ABERDEEN HARBOUR
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CHAPTER 7: MARINE WATER AND SEDIMENT QUALITY

7. MARINE WATER AND SEDIMENT QUALITY

7.1 Introduction

This chapter describes the impacts on marine and coastal water and sediment quality from the construction and operation activities of the proposed Aberdeen Harbour Expansion Project (hereafter referred to as “the development”). It also assesses the significance of the effects on marine and coastal water and sediment quality receptors and proposes mitigation measures that can be applied to reduce effects to acceptable levels.

During the construction phase, dredging works in the harbour basin and access channel, disposal of the dredged sediment and the relocation of existing outfalls within the area have been identified as having the potential for causing an impact on sediment and water quality. Certain elements during the operational phase of the project such as the physical presence of the harbour, maintenance dredging and vessel and harbour operations can also result in impacts on water and sediment quality. Accidental events have also been considered. Chapter 3: Description of the Development provides a detailed description of these elements.

This chapter is supported by and should be read in conjunction with:

- Chapter 6: Marine Physical Environment;
- Chapter 12: Benthic Ecology and ES Appendices:
    - 6-A: Oceanographic Works;
    - 6-B: Hydrodynamic Modelling and Coastal Processes Assessment;
    - 7-A: Water Quality Monitoring Data;
    - 7-B: Water Quality Modelling Assessment;
    - 7-C: Water Framework Directive Assessment;
    - 7-D: Sediment Plume Modelling; and
    - 12-B: Subtidal Benthic Ecological Characterisation Survey.

Water and sediment quality aspects in this chapter will include physico-chemical characteristics of the water and sediments of Nigg Bay; as well as surrounding areas that may be indirectly impacted by the project as shown by the results of the numerical modelling. Designated features such as water bodies under the Scotland River Basin Management Plan and Bathing Waters have also been considered in the assessment.

This chapter does not assess changes to physical processes within the study area (e.g. hydrodynamics and sediment transport) or benthic ecosystems. For further information regarding the potential effects of the project on these receptors, please refer to Chapter 6: Marine Physical Environment and Chapter 12: Benthic Ecology.

7.2 Legislation and Guidance

This section outlines the policy, legislation and guidance that are relevant to water and sediment quality. Policy, legislation and guidance applicable to the wider project can be found in Chapter 4: Planning and Legislation.

7.2.1 International Legislation

International and European policy and legislation used to inform the water and sediment quality assessment include:

- Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy (the Water Framework Directive);
- Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC (Bathing Water Directive);
- Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive); and
- The International Convention for the Prevention of Marine Pollution by Ships 73/78 (MARPOL).

7.2.1.1 Water Framework Directive

The Water Framework Directive (WFD) was introduced to establish a framework for action in the field of water policy. It specifies environmental objectives for surface waters and groundwater, requiring that they reach at least 'good ecological status' (or potential) by 2015. The WFD also requires Member States to put in place systems for managing their water environments based on natural river basin districts. A River Basin Management Plan (RBMP) is to be developed for each district. The overarching objectives of the RBMPs are to:

- Prevent the deterioration and enhance the condition of aquatic ecosystems;
- Promote a sustainable water use;
- Reduce pollution; and
- Contribute to the mitigation of floods and droughts.

The WFD also encompasses a number of revoked water quality Directives, such as the Dangerous Substances Directive (2006/11/EC) and the Shellfish Waters Directive (2006/113/EC).

7.2.1.2 Bathing Water Directive

The Bathing Water Directive 76/160/EEC set a range of parameters by which compliance of bathing waters was to be measured. The Directive contains provisions aimed at preserving, protecting and improving the quality of the environment and protecting human health. The revised Bathing Water Directive (BWD) 2006/7/EC came into force in 2006 to take account of the lessons learned with the implementation of the previous Directive, coupled with developments in science and knowledge.

A bathing water, according to the BWD, is one where a large number of people are expected to bathe and a permanent bathing prohibition or permanent advice against bathing has not been issued. The BWD requires Member States to identify all bathing waters and monitor them during the specified season, and sets the microbial standards for bathing water quality. Under a new classification system, from 2015, bathing waters will be classified as 'Excellent', 'Good', 'Sufficient' or 'Poor' for each bathing season.

7.2.1.3 Marine Strategy Framework Directive

The Marine Strategy Framework Directive (MSFD) requires Member States to put in place measures to achieve or maintain 'good environmental status' in their waters by 2020. Among the 11 descriptors that the MSFD provides for determining good environmental status, several are related to water and sediment quality including:

- Descriptor 5: Eutrophication is minimised;
- Descriptor 8: Concentrations of contaminants give no effects; and
- Descriptor 9: Contaminants in seafood are below safe levels.

Member States must produce national Marine Strategies to manage their seas in order to achieve this objective. The MSFD is transposed into UK law by the Marine Strategy Regulations 2010.

7.2.1.4 MARPOL Convention

The International Convention for the Prevention of Pollution from Ships (MARPOL), to which the UK is a signatory, seeks to prevent and minimise marine pollution from ships arising from operational and accidental events.

7.2.2 National Legislation

7.2.2.1 Water Environment and Water Services (Scotland) Act 2003 and Supporting Legislation

The WFD is transposed into Scottish law by the Water Environment and Water Services (Scotland) Act (WEWS) 2003. The Act is supplemented by the Water Environment (River Basin Management Planning: Further Provision) (Scotland) Regulations 2013 and the Cross-Border River Basin Districts (Scotland) Directions 2014.

In 2014, the Scottish Government issued new Directions to incorporate an updated package of standards for the water environment in Scotland. The Scotland River Basin District (Standards) Directions 2014 provide an updated and expanded set of environmental standards for water bodies. The Scotland River Basin District (Status) Directions 2014 incorporate the changes needed to take account of these updated standards.

7.2.2.2 Bathing Waters (Scotland) Regulations 2008 (as amended)

The revised BWD has been transposed into Scottish legislation through the Bathing Waters (Scotland) Regulations 2008 and The Bathing Waters (Sampling and Analysis) (Scotland) Directions 2008. The Bathing Waters (Scotland) Amendment Regulations 2012 amended the 2008 Regulations to clarify points in respect of the requirements of the Scottish Environment Protection Agency (SEPA) and Local Authorities in carrying out monitoring and public information duties at designated bathing waters.

SEPA is the competent authority for bathing waters monitoring in Scotland. Scotland has 84 designated bathing waters, with the bathing season ranging between early June and mid-September.

7.2.2.3 Marine (Scotland) Act 2010

The Marine (Scotland) Act 2010 applies to the Scottish inshore region (between 0 nautical miles and 12 nautical miles) and provides the framework for a marine planning system that balances the need for resources with the need to protect the marine environment. Scotland's National Marine Plan sets out the objectives and national priorities, and regional marine plans provide further context.

The Marine (Scotland) Act 2010 introduced a new licensing system for many developments and activities in the marine environment. Licensable activities include the deposit of any substance or object in the sea or on or under the seabed, the construction of works on or over the sea or on or under the seabed, and dredging operations. Under the Act, Environmental Impact Assessment (EIA) of the licensable activities may be required.

7.2.3 Regional and Local Policy

The project is located within the Scotland River Basin district, where the competent authority is SEPA. The Scotland RBMP divides the surface waters in the river basin to over 3,000 water bodies which are classified according to their environmental status. The initial Scotland RBMP was produced in 2009 and is currently in the process of being updated, and consultation on its development closed in April 2015. The new RBMP is anticipated to be published in December 2015.

The Scotland RBMP sets out the quality objectives for all water bodies in the Scotland river basin district and the measures to achieve them. The overall objective is for 98% of water bodies to be in 'Good' or better condition in 2027.

7.2.4 Guidance Documents

SEPA has produced a number of guidance documents and Pollution Prevention Guidelines (PPG) (in collaboration with the Environment Agency and the Northern Ireland Environment Agency) in the field of water quality which are relevant to the project:

- Supporting Guidance WAT-SG-53 on Environmental Quality Standards and Standards for Discharges to Surface Waters;
- PPG3: Use and design of oil separators in surface water drainage systems;
- PPG5: Works and maintenance in or near water;
- PPG6: Working at construction or demolition sites;
- PPG7: The safe operation of refuelling facilities;
- PPG8: Safe storage and disposal of used oils;
- PPG21: Pollution incident response planning; and
- PPG22: Dealing with spills.

7.2.5 Sediment Quality Guidance

There is no specific legislation concerning marine sediment quality. There are however, non-statutory guidelines and assessment criteria applicable to marine sediments, and the following have been used in this assessment:

- The revised Marine Scotland Action Levels (ALs) for the disposal of dredged sediment; and
- The Canadian Interim Sediment Quality Guidelines (ISQG).

7.3 Consultation

As part of the EIA process, Aberdeen Harbour Board (AHB) has undertaken extensive consultation. The outcomes of this process with regards to water and sediment quality, and an explanation of how these have been addressed, are summarised in Table 7.1. The only consultation comments that were specific to this chapter were from SEPA.

Table 7.1: Summary of consultation

Consultee	Date	Summary of Consultation	Where addressed in ES
SEPA	29 August 2013	The ES should identify if the impacts of the proposal are likely to lead to deterioration of the water environment or present opportunities for improving it.	A discussion on the changes to water quality as a result of the development is included in Section 7.5.
		The datasheets for the Don Estuary to Souter Head (WB ID 200105) and Dee (Aberdeen) Estuary (WB ID 200103) water bodies should be included in the baseline characterisation of the ES.	These data sheets have been used in Section 7.4.2.3 of the baseline environment description.
		The footprint areas for the proposed dredging and new structures in the marine environment should be included in the site layout description in the ES.	This information has been included in Chapter 3: Description of the Development
		The ES will need to demonstrate that the changes to the hydrodynamics in Nigg Bay will not impact upon the dispersion characteristics of the existing discharges within the bay.	A discussion on the changes to the dispersion of contaminants in Nigg Bay as a result of the development is included in Section 7.5.5.1.
		The EC designated bathing water at Aberdeen is situated nearby. Information on the substrate type within the area to be dredged, dredging techniques and mitigation measures to minimise impacts upon the marine environment (e.g. suspended sediment plumes and release of contaminants) should be provided in the ES.	Information on the substrate type from the areas to be dredged is provided in Section 7.4.3.2. Information on the area to be dredged and dredging techniques is presented in Chapter 3: Description of the Development. Mitigation measures are described in Section 7.6.
		During the construction phase there is the potential for the pollution of transitional and coastal waters from silt, oil spills and chemicals. Information should be provided in the ES on measures to reduce these risks.	Information on risk reducing measures is provided in Section 7.6.

7.4 Methodology

7.4.1 Study Area

The study area comprises the footprint of the project, including Nigg Bay and the proposed dredged areas. Adjacent areas to Nigg Bay containing designated water bodies and/or bathing waters that may be indirectly impacted (as evaluated in the hydrodynamic and water quality modelling studies) have also been included in the assessment.

7.4.2 Data Sources

This section describes the data sources used to inform the assessment of effects of the development on water and sediment quality. Data were collated through desk based studies, site specific survey work and technical studies commissioned to inform this ES.

Fugro EMU requested all relevant datasets from the regulators and statutory consultees to support the hydrodynamic modelling, water quality modelling and Water Framework Directive Assessment studies during the baseline scoping exercise in February 2015 and during further consultation in March 2015. No datasets were available at the time of writing, therefore water quality modelling was based on samples from East Tullos Burn and Ness Tip Burn taken between November 2014 and March 2015, and samples from the United Fish Industries (UFI) outfall taken during April 2013.

7.4.2.1 Desk Based Studies

Data sources consulted have included:

- Scotland's National Marine Plan and supporting documents and tools: the Scotland's Marine Atlas and the National Marine Plan Interactive tool (NMPi). These provide an assessment of the condition of the Scottish marine area, including water and sediment quality parameters and designated water bodies under the Scotland RBMP;
- SEPA website and tools: including the RBMP interactive map and designated water bodies data sheets. These provide detailed profiles of designated water bodies, classification results and visualization tools;
- Scotland's Environment web portal, which provides data on other aspects of the Scottish environment, water bodies classification, bathing waters and river basin planning;
- Water quality monitoring data from the UFI outfall discharge consents; and
- SEPA Public Register datasets on water quality parameters from the UFI outfall discharge into Nigg Bay.

7.4.2.2 Site Specific Surveys

A number of field surveys were undertaken to inform the EIA process for the project:

Meteorological and Oceanographic Monitoring

A 5 month monitoring programme (February 2015 to June 2015) of metocean conditions in Nigg Bay was undertaken to inform the ES, with a service visit half way through the deployment. The following data were collected as part of the monitoring programme: meteorological data, wave statistics, tidal levels, current velocity, suspended sediment concentration, sea temperature, salinity and dissolved oxygen. A full description, methodology and results from this monitoring programme can be found in ES Appendix 6-A: Oceanographic Works.

Subtidal Benthic Ecological Characterisation Survey

A subtidal benthic ecological survey was undertaken in March 2015 to characterise the benthic ecology within the predicted footprint of the development and adjacent areas. Sediment samples were collected from point sample stations in Nigg Bay and the surrounding area and analysed for sediment size and chemistry. A full description, methodology and results from the ecological survey can be found in ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey.

Surface Water Monitoring Survey

A 5 month monitoring programme of the two streams discharging into Nigg Bay (the East Tullos Burn and the Ness Tip (or South) Burn) was undertaken between November 2014 and March 2015. Water samples were taken on a monthly basis and analysed for metals, total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAH), pesticides, volatile organic compounds (VOC) and other miscellaneous water quality indicators such as nutrients or dissolved oxygen. Full results can be found in ES Appendix 7-A: Water Quality Monitoring Data.

7.4.2.3 Technical Studies

A number of technical studies were commissioned to inform the ES. These included:

Hydrodynamics and Sediment Transport Modelling

A hydrodynamic and sediment transport model was carried out to characterise the physical processes baseline of the study area and describe the impacts on these elements. The model predicted water levels, tidal currents, wave processes, wave induced littoral currents and sediment dynamics in the study area. A full description of the methodology and results from the hydrodynamic and sediment transport model can be found in ES Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment.

Water Quality Modelling

Based on the hydrodynamic model described above, a water quality model was carried out to assess the effects of the project on various water quality parameters. The modelling focused on evaluating potential changes to local discharges and their dispersive behaviour following construction of the project. The modelling was informed by a screening process which determined the substances and parameters most relevant for the analysis from a WFD perspective. The results of the surface water monitoring surveys described in Section 7.3.2.2 were used to determine the substance concentrations to be modelled. A full description, methodology and results can be found in ES Appendix 7-B: Water Quality Modelling Assessment and ES Appendix 7-C: Water Framework Directive Assessment.

Sediment Plume Modelling

Based on the hydrodynamic model described above, a sediment plume dispersion model was commissioned to assess the effects of the project on suspended sediment concentrations (SSC) as a result of dredging works. A full description, methodology and results can be found in Technical Appendix 7-D: Sediment Plume Modelling. Due to the dredging and disposal methods, and since the detailed construction methodology has not yet been developed (see Chapter 3: Description of the Development for further details of the 'Rochdale Envelope'), the plume modelling assessment adopted an extremely conservative approach when considering the effects. As a result, the effects represent the worst possible case. The effects from the dredging operations are likely to be less than presented in this assessment, including for the existing maintenance dredging activity, with the effects reduced by one to two orders magnitude depending on the dredging method and programme applied.

