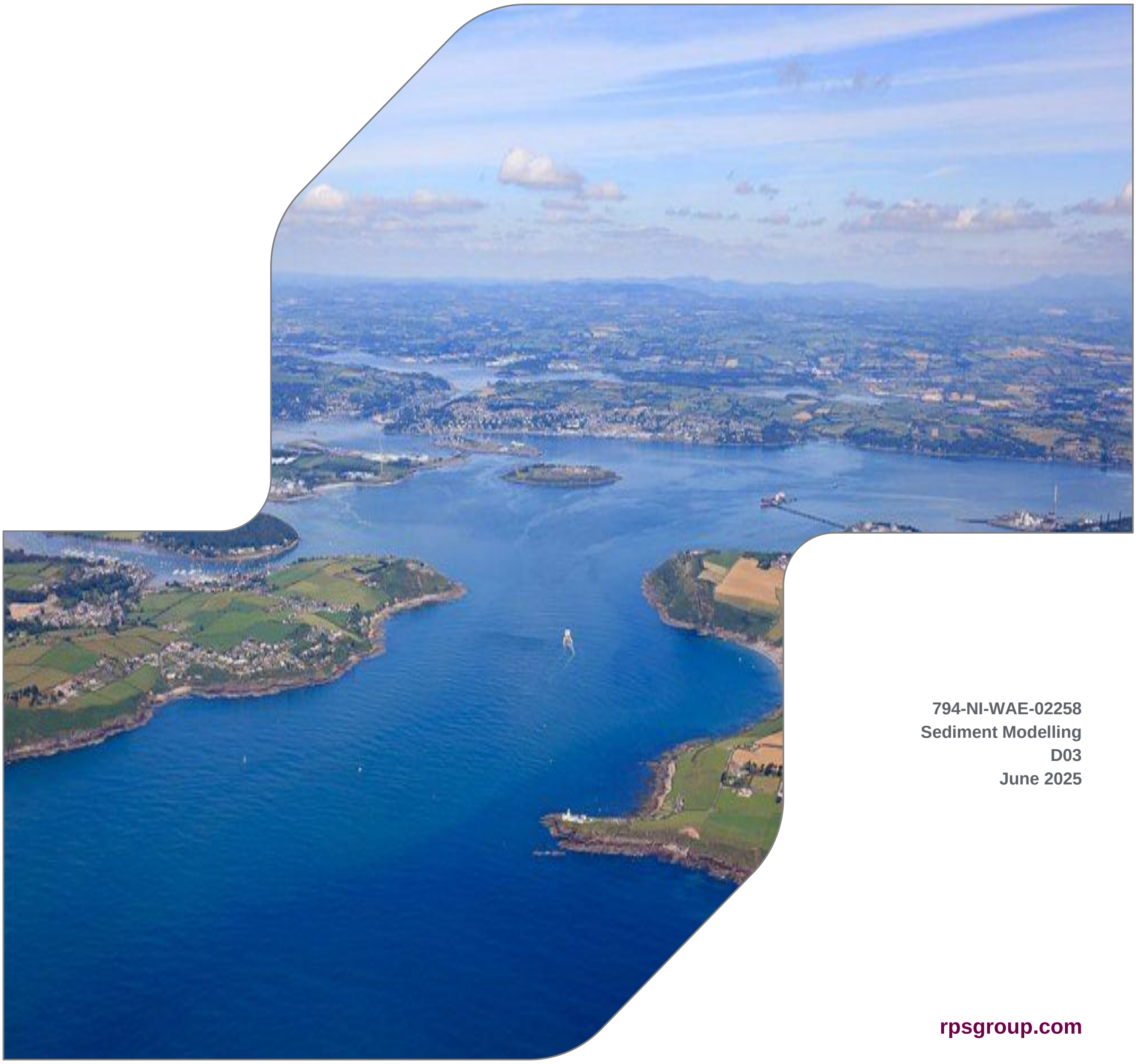
HAULBOWLINE HARBOUR DREDGING

Sediment Plume Dispersion Assessment



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Contents

Tables

Figures

Appendices

1 INTRODUCTION

Ayesa Ltd engaged the services of RPS for the provision of sediment plume dispersion information relating to dredging at Haulbowline Harbour. The Harbour is located within the Port of Cork and is used to berth vessels for the Irish Naval Service. As part of the licensing for dredging operations, modelling was required to determine the fate of the suspended fractions of the dredged material. This was undertaken using numerical modelling techniques which provided information on tides and sediment transport.

This technical report presents the findings of the numerical modelling programme and describes the dispersion of dredge material suspended during the dredging operations and the fate of dredge material when dumped at the licensed disposal site. In the interest of presenting a conservative assessment, the modelling assessment was undertaken based on a trailing suction hopper dredger (TSHD) which can have higher production rates / losses relative to other possible dredge methods and thus represent a worst-case scenario for the sediment dispersion.

Furthermore, modelling the worst-case scenario, based on the TSHD, ensures that alternative dredging methods proposed at tender or during the works, such as a backhoe dredger or a Dredging Outboard Pump (DOP), will be permissible due to their lower environmental impact. This approach provides contractors with flexibility to determine the most suitable dredging method, recognising that under Public Works Contracts, the dredging method cannot typically be prescribed. It also accounts for the likelihood that dredging will occur in stages depending on funding and permitting, allowing different dredging methodologies to be considered for each stage.

The location of the licensed disposal site in relation to Haulbowline Harbour is illustrated in Figure 1.1 below.

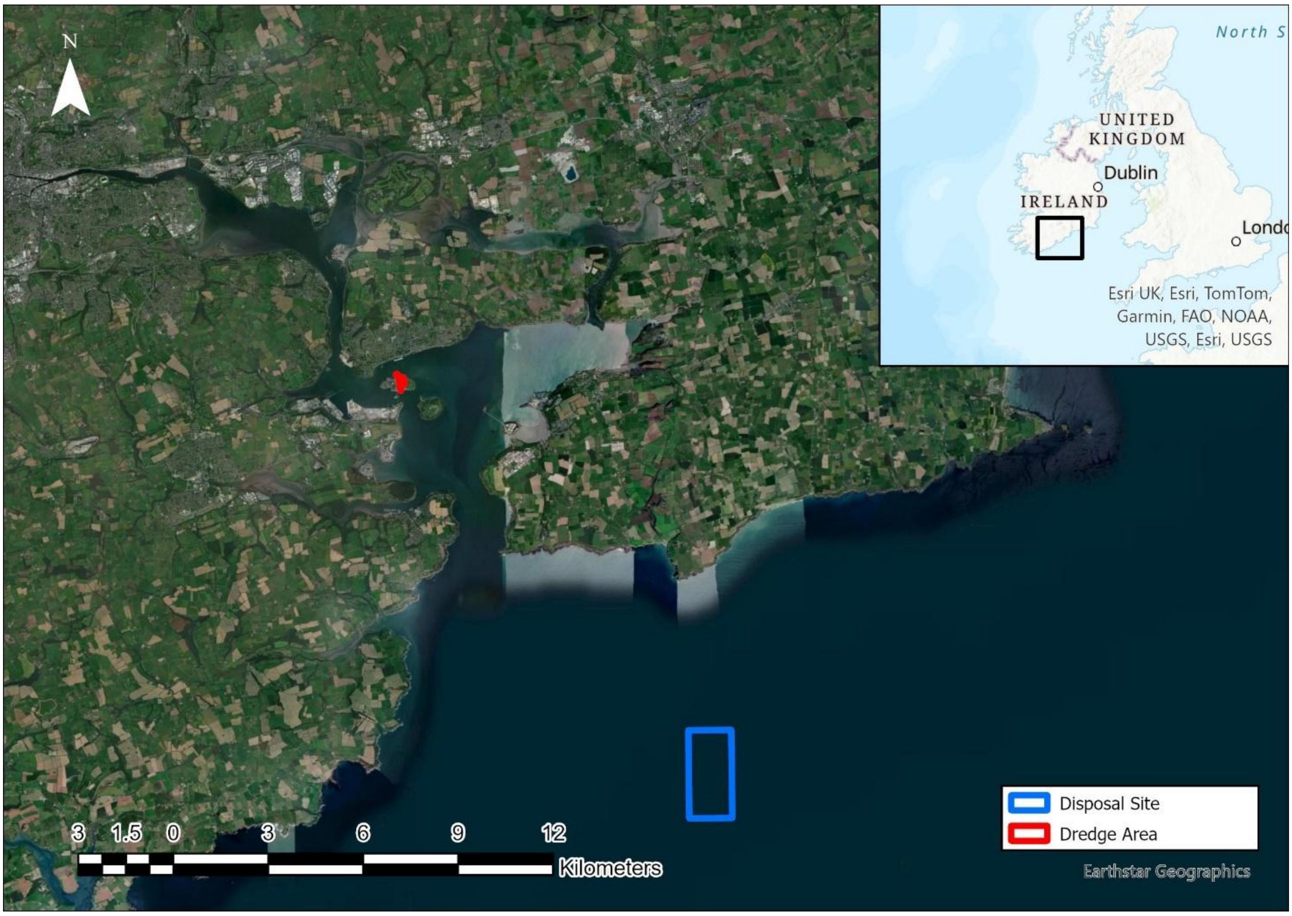

Figure 1.1: Location of Haulbowline Harbour in relation to the existing licensed disposal site

2 DESCRIPTION OF DREDGING WORKS

Maintenance dredging at Haulbowline has been carried out at regular intervals. Previous dredging campaigns were carried out in 2010 and 2017. A dredging campaign is again required to restore the basin level to -5.5m CD. To achieve this, approximately 47,630m^3 of material must be dredged from the area illustrated in Figure 2.1. The Naval Base shall remain operational throughout the dredging campaign. The current bed level and the rate of siltation within the basin pose an operational and safety risk to the navigation of vessels in the harbour.

Frequent maintenance dredging is required to increase the water depths in the naval dockyard for the navigability and berthing of Irish Naval vessels. This restoration of water depth requires approximately 32,000m^3 of suitable excavated material (non-contaminated material) to be disposed of at the previous licenced Roches Point dump site south of Power Head (Figure 1.1).

The remaining 15,630m^3 material to be dredged is considered contaminated and is contained within the exclusion zones illustrated in Figure 2.1. Given the contaminated status of this material, it will be disposed of at a licensed onshore facility.

The appointed contractor will determine the finalised methodology for dredging, disposal (offshore, drying and stabilising) of both non-contaminated the contaminated materials, ensuring that the most effective and compliant approach is implemented based on their expertise and adherence to regulatory standards. It is likely that the dredging works will be procured under different stages which may result in different methodologies. This report ensures the worst-case is considered and the permitted limits identified to allow maximum flexibility aligned with public procurement.

Figure 2.1: Location of the proposed dredging location within at Haulbowline Harbour. The areas to be dredged but not dumped at sea are highlighted in yellow.

2.1 Sediment Characteristics

As part of the Dumping at Sea application process, it was necessary to collect and analyse sediment samples to determine potential contamination and the physical nature of the sediment to be dredged. To this end, Socotec was commissioned to analyse 18 discrete sediment samples collected from Haulbowline Harbour.

In addition to examining the potential for contaminates, the material was also examined to quantify the percentage of sand and silt material. The results of this assessment are presented in Table 2.1 below. As demonstrated by this information, approximately 96.6% of the material to be dredged was identified as silt whilst the remaining 3.4% of material had a grain size equivalent to or greater than that of sand material.

This information was subsequently used to inform the numerical modelling described in Section 4 of this report.

Table 2.1: Summary of the Dumping at Sea material analyses report from Haulbowline Harbour

Sample ID code	Particle size >2mm % (Gravel)	Particle size <2mm >63um % (Sand)	Particle size <63um % (Silt)
S1	0.00	8.10	91.90
S2	0.40	6.00	93.60
S3	0.00	3.40	96.60
S4	0.00	4.00	96.00
S5	0.00	0.50	99.50
S6	0.00	4.00	96.00
S7	0.00	1.80	98.20
S8	0.00	1.10	98.90
S9	0.00	2.00	98.00
S10	0.60	4.50	94.90
S11	0.00	0.70	99.30
S12	0.00	5.60	94.40
S13	0.00	2.00	98.00
S14	0.00	1.20	98.80
S15	0.00	0.60	99.40
S16	1.30	1.60	97.10
S17	0.00	5.70	94.30
AVERAGE [%]	**0.13**	**3.30**	**96.57**

3 MODELLING METHODOLOGY

3.1 Overview

It was necessary to develop a suitable numerical modelling programme to assess and quantify the sediment plumes generated as a result of the proposed dredging operations.

