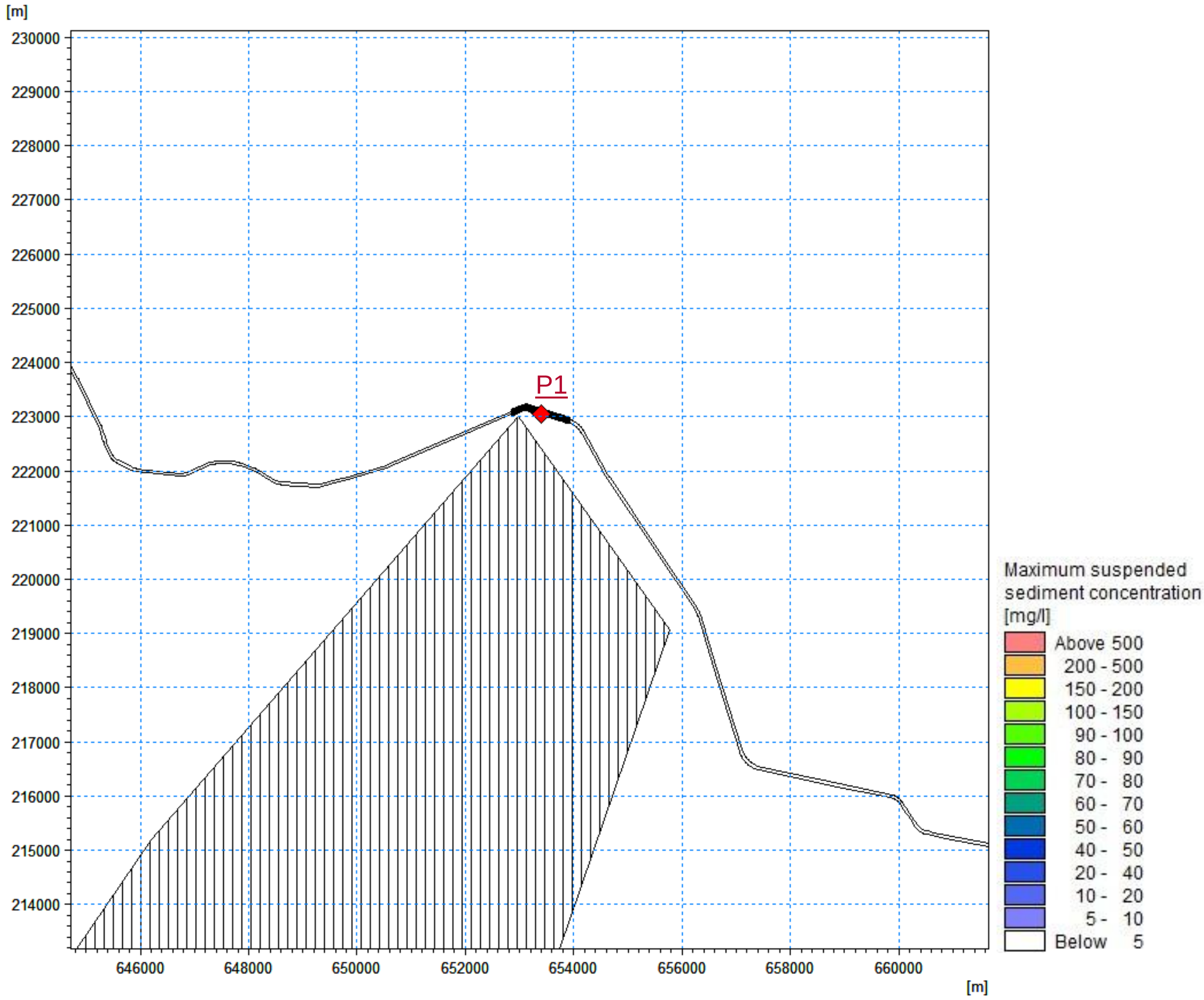

Figure 7-101 Maximum suspended sediment concentration during dredging operations at Pilot Boarding Area occurring in the middle of water column

(red points = time series extraction point)

, (vertical hashed area = MLS SAC)