Water Framework Directive Assessment

A WFD assessment was commissioned to assess any potential effects on the current status of the RBMP water bodies affected by the project. This assessment was informed by the results of the water quality and sediment plume modelling studies described above and baseline WFD data. A full description, methodology and results can be found in Technical Appendix 7-C: Water Framework Directive Assessment.

7.4.2.4 Data Gaps

The following data gaps and/or limitations have been identified during the data gathering process.

A number of streams and outfalls (the East Tullos and Ness Tip Burns and the UFI outfall) discharge into Nigg Bay, as shown on Figure 7.1. During the scoping and consultation phases of the EIA, it was found that no long term data sets on the characteristics of these streams were available, apart from limited water quality datasets from the UFI outfall. A monitoring campaign was commissioned in order to gather data to inform the EIA and at the time of writing the duration of the monitoring campaign comprised of 4 months data for the East Tullos and Ness Tip Burns. For the UFI outfall, annual data between 2012 and 2014 were available but only for some water quality parameters, with only one complete dataset available, corresponding to an analysis carried out in April 2013.

Therefore, it has not been possible to obtain data on seasonal patterns or long-term average concentrations of pollutants in these discharge streams. The results of the short-term monitoring campaigns and gathered datasets, where available, have been used to inform the water quality modelling and assessment.

7.4.3 Assessment Methodology

7.4.3.1 Basis of Assessment

A number of the activities to be undertaken as part of the proposed development will result in an impact (change) to the environment baseline conditions, as defined in Chapter 5: Environmental Impact Assessment Process. As such, in this assessment, any changes to baseline water and sediment quality parameters (substance concentrations in the water column or sediment, contaminant or plume dispersion patterns, etc.) due to the project activities have been regarded as impacts.

In some cases impacts may have an environmental effect (consequence) on a receptor (a specific component of the baseline). For the purposes of this assessment, a receptor is any water or sediment body whose environmental or legal characteristics may be changed as a consequence of an impact. The following receptors have been identified and considered in the assessment of effects on water and sediment quality:

- Designated water bodies under the Scotland RBMP;
- Designated Bathing Waters under the BWD;
- Designated Shellfish Waters; and
- Sediment quality as classified by Marine Scotland Action Levels and/or Canadian Interim Sediment Quality Guidelines.

Seabed sediments with regards to their importance as benthic habitats have been considered as receptors in Chapter 12: Benthic Ecology.

This chapter describes the impact classification and effect assessment methodology, identifies impacts on water and sediment quality parameters arising from the project activities, and assesses the significance of any effects on water and sediment quality receptors where there is the potential for these to occur. Where there is an impact but no effect is anticipated to happen as a consequence, this chapter will describe and classify the impact but no effect assessment will be provided.

The criteria used to categorise impact magnitude, effect magnitude and receptor value are specific to each receptor. The relevant parameters used in the assessment of effects on water and sediment quality receptors are described in this section.

7.4.3.2 Magnitude of Impacts

The magnitude of the impacts on water and sediment quality has been determined based on a combination of the factors identified in Chapter 5: Environmental Impact Assessment Process. The final magnitude of the impact is categorised as negligible, minor, moderate, major or severe as shown in Table 7.2.

Table 7.2: Characterisation of the magnitude of the impact

Impact Category	Definition
Severe	Permanent major change to several or all parameters of the water and sediment physico-chemical characteristics.
Major	Major change to one or more parameters of the baseline water and sediment physico-chemical characteristics.
Moderate	Noticeable change to one or more parameters of the baseline water and sediment physico-chemical characteristics.
Low	Small or short term change from the baseline water and sediment physico-chemical characteristics.
Negligible	No detectable change to water and sediment physico-chemical characteristics or change is within natural variation.

7.4.3.3 Valuation of the Water and Sediment Quality Receptors

The valuation of the water and sediment quality receptors has been undertaken based on the parameters listed in Table 7.3

Table 7.3: Characterisation of the water and sediment quality receptor value

Value	Description/Criteria
Very High	A designated water body with an overall status of "High". A designated Bathing Water with a status of "Mandatory" (from 2012 to 2014) or "Excellent" (from 2015). An artificial or Heavily Modified Water Body (HMWB) with an overall status of "Maximum". Sediment is uncontaminated, contaminant levels are below Canadian ISQG Threshold Effect Levels (TEL).
High	A designated water body with an overall status of "Good". A designated Bathing Water with a status of "Mandatory" (from 2012 to 2014) or "Good" (from 2015). An artificial or Heavily Modified Water Body (HMWB) with an overall status of "Good". Sediment contaminant levels are below Marine Scotland Action Level 1.
Medium	A designated water body with an overall status of "Moderate". A designated Bathing Water with a status of "Guideline" (from 2012 to 2014) or "Sufficient" (from 2015). An artificial or Heavily Modified Water Body (HMWB) with an overall status of "Moderate". Sediment contaminant levels are between Marine Scotland Action Level 1 and the Canadian ISQG Probable Effect Levels (PEL).
Low	A designated water body with an overall status of "Poor". A designated Bathing Water with a status of "Fail" (from 2012 to 2014) or "Poor" (from 2015). An artificial or Heavily Modified Water Body (HMWB) with an overall status of "Poor". Sediment presents contaminant levels between the Canadian ISQG Probable Effect Levels (PEL) and Marine Scotland Action Level 2.
Negligible	A non-designated water body or a designated water body with an overall status of "Bad". An artificial or Heavily Modified Water Body (HMWB) with an overall status of "Bad". Sediment is contaminated, presents contaminant levels above Marine Scotland Action Level 2.

7.4.3.4 Magnitude of Effects

Where effects are anticipated to occur, their magnitude has been determined as per the criteria stated in Table 7.4.

Table 7.4: Characterisation of the magnitude of the effect

Effect Category	Definition
Severe	A major downgrading of a designated water body status or sediment quality classification as a result of a permanent inability to meet Environmental Quality Standards or major changes to other classification parameters.
Major	A significant downgrading of a designated water body status or sediment quality classification as a result of a long term inability to meet Environmental Quality Standards or changes to other classification parameters.
Moderate	A downgrading of a designated water body status or sediment quality classification as a result of a temporary inability to meet Environmental Quality Standards or short-term changes to other classification parameters.
Minor	One or more classification parameters change but this does not result in the modification of the status of a designated water body or sediment quality classification.
Negligible	Impact does not result in changes to any of the classification parameters that decide the status of a designated water body or sediment quality classification.

7.4.3.5 Assessment of the Significance of Effects

The significance of each predicted effect is defined by combining the magnitude of the effect and the value of the receptor, as described in Chapter 5: Environmental Impact Assessment Process. Effects are assessed this way as negligible, minor, moderate or major.

Minor significance relates to an effect which may be measurable, but from which receptors are expected to recover under natural processes. Mitigating measures to ameliorate the impact or facilitate return to the baseline condition may not therefore necessarily be required. Moderate or major effects will require mitigation recommendations. Effects will be reassessed as described above until either the effect significance is reduced to minor or negligible levels, or there are no further practicable means of mitigation that can be applied. The significance of residual effects (post application of mitigation) is then estimated.

The likelihood of the effect occurring has also been taken into consideration to provide a measure of the environmental risk. The probability of an effect occurring has been categorised as certain, near certain, probable, unlikely or extremely unlikely as indicated in Chapter 5: Environmental Impact Assessment Process, based on experience and industry knowledge.

7.4.4 Cumulative Impact Assessment Methodology

Cumulative effects on water and sediment quality have been assessed based on the methodology described in Chapter 5: Environmental Impact Assessment Process. Chapter 5 also presents a list of projects and activities considered for cumulative assessment.

7.5 Baseline Description

7.5.1 Introduction

This section presents a description of the baseline environmental conditions in the study area with regards to water and sediment quality, based on the data sources listed in Section 7.4.2.

7.5.2 Desk Based Characterisation

7.5.2.1 General Overview

The catchment area draining into the coastal waters of Aberdeen and Nigg Bay is large (3,440 km^2), extending from the Cairngorms and the north-east Grampians to the coastline of Aberdeenshire. The rivers Dee and Don are the main water courses in the area (SEPA, 2014a). Aberdeen is the main population centre in the catchment area, the rest being predominantly rural with a low population density. Agriculture and farming are the major land use in the catchment, with estate lands found in the upper areas and forestry and moorland also common within the River Dee catchment. Closer to the coastline, Aberdeen Harbour in the River Dee mouth hosts commercial and industrial activities (SEPA, 2014a).

There are several trade effluent discharges to Aberdeen Harbour and to the lower reaches of the rivers Don and Dee, as well as numerous surface water discharges. A major sewage works for Aberdeen city, the Persley Waste Water Treatment Works, discharges to the river Don approximately 4 km upstream of the estuary. The King’s Links Combined Sewer Overflow (CSO) also discharges to the Don estuary (SEPA, 2014a).

In addition to direct discharges there is diffuse pollution from agricultural and urban run-off occurring in both the River Dee and the River Don catchments. This can pose a risk to water quality in the coastal area, particularly during periods of wet weather (SEPA, 2014a).

AHB undertakes annual maintenance dredging of the harbour entrance, with the dredged material being disposed of at the licensed offshore disposal site CR110, located approximately 3.5 km offshore of Nigg Bay in water depths of 30 m (see Figure 3.7 in Chapter 3: Description of the Development). In order to inform the baseline environmental description, numerical modelling of the sediment plumes arising from these maintenance dredging operations was carried out. The results are described in Section 7.4.4.

7.5.2.2 Nigg Bay

Nigg Bay is a former channel of the River Dee which has been partially infilled with glacial tills and sediments associated with the last Ice Age. The bay is delimited by the headlands of Greg Ness to the south and Girdle Ness to the north. Water depths reach up to 8 m in the entrance and 20 m in the wider area (Aspect, 2014).

Tides in Nigg Bay are semi-diurnal, with mean spring tidal ranges of 3.5 m. Water circulation within the bay varies with the tide status: there is a weak anti-clockwise circulation during ebb tides caused by the tidal stream crossing the mouth of the bay following the coast northwards. During flood tides this flow reverses and the gyre within the bay changes to a clockwise one (as described in the EIA Appendix 1-C: Scoping Report 2013). Further information on the oceanographic regime and coastal processes in Nigg Bay can be found in Chapter 6: Marine Physical Environment.

Two small streams discharge into Nigg Bay: the East Tullos Burn and the Ness Tip Burn. The Ness Tip Burn consists of leachate from the neighbouring landfill which discharges at the southern end of the beach in Nigg Bay and is a potential source of pollution in the area. The East Tullos Burn runs through the East Tullos Industrial Estate located to the west of Nigg Bay and discharges in the central area of the bay (SEPA, 2015a). The East Tullos Burn is thought to be affected by diffuse source contamination (Wilson et al., 2005) and was the subject of an environmental improvement project in 2014 which addressed the poor water quality and litter issues in the burn (Aberdeen City Council, 2015). These burns were the subject of a water quality monitoring campaign in order to inform this EIA process, the results of which are described in 7.4.2.2. There is also a water intake for the Marine Scotland Marine Laboratory in the central area of Nigg Bay.

In addition to the aforementioned burns, there is an outfall from the nearby UFI plant that discharges to Nigg Bay. The UFI water intake is located in the river Dee mouth inside the existing Aberdeen Harbour, and the water is used in the UFI plant for cooling purposes. After use, the water is circulated to the outfall, a single pipe that runs under the beach before discharging approximately 1 m above Chart Datum (CD) in the central area of Nigg Bay.

The Nigg sewage treatment plant is located adjacent to Nigg Bay. Its effluents are discharged via an outfall that ends approximately 2 km offshore the headland of Greg Ness. There is also a CSO from this plant that discharges near Girdle Ness (SEPA, 2014a).

The location of these burns and point discharges are shown in Figure 7.1.

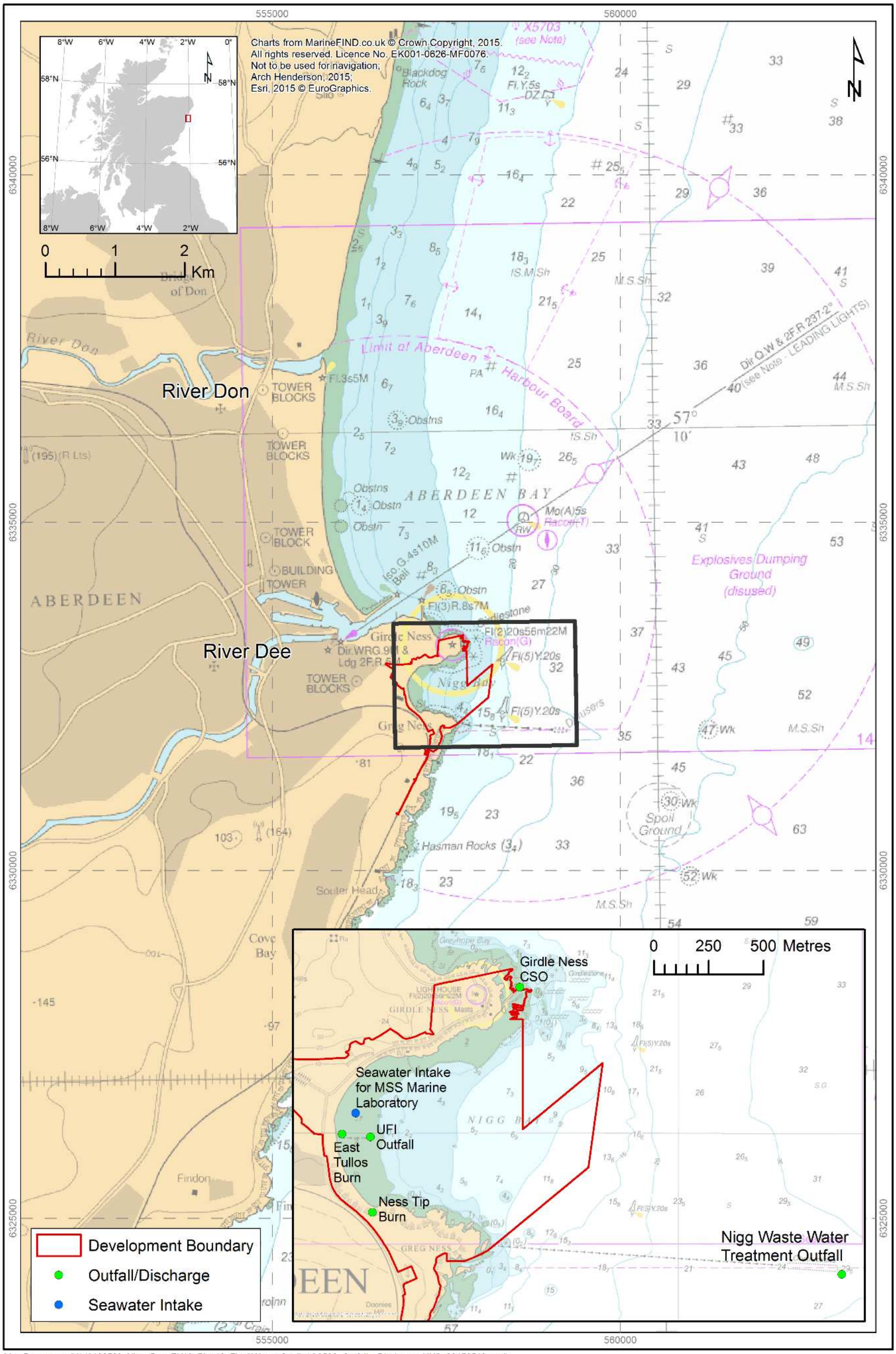

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Figure 7.1: Outfalls and discharge points within the project area

The UFI outfall has been sampled regularly on an annual basis since 2012 for a number of water quality parameters: ammoniacal nitrogen, biological oxygen demand (BOD) and suspended solids. In addition, in April 2013 a full chemical analysis was conducted on one sample from the outfall, testing for heavy metals, pesticides (organochlorine, organophosphorous and others), PAHs, VOCs and organotins. The full set of results can be found in ES Appendix 7-A: Water Quality Monitoring Data), and a summary of the results is provided in the following paragraphs.