The computational modelling was undertaken using RPS' in house suite of MIKE coastal process modelling software developed by the Danish Hydraulic Institute. A description of the modelling software used in this study is presented in the following Section.

Existing data was collected and reviewed by the study team. The relevant data on bathymetry, current flows, sediment grading etc., were analysed and prepared for use in the modelling study. For the purposes of this assessment, RPS utilised an existing hydraulic model of the Port of Cork area. As described in Appendix A, this model has been fully calibrated and is considered fit for purpose.

3.2 Modelling Software

The sediment plume dispersion simulations were undertaken using the coupled MIKE 21 Flow Model (FM) model. The FM model is a state-of-the-art modelling system based on a flexible mesh approach. The modelling system was developed by the Danish Hydraulics Institute (DHI) for applications within oceanographic, coastal and estuarine environments. The MIKE modelling software package has been approved by numerous leading institutions and authorities including the US Federal Emergency Management Agency (FEMA).

The Hydrodynamic Module is the basic computational component of the entire MIKE 21 Flow Model FM modelling system providing the hydrodynamic basis for the advection/dispersion Module, ECO Lab Module, Mud Transport Module and Sand Transport Module. For this study RPS utilised the following modules within the MIKE software package:

- Hydrodynamic module
- Mud Transport module

A more comprehensive description of these modules and the key parameters governing the coastal processes within the simulations are described in the following sections.

3.2.1 Hydrodynamic Module

The Hydrodynamic Module simulates water level variations and flows in response to a variety of forcing functions in lakes, estuaries and coastal regions. The effects and facilities include:

- Flooding and drying;
- Momentum dispersion;
- Bottom shear stress;
- Coriolis force;
- Wind shear stress;
- Barometric pressure gradients;
- Ice coverage;
- Tidal potential;
- Precipitation/evaporation;
- Wave radiation stresses; and
- Sources and sinks.

The Hydrodynamic Module can be used to solve both three-dimensional (3D) and two-dimensional (2D) problems. In 2D the model is based on the shallow water equations - the depth-integrated incompressible Reynolds averaged Navier-Stokes equations.

3.2.2 Mud Transport (MT) Module

The Mud Transport (MT) module of the MIKE 21/3 Flow Model FM describes erosion, transport and deposition of mud or sand/mud mixtures under the action of currents and (if appropriate) waves. The hydrodynamic basis for the MT Module is calculated using the Hydrodynamic Module of the MIKE 21/3 Flow Model FM modelling system and the MT is implemented as a couple model with the two running concurrently. The MT module is applicable for mud fractions and sand/mud mixtures.

The following processes may be included in the simulation.

- Forcing by waves;
- Salt-flocculation;
- Detailed description of the settling process;
- Layered description of the bed; and
- Morphological update of the bed.

In the MT-module, the settling velocity varies, according to the salinity, if included, and the concentration considering flocculation in the water column. Bed erosion can be either non-uniform, i.e. the erosion of soft and partly consolidated bed, or uniform, i.e. the erosion of a dense and consolidated bed. The bed is described as layered and is characterised by the density and shear strength.

3.3 Model Domain

As the proposed dredging operations included dredging within Haulbowline Harbour and the dumping of dredge material at the license site *c.* 8km south of Roches Point it was necessary to develop two individual numerical models.

The outer Cork Harbour model developed to simulate the dispersion of dumped material at the licensed disposal site is illustrated in Figure 3.1 below. This model extended approximately 40km offshore and from Ballycotton at the east boundary to the Old Head of Kinsale at the west boundary. As the model was developed using flexible mesh technology, it was possible to define the disposal site using a high-resolution mesh with an effective cell size of 50m^2. The model resolution was decreased to *c.* 1,500m^2 at the offshore boundary to increase computational efficiency.

The inner Cork Harbour model was developed to simulate the dispersion of spilled material during dredging is illustrated in Figure 3.2. This high-resolution model had a mesh size ranging from 40m^2 at the channel outside Haulbowline Harbour and within the fairway approach channels to *c.*360m^2 across the wider flat areas, with a smaller mesh size of 20m^2 in the harbour itself. The mesh structure and resolution of this model is illustrated in Figure 3.3 and Figure 3.4.

Bathymetry data for both models was based on data from the Irish National Seabed Survey (INSS), INFOMAR, and other local bathymetry surveys undertaken within Haulbowline Harbour.

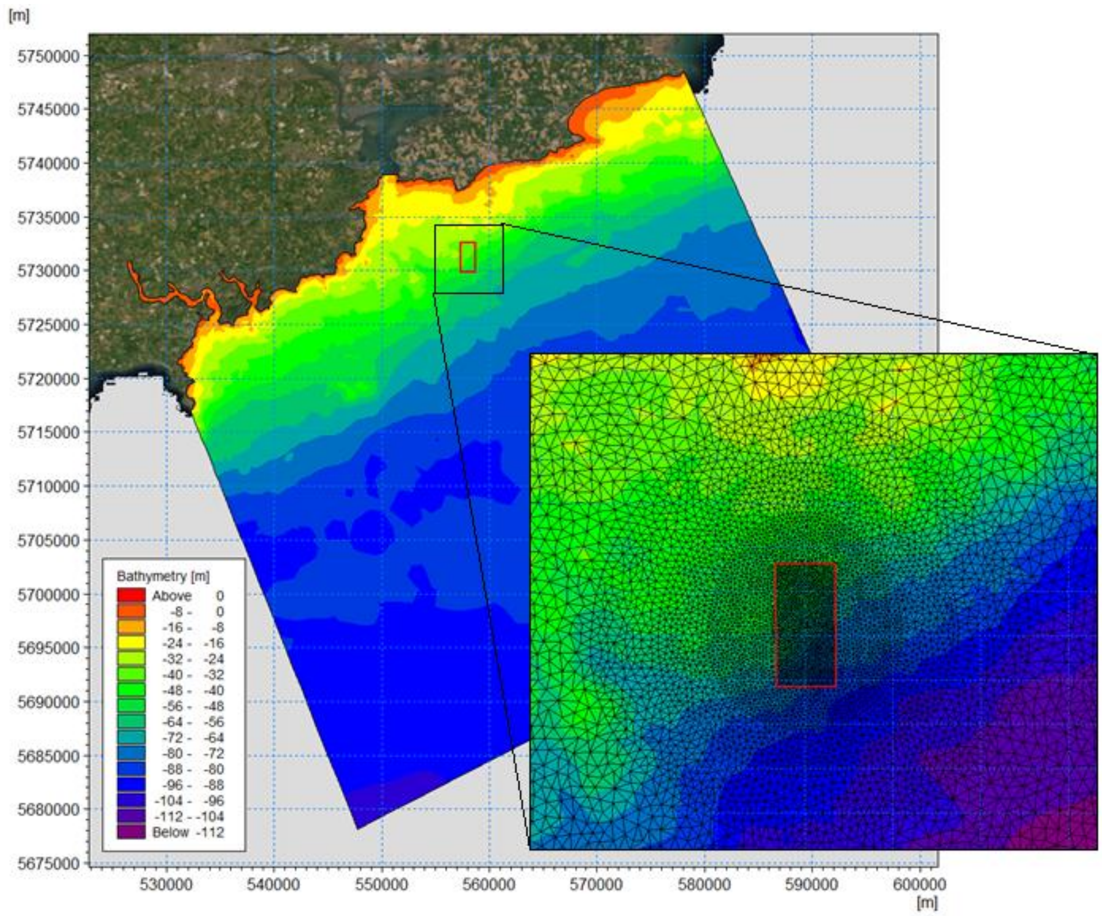

Figure 3.1: Extent and bathymetry of the Outer Cork model with high resolution around the disposal site shown in the inset

Figure 3.2: Extent and bathymetry of the inner Cork Harbour model

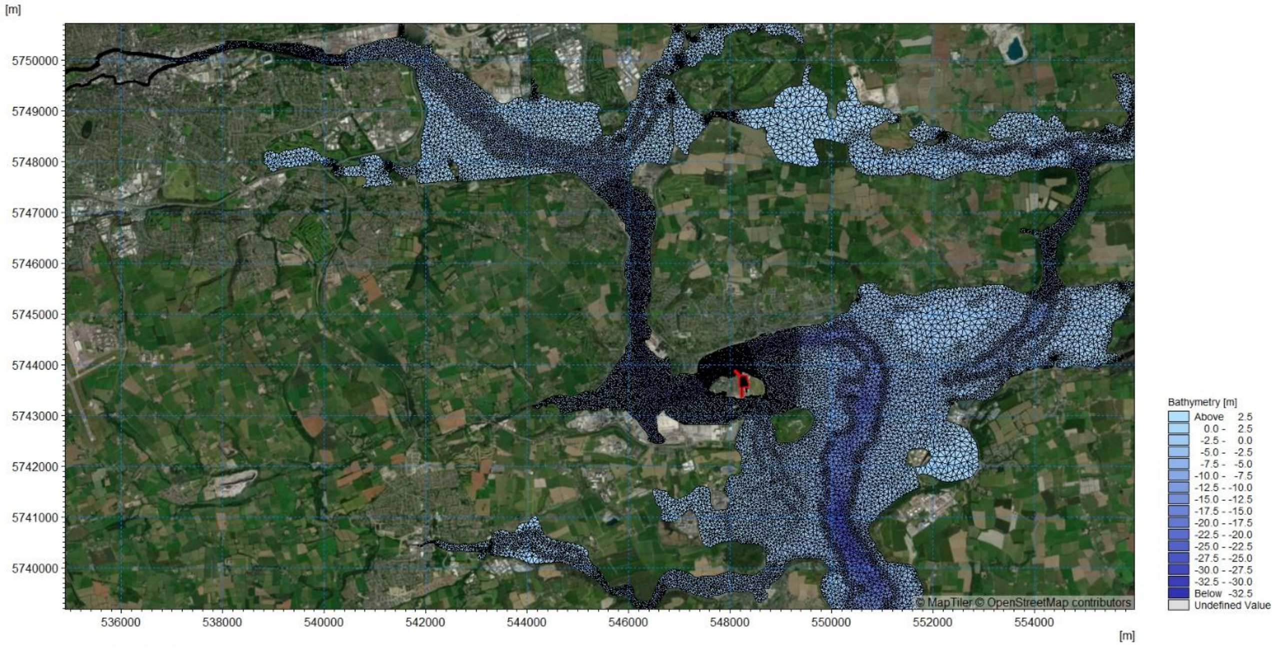

Figure 3.3: Mesh resolution and structure of the inner Cork Harbour model

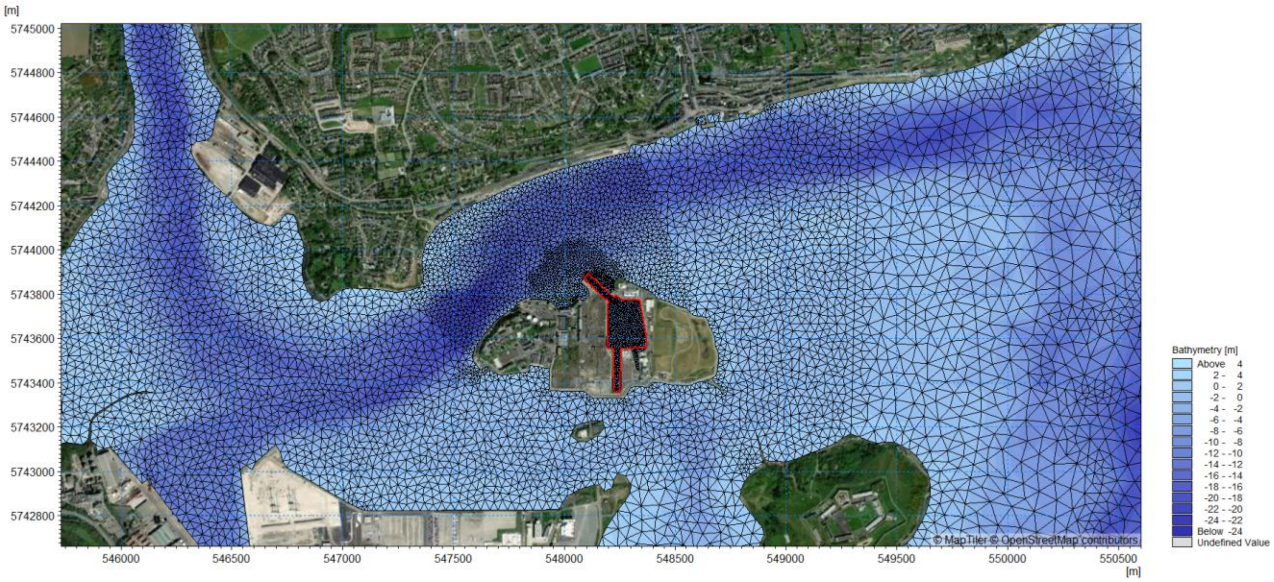

Figure 3.4: Mesh resolution and structure of the model in the Haulbowline Harbour area

3.4 Boundary Conditions

The tidal boundary data used for the Cork Harbour models was generated using RPS' Irish Sea Tidal and Storm Surge model. This model stretches from the North-western end of France, including the English Channel as far as Dover, out into the Atlantic to 16° west, including the Porcupine Bank and Rockall. In the other direction it stretches from the Northern part of the Bay of Biscay to just south of the Faeroes Bank. Overall, the model covers the Northern Atlantic Ocean and UK continental shelf up to 600km from the Irish Coast as illustrated in Figure 3.5.