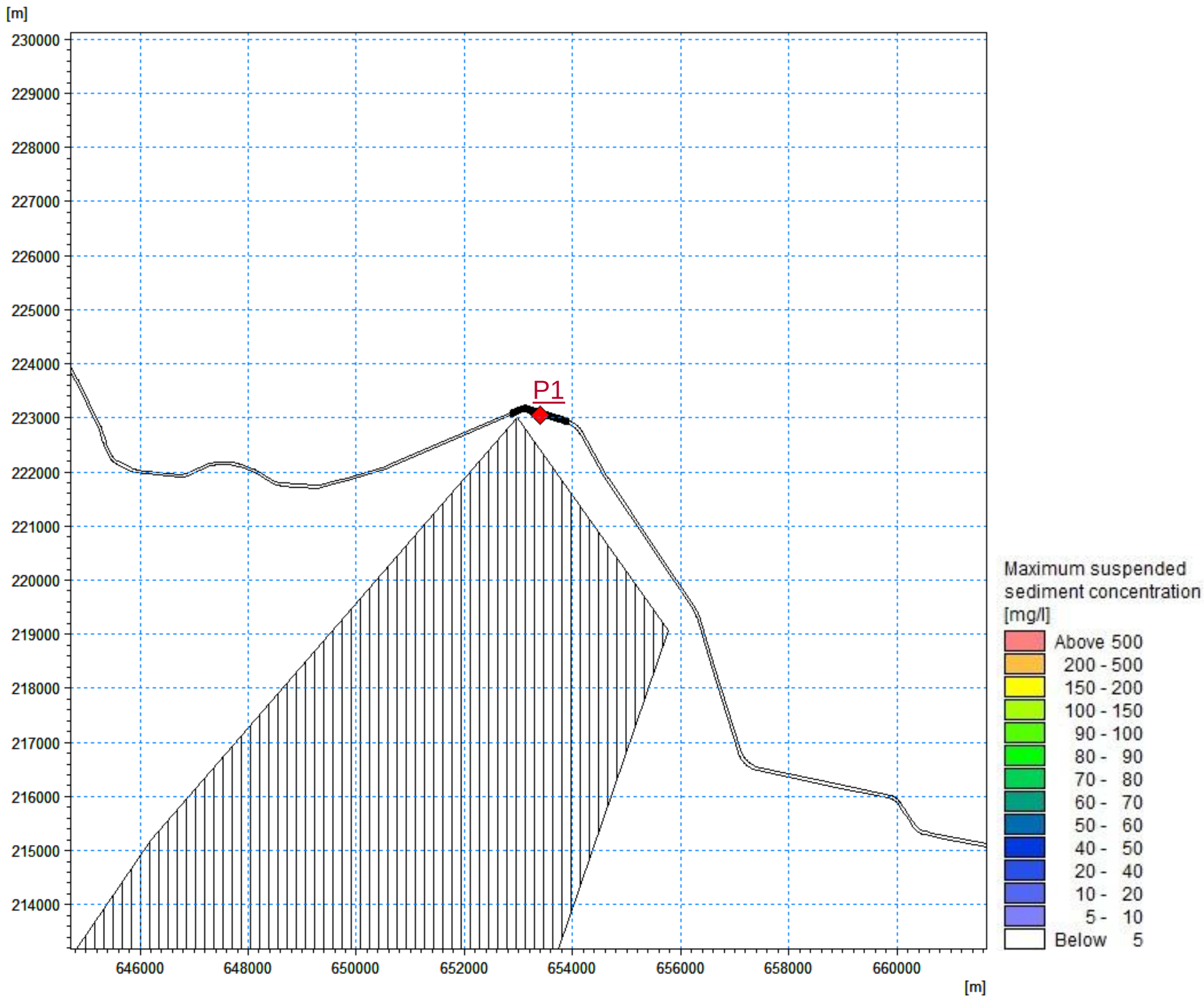

Figure 7-102 Maximum suspended sediment concentration during dredging operations at Pilot Boarding Area occurring near the water surface

((red points = time series extraction point)

, (vertical hashed area = MLS SAC)