Average annual BOD levels in the UFI outfall range between 86 mg/l and 104 mg/l; while average annual ammoniacal nitrogen concentrations range between 3 mg/l and 20.5 mg/l. Average annual suspended solid concentrations were between 71 mg/l and 137 mg/l.

Mercury levels in the 2013 sample were found to be high, due to high levels of mercury above the Maximum Allowed Concentration for mercury in seawater as per SEPA guidance WAT-SG-53 (see Section 7.1.4) measured in the waters of the Dee estuary where the intake is located, which was also sampled as part of the analysis. Phenol and a number of heavy metals (arsenic, chromium, nickel) were also detected. All pesticides, PAH, VOC and organotin concentrations were below the detection limit of the method used.

7.5.2.3 Designated Water Bodies

The WFD and its enacting legislation in Scotland aim to ensure the water environment is protected and where necessary and possible improved to a good ecological condition. The RBMP developed under this framework provide an assessment of the state of the water environment, a description of the pressures upon it and a set of environmental improvement targets.

The project falls under the Scotland RBMP, and is located within the 'Don Estuary to Souter Head' coastal water body, which extends from Souter Head to the Bridge of Don, as shown in Figure 7.2. Water bodies in the RBMP are classified according to their ecological and chemical status. The ecological status is assessed on its biological (water plants and animals), physico-chemical (oxygen, nutrient levels) and hydromorphological (water flows, condition of beds and shores) elements, and is determined by the lowest-classed element. The chemical status is assessed based on whether the Environmental Quality Standards for priority substances and other dangerous substances identified at EU level are being exceeded or not. The ecological and chemical statuses are then combined to provide an assessment of the overall water body status.

The 'Don Estuary to Souter Head' water body was classified as having 'Good' overall status from 2007 to 2012 (SEPA, 2015a). However, from 2013 onwards new standards have been introduced to reflect developments in scientific understanding that have taken place since 2009. Under these new standards, this water body was classified in 2013 as having 'poor' overall status, having obtained a 'poor' classification in the hydromorphological element of the assessment (SEPA, 2014b). The full classification is shown in Table 7.5.

Table 7.5: 'Don Estuary to Souter Head' water body 2013 classification

Parameter	Status	Confidence of Class
Overall status	Poor	Medium
Pre-HMWB status	Poor	Medium
Overall chemistry	Pass	Low
Priority Substances	Pass	Low
Overall ecology	Poor	Medium
Physico-Chemical	High	Low
Dissolved oxygen	High	Low
Dissolved inorganic nitrogen	High	Low
Biological elements	Good	Medium
Benthic invertebrates	Good	Medium
Imposex assessment	Good	Medium
Benthic invertebrates (IQI)	High	Medium
Alien species	High	Low
Macroalgae	High	Low
Macroalgae (FSL)	High	Low
Macroalgae (RSL)	High	Low
Combined phytoplankton	High	High
Specific pollutants	Pass	Low
Copper	Pass	Low
Zinc	Pass	Low
Unionised ammonia	Pass	Low
Hydromorphology	Poor	Medium
Morphology	Poor	Medium
Overall status	Poor	Medium
Water quality	Good	Medium
Oxygen levels	High	Low
Nutrient levels	High	High
Benthic invertebrates	Good	Medium
Toxic pollutants	Good	Medium
Physical conditions and barriers	Poor	Medium
Invasive non-native species	High	Low

This water body will be assessed again in 2015, 2021 and 2027, and the target is that sustainable improvements to its status are made over time, or alternatively that no deterioration in its status occurs. This water body is not considered at risk of not meeting the 2015 targets (SEPA, 2015b).

The 'Dee (Aberdeen) Estuary' water body comprises the final section of the River Dee and existing Aberdeen Harbour as shown in Figure 7.2. It is classified as a heavily modified water body (HMWB), i.e., a water body substantially changed in character, for which any changes to its hydromorphological characteristics necessary to achieve 'good' status would have a significant adverse consequence on its current uses. HMWBs are classified according to their ecological potential, representing the degree to which the quality of the water body approaches the maximum it could have given its heavily modified status. The 'Dee (Aberdeen) Estuary' water body has been classified as of 'good ecological potential' from 2008 onwards (SEPA, 2015a). The full classification is shown in Table 7.6 (SEPA, 2014c).

Table 7.6: Dee (Aberdeen) estuary water body 2013 classification

Parameter	Status	Confidence of Class
Overall status	Good ecological	Medium
Pre-HMWB status	Bad	Medium
Overall chemistry	Pass	Low
Priority substances	Pass	Low
Overall ecology	Bad	Medium
Physico-chemical	High	Low
Dissolved oxygen	High	Low
Dissolved inorganic nitrogen	High	Low
Biological elements	High	Low
Benthic invertebrates	High	Low
Alien species	High	Low
Fish	High	Low
Macroalgae	High	Low
Combined phytoplankton	High	Low
Specific pollutants	Pass	Low
Copper	Pass	Low
Zinc	Pass	Low
Hydromorphology	Bad	Medium
Morphology	Bad	Medium
Water quality	High	Low
Overall status	Good ecological	Medium
Water quality	High	
Oxygen levels	High	Low
Nutrient levels	High	Low
Benthic invertebrates	High	Low
Toxic pollutants	High	
Physical conditions and barriers	Bad	Medium
Invasive non-native species	High	Low
Fish	High	Low

The identified pressures on this water body are morphological alterations and diffuse source pollution as a result of construction, dredging and/or water transport. This water body will be assessed again in 2015, 2021 and 2027, and the target is a status of 'Pass' (SEPA, 2014c).

Other nearby designated water bodies in the area are 'Cruden Bay to the Don Estuary', 'Don Estuary' and 'Ythan Estuary' to the north of the development area, and 'Souter Head to Garron Point' and 'Garron Point to Downie Point' water bodies to the south. These water bodies were classified as of 'High' (Cruden Bay to the Don Estuary, Souter Head to Garron Point and Don Estuary), 'Good' (Garron Point to Downie Point) or 'Moderate' (Ythan Estuary) status in 2013 (SEPA, 2014d, 2014e, 2014f, 2014g).

7.5.2.4 Bathing Waters

Aberdeen Ballroom is the closest designated bathing water, located approximately 1 km to the north of the existing Aberdeen Harbour, adjacent to the Aberdeen urban area, as seen in Figure 7.2. The Balmedie and Stonehaven bathing waters are located approximately 12 km and 20 km to the north and south of Nigg Bay respectively.

During the bathing season (1 June to 15 September), designated bathing waters are monitored by SEPA for faecal indicators (bacteria) and classified according to the levels of these indicators in the water. Between 2012 and 2014 (the transition period between the former and revised BWD) bathing waters were classified as of 'Mandatory' or 'Guideline' pass status, and from 2015, bathing waters will be assessed as of 'Excellent', 'Good', 'Sufficient' or 'Poor' status.

Aberdeen Ballroom waters met the 'Mandatory' standard in 2014. It has met this or the 'Guideline' standard for over 11 years, with the exception of 2008 when it recorded a failure as a result of two mandatory exceedances, both following very heavy rainfall (SEPA, 2015c). Aberdeen Ballroom beach has been awarded a Seaside Award from 2007 onwards in recognition of its good safety and environmental management procedures (KSB, 2015).

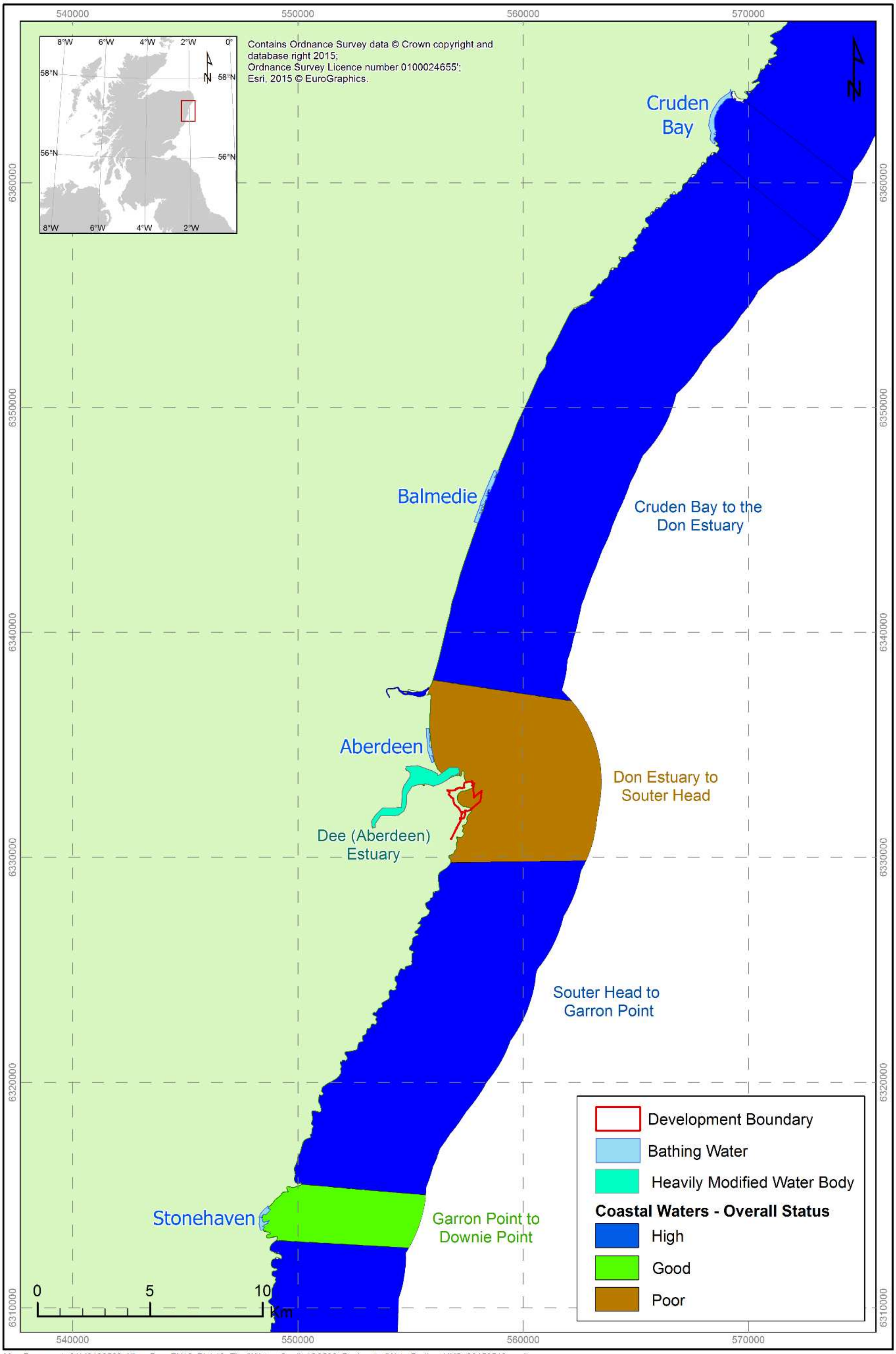

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Figure 7.2: Designated water bodies

7.5.2.5 Shellfish Waters

There are no designated shellfish protected waters or shellfish harvesting areas in the vicinity of Nigg Bay (NMPi, 2015).

7.5.3 Site Specific Survey Work

In order to inform the baseline a number of site-specific field work campaigns were carried out, as described in Section 7.3.2.2. The following sections summarise the results of these surveys.

7.5.3.1 Metocean Characterisation

Metocean data were collected at two locations, one inside Nigg Bay at 5 m depth (west location) and another outside Nigg Bay at 20 m depth (east location). Several water quality parameters were monitored during the campaign, including suspended sediment concentrations (SSC), dissolved oxygen (DO), salinity and temperature.

Average SSCs from optical backscatter measurements were 144 mg/l in the west location and 24 mg/l in the east location. The maximum SSC recorded was 899 mg/l at the west location and 529 mg/l at the east location. The minimum SSC recorded was 5 mg/l at the west location and 7 mg/l at the east location. SSC were also measured using acoustic backscatter, returning results in poor agreement with the optical backscatter results (i.e., significantly lower). This suggested that suspended sediment in Nigg Bay is very fine and therefore incompatible with acoustic measurements. Laser diffraction analysis conducted on water samples taken half way through the deployment confirmed the very fine nature of the suspended sediment. A number of events of high SSC were recorded showing reasonable correlation with the wave height time series. Other instances of high turbidity in the inner bay area during calm conditions were also observed, which are potentially due to fresh-water runoff and/or outfall discharge.

Salinity levels at both locations were highly variable, particularly at the West location where salinity levels ranged between 15.1 ppt (parts per thousand) and 35.1 ppt. This variation is related to low salinity events observed during the course of the campaign, which may be associated with storm discharges from the CSO at Girdle Ness. DO was also variable, reflecting the changes in salinity observed, ranging between 5.4 mg/l and 10.6 mg/l at the west location, and from 5.4 mg/l to 9.7 mg/l at the east location. Water temperatures during the monitoring period ranged from 5.7 ºC and 9.9 ºC. Water quality vertical profiles showed the water column to be well mixed.

7.5.3.2 Seabed Sediments

A geophysical survey carried out in Nigg Bay in 2012 (CG, 2012) suggested that sandy seabed was predominant in the area with a fringe of subtidal rock. During the 2015 survey, the camera survey showed sediments at the majority of locations in Nigg Bay (except in the areas surrounding the two headlands) to consist of sand, with very little gravel or boulders. At the stations closer to the headlands, the seabed was comprised of a mixture of boulders/rock and sand. Particle size analysis showed that samples from Nigg Bay were composed by mainly sand, with fine and medium sand prevalent and low gravel and silt content. Borehole sampling showed that the sediment is up to 30 m thick in the centre of the bay.

Sediment samples from ten stations in Nigg Bay were tested for a range of contaminants: metals, tributyltin (TBT), polychlorinated biphenyls (PCBs) and PAHs. Results were compared against the thresholds set in the Marine Scotland guidance document for sea disposal of dredged material (revised Action Levels 1 and 2). Contaminant levels below Action Level 1 are deemed as posing no risk to the environment if the dredged sediment is disposed of at sea. All samples returned contaminant concentrations below Action Level 1 for all contaminants tested for, as seen in ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey.

A Water Framework Directive (WFD) biological assessment was carried out on the macrofaunal data collected from the grab samples taken during the subtidal ecological survey. All stations were classified as having “moderate” or “good” ecological quality ratio (EQR), except for one station classified as “high”. The stations of “moderate” ecological quality tended to be located within Nigg Bay, whereas the stations classified as “good” or “high” were located predominantly outside the bay.

7.5.3.3 Water Quality Monitoring of Discharges into Nigg Bay

A monitoring programme was undertaken from November 2014 to July 2015 at the East Tullos Burn and the Ness Tip Burn, with water samples taken on a monthly basis. Several types of contaminants were tested for: heavy metals, TPH, PAH, organochlorine and organophosphorous pesticides, VOC and a range of miscellaneous indicators, including ammonia, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), chloride, Mecoprop, sulphate, suspended solids, Total Organic Carbon (TOC), Total Oxidised Nitrogen (TON) and pH. Results were compared against their respective Environmental Quality Standards (EQSs), obtained from SEPA guidance WAT-PS-SG53: Environmental Quality Standards and Standards for Discharges to Surface Waters. The full set of parameters analysed and results can be found in ES Appendix 7-A: Water Quality Monitoring Data.

EQSs are the standards which, if exceeded, could result in adverse effects to ecosystems. EQSs are expressed as an Annual Average (AA) (the average concentration in samples taken over a period of a year) and/or a Maximum Allowable Concentration (MAC) (the maximum allowed concentration as a result of a short-term pollution peak). As explained in Section 7.3.2.4, it has not been possible to calculate annual average concentrations of substances in the East Tullos and Ness Tip Burns because of the lack of long term monitoring data. Therefore the concentrations measured during the monitoring campaign have been compared to the freshwater MAC standards where possible, as MACs are not available for all substances.

It should be noted that EQSs for heavy metals refer to dissolved concentrations of these metals in water. During the course of the monitoring campaign at the East Tullos and Ness Tip Burns, total heavy metal concentrations were measured, which are generally higher than dissolved concentrations. Therefore, the figures provided in ES Appendix 7-A: Water Quality Monitoring Data) and used for modelling and assessment purposes with regards to the East Tullos and Ness Tip Burns represent conservative estimates of heavy metal contamination.

Mercury is the only heavy metal for which a MAC standard is available (i.e. 0.07 µg/l). During the monitoring campaign, all samples except two returned mercury concentrations below the detection limit of the analysis method. Of these two, only one sample from the Ness Tip Burn (January 2015) reached the MAC. It should be noted however that for the May 2015 samples from both burns the limit of detection was increased due to high levels of dissolved solids in the samples. The new limit of detection (1.3 µg/l) was higher than the MAC, therefore it is not possible to definitively conclude if this standard was exceeded in the May 2015 samples.

The vast majority of the samples analysed showed PAH concentrations below the detection limit of the method (0.01 µg/l). For those PAHs for which MACs are available (anthracene, fluroanthene and benzo(a)pyrene), all results were below these standards. Phenol concentrations in all samples were below the detection limit of the method (0.5 µg/l), which is well below its MAC (46 µg/l). All samples taken during the monitoring campaign returned VOC concentrations below the detection limit of the method (1 µg/l). MACs for these substances are in the range of 50 µg/l to 1,848 µg/l, therefore no samples exceeded these standards.

TPH, organochlorine pesticides and organophosphorous pesticides concentrations were below the limits of detection of the method in all samples. It should be noted however that limits of detection of organochlorine pesticides and organophosphorous pesticides were increased for the samples taken in May 2015 due to matrix interference. The new limits of detection were higher than the MACs for hexachlorocyclohexane (organochlorine pesticide) and diazinon (organophosphorous pesticide), therefore it is not possible to definitely conclude for the May 2015 samples if MACs for these two substances were exceeded.

BOD in the Ness Tip Burn ranged between less than 1 µg/l (below the limit of detection of the method) and 30 µg/l, while in the East Tullos Burn ranged between below the limit of detection and 2 µg/l.

7.5.4 Numerical Modelling of Baseline Situation

Numerical modelling studies were carried out to inform the environmental baseline description. The results of these studies, as described in the following sections, provide a conservative modelled description of the baseline conditions in the AHEP area. These studies were based on the data gathered during the site survey work described in Section 7.4.3.

7.5.4.1 Hydrodynamic and Sediment Transport Modelling

A numerical model of the baseline situation was built in order to characterise the hydrodynamics and sediment transport of the area. The methodology and full results of the modelling study can be found in ES Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment, and the results are summarised below.

The model indicates that tidal currents are uniform in the offshore area with velocities around 0.4 m/s to 0.5 m/s, decreasing in the inner Nigg Bay area to less than 0.1 m/s. A large eddy develops inside Nigg Bay as a result of tidal circulation, with the direction changing with the phase of the tide. Easterly waves cause the greatest wave heights inside Nigg Bay, while the Greg Ness and Girdle Ness provide partial shelter from waves from the north-east and south-east. Modelled net sediment transport in the offshore area is from south to north following the coast, with a net clockwise circular movement of sediment in Nigg Bay.

7.5.4.2 Water Quality Modelling

Based on the hydrodynamic model described above, a water quality model was developed to describe the baseline conditions by modelling the dispersive behaviour of tracer discharges into Nigg Bay and the surrounding area over a mean spring-neap tidal cycle. The methodology and full results of the modelling study can be found in ES Appendix 7-B: Water Quality Modelling Assessment, and are summarised below.

Discharges from the locations shown in Figure 7.1 were included in the model. Measured water quality data for these discharges were used where available (sampling and analysis results and the monitoring campaign described in Sections 7.4.2.2 and 7.4.3.3). Data from SEPA discharge consent documents or conservative industry standards were used where no measured data were available. Results (concentrations of pollutants/water quality parameters) were compared against the relevant EQSs as set in SEPA guidance WAT-SG-53.

The discharges modelled can be broadly divided in two groups: those streams and outfalls discharging into Nigg Bay (the East Tullos Burn, the Ness Tip Burn and the UFI outfall); and discharges taking place outside of the development boundaries (the Nigg waste water outfall, the Girdle Ness CSO and the rivers Dee, Don and Ythan), as seen in Figure 7.1. These streams have different chemical compositions, resulting in certain pollutants being discharged mainly within Nigg Bay, while others are discharged mostly from outer locations. Substances modelled and their main sources into the marine environment are presented in Table 7.7 below.

Table 7.7: Substances modelled and location of main sources

Substance	Main Source(s)	Location
Heavy Metals		
Cadmium	UFI outfall	Nigg Bay
Chromium	UFI outfall	Nigg Bay
Copper	Girdle Ness CSO, Ness Tip burn	Nigg Bay and outer area
Lead	Girdle Ness CSO, Ness Tip burn	Nigg Bay and outer area
Mercury	UFI outfall	Nigg Bay
Zinc	Girdle Ness CSO	Outside Nigg Bay
TPHs		
C_{10-13} chloroalkanes	East Tullos burn, Ness Tip burn, UFI outfall	Nigg Bay
PAHs		
Anthracene	Rivers Dee, Don and Ythan; Girdle Ness CSO	Outside Nigg Bay
Benzo(bk)fluoranthene	Rivers Dee, Don and Ythan	Outside Nigg Bay
PAHs	Girdle Ness CSO	Outside Nigg Bay
Pesticides		
Hexachlorobutadiene	UFI outfall	Nigg Bay
Miscellaneous Indicators		
Biological Oxygen Demand (BOD)	UFI outfall	Nigg Bay
Dissolved Inorganic Nitrogen (DIN)	UFI outfall	Nigg Bay
Dissolved oxygen (DO)	Rivers Dee, Don and Ythan	Outside Nigg Bay
Escherichia coli	Ness Tip burn, UFI outfall, Nigg waste water outfall, Girdle Ness CSO	Nigg Bay and outer area
Phenol	UFI outfall	Nigg Bay
Total ammonia	Ness Tip burn, UFI outfall, Nigg waste water outfall	Nigg Bay and outer area

The East Tullos Burn, the Ness Tip Burn and the UFI outfall all discharge to the western shore of Nigg Bay. Model results show that for those substances released mainly from these streams (TPHs, cadmium, chromium, mercury, hexachlorobuthadiene and phenol), temporary exceedances of EQSs associated with periods of low tide (and thus lower dilution) are seen in the inner Nigg Bay area, next to where these streams discharge. In the wider area however, concentrations remain below EQSs due to the high levels of dilution achieved. DO levels also fall below the standard in the inner Nigg Bay area during low tides.

Modelled levels of anthracene and benzo(bk)fluoranthene are generally above their EQSs in Nigg Bay and the wider area as a result of the high concentrations of these substances discharged by the rivers Dee, Don and Ythan. *E. coli* modelled concentrations also fail to achieve the "Excellent" threshold in Nigg Bay and the wider area as a result of the effluent discharges from the UFI outfall and the Girdle Ness CSO, but these high concentrations do not reach the Aberdeen Ballroom Bathing Waters, where the "Excellent" standard is achieved. The Girdle Ness CSO is also a source of copper and zinc into the marine environment and the model shows temporary exceedances of the EQSs for these metals in the area immediately surrounding the CSO, although in reality discharges from the CSO are not continuous events.

Modelled concentrations of lead and PAHs were always below their respective EQSs in Nigg Bay and the wider area.

Modelling of the residence time of water in Nigg Bay was also carried out, showing that the water within the bay is subject to a rapid exchange with offshore waters and 90% of the bay water is flushed within 6 hours.

7.5.4.3 Sediment Plume Modelling

The current maintenance dredging operations at the existing Aberdeen Harbour result in the generation of a sediment plume during dredging and disposal at sea. The extent and SSCs arising from this plume were assessed by numerical modelling, based on the hydrodynamic model previously described, sediment size data within Aberdeen Harbour and Nigg Bay, and barge performance records and dredged volumes from previous dredging operations at the harbour. The methodology and full results of the modelling study can be found in ES Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment, and ES Appendix 7-D: Sediment Plume Modelling, and the results are summarised in the following paragraphs.

The sediment disposed of at the disposal site will be dispersed over the water column before settling on the seabed. The extent over which the sediment plume will disperse depends on the size of the sediment, with coarser sizes settling rapidly and finer sizes being more widely dispersed by waves and currents.

The sediment dredged during maintenance works at Aberdeen Harbour comprises predominantly silt (approximately 59% in volume) and very fine sand (approximately 19%). Model results show that over a mean spring-neap tidal cycle, the disposal of this sediment results in a plume elongating in a north-east to south-west direction centred on the disposal site, following the direction of the tidal currents.

Suspended sediment concentrations quickly achieve equilibrium with tidal currents rapidly transporting the sediment from the disposal site or sedimentation occurring. At the disposal site concentrations of medium sand and coarser grain sizes return to background levels within a maximum of 45 minutes, with a minimum duration of 15 minutes. Finer grain sizes require longer to return to background levels, with very fine sand requiring 0.25 to 3.25 hours. This variability is due to releases taking place at different periods within the tidal cycle.

Concentrations of suspended silt show greater variability due to the lower settling velocity of this grain size. This can be seen in silt concentrations achieving background levels within 15 minutes, before increasing in concentration between sediment releases. This is due to multiple releases of silt being present in the water column simultaneously, producing variations in the suspended sediments according to when sediment is released during the tidal stage.

The fine sediments (silt and very fine sand fractions) deposit on the seabed over distances of up to 20 km from the disposal site in both directions of the plume. The thickness of the layer of these fine sediment deposits decreases from 45 mm at the disposal site to 1 mm at the edges of the deposition area. The coarser fraction of the material will disperse over a much smaller area, reaching deposited thicknesses of 256 mm in the disposal area.

The SSCs in the water column arising from the sediment plume are greatest at the disposal site and caused principally by the silty fraction of the disposed material. Peak silty SSC at the disposal site at the time of disposal is 11,657 mg/l, and peak total SSC (all sediment fractions) is 19,524 mg/l. However, these levels are highly localised and decay very quickly after disposal, with average silty sediment concentration falling to 327 mg/l and total SSC falling to 527 mg/l at the disposal site. These levels also reduce rapidly with distance from the disposal site, with total SSC falling to 92 mg/l at 463 m to the north of the disposal site, and 99 mg/l at 463 m to the south.

7.6 Assessment of Impacts and Effects

7.6.1 Identification of Impacts

The impact assessment process starts with the identification of the impacts that are predicted to arise from the construction and operation of the development, based on the project description that can be found in Chapter 3: Description of the Development.

Table 7.8 presents the potential construction and operational impacts arising from the project activities and the pathways through which these impacts can result in effects on water and sediment quality receptors.

Table 7.8: Predicted impacts on water and sediment quality and associated pathways

Activity	Impact and Transmission Pathway	Receptor	Description of Potential Effects
Construction			
Intake and outfall diversion	The diversion alters plume dispersion patterns, resulting in changes to spatial distribution of contaminant concentrations in the water column	Designated water bodies and bathing waters	Changes to classification status of designated RBMP water bodies or Bathing Waters as a result of noncompliance with standards
Capital dredging	Sediment disturbance	Designated water bodies	Changes to classification status of designated RBMP water bodies as a result of noncompliance with standards
	Release of sediment-bound substances into the water column due to sediment resuspension	Designated water bodies	Changes to classification status of designated RBMP water bodies as a result of noncompliance with standards
	Deposition of suspended sediments on the seabed	Sediment quality	Changes to sediment quality classification in the areas affected by sediment disposal and/or deposition
Accidental events/spills	Increased contaminant levels in water	Designated water bodies	Changes to classification status of designated RBMP water bodies as a result of noncompliance with standards
Operation			
Physical presence of development	Modification of water and sediment circulation patterns resulting in changes to spatial distribution of contaminants	Designated water bodies and bathing waters	Changes to classification status of designated RBMP water bodies or Bathing Waters as a result of noncompliance with standards
Maintenance dredging	Sediment disturbance	Designated water bodies	Changes to classification status of designated RBMP water bodies as a result of noncompliance with standards
	Release of sediment-bound substances into the water column due to sediment resuspension	Designated water bodies	Changes to classification status of designated RBMP water bodies as a result of noncompliance with standards
	Deposition of suspended sediments on the seabed	Sediment quality	Changes to sediment quality classification in the areas affected by sediment disposal and/or deposition
Operational activities	Increased levels of contaminants in water	Designated water bodies	Changes to classification status of designated RBMP water bodies as a result of noncompliance with standards

7.6.2 Design Parameters

Table 7.9 presents the design parameters used in the assessment of the potential effects of the development on water and sediment quality. These parameters have been taken from the project description presented in Chapter 3: Description of the Development.

Table 7.9. Design parameters used in the classification of impacts on water and sediment quality

Description of Impact	Parameters
Construction	
Changes to contaminant concentrations in the water column due to outfall dispersion	The East Tullos and Ness Tip Burns and the UFI outfall will remain in their current locations, with appropriate protection as necessary.
Sediment disturbance and release of sediment-bound substances into the water column due to dredging operations; deposition of suspended sediments on the seabed	The inner basin will be dredged to 9 m below CD. The eastern berth and the approach channel will be dredged to 10.5 m below CD. The total volume of dredged material is 2,300,000 m^3. Dredging will be undertaken using a combination of Trailer Suction Hopper Dredging (TSHD) for the first approximately 45% of unconsolidated material (i.e. up to 1,035,000 m^3) and backhoe dredging for the remainder consolidated sediment (up to 1,265,000 m^3). Up to 109,000 m^3 of the dredged material is anticipated to be rock, which will be reused. It is anticipated that a proportion of the remaining dredged material will also be reused in construction works; however as a worst case scenario it has been assumed that all of the material (except the rock) will be disposed at the licensed offshore site. Dredging is anticipated to take place over 19 months, seven days a week, potentially as a 24-hour operation. Dredged material will be disposed of at sea at an existing licensed disposal site (CR110). Disposal of material is anticipated to take place on a daily basis over 19 months.
Increased contaminant levels in water due to construction activities and accidental spills	Construction activities are anticipated to last for up to 3 years.
Operation	
Modification of water and sediment circulation patterns resulting in changes to spatial distribution of contaminant concentrations	The new harbour layout will comprise two rubble mound breakwaters (north and south) to be built off the Girdle Ness and Greg Ness headlands. Each breakwater will be 600 m long, with a maximum crest level of >12 m above CD. A quay wall will be built along the lee of the northern breakwater. Local bathymetry will be altered as a result of dredging operations. The presence of the breakwaters and the new bathymetry will cause changes to local hydrodynamics and water circulation.
Sediment disturbance and release of sediment-bound substances into the water column due to maintenance dredging operations; deposition of suspended sediments on the seabed	The entrance channel and basin will require regular maintenance dredging to remove accumulated material. The amount of material to be dredged will depend on the maritime climate but it will be significantly lower than the volume dredged during construction. It is anticipated that dredged material from maintenance dredging will be disposed of at sea at a licensed disposal site (CR110), a licence application will be made for this purpose.
Increased contaminant levels in water due to operational activities	The traffic forecasted to use Nigg Bay on an annual basis is approximately 550 commercial vessels; 1,700 Platform Supply Vessels (PSV)/Offshore vessels; 40 Diving Support Vessels (DSV) and 33 cruise ships; in addition to the traffic currently using the existing harbour.

7.6.3 Impacts During the Construction Phase

Based on the impacts identified in Table 7.8, the design parameters listed in Table 7.9 and the methodology outlined in Section 7.3.3, a discussion of the potential impacts and effects anticipated to occur from the construction phase is presented in this section.

7.6.3.1 Dredging Model Assumptions

As the D&B contractor's dredger was unknown at the time of modelling, all dredging overspill and disposal parameters within the models were set as worst case. Model outputs, therefore, should significantly exceed any likely real world scenario. This level of conservatism also means that all predicted effects based on model outputs are likely to exceed real world scenarios.

7.6.3.2 Disturbance of Sediments During Capital Dredging

Capital dredging operations in the new harbour basin and entrance channel will disturb the seabed, resulting in the resuspension of seabed sediments, generation of a sediment plume and increased turbidity levels in the water column. Losses of fine sediments during dredging works and as a result of hopper or bucket overspill will also contribute to the creation of sediment plumes at the dredging site. In addition to dredging operations at the project area, the disposal at sea of the dredged material will generate a sediment plume at the disposal site. The fine sediments in the plumes will be dispersed over a wider area by the action of waves and currents until eventually resettling on the seabed.

Other construction activities such as the construction of breakwaters and quays will also cause seabed disturbance and resuspension of sediments. However, the impacts on water quality arising from these operations have been deemed as being of smaller magnitude than those arising from capital dredging operations, which will disturb the greatest extent and volume of seabed sediments. Therefore, this assessment has been based on the impacts caused by dredging operations. This impact may occur in a continuous manner during the 19 months over which the dredging operations will take place, given that they are anticipated to be undertaken 24 hours a day during this period. Disposal of the dredged material will also take place on a continuous basis, with an estimated 25 daily trips made by the barges to the disposal site.

Dredging will be undertaken using a combination of Trailer Suction Hopper Dredging (TSHD) for the first approximately 45% of unconsolidated material (i.e. up to 1,035,000 m^3) and backhoe dredging for the remainder consolidated sediment (up to 1,265,000 m^3). Unconsolidated sediments are comprised mostly by fine to medium sands (approximately 47% of the material in volume). Consolidated sediments comprise mainly silt (approximately 30% in volume) and fine to medium sands (33%).

Average background SSCs in Nigg Bay range from 24 mg/l in the outer bay area to 144 mg/l in the inner bay area. Maximum SSCs of up to 529 mg/l and 899 mg/l have been recorded in the outer bay and inner bay areas during high energy wave events, as shown in ES Appendix 6-A: Oceanographic Works.

To characterise the increased SSC impacts arising from capital dredging operations, numerical modelling of the sediment plume was carried out. A number of conservative scenarios were modelled based on the dredged sediment size composition, the volumes to be dredged and barge performance records from previous dredging operations at the existing Aberdeen Harbour. The scenarios modelled are described below. For these scenarios, it has been assumed that construction is at mid-point, i.e., the breakwaters are in place and dredging of the inner basin is taking place. The methodology and full results can be found in ES Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment.

Increased SSCs at Construction Site from Hopper Overspill During THSD

During the dredging of the first layer of unconsolidated material, overspill of the hopper at the end of each dredging cycle will release the finer fraction of the sediment dredged (silt and very fine to fine sands), resulting in increased SSCs within Nigg Bay. Figure 7.3 shows a contour plot of maximum SSC during TSHD overspill. Whilst the peak increase in SSC for TSHD is predicted to be above 8,000 mg/l above background levels, these events are intermittent and short-lived, and are highly localised (confined to within Nigg Bay itself). The low levels of tidal energy within the bay mean that sediment settles very quickly. This is demonstrated in the modelling results showing a peak SCC of only 763 mg/l at data extraction point 5 in the north of Nigg Bay for the same model run (Appendix 7-D: Sediment Plume Modelling). Increases in SSC from these fractions are noticeable only in the immediate vicinity of the barge.

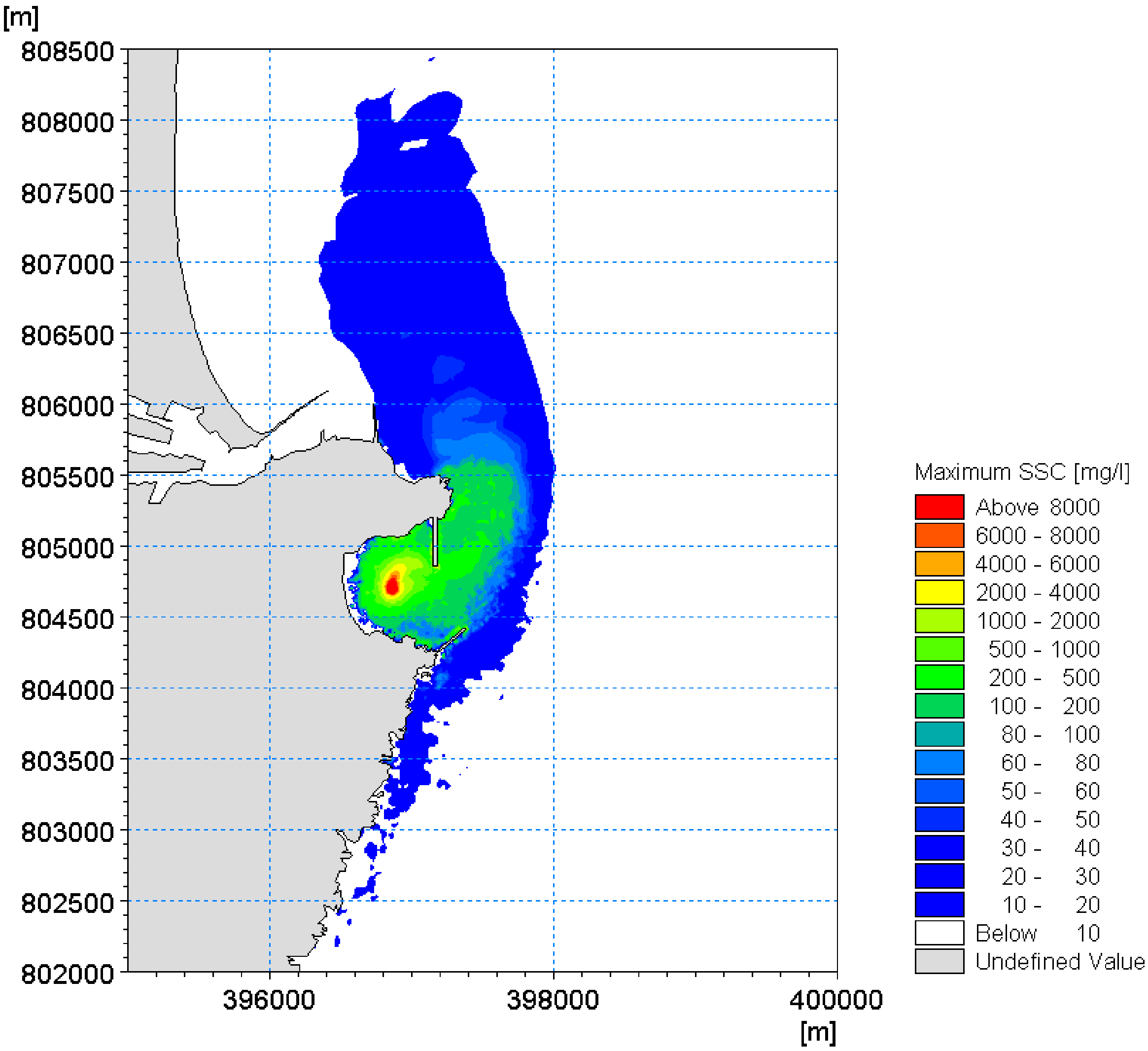

Figure 7.3: Contour plot of maximum SSC from construction TSHD overspill in Nigg Bay

The silty fraction of the overspilled material disperses further, reaching the entrance channel and the outer coastal area. The peak increases in SSC north of Girdle Ness are predicted to be no higher than 100 mg/l to 200 mg/l above background levels, and generally around 10-40 mg/l in front of the mouth of the River Dee, which is well within natural background variation. For this fraction, the peak values are very short-lived, returning to background levels before the next overspill episode (modelled as occurring every 90 minutes). The short-lived nature of these over-spill events is demonstrated by the lower values and much smaller extent of average SSC plume. Figure 7.4 shows the extent of the average increases in SSC during TSHD overspill.

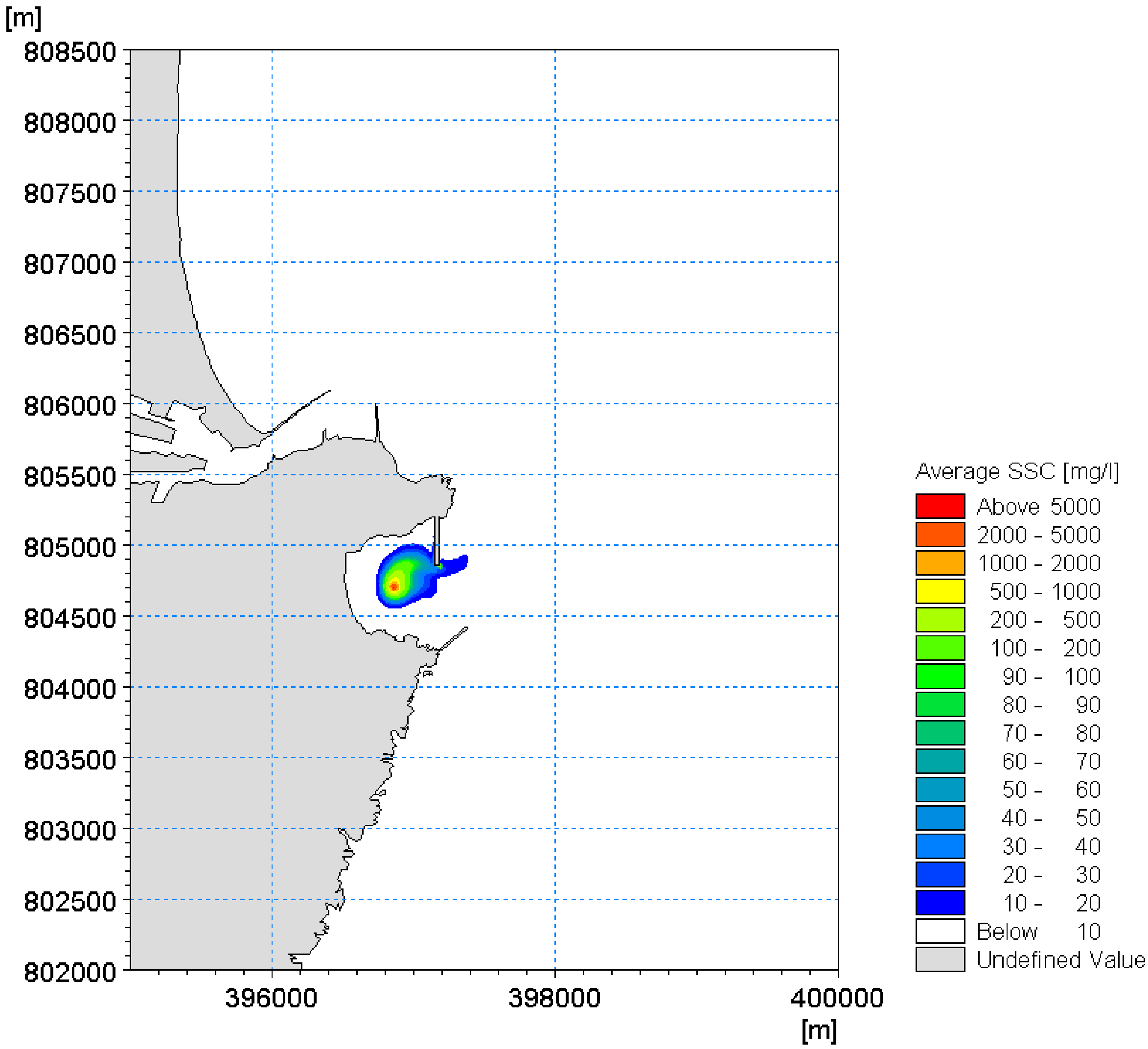

Figure 7.4: Contour plot of average SSC from construction TSHD overspill in Nigg Bay

Whilst the highest average SSC is above 5,000 mg/l, it is extremely localised around the dredging vessel. Figure 7.4 shows that almost all the plume is predicted to stay within the bay, and that the majority of average plume concentrations are within the natural range of variation of SSC in the area (average SSCs measured at Nigg Bay ranged between 24 mg/l and 144 mg/l, with high turbidity events raising SSC to levels of between 529 mg/l and 899 mg/l).

Increased SSCs at Disposal Site of THSD Material

In the event that all the dredged material (except the rock fraction) is disposed of at sea, the coarser fraction of the sediment dredged (medium sands to very coarse gravel) will be transported to the offshore disposal site CR110 and released at this location. The model shows that the coarser materials (gravels and very coarse sand) will settle on the seabed rapidly. Increases in SSC will be caused by the finer fraction of the material released (medium sand), which remains in suspension for longer than the coarser fraction. This material will disperse in a plume orientated in the north-east-south-west direction, following the direction of the tidal current. However, the extent of the plume to where modelled increased SSC are discernible is limited up to approximately 1.5 km along the axis of the plume. This is significantly smaller in extent than the plumes generating by the baseline licensed maintenance dredging (Figure 7.5).

Peak SSC at the disposal site reaches 10,192 mg/l, but these peaks are very-short lived and SSC return to background concentrations very rapidly, before the next release, with average SSC at the disposal site of 300 mg/l. It should be noted that this average is considered to be a worst case scenario as the release rate modelled is the maximum possible, which is 2.6 times greater than release rate required to achieve the programme. Within 0.5 km from the disposal site peak SSC falls to between 872 mg/l and 974 mg/l on each release. Peak baseline SSC at the disposal site reaches 19,524 mg/l during annual maintenance dredging, therefore the disposal of TSHD dredged material at the disposal site is currently less than current baseline licensed maintenance dredging. Whilst disposal of construction related material will be more frequent than maintenance dredging, the granular material will settle much faster than silts and fine sands and produce much lower average SSC levels.

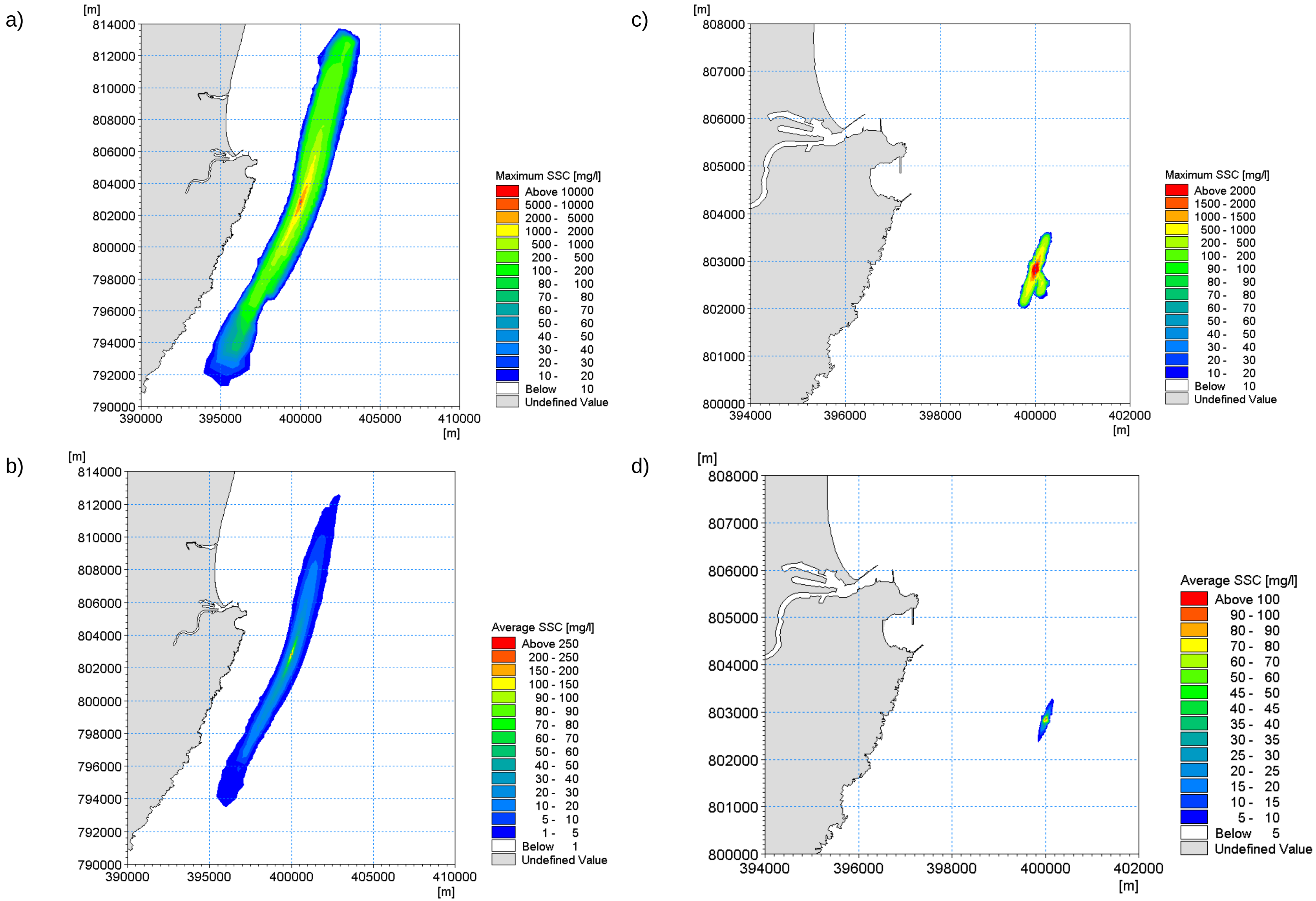

Figure 7.5: (a) Maximum SSC and (b) mean SSC for baseline maintenance dredged material disposal and (c) maximum SSC and (d) mean SSC for TSHD construction dredged material disposal
Note: panels (a) and (b) cover a greater extent than panels (c) and (d)

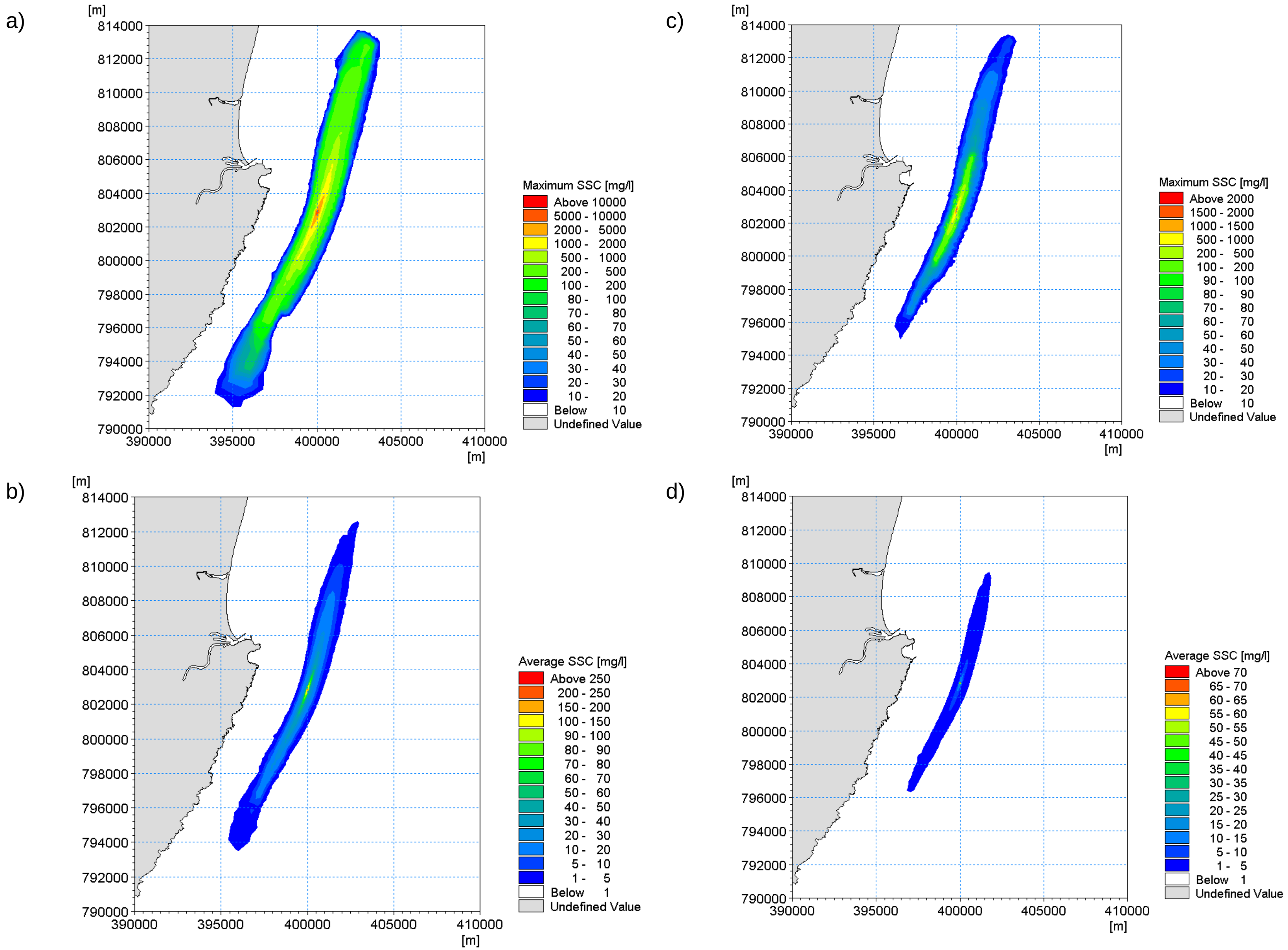

Figure 7.6: (a) Maximum SSC and (b) mean SSC for baseline maintenance dredged material disposal and (c) maximum SSC and (d) mean SSC for backhoe construction dredged material disposal

Should the disposal of this material overlap with the maintenance dredging operations at Aberdeen Harbour, this will result in cumulative increases in SSC at the disposal site. However, the modelling undertaken shows that these increased SSC are very short lived episodes and return to background levels immediately once operations finish. Therefore, the cumulative impacts arising from the simultaneous disposal of material from both dredging sites will be temporary, limited to the duration of the maintenance dredging works in the existing harbour. In addition, disposal would not take place simultaneously but barges from the two locations would alternate at the disposal site, hence giving time for SSC to return to background levels before the next release. The sediment plumes generated at the disposal site do not reach the coastline and hence do not overlap with the overspill plumes described in the previous sections.

Should the consolidated fraction of the dredged material be reused during construction, the above impact would not take place given that this material would not be disposed of at sea.

Increased SSCs at Construction Site from Bucket Overspill During Backhoe Dredging

During backhoe dredging of the layer of consolidated material, overspill of the buckets will release part of the sediment dredged into the water column, resulting in increased SSCs within Nigg Bay. The model shows that all sediment except the silt fraction will deposit rapidly on the seabed due to the restricted water circulation in the bay when the breakwaters are in place. Temporary increases in SSC from these fractions will occur only in the immediate vicinity of the barge. The silty fraction of the overspilled material disperses further over Nigg Bay and the entrance channel, causing maximum peak SSCs of up to 250 mg/l in the central area of the bay, but these peaks are very-short lived and SSC returns to background concentrations very rapidly, before the next release. Within Nigg Bay, the average SSC is of a very small magnitude, falling to 9 mg/l. Any increases in SSC in Nigg Bay can be anticipated to be within the natural range of variation of SSC in the area (average SSCs measured at Nigg Bay ranged between 144 mg/l and 24 mg/l, with high turbidity events raising SSC to levels of between 529 mg/l and 899 mg/l).

Should these dredging operations in Nigg Bay overlap with maintenance dredging at Aberdeen Harbour, this would result in overspill plumes occurring in both locations simultaneously. Modelling shows that these operations would not result in cumulative increased SSCs in the area, as they will not overlap given the limited spatial extent of each resulting plume.

Increased SSCs at Disposal Site of Backhoe Dredged Material

The material dredged will be transported to the offshore disposal site and released at this location. Similarly as with the results for the TSHD, the model shows that coarser materials (gravels and coarse sand) will settle on the seabed in the disposal area and immediate vicinity. Increases in SSC will be caused by the finer fraction of the material released (medium to very fine sands and silt), dispersing in a north-east-southwest plume. The silt fraction will create the largest plume, with discernible increases in SSC extending up to 11 km along the plume axis. The peak SSC at the disposal site is 4,719 mg/l, though dredged material settles quickly, resulting in an average SSC of 309 mg/l. Within 2 km from the disposal site peak SSC fall to 207 mg/l to the north and 123 mg/l to the south on each release. Maximum peak SSC at the disposal site, caused by this silt fraction, reach up to 280 mg/l, but these peaks are very short lived and SSC return to background concentrations before the next release. Peak baseline SSCs at the disposal site reach up to 19,524 mg/l during annual maintenance dredging, therefore the disposal of backhoe dredged material at the disposal site is currently less than current baseline licensed maintenance dredging.

The disposal of this material may overlap with the disposal of sediment from maintenance dredging operations at Aberdeen Harbour, resulting in cumulative increases in SSC at the disposal site. As with THSD, the modelling results shows that these increased SSC are very short-lived episodes and return to background levels immediately once operations finish. Therefore, the cumulative impacts arising from the simultaneous disposal of material from both dredging sites will be temporary, limited to the duration of the maintenance dredging works in the existing harbour. The sediment plumes generated at the disposal site do not reach the coastline and hence do not overlap with the overspill plume described in the previous section.

In summary, dredging operations in Nigg Bay and the subsequent disposal of the dredged material at sea will result in a series of localised short-lived episodes of increased SSC in Nigg Bay and the disposal site; occurring at regular intervals over the whole duration of the dredging period (19 months). As measured during the metocean monitoring campaign (ES Appendix 6-A: Oceanographic Works), SSCs in Nigg Bay increase significantly during high energy wave events, and the modelled increases in SSC inside the bay are within this range of natural variation.

The potential effects of increased SSC on each of the receptors considered are described in the following paragraphs.

Effects on Bathing Waters

Increased SSCs in the water column will not have an effect on designated bathing waters in the area, given that their classification status or the concession of a Seaside Award is not affected by turbidity levels, but by bacteriological contamination levels (and in any event, increases in SSC are not predicted to extent to any designated bathing waters).

Effects on RBMP Water Bodies

Increased SSCs do not have a direct effect on the classification of designated water bodies under the Scotland RBMP, as turbidity is not one of the parameters used in the assessment of their quality status. However, the DIN standards against which the chemical status of transitional waters is assessed is dependent on the turbidity of the waters. Hence, increased SSC may have an indirect effect on the classification of a designated transitional water body by changing the applicable DIN standards.

Don Estuary to Souter Head is a coastal water body and hence its chemical classification status is not influenced by turbidity levels. As such, no effects from increased SSCs will occur on this water body.

Dee (Aberdeen) Estuary is, however, classified as a transitional water body and as such increased SSCs may result in a shift of its applicable DIN standards, potentially affecting its assessment results on this parameter. The magnitude of the effect on the Dee (Aberdeen) Estuary water body is considered to be negligible. The Dee (Aberdeen) Estuary water body was classified in 2013 as of ‘Good Ecological Potential’ in 2013, corresponding to a high value receptor. The effect has thus been assessed as of **negligible** significance, which is not significant in EIA terms. As previously discussed, increased SSCs do not have a direct effect on the classification of designated water bodies under the Scotland RBMP. Therefore, the likelihood of the effect is deemed to be extremely unlikely, resulting in a **low** risk to the environment. There is no predicted change in the status of these water bodies.

7.6.3.3 Release of Sediment-Bound Substances into the Water Column

The resuspension and subsequent dispersion of sediments during capital dredging, dredged material disposal and construction operations may lead to the release into the water column of any sediment-bound substances or organisms, including contaminants, nutrients and bacteria. Reductions in dissolved oxygen levels can also occur. This release can occur as a result of the partition into the water column of contaminants adsorbed to sediment particles or due to the release of porewater when the sediment is disturbed, carrying dissolved contaminants or nutrients.

The likelihood of contaminant releases occurring depends on the nature and degree of contamination of the sediment dredged. Sediment samples from Nigg Bay were analysed for a range of contaminants including heavy metals, tributyltin (TBT), polychlorinated biphenyls (PCBs) and PAHs as part of the site-specific works to inform the ES. The results showed levels of all contaminants in the samples to be below Marine Scotland Revised Action Level 1, indicating very low contaminant concentrations which make the sediment suitable for disposal at sea (ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey). Given the low levels of contaminants in the sediment, no significant release of these pollutants into the water column is anticipated to occur as a result of capital dredging and disposal operations.

Nutrients in the sediment tend to be associated with very fine sediments such as silt. There is limited information on the degree of release of nutrients or bacteria into the water column as a result of dredging, or of subsequent reductions in dissolved oxygen levels in the water. However, previous studies suggest that these impacts are localised around the vicinity of the dredging area and short-lived, ceasing shortly once operations end (CEFAS, 2012). Silt content in the sediments in Nigg Bay is low, as is the Total Organic Carbon (TOC) content which ranges from 0.08% to 0.25% (ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey). Given the sandy nature of the sediments and the low levels of organic matter present in them, no significant release of nutrients into the water column is anticipated to occur as a result of capital dredging and disposal operations. Any increase in concentrations of nutrients or bacteria in the water column would be limited to the area affected by the sediment plumes caused by overspill and dredge disposal, which as explained in Section 7.5.3.2, will be largely limited to the area confined by the breakwaters and the vicinity of the offshore disposal area.

The potential effects of the release of sediment-bound contaminants and organisms on each of the receptors considered are described in the following paragraphs.

Effects on Bathing Waters

The release of sediment-bound bacteria may result in an increase in bacteriological contamination of Bathing Waters and their downgrading or losing of a Seaside Award, should this release be of a significant magnitude and the suspended sediment plume reach these waters.

As described in Section 7.5.3.2, plume modelling indicates that the sediment suspended as a result of capital dredging operations would not reach nearby Bathing Waters, being mostly confined to the limits of Nigg Bay by the breakwaters, or to the offshore disposal site and surroundings. Model results at the nearest Bathing Water, Aberdeen Ballroom, show no increase in SSC in the area as a result of capital dredging and disposal; hence no increase in the bacteriological content of these waters is anticipated because of the proposed operations. Therefore, the magnitude of this effect on Bathing Waters is considered negligible. The Aberdeen Ballroom Bathing Waters are classified as of 'Mandatory' status so its value is very high. The significance of the effect is thus **minor adverse**, which is not significant in EIA terms. As previously discussed, plume modelling indicates that sediment suspended as a result of capital dredging operations would not reach nearby Bathing Waters. Therefore, the likelihood of the effect is deemed to be unlikely, resulting in a **low** risk to the environment.

Effects on RBMP Water Bodies

The release of sediment-bound contaminants in the water column may have an effect on the status of designated RBMP water bodies if compliance with Environmental Quality Standards (EQSs) of pollutants in water is compromised. However, the very low levels of contaminants in the dredged sediment suggest that any increases in pollutant concentrations in the water column as a result of sediment resuspension will be negligible. The magnitude of this effect is considered to be negligible. The area affected by the suspended sediment plumes is located within the Don Estuary to Souter Head designated water body which was classified in 2013 as having an overall status of "Poor", hence its value is deemed as low. The overall significance of the effect is considered **negligible**, which is not significant in EIA terms. As previously discussed, the very low levels of contaminants in the dredged sediment suggest that any increases in pollutant concentrations in the water column as a result of sediment resuspension will be negligible. Therefore, the likelihood of the effect is deemed to be unlikely, resulting in a **low** risk to the environment.

7.6.3.4 <u>Deposition of Suspended Sediments on the Seabed</u>

Suspended sediment plumes generated during capital dredging, disposal of dredged material, and other construction operations will spread over a wide area due to the action of waves and currents, before suspended particles settle again on the seabed. Coarser sized particles will settle in close proximity to the disturbance source, while the finer sediment will be transported further away before resettling. Dredge disposal operations will also deposit significant amounts of sediment on the seabed at the disposal site. This way, areas of seabed not directly affected by the dredging, disposal or construction operations may be impacted by the settling of plume material, which may have different physical and chemical characteristics.

Sampling work carried out to inform the ES (see ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey) showed that sediments in the areas of Nigg Bay to be dredged consist of fine and medium sand, with very little gravel or boulders. Chemical analysis showed that the sediments presented levels of all contaminants tested below Marine Scotland Revised Action Level 1, hence they are not deemed to pose an environmental risk if disposed of at sea.

The results of sediment plume numerical modelling have informed the assessment of potential effects of the deposition of sediment plumes in the area surrounding the disposal site. No assessment has been carried out of redeposited material in Nigg Bay given that, as described in Section 7.5.2.2, sediment re-suspended as a result of overspill during dredging will be retained within the bay. Any overspilled and settled sediment will be removed by subsequent dredging.

Settling of Sediments at Disposal Site During THSD

Numerical modelling shows that should this material be disposed of at sea instead of reused, the coarser fraction of the disposed material (gravels and very coarse sand) will settle on the seabed of the disposal site without dispersing over the wider area. The medium sand fraction will deposit on the seabed in thicknesses ranging between 1,042 mm and 74 mm over an area elongated in the northeast-southwest direction, up to 0.9 km to each side of the disposal site. An even distribution of all sediment disposed of across the disposal site would result in a seabed level increase of approximately 2.6 m. In reality, this increase will be greater towards the centre of the disposal site and will decrease towards its outer areas. The action of waves and currents will level the seabed at the disposal site over time, smoothing the seabed bathymetry. Figure 7.7 shows the predicted deposition of coarse gravel and medium sand from TSHD disposal.

Should the disposal of this material overlap with the maintenance dredging operations at the existing Aberdeen Harbour, this will result in cumulative deposits of sediment at the disposal site. The model shows that the cumulative deposition of River Dee maintenance dredged material combined with construction TSHD and backhoe dredged material would lead to a maximum increase in the height of the seabed of approximately 4 m, within the disposal site itself.

Modelling of the baseline disposal of sediments from maintenance dredging at the existing harbour shows that material settles following north-east to south-west pattern. The modelled thickness of deposited sediment at the disposal site is 594 mm, decreasing towards the edges of the area. At 8 km in the north-east and south-west directions, sediment thicknesses are 7 mm and 11 mm respectively.

Settling of Sediments at Disposal Site During Backhoe Dredging

Numerical modelling shows similar results as for THSD in terms of deposition of sediment on the seabed around the disposal site. However, the extent of the area of deposition is larger, given that finer fractions are present in the material disposed of from backhoe dredging (these finer fractions were removed from TSHD disposal material via overspill). These fine sediments deposit on the seabed up to 7 km over an area elongated in the northeast-southwest direction, with a maximum thickness of 45 mm at the disposal site. Coarser fractions settle on the seabed at the disposal site or its immediate vicinity. Figure 7.7 shows the predicted deposition of coarse gravel and medium sand from TSHD disposal. Figure 7.8 shows the predicted deposition of coarse gravel and silt from backhoe disposal. An even distribution of all sediment disposed of across the disposal site would result in a seabed level increase of approximately 1.3 m, within the disposal site itself.

Cumulative deposition of sediment on the seabed at the disposal site as a result of backhoe dredging and maintenance dredging at Aberdeen Harbour would amount to a layer of settled sediment of approximately 2.4 m thickness. Cumulative deposition of maintenance dredging with TSHD and backhoe dredging combined would lead to a maximum increase in the height of the seabed of approximately 5.3 m, within the disposal site itself. In summary, dredging operations in Nigg Bay and the subsequent disposal of all dredged material at sea (except rock) will result in the deposition of the released sediment at the disposal site in layers up to 2.6 m and 1.3 m for THSD and backhoe dredging respectively, within the disposal site itself. The finer fraction of the disposed sediment will deposit over a wider area of up to 7 km, with the thickness of the deposited layer decreasing from the disposal site to the edges of the area. The action of waves and currents will level the seabed at the disposal site over time, smoothing the seabed bathymetry. These impacts will be reduced should part of the dredged material being reused in construction.

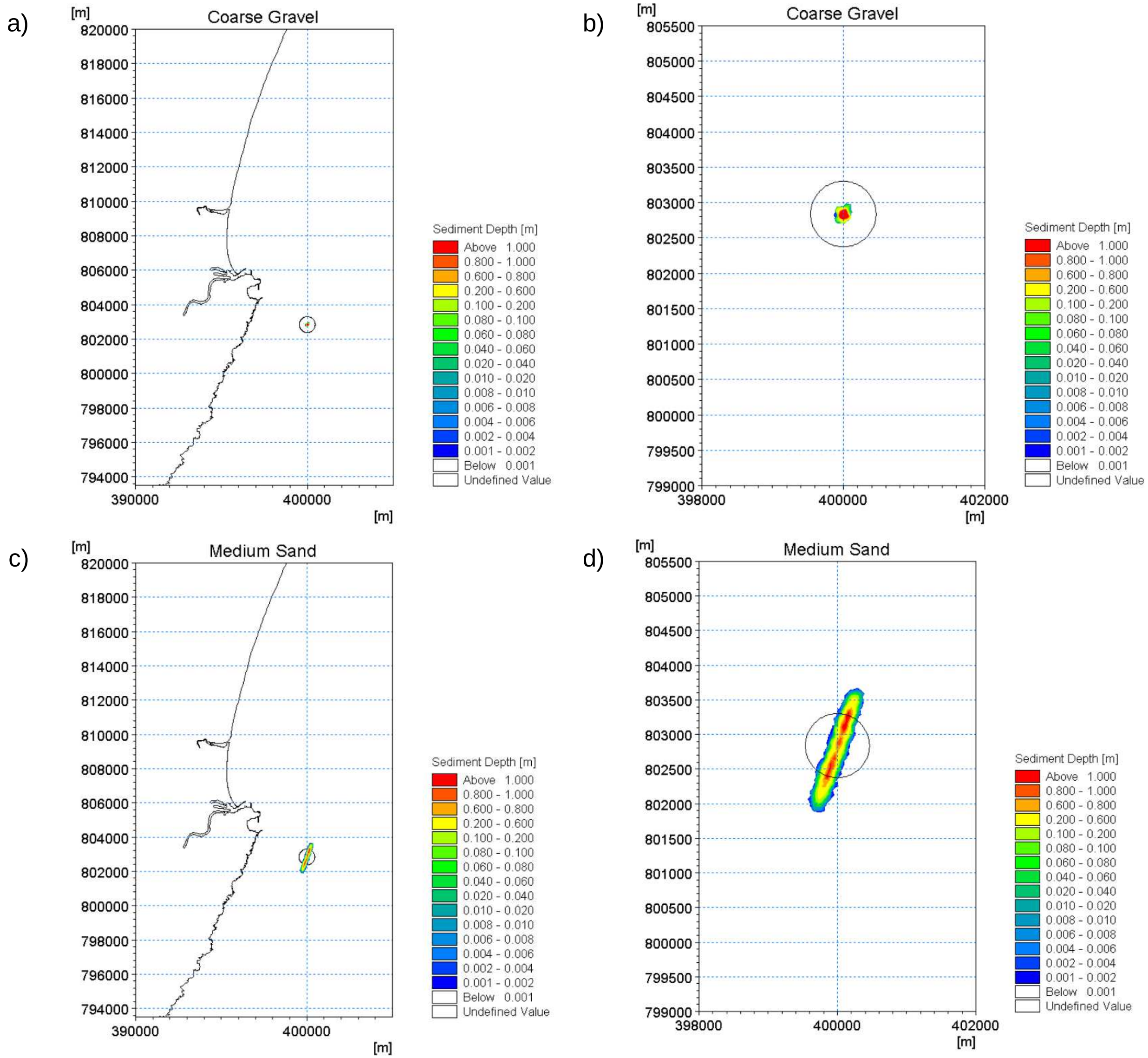

Figure 7.7: Redeposited coarse gravel shown (a) over a large extent, (b) local to the disposal site; and medium sand shown (c) over a large extent, (d) local to the disposal site for construction TSHD dredged material disposal

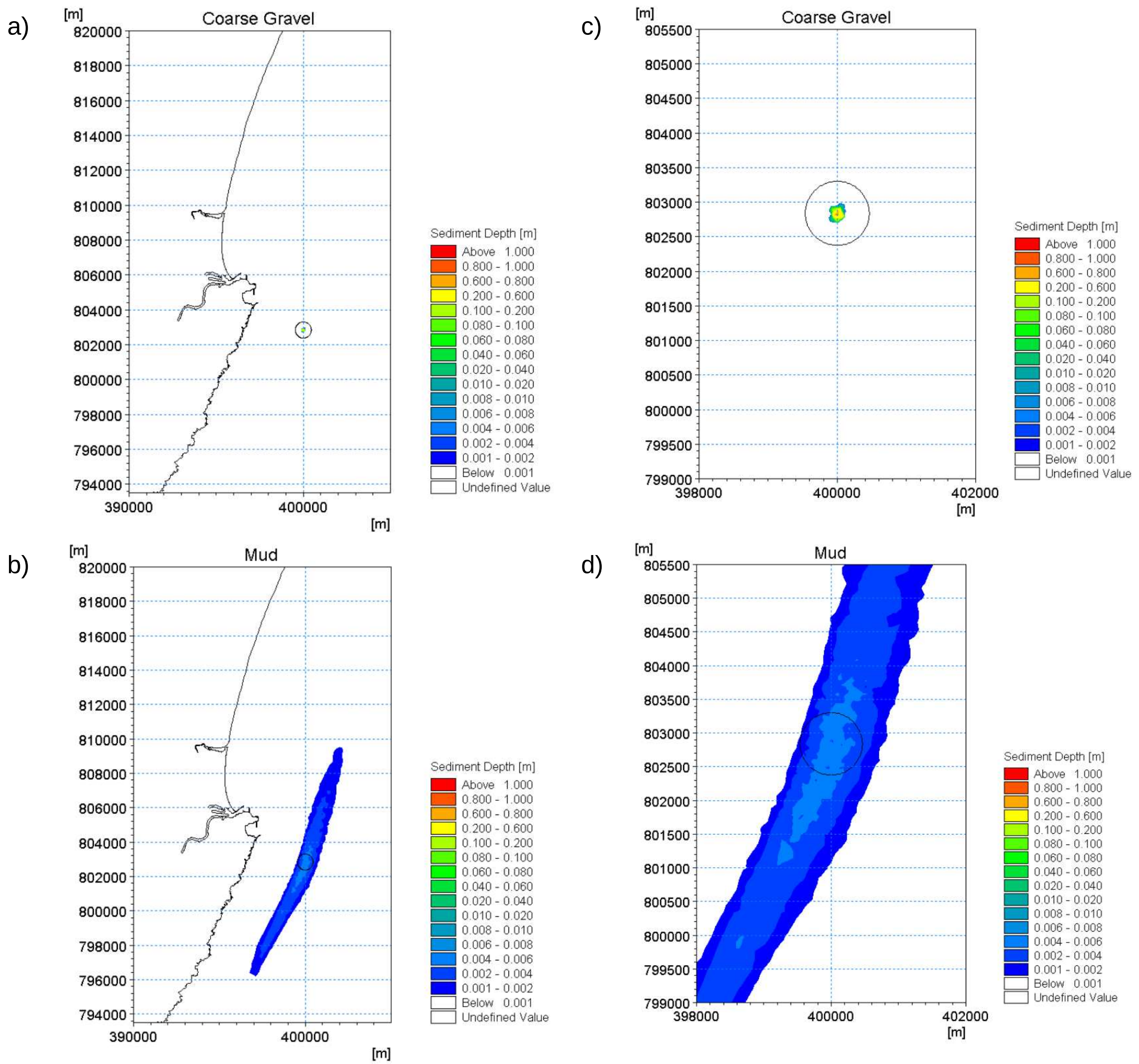

Figure 7.8: Redeposited coarse gravel shown (a) over a large extent, (b) local to the disposal site; and silt shown (c) over a large extent, (d) local to the disposal site for construction backhoe dredged material disposal

The potential effects of the deposition of suspended sediments on the seabed on each of the sediment quality receptor are described in the following paragraphs.

Effects on Sediment Quality

Analysis of sediments in the areas of Nigg Bay shows that contaminant levels are below the revised Marine Scotland Action Level 1, below which disposal of the sediment at sea is not considered to pose an environmental risk. Given these low levels of contaminants present in the sediment to be dredged, the settling of suspended sediments is not deemed to cause an increase in contaminant levels in the seabed of the disposal site and settling areas. In terms of sediment size, the seabed of the disposal area is deemed to have a similar composition to the material that will be deposited, given its long term use as a licensed disposal site. Hence the magnitude of the effect is considered to be negligible, and thus the effect is considered to be of **negligible** significance, which is not significant in EIA terms. As previously discussed, the contaminant levels of the sediments to be dredged in Nigg Bay are below the revised Marine Scotland Action Level 1. Therefore, the likelihood of the effect is hence deemed to be extremely unlikely, resulting in **low** risk to the environment.

7.6.3.5 <u>Release of Contaminants into the Water Column as a Result of Construction Activities</u>

Operational and accidental releases of chemicals into the marine environment such as fuel, oil and/or lubricants used by vessels and equipment during construction operations would introduce contaminants in the water column. Potential spills of stored chemicals are another source of pollutants into the marine environment during construction. The potential effects of accidental releases of contaminants on each of the receptors considered are described in the following paragraphs.

Effects on Bathing Waters

Releases of contaminants in the water column will not have an effect on designated Bathing Waters in the area, given that their classification status is determined only by bacteriological contamination.

Effects on RBMP Water Bodies

The release of contaminants in the water column may have an effect on the status of designated RBMP water bodies if compliance with Environmental Quality Standards (EQSs) of pollutants in water is compromised.

The magnitude of the effect would depend on the volume and nature of the spills, hence, there is the potential for an effect of moderate or major magnitude should a large or toxic pollutant spill occur. The Project area is located within the Don Estuary to Souter Head designated water body which was classified in 2013 as having an overall status of “poor”, hence its value is deemed as low. The overall significance of the effect is considered to be **moderate adverse**, which is significant in EIA terms.

In order to reduce the likelihood of such an event occurring, a Construction Environmental Management Plan (CEMP) including pollution prevention and contingency plans will be implemented, which will detail the control measures required for the safe storage and handling of potential pollutants, operation procedures and contingency measures to mitigate damage should an accidental event occur. SEPA’s Pollution Prevention Guidelines will be implemented during construction works. The likelihood of the effect is hence deemed to be extremely unlikely, resulting in a **low to moderate** risk to the environment.

7.6.4 Impacts During Operational Phase

7.6.4.1 Modification of Circulation Patterns

The presence of the north and south breakwaters and the modification of the local bathymetry as a result of dredging will alter the water circulation patterns in Nigg Bay and local area. As a worst case scenario it has been assumed for assessment purposes that the UFI outfall will discharge to the same location during the operational phase. This will result in modifications to the dispersion patterns of the substances discharged to the bay via the East Tullos Burn, the Ness Tip Burn and the UPI outfall.

In order to assess these impacts numerical water quality modelling has been undertaken. A screening process to select those substances to be modelled relevant from a WFD perspective was carried out. Changes to water circulation patterns and water quality were investigated by modelling of hydrodynamics, dispersion of tracer plumes and residence time of water within the new harbour area. The full WFD screening process and modelling reports can be found in ES Appendix 7-C: Water Framework Directive Assessment, ES Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment and ES Appendix 7-B: Water Quality Modelling Assessment.

As described in Section 7.4.4.2, contaminant sources considered in the modelling can be divided in two groups: those streams and outfalls discharging into Nigg Bay (the East Tullos Burn, Ness Tip Burn and UFI outfall); and discharges taking place outside of the development boundaries (the Nigg waste water outfall, the Girdle Ness CSO and the rivers Dee, Don and Ythan), as shown in Figure 7.1. This is a relevant distinction, given that results from the hydrodynamic model show that changes to water circulation as a result of the development will be localised in Nigg Bay, with no significant changes occurring in the wider coastal zone. Hence, any changes to the dispersion characteristics of existing discharges would be expected to be localised in the Nigg Bay area and affect principally those contaminants being discharged within its boundaries.

This is confirmed by the tracer plume modelling results (ES Appendix 7-B: Water Quality Modelling Assessment), which show as a general pattern that for those contaminants that are discharged into Nigg Bay, concentrations tend to increase in the harbour basin and entrance channel once the development is in place, due to the reduced water exchange with the offshore area. Percentage difference plots for these substances show that the increased pollutant concentrations tend to occur on the eastern side of the new harbour, against the inner wall of the northern breakwater coinciding with an area of reduced current speeds, while pollutant concentrations on the western area of the harbour basin decrease. Dissolved oxygen levels in the harbour basin significantly decrease to below the EQS after construction. Conversely, for those substances that are discharged to sea outside the development boundaries, the limited water exchange causes concentrations inside the new harbour area to decrease from those in the baseline situation. In the wider coastal area, contaminant dispersion patterns are not affected by the presence of the development.

This is confirmed by the dilution rates calculated from the modelling (ES Appendix 7-B: Water Quality Modelling Assessment), which decrease within the new harbour and its immediate vicinity after construction for discharges to Nigg Bay, but increase slightly for discharges out of the project boundaries. Dilution rates for the Girdle Ness CSO are expected to decrease within and close to the new harbour as a result of the modified circulation patterns imposed by the presence of the breakwaters.

Residence time modelling outputs further confirm the reduced water exchange as a result of harbour construction, with 90% of harbour water remaining inside its boundaries after 6 hours compared to 10% in the baseline situation. Model results also show that after 30 days, approximately 15% of the harbour water remains within its boundaries. The modelled average e-folding time (the time to increase by the factor e = 2 71828) after construction of the harbour is 342 hours (14.25 days).

In summary, as a result of construction of the proposed development, circulation will be restricted in the new harbour, with limited exchange with outer waters and an increased residence time of water within the bay. Contaminant dispersion patterns will be modified as a result, although these changes will be localised in Nigg Bay and the immediate surrounding area. A number of modelled pollutants will exceed their EQS in the new harbour basin: AA concentrations are exceeded for anthracene, benzo(bk)fluoranthene, C_{10-13} chloroalkanes, cadmium, chromium, DIN, hexachlorobutadiene, total ammonia and phenol; mercury exceeds its AA and MAC. All of these substances already exceeded their EQS in the baseline situation, mostly during low tides when dilution is lowest and the maximum concentrations are reached in the bay. After construction, modelled fluctuations of concentrations inside the harbour are greatly reduced, so exceedance of EQSs occur in a continuous manner. Levels of DO decrease significantly within the harbour after construction.

The potential effects of modified circulation patterns on each of the receptors considered are described in the following paragraphs.

Effects on Bathing Waters

The main discharges and outfalls that can potentially alter water quality at the nearby bathing waters are the Ness Tip Burn, the UFI outfall, the Nigg waste water plant outfall and the Girdle Ness CSO, given the high levels of *E. coli* present on these streams. Increased *E. coli* levels in bathing waters can result in the waters being classified as of ‘poor’ status if standards are exceeded.

As explained in the previous paragraphs, once the development is in place the limited water exchange within Nigg Bay will result in pollutants from the Ness Tip Burn and UFI outfall being primarily retained within the new harbour. The modelled dilution rates for the Nigg waste water outfall and CSO discharges at the Aberdeen Ballroom Bathing Water area decrease after construction of the development due to a modified circulation pattern during ebb tides, but these changes do not result in an increased risk or a change to Bathing Waters classification. Tracer modelling results shows maximum *E. coli* concentrations at Aberdeen Ballroom below 250 *E coli* (ec)/dl in the post-development situation, corresponding to an ‘Excellent’ classification under the BWD. As such, the magnitude of the effects of the development on bathing waters is considered to be negligible. Aberdeen Ballroom Bathing Waters were classified as of ‘Mandatory’ standard in 2014, corresponding to a very high value of the receptor. Hence, the effect has been assessed as of **minor adverse** significance, which is not significant in EIA terms. As previously discussed, tracer modelling results shows maximum *E. coli* concentrations at Aberdeen Ballroom in the post-development situation correspond to an ‘Excellent’ classification under the BWD. Therefore, the likelihood of the effect is deemed to be unlikely, resulting in a **low** risk to the environment.

Effects on RBMP Water Bodies

Water bodies under the RBMP are classified according to their ecological and chemical status. The ecological and chemical statuses are then combined to provide an assessment of the overall water body status.

The ecological status is assessed based on three elements, with the overall ecological status determined by the lowest-classed element: biological (water plants and animals), physico-chemical (oxygen, nutrient levels) and hydro-morphological (water flows, condition of beds and shores).

The chemical status is assessed based on whether or not the Environmental Quality Standards for priority substances and other dangerous substances at EU level are being exceeded.

Hence, the modified circulation patterns due to the presence of the development may have an effect on the classification of nearby water bodies by affecting the following elements:

- Ecological status:
  - Changes to the physico-chemical element as a result of reduced dissolved oxygen levels and increased nutrient levels inside the new harbour after construction;
  - Changes to the hydro-morphological element as a result of modified circulation patterns and the presence of the breakwaters and quays; and
- Chemical status:
  - Changes to the chemical status as a result of modified dispersion patterns of pollutants, causing increased concentrations inside the new harbour and exceedance of EQS.

Changes to the biological element of the classification status of surrounding water bodies have been assessed in Chapter 12: Benthic Ecology and ES Appendix 7-C: Water Framework Directive Assessment.

A Water Framework Directive Assessment (WFDA) has been undertaken to assess the potential effects of the proposed development on the nearby designated water bodies. The full methodology and results are provided in ES Appendix 7-C: Water Framework Directive Assessment. The WFDA comprised the following steps to evaluate the consequences of the development on the designated RBMP water bodies:

- Identification and characterisation of the water bodies that can potentially be affected by the proposed development;
- Assessment of the potential impacts of the development on the WFD classification elements and objectives, for the assessed water bodies. These objectives were:
  - The development not to cause a deterioration in the status of the elements of the water bodies identified in the previous step;
  - The development not to compromise the ability of the water bodies to meet their WFD status objectives;

- The development not to cause a permanent exclusion or compromise achieving the WFD objectives in other water bodies within the same River Basin District; and
- The development contributes to the delivery of the WFD objectives.

The Don Estuary to Souter Head and the Dee (Aberdeen) Estuary water bodies, shown in Figure 7.2, were identified as having the potential to be affected by the proposed harbour expansion. As described in Section 7.5.2.3, the 'Don Estuary to Souter Head' water body was classified as having 'Poor' overall status in 2013 due to a 'Poor' classification in the hydro-morphological element. The target for this water body is to make sustainable improvements to its status over time or alternatively to ensure no deterioration in its status. The 'Dee (Aberdeen) Estuary' water body has been classified as of 'Good ecological potential' from 2008 onwards. The identified pressures on this water body are morphological alterations and diffuse source pollution as a result of construction, dredging and/or water transport; and the target for next assessment is a status of 'Pass'.

Don Estuary to Souter Head Water Body

The WFDA determined that the proposed development is anticipated to result in a localised deterioration of the following elements of this water body within the area occupied by the proposed development:

- Ecological status:
  - Deterioration to the physico-chemical element as a result of reduced dissolved oxygen levels and increased nutrient levels inside the new harbour after construction, as shown by the water quality modelling results; and
  - Deterioration of the hydro-morphological element as a result of the presence of the breakwaters and quays in Nigg Bay.
- Chemical status:
  - Deterioration of the chemical status as the modified circulation patterns will cause a number of pollutant concentrations (including priority substances and specific pollutants) to increase inside the new harbour over their EQS, as shown by the water quality modelling results.

Based on the results of the water quality modelling described above, no deterioration of the ecological and chemical status of this water body is anticipated to occur outside of the boundaries of the proposed development, so this effect is not considered to be significant at a water body level.

The magnitude of the effect on the Don Estuary to Souter Head water body is considered to be major due to the permanent change to water quality parameters and hydro-morphology within the boundaries of the new harbour, although this change will be localised over a small area of the water body (approximately 1.5% of the total area). This water body was classified in 2013 as having an overall status of "Poor", hence its value is deemed as low. The overall significance of the effect is considered **moderate adverse**, which is significant in EIA terms. As previously discussed, water quality modelling deemed this effect to be not significant at a water body level. Therefore, the likelihood of the effect is deemed to be unlikely, resulting in a **low to medium** risk to the environment.

Dee (Aberdeen) Estuary Water Body

The magnitude of the effect of the development on the Dee (Aberdeen) Estuary water body is considered to be negligible as modelling results show no noticeable changes to circulation patterns in this water body, so no changes to contaminant dispersion and water quality are anticipated. This water body was classified in 2013 as of 'Good Ecological Potential' in 2013, corresponding to a receptor of high value. The effect has thus been assessed as of **negligible** significance, which is not significant in EIA terms. As previously discussed, modelling results show no noticeable changes to circulation patterns in this water body. Therefore, the likelihood of the effect is deemed to be unlikely, resulting in a **low** risk to the environment.

7.6.4.2 <u>Increased SSC in the Water Column and Release of Sediment-Bound Contaminants</u>

Maintenance dredging takes place in the existing Aberdeen Harbour each year to remove the sediment accumulated in the harbour. The amount of material dredged is variable from year to year, depending on the duration and intensity of winter storms. The dredged sediment is disposed of at the existing licensed marine site CR110 offshore of Aberdeen.

During the operational phase of the proposed development, regular maintenance dredging will be required to ensure the required water depths are maintained in the harbour basin and entrance channel. It is intended to dispose of the material dredged at sea, at the existing licensed site currently used by Aberdeen Harbour and proposed for disposal of capital dredging material. These operations will result in a series of impacts, namely an increase in SSCs in the dredge and disposal areas and the potential release into the water column of contaminants bound to the dredged sediment.

The extent and volume of dredged material arising from these maintenance operations will be significantly smaller than those required during the construction phase. Hence, any impacts arising from these operations are anticipated to be of a significantly smaller magnitude than those occurring during the construction phase and similar to those caused by the current maintenance dredging operations at Aberdeen Harbour. Impacts will occur in an intermittent manner (when maintenance dredging operations take place) and be of shorter duration than those related to the construction phase.

Cumulative impacts can arise from an overlap of maintenance dredging at the new harbour site and the existing Aberdeen Harbour. However, as described in the paragraphs above, these cumulative impacts are anticipated to be of much lower magnitude than those during the construction phase given the much smaller volumes of material involved.

Effects on