This model was also constructed using flexible mesh technology; along the Atlantic boundary the model features a mesh size of 13.125' (24km). The Irish Atlantic coast has been described using cells of on average 3km size while in the Irish Sea the maximum cell size is limited to 3.5 km decreasing to 200m along the Irish coastline. The bathymetry of this model was generated from several different sources including digital chart data and surveys of several banks and coastal areas. This model is driven by astronomic tides generated using a global tidal model designed by a team at the Danish National Survey and Cadastre Department (KMS) and include pressure wave fields based on forecast data from the ECMWF.

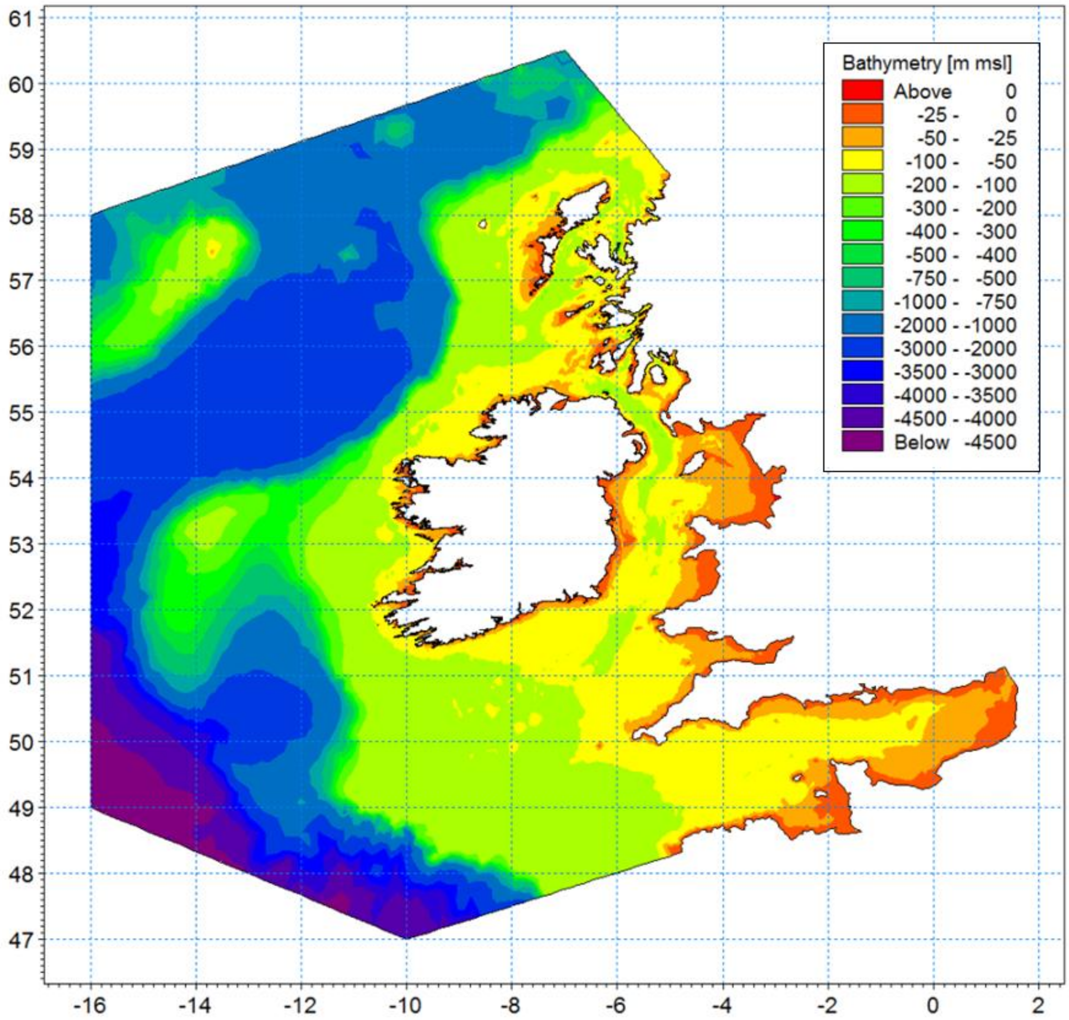

Figure 3.5: Extent and bathymetry of RPS' Irish Sea Tidal and Storm Surge model

4 SEDIMENT DISPERSION MODELLING

4.1 Summary of works

The proposed dredging works are comprised of two distinct activities in respect to the generation of sediment plumes, these are:

- The dredging activities. During this phase of the works, sediment will be released into the water column due to the turbulent interaction of the dredger and the material comprising the seabed.

- The dumping of dredged material at the licensed disposal site. During this phase of the works, a fraction of the sediment will become suspended in the water column as the bulk load of dredge material is released from the dredge hopper.

As the dredging and dumping activities occur inside and outside of Cork Harbour, it was necessary to complete an individual simulation for each activity. More information on the model setups and results from the numerical modelling is presented in the following Sections of this report.

4.2 Sediment plumes generated from the dredging activity

4.2.1 Characterisation of dredging activity

The total volume of material to be dredged equated to 47,630m^3. Production rates (i.e., rate of dredging) and percentage spill was set at an upper bound to cover the range of dredging techniques which could be utilised to undertake these works, i.e. cutter suction, backhoe, grab bucket etc. The assessment described in this report therefore applied a maximum design scenario aka Rochdale Envelope approach.

The adoption of the Rochdale Envelope approach facilitates a meaningful assessment to take place by defining a 'realistic worst case' scenario that decision makers can consider in determining the acceptability, or otherwise, of the environmental impacts of a project. As long as a project's technical and engineering parameters fall within the limits of the envelope and the relevant assessment has considered the impacts of that envelope, then flexibility within those parameters is deemed to be permissible within the terms of any consent granted, i.e., if consent is granted on the assessed maximum parameters of a development, any parameters equal to or less than those assessed is permitted to be constructed. The principle of Rochdale permits the developer or applicant to provide broad or alternative project engineering and construction parameters, of which one or a selection of the scenarios or parameters will ultimately be constructed.

Importantly, this gives flexibility to the contractor and mitigation measures to be developed and applied should likely significant impacts be identified. Such mitigation may include the prescribed use of specific dredging techniques like the use of environmental lidded buckets (which have lower spill percentages and dredging rates are slower) or tidal restrictions to limit plume excursion.

Taking a “worst case scenario” approach, RPS assumed that the dredging operations would be undertaken twice a day (i.e. two dredge cycles) and using a TSHD. A typical dredging cycle which has been used for this modelling study is presented in Table 4.1 below.

The path used to define the location and movement of the dredging source term in the numerical model is presented in Figure 4.1. A TSHD with a hopper capacity of 1,000m^3 was assumed due to the spatial constraints and the difficulties associated with navigating larger vessels through the entrance of Haulbowline Harbour. It was assumed that production rates would equate to 200m^3/hr which is typically proportional to a vessel of this size. Each dredge cycle was assumed to be 8 hours and two dredge cycles could be completed in one day. It should be noted that 32,000m^3 will be dumped at the licenced site with the remaining 15,630m^3 of dredged material which is contaminated being taken ashore for treatment (subject to a finalised methodology).

Table 4.1: Typical dredging cycle commensurate with historical operations

Cycle Phase	Duration [min]
Loading time	300
Sailing to Dump	85
Dumping	10
Sailing from Dump	85
Total	**480**

Figure 4.1: The path used to define the location and movement of the dredging source term

The composition of material to be dredged was determined via a series of sediment samples. The results of these samples indicated that approximately 96.6% of material to be dredged was comprised of silt. RPS characterised this silt fraction in the numerical modelling using a distinct coarse silt and medium silt fraction (50:50). Key parameters including the mean grain diameter and fall velocities associated with these fractions are summarised in Table 4.2 below.

The percentage of fines lost at the dredger head was assumed to be 3%, this equated to a loss of *c.*2.83kg/s during active dredging times (i.e. 5 hours of every 8hr dredging cycle). This loss was introduced as a source term that traversed the dredger path illustrated in Figure 4.1.

The remaining 3.4% of material which comprised of sand material was not included in the modelling simulations. This is because sand fractions have a much higher fall velocity and would therefore quickly re-settle onto the seabed before being removed by the dredger.

It should be noted that since the initial version of this technical report was published in May 2024, it is understood that the client has commenced the tendering process with prospective contractors on a preliminary basis. Whilst the exact dredging methodology is therefore still to be determined, initial feedback indicates that production rates are unlikely to exceed *c.* 110m^3/hr. Given that the dredging assessment presented in this report is based on a production rate of 200m^3/hr, it can be concluded that the outputs presented in this report represent a maximum design “worst case” scenario.

Table 4.2: Specification of silt material used in the dredging simulations

Representative material	Fraction	Class	Mean Diameter [mm]	Fall Velocity [m/s]	Proportion of source [%]
Silt	1	Coarse Silt	0.0625	0.007	50
	2	Medium Silt	0.0310	0.005	50

4.2.2 Typical Plume Simulations

The total suspended sediment concentrations (SSCs) during typical dredging operations are presented in Figure 4.2 to Figure 4.8. A summary description of these plots has been presented in Table 4.3 below.

Table 4.3: Summary description of the sediment plumes

Figure	Tidal Phase
Figure 4.2	Low water in main harbour basin
Figure 4.3	Mid-flood in main harbour basin
Figure 4.4	Mid-flood in harbour entrance
Figure 4.5	High water in main harbour basin
Figure 4.6	Mid-ebb in harbour entrance
Figure 4.7	Mid-ebb in main harbour basin
Figure 4.8	Mid-ebb in inner harbour

Based on the output of the modelling results it was found that:

- As would be expected, the extent and concentration of resultant dredge plumes is highly dependant on the location of dredge operations.
    - Dredging at the harbour entrance or near the entrance resulted in larger plume extents with lower SSCs due to the greater dispersion caused by the stronger flood or ebb tides which are experienced within the main channel outside of the harbour (Figure 4.4 and Figure 4.6).
- Most of the plume extents outside the main harbour basin were greatest during the ebb tide, as this removed suspended sediment through the harbour entrance during dredging in the main basin (Figure 4.7).
- Dredging during high water, low water and the flood tide caused less dispersion outside the harbour (Figure 4.2 and Figure 4.5). This was because suspended sediment was not flowing out of the harbour entrance. Instead, suspended sediment flowed into the harbour basin during the flood tide (Figure 4.3). With regards to low and high water, lower current velocities meant suspended sediments also remained in the harbour.
- The plumes associated with dredging operations within the harbour were generally confined within the harbour given the very sheltered nature of this area. However, owing to the limited dispersion, SSCs inside the harbour tended to be much more concentrated with typical values of >500mg/L.
- Sediment plumes did not *generally* extend for more than *c*.1,000m along an east – west axis during periods of flood or ebb tidal flows. The SSC of these plumes were generally less than 50mg/L due to dispersion. Importantly, these plumes were only observed during dredging operations at or near the harbour entrance. Most plumes were carried by the ebb tide around the eastern coast of Haulbowline Island.

Sediment deposition in the Haulbowline Harbour upon completion of the dredging operations is illustrated in Figure 4.9. As demonstrated by this figure, deposition levels within Haulbowline Harbour were generally <0.60m. It should be noted that most of this sediment would actually be removed given that dredging operations continue until the target depth is achieved. Outside the harbour, deposition levels were <0.01m due to the greater dispersion achieved outside the harbour.

Figure 4.2: Sediment plume envelope created at Low Water from dredging operations in Haulbowline Harbour

Figure 4.3: Sediment plume envelope created at Mid Flood from dredging operations in Haulbowline Harbour

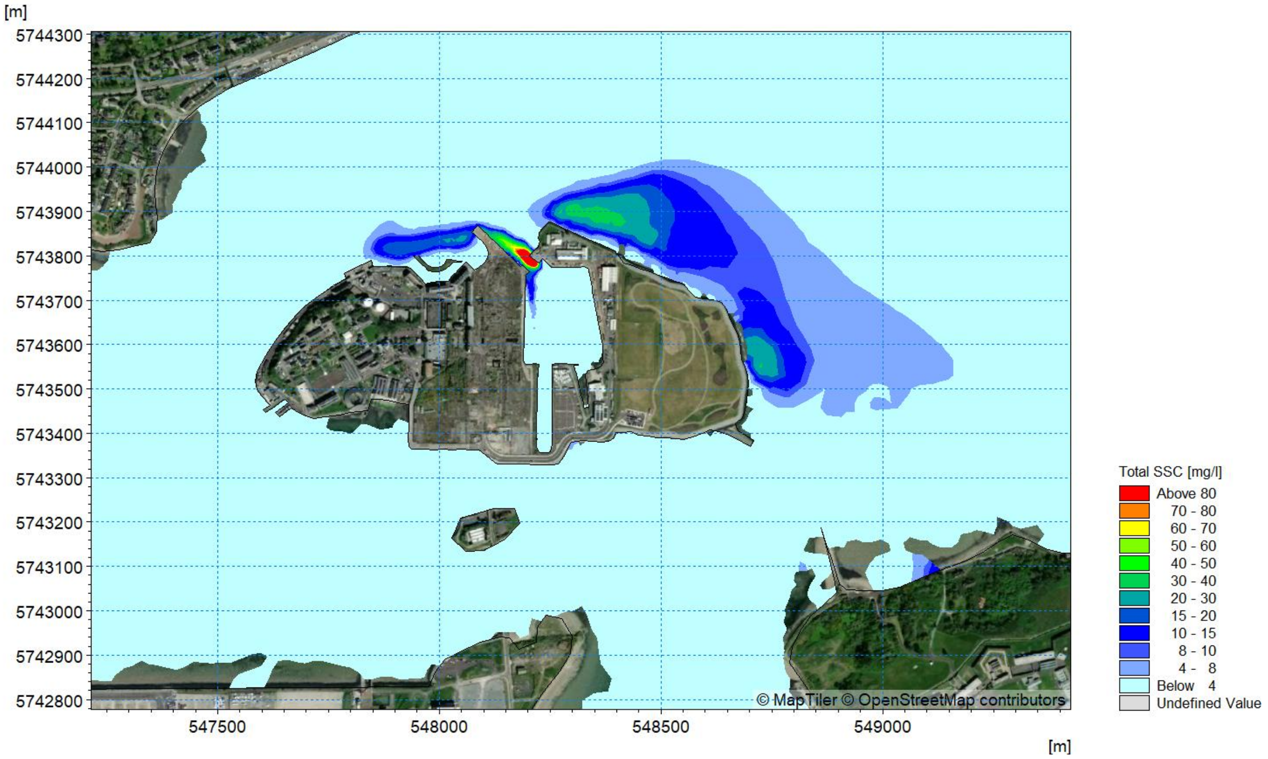

Figure 4.4: Sediment plume envelope created at Mid Flood from dredging operations in Haulbowline Harbour at the entrance. Note: this plot also shows the residual plume from the previous dredging cycle when the plume dispersed eastwards

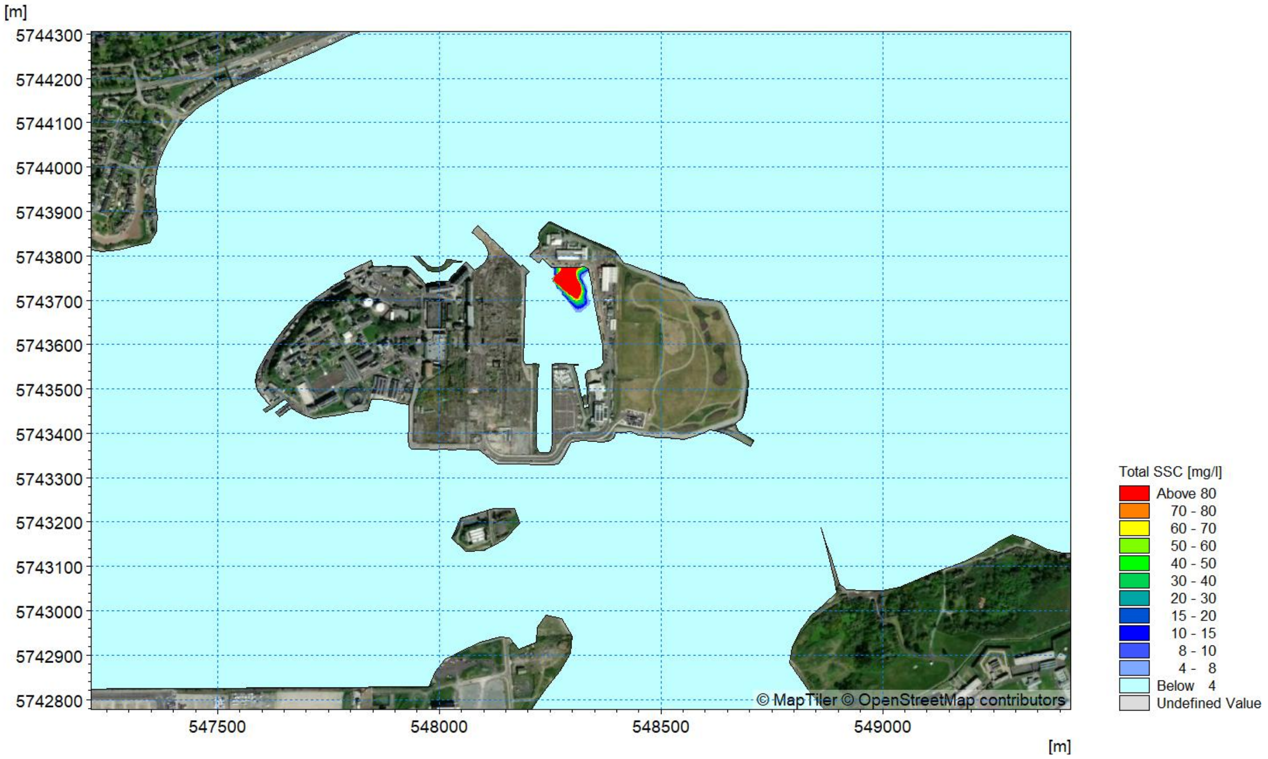

Figure 4.5: Sediment plume envelope created at High Water from dredging operations in Haulbowline Harbour

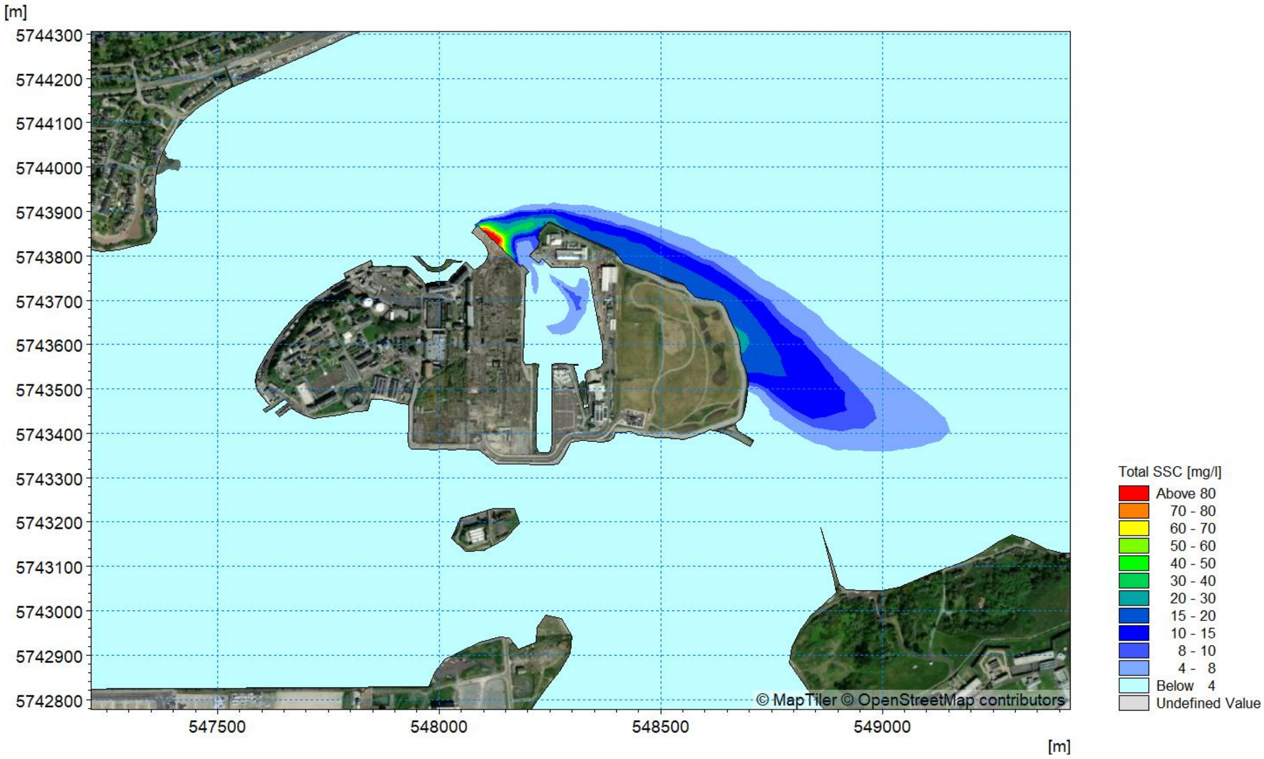

Figure 4.6: Sediment plume envelope created at Mid Ebb from dredging operations in Haulbowline Harbour at the entrance

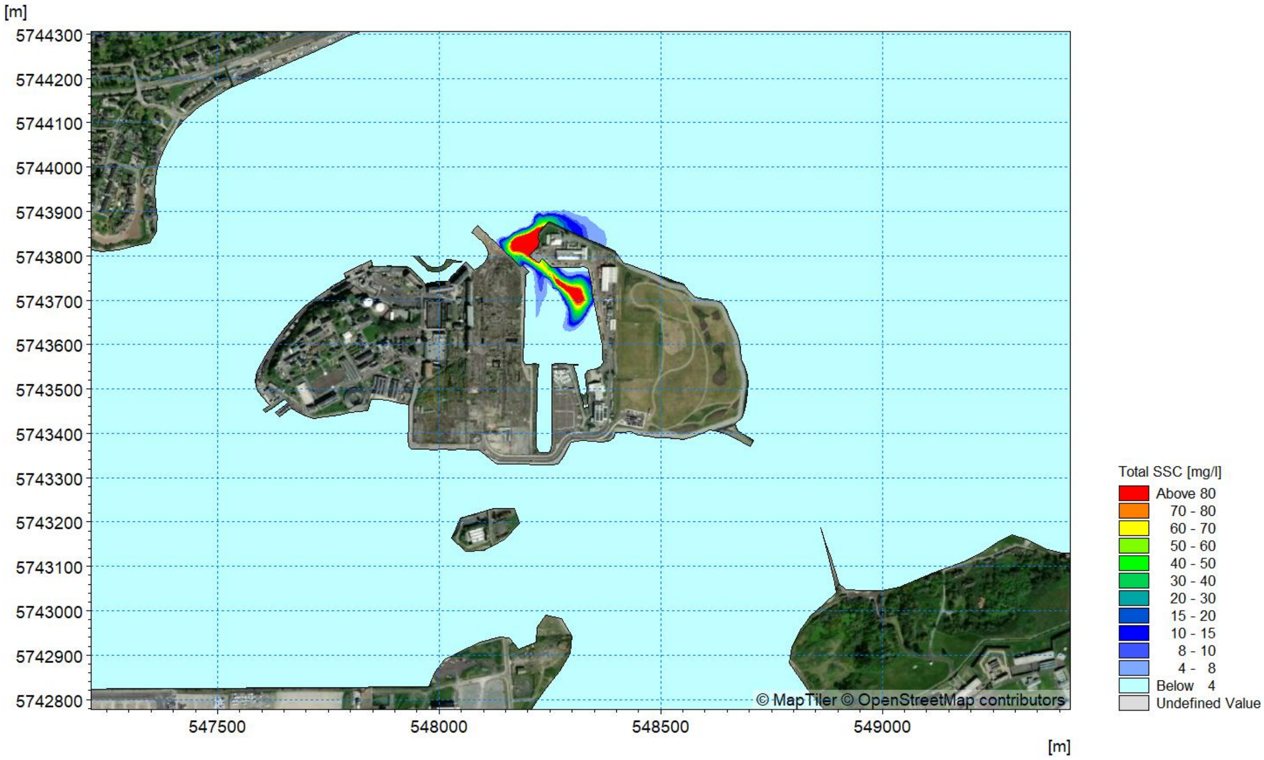

Figure 4.7: Sediment plume envelope created at Mid Ebb from dredging operations in Haulbowline Harbour at the main basin

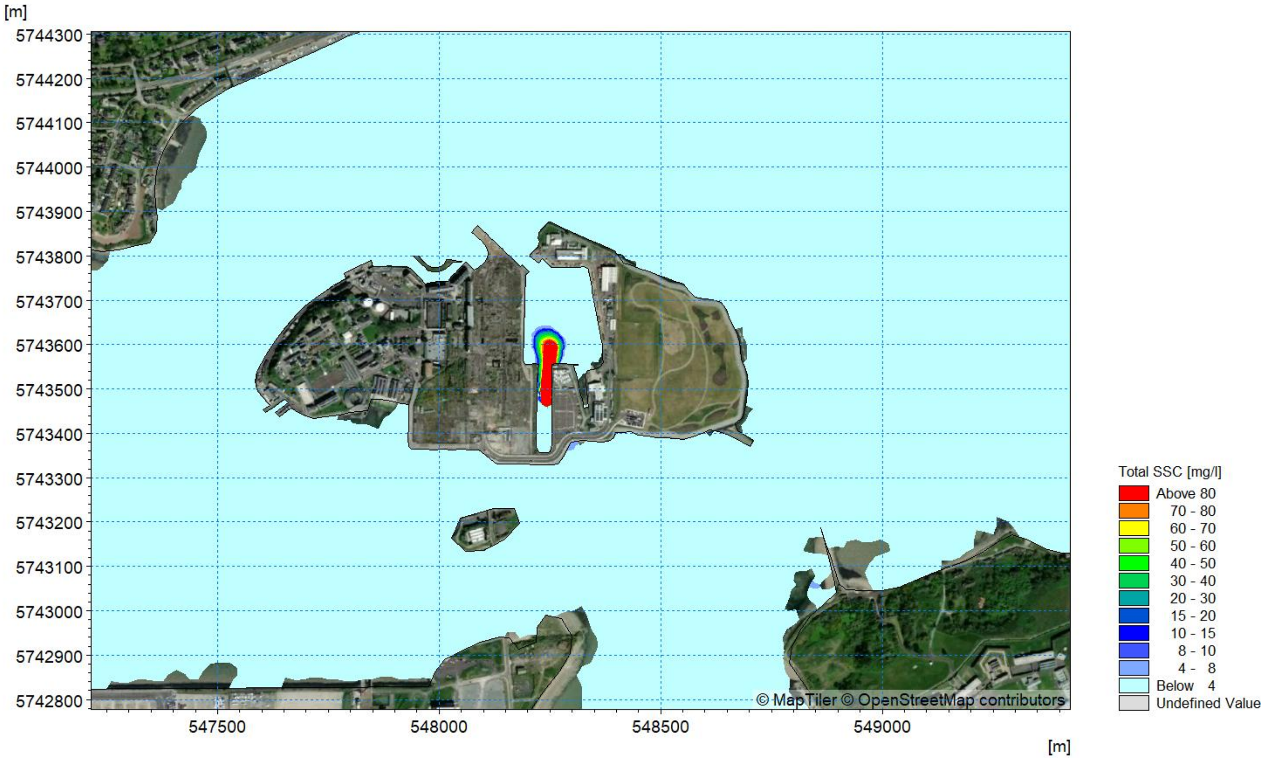

Figure 4.8: Sediment plume envelope created at Mid Ebb from dredging operations in Haulbowline Harbour at the inner dock

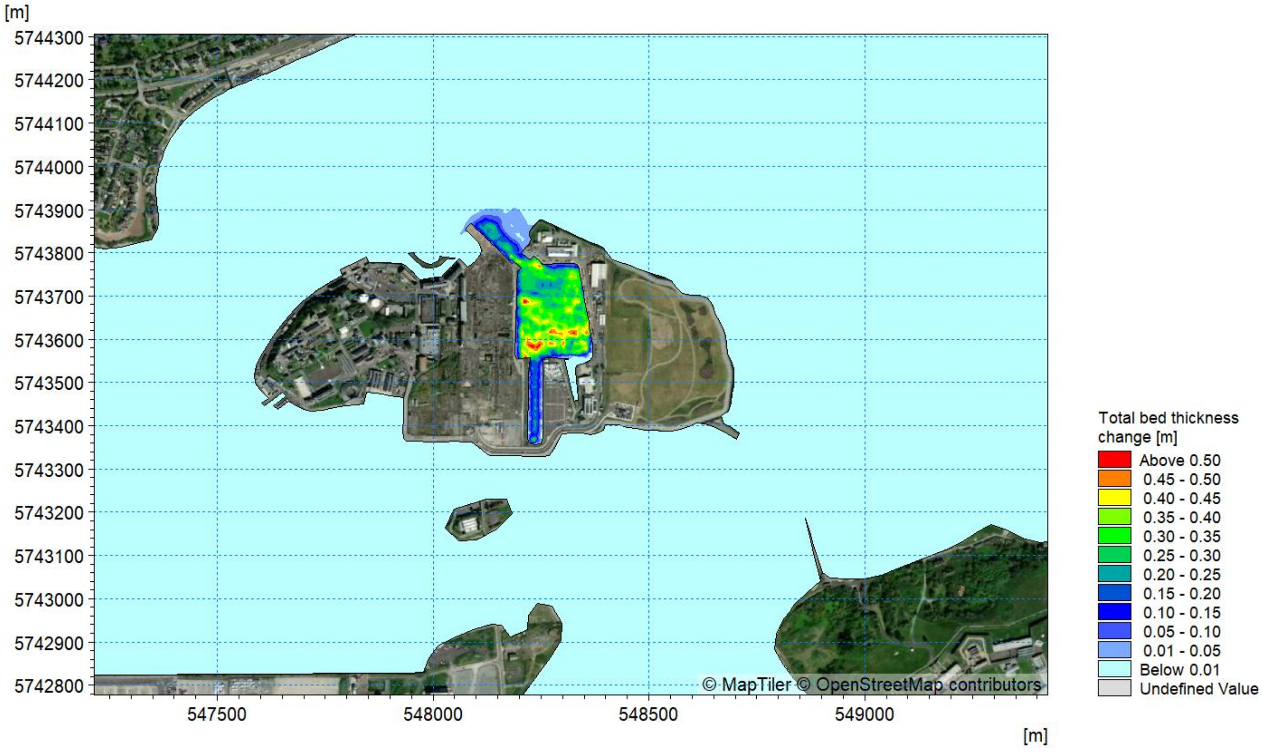

Figure 4.9: Total bed thickness change within Haulbowline Harbour following the proposed dredging operations

4.2.3 Average and Maximum Sediment Plumes

Having presented predicted instantaneous total suspended sediment plume envelopes for the dredging activities at Haulbowline Harbour during specific phases of the tide, this Section of the report presents the statistical mean and maximum total suspended sediment plumes for the dredging works.

Figure 4.10 which illustrates the statistical mean total suspended sediment plume envelope demonstrates that the average total SSC throughout Cork harbour does not generally exceed 0.5mg/L during the course of the dredging operations. This is true for most of the area except within Haulbowline Harbour whereby the constrained nature of the tidal currents limits tidal flushing and results in a marginally higher average total SSC of up to 20mg/L. Lower concentrations of less than 2mg/L can be seen to the east side of Haulbowline Island whereby sediment is dispersed from the dredging area during the ebb tide.

The maximum total SSC plume envelope observed from the dredging simulations is presented in Figure 4.11 overleaf. This Figure should be assessed with caution as it represents the maximum suspended sediment concentration experienced in each mesh element over the course of the simulation. These values may not have occurred simultaneously nor have persisted for any significant period. It will be seen from this figure that beyond Haulbowline Harbour the maximum total SSCs do not generally exceed 80mg/L. Within the active dredge areas, the maximum SSC can on occasions exceed 3,000mg/L. It should be noted that these maximum total SSCs almost always related to times when the dredger was active and therefore represented the sediment source before any mixing or dispersion had occurred.

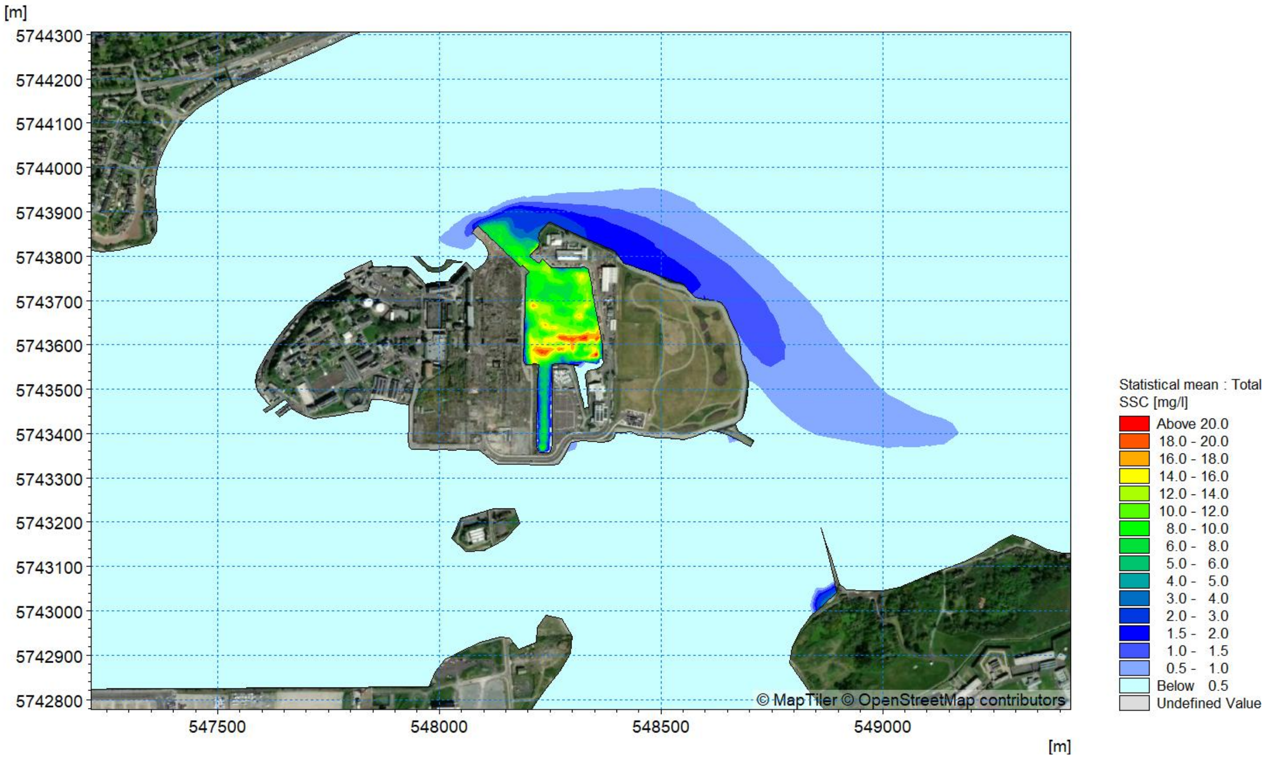

Figure 4.10: Average total suspended sediment concentration within Haulbowline Harbour during the course of the proposed dredging operations

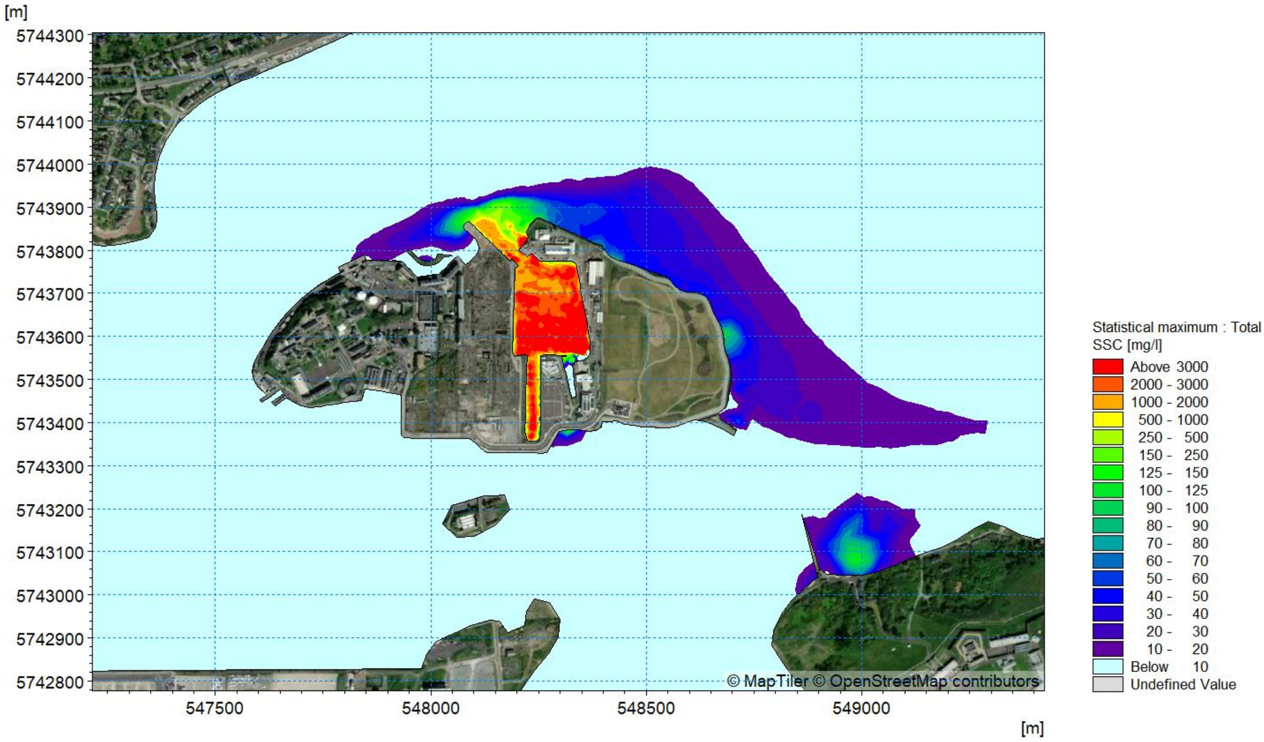

Figure 4.11: Maximum total suspended sediment concentration within Haulbowline Harbour during the course of the proposed dredging operations

4.3 Sediment plumes generated from the dumping activity

4.3.1 Characterisation of dumping activity

In addition to assessing sediment plumes generated from the dredging operation within Haulbowline Harbour, RPS also assessed the dispersion and settlement of material released from dumping dredged material at the licensed disposal site approximately 8km south of Roches Point.

Dumping activities would last for approximately 10min in every 8-hour dredging cycle. Given that the proposed dredger has a hopper capacity of 1,000m^3, a suitable spill rate was determined for the model. As described in Section 2.1 of this report, analysis of sediment samples taken throughout Cork Harbour demonstrated that the material to be dredged comprised mostly of silt material. These sediment fractions were therefore defined in the numerical model as per the specifications presented in Table 4.4 below. This dumped material was introduced as a source term that traversed the disposal site illustrated in Figure 4.12.

Table 4.4: Specification of the silt material used in the dredging simulations

Representative material	Fraction	Class	Mean Diameter [mm]	Fall Velocity[m/s]	Proportion [%]
Silt	1	Coarse Silt	0.0625	0.007	50
	2	Medium Silt	0.0310	0.005	50

The findings presented in the following Section of this report represent approximately 32,000m^3 of sediment material being dumped at the licensed disposal site over the course of the dredging operations.

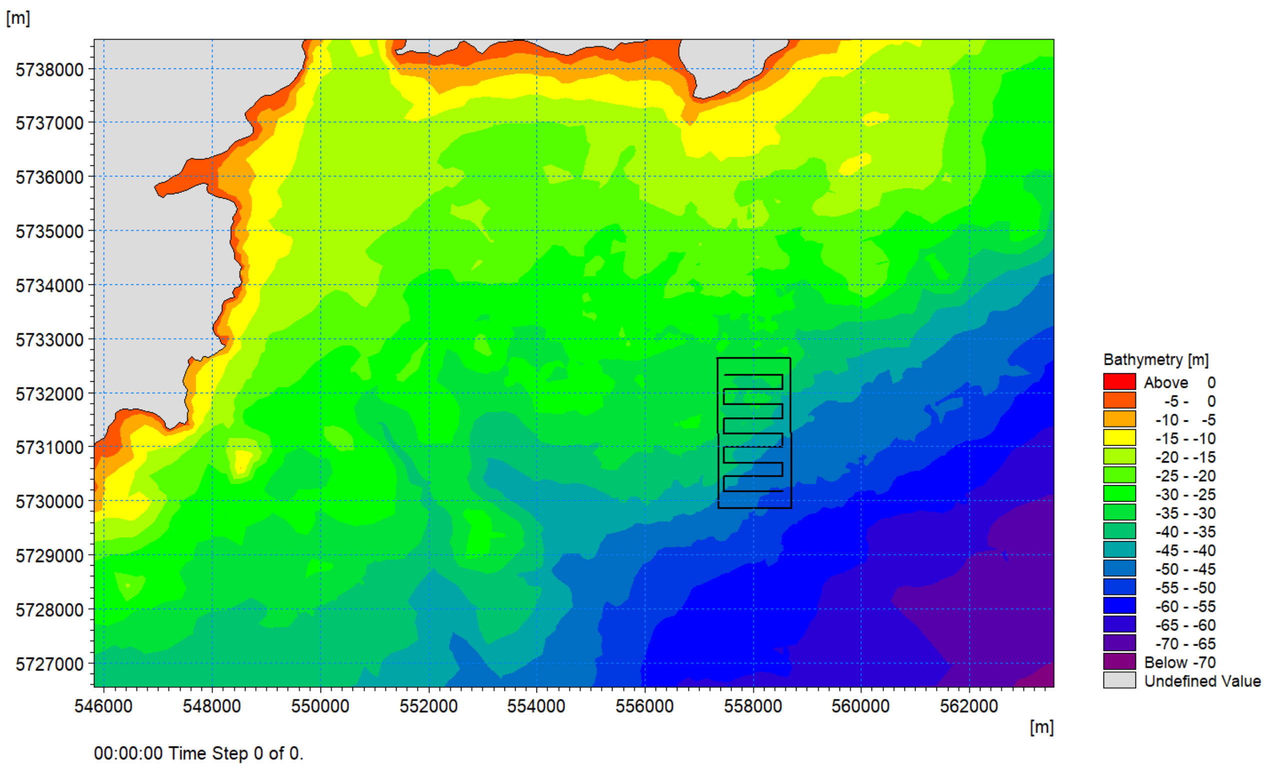

Figure 4.12: The path used to define the location and movement of the dumping source term

4.3.2 Sediment plume envelopes and deposition levels

The average total suspended sediment concentration across the disposal site as a result of the dredging operation is presented in Figure 4.13. As demonstrated by this Figure, the highest total SSCs are observed within the confines of the licensed disposal site. The average total SSC beyond the immediate vicinity of the licensed disposal site does not generally exceed 10mg/L and is dispersed to less than 0.5mg/L approximately 2km from the disposal site boundary.

It will be seen from Figure 4.14 overleaf that at the end of the dumping operations that there is very little change in bed level across the dumpsite, with bed thickness changes not exceeding *c.*0.06m. This is unsurprising given that this site is almost completely dispersive for fine material with slow fall velocities such as the silt material being dredged from Haulbowline. Instead, the majority of silt material disposed of at this site disperses to the point it becomes indistinguishable from background levels.

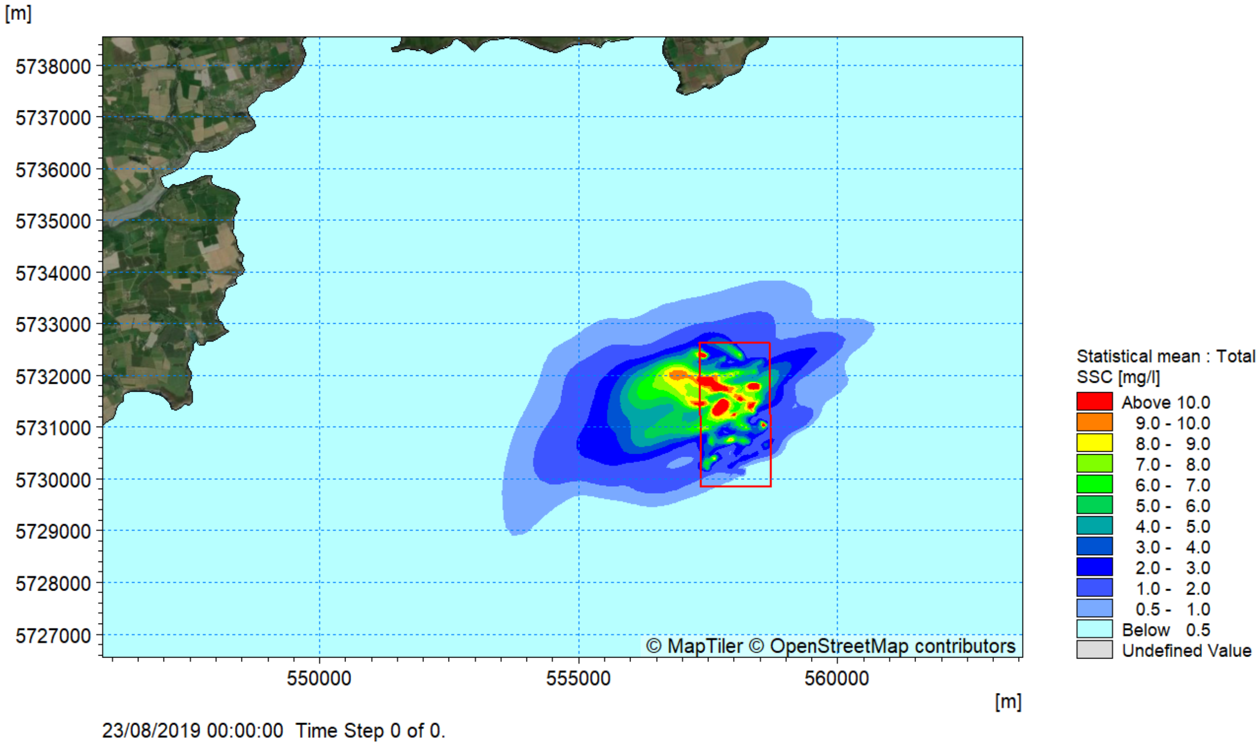

Figure 4.13: Average total suspended sediment concentration at the licensed disposal site during the course of the dredging operations

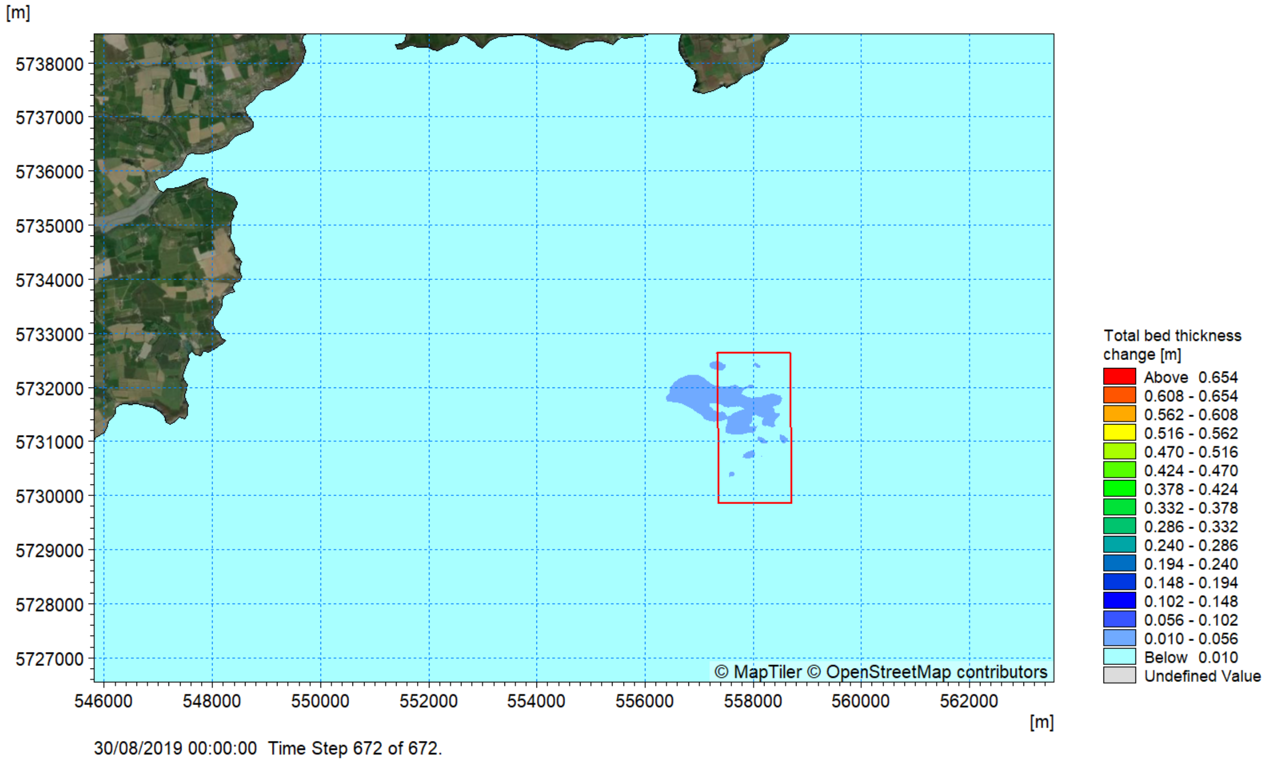

Figure 4.14: Total bed thickness change at the licensed disposal site following the dredging operations

5 CONCLUSION

A modelling study was undertaken to evaluate both the dredging and disposal phases of the proposed maintenance dredging operations within Haulbowline Harbour; this included extensive tide and sediment dispersion modelling. The computational modelling was undertaken using RPS' in house suite of MIKE coastal process modelling software by the Danish Hydraulic Institute (DHI).

An assessment of the operations including the dredging of 47,630m^3 and the disposal of 32,000m^3 of material (discounting the 15,630m^3 of material for treatment) which was based on a maximum design "worst case" scenario basis found that the average total SSC within the vicinity immediately beyond Haulbowline Harbour throughout the Port of Cork does not change. Within the actual harbour, the constrained nature of the tidal currents limits tidal flushing to result in a higher average total SSC of up to 20mg/L. Lower concentrations of less than 2mg/L are predicted to the east side of Haulbowline Island which can be dispersed during ebb tides.

The maximum total SSC plume envelope observed during the dredging simulations did not generally exceed 80mg/L outside of Haulbowline Harbour. The higher maximum total SSCs observed inside the harbour were almost always related to times when the dredger was active and therefore represented the sediment source before any mixing or dispersion had occurred.

Numerical model results demonstrated that the deposition of sediment as a result of the dredging works would likely be less than 0.01m and 0.6m outside and inside of Haulbowline Harbour respectively. Most of the sediment accumulation in Haulbowline Harbour would be removed by the passing dredger once it had settled.

An assessment of the dumping phase of the dredging operations found that the average total suspended sediment concentration beyond the immediate vicinity of the licensed disposal site did not generally exceed 10mg/L. The average suspended sediment concentration quickly dispersed to less than 0.5mg/L approximately 2km to the west from the disposal site boundary, and within c.0.5km to the east.

There is very little change in bed level across the dumpsite, with bed thickness changes not exceeding *c.*0.06m. This is unsurprising given the majority of silt material disposed of at this site disperses to the point it becomes indistinguishable from background levels.

It should be noted that early engagement with potential contractors indicates that the production rates associated with the actual dredge plan are likely to be significantly lower than those assessed in this report (i.e., 110m3/hr as opposed to 200m3/hr). As such, the dispersion and settlement associated with actual dredging operations are expected to less than described in this report which has considered a worst case scenario.

– Model Calibration

A.1 Calibration using measured data

The model was verified by comparison with tidal heights across the domain and published Admiralty tidal stream data. The two most relevant gauge locations are Cobh and Ringaskiddy, the locations of which are indicated in Figure 5.1. In addition, some limited hydrographic data was available at four locations near Paddy's Point. The model showed good agreement with the current speed during mid tide which was recorded to be 0.6m/s.

Figure 5.1: Calibration locations for data presented

The inner Cork Harbour model was used to simulate the full range of tidal excursion and was therefore calibrated over this range.

Figure 5.2 and Figure 5.3 show the comparison between the predicted astronomic tide from the tide gauge at Cobh with the model data for the spring and neap tides respectively. Figure 5.4 and Figure 5.5 shows the same data for Ringaskiddy. Both locations indicate that the model simulates the tidal flows well.

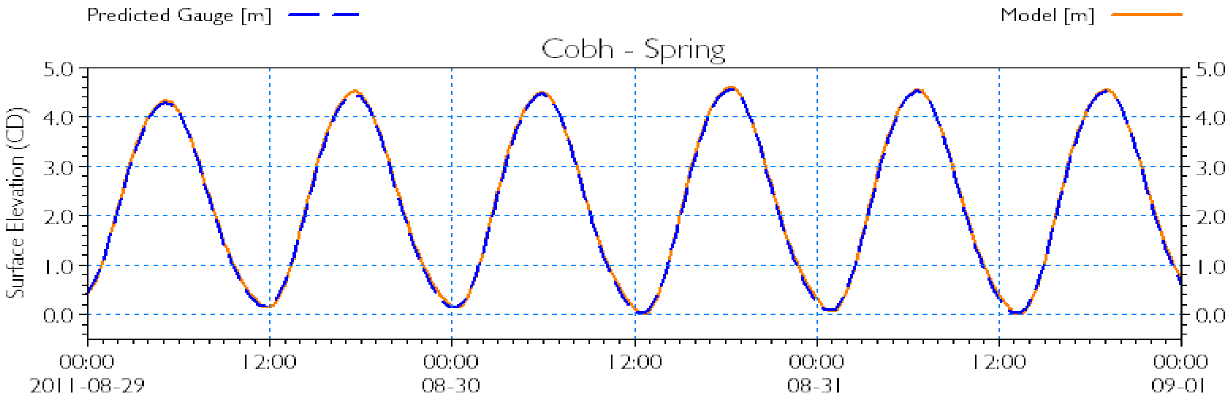

Figure 5.2: Tidal Elevation from Gauge and Model Data - Cobh Spring tide

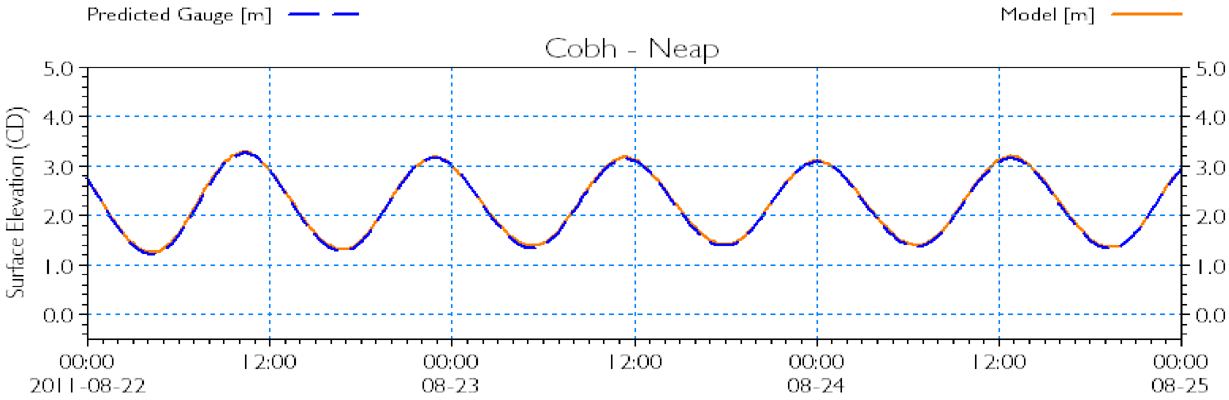

Figure 5.3: Tidal Elevation from Gauge and Model Data - Cobh Neap tide

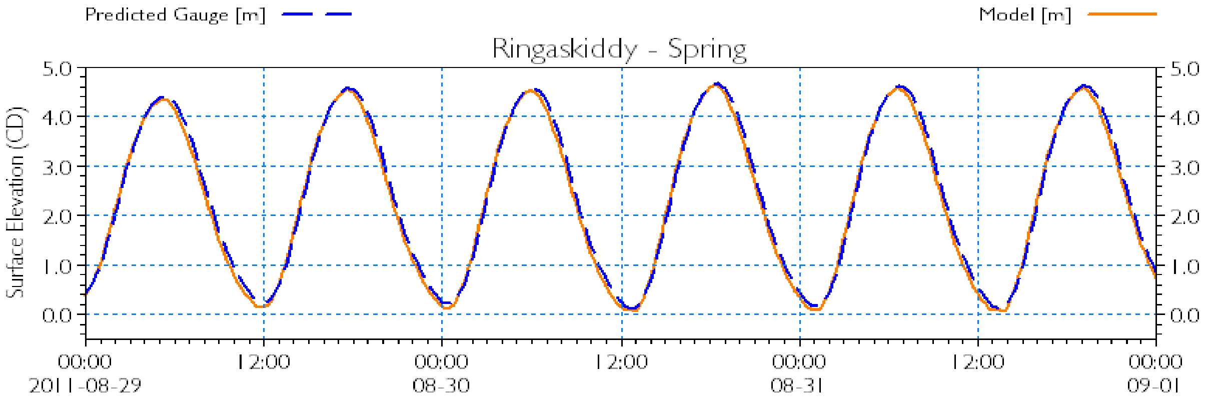

Figure 5.4: Tidal Elevation from Gauge and Model Data - Ringaskiddy Spring tide

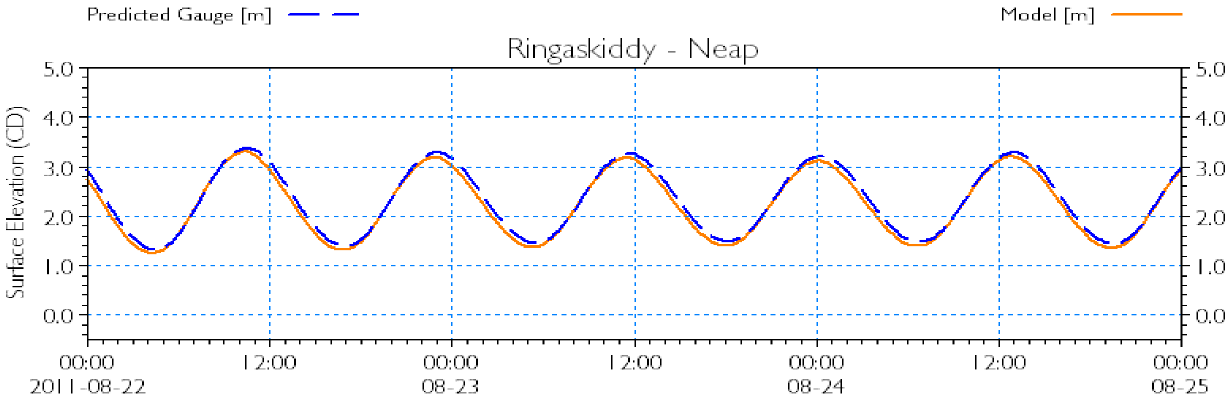

Figure 5.5: Tidal Elevation from Gauge and Model Data - Ringaskiddy Neap tide

A.2 Calibration using Admiralty Tide data

In addition to calibrating the inner Cork Harbour model using recorded gauge data, RPS also verified the model using tidal harmonics and published high and low water times/levels taken from the Admiralty Tide Tables.

The locations at which the model was calibrated are shown on Figure 5.6, with the comparison between the model and verification data shown in Figure 5.7 to Figure 5.11.

It can be seen from these figures that that the model is well calibrated in terms of water level across the dredged extent and is therefore considered fit for purpose.

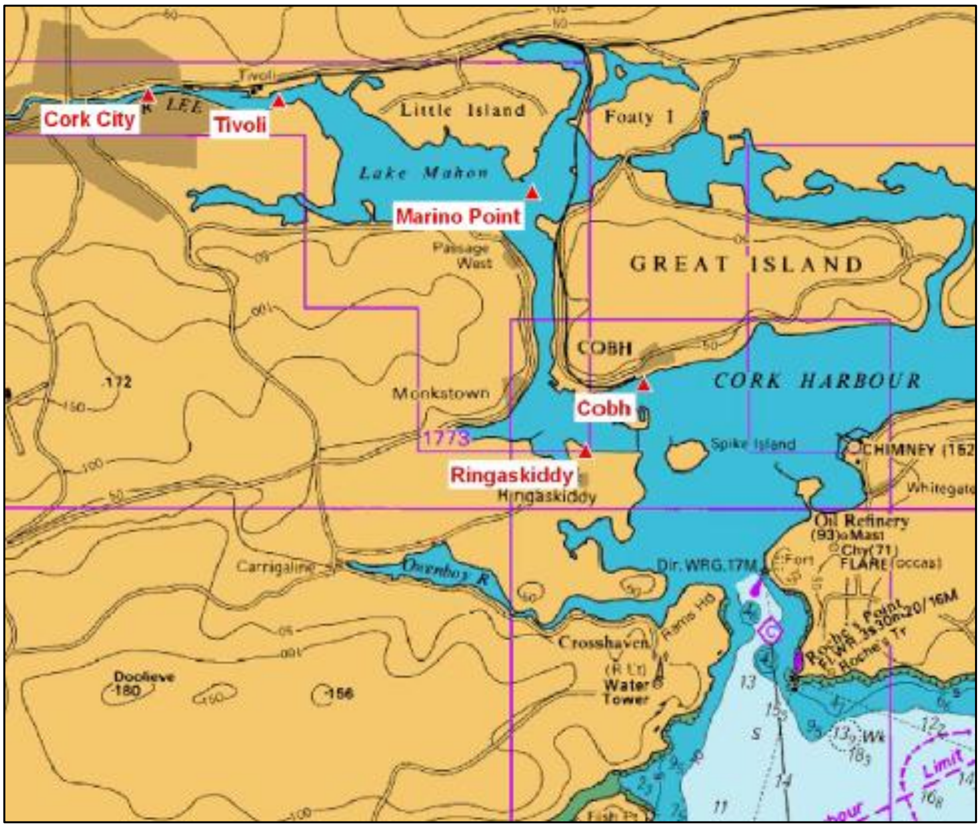

Figure 5.6: Calibration locations for data presented

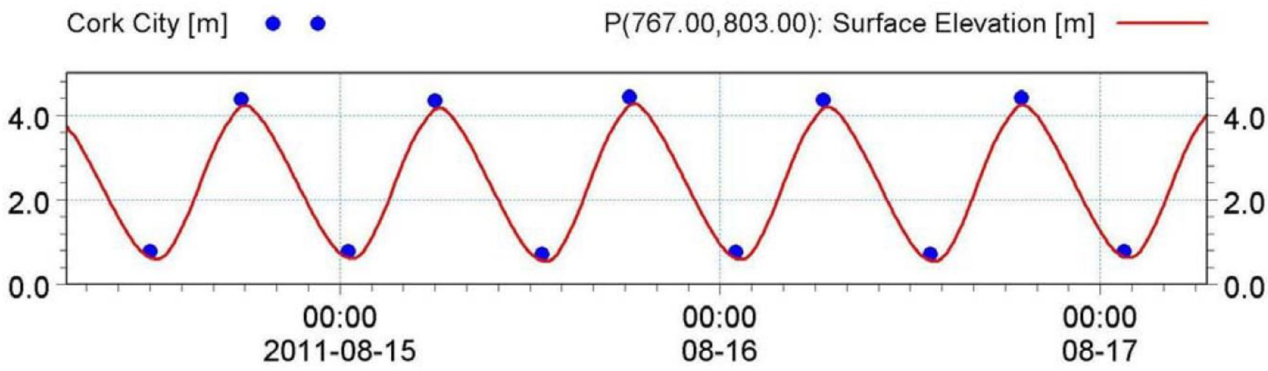

Figure 5.7: Simulated and predicted tidal elevation Cork City

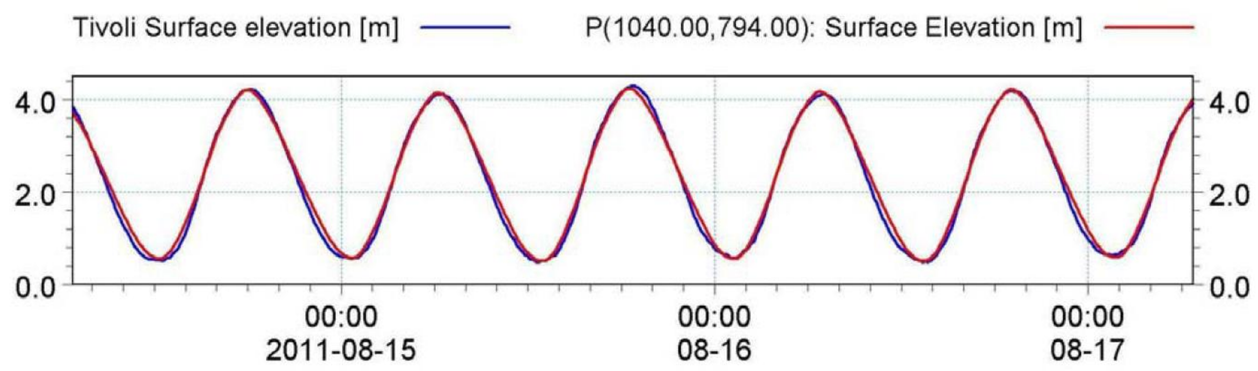

Figure 5.8: Simulated and measured tidal elevation Tivoli

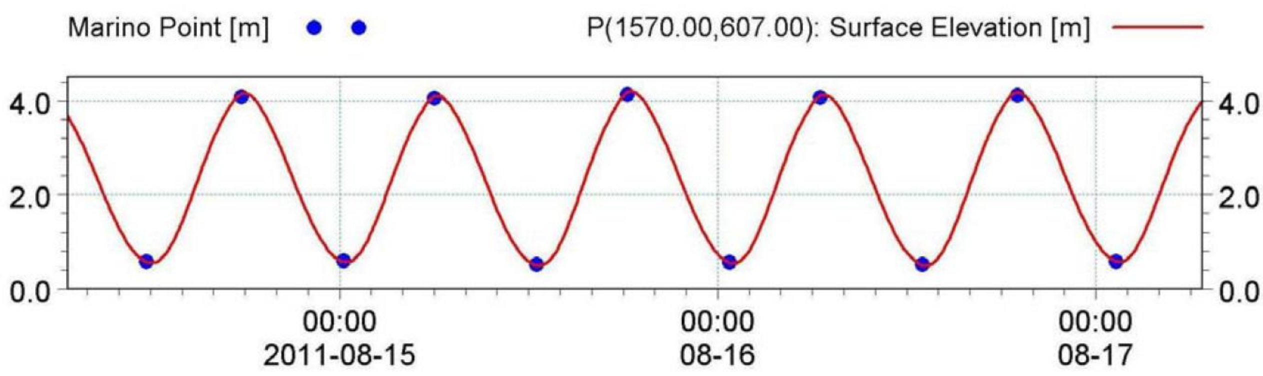

Figure 5.9: Simulated and predicted tidal elevation Marino Point

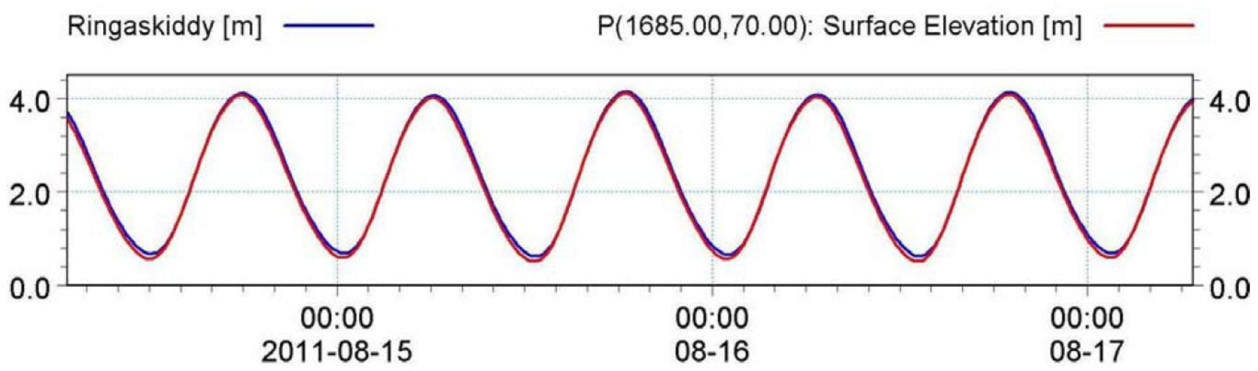

Figure 5.10: Simulated and predicted tidal elevation Ringaskiddy

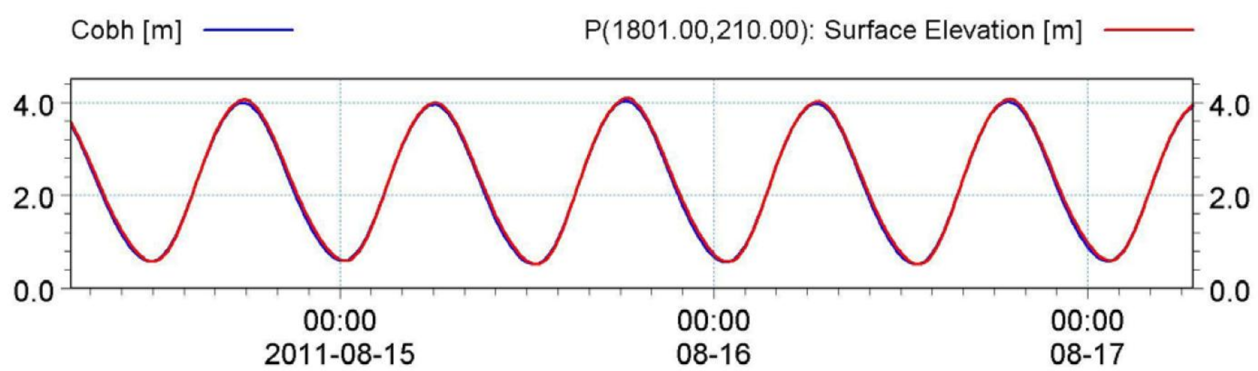

Figure 5.11: Simulated and measured tidal elevation Cobh