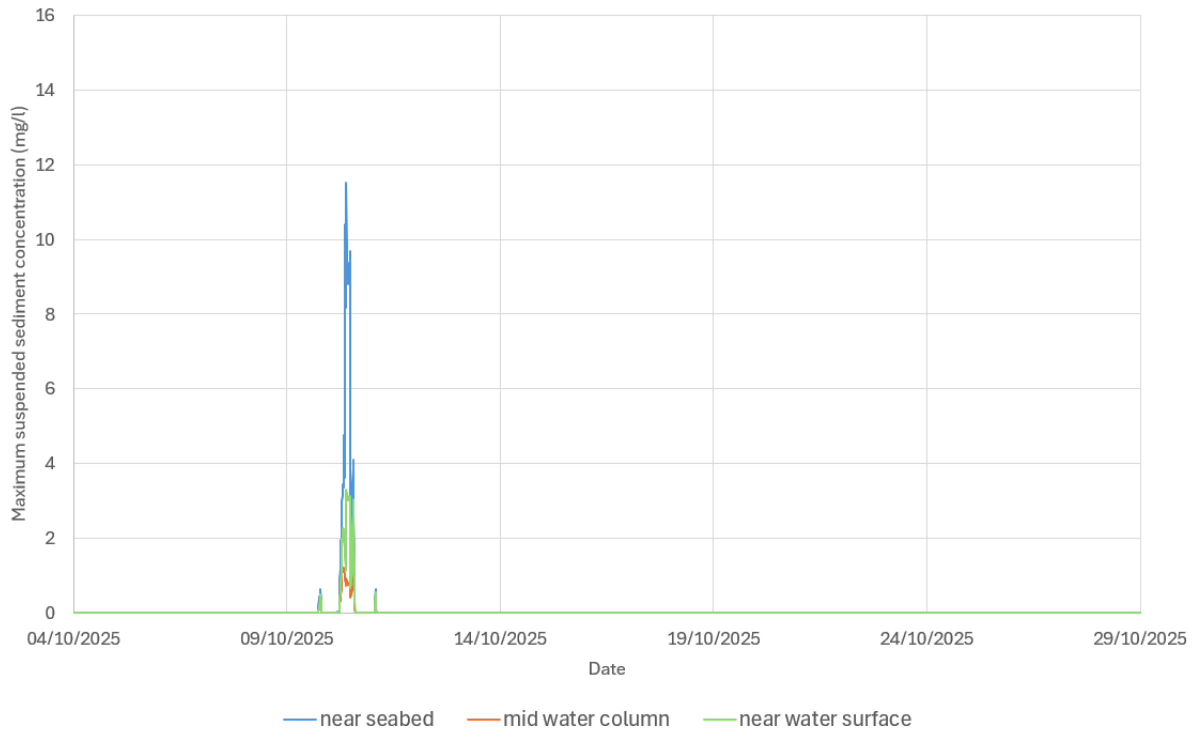

Figure 7-103 Time series of suspended sediment concentration at P1 during dredging at ~~Sunk DWR~~Pilot Boarding Area near seabed, middle of water column and near water surface

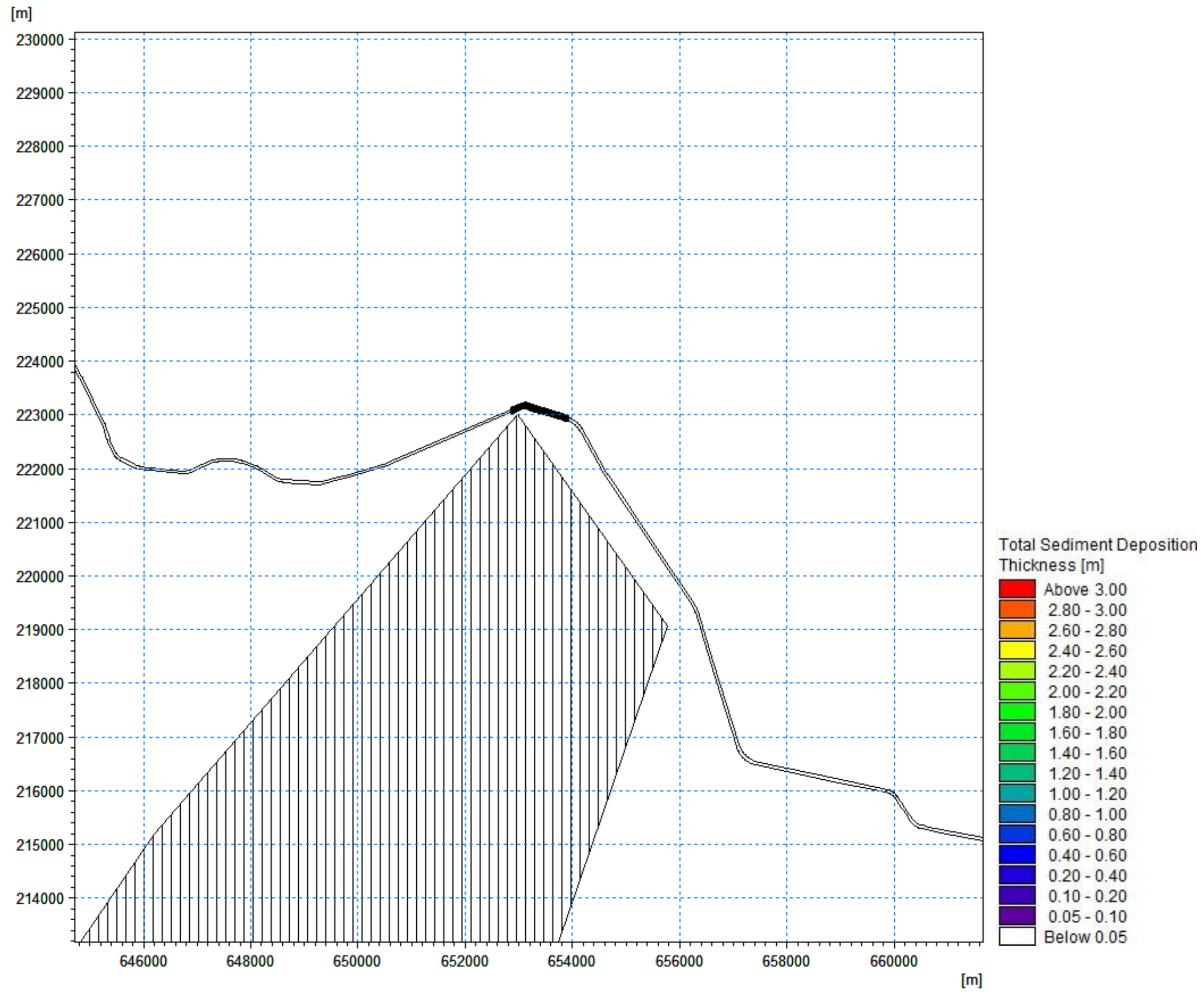

Figure 7-104 Total sediment deposition thickness during dredging operations at ~~Sunk DWR~~Pilot Boarding Area (vertical hashed area = MLS SAC)

8 CONCLUSION

8.1.1 The maximum suspended sediment concentration is greatest near the seabed and gradually becomes less when reaching the water surface for all construction activities.

8.1.2 The largest plume and highest suspended sediment concentrations are created by the levelling of sandwaves along the export cables and array cables. This is due to the high volume that is being released at a high rate. However, even the highest suspended sediment concentrations only last a few hours and are then dispersed to levels below the ambient level of 15 mg/l.

8.1.3 The trenching activities along the export cables and array cables result in suspended sediment concentrations higher than 50 mg/l immediately around the cables. Any peak in SSC only last for approx. 8 hours or less.

8.1.4 The dredging activities around the Sunk DWR, ~~and~~ Trinity DWR and Pilot Boarding Area are below 20 mg/l and last no longer than 2 hours.

8.1.5 The suspended sediment concentrations for drilling activities for structures inside the array for both layouts are below 5 mg/l which is well below the threshold.

8.1.6 The maximum suspended sediment concentrations for seabed preparation activities for structures inside the array for both layouts are above 500 mg/l and cover most of the array area close to the seabed, however the peak in SSC last less than 2 hours.

8.1.7 The total sediment deposition thickness is greatest for the levelling of sandwaves along the export cables and array cables, however the high spots are located close to the cables themselves, whilst the wider extent of deposition is between 0.05 to 0.2m.

8.1.8 The trenching activities along the export cables and array cables result in total sediment deposition thickness of less than 5 cm.

8.1.9 The maximum sediment deposition for drilling activities for structures (both layouts) inside the array is less than 5 cm.

8.1.10 The maximum sediment deposition for seabed preparation activities for structures (both layouts) inside the array area occurs only localised close to the structures and is of the order of 0.6m with the average being around 0.2m.

8.1.11 Comparing two array disposal simulations (Simulations 11 and 12), the predicted maximum extent of suspended sediment concentration by disposal of ‘Sandwaves’ material (Simulation 12) appears to be slightly shorter and narrower due to slightly coarser sediment.

8.1.12 During sediment disposal during slack water, the maximum sediment concentration extent and SSC level contours are broadly the same throughout the water column.

8.1.13 During sediment disposal during peak flood and peak ebb, the maximum sediment concentrations are greatest near the seabed and gradually become less when reaching the water surface.

8.1.14 All sediment deposition occurring during sediment disposal during slack water near high and low water during neap tide are <0.5m. The area of deposition is localised around the release point and extends no further than 800m.

8.1.15 All sediment deposition occurring during sediment disposal during peak flood and peak ebb during spring tide are <5cm.

HARNESSING THE POWER OF NORTH SEA WIND

North Falls Offshore Wind Farm Limited

A joint venture company owned equally by SSE Renewables and RWE.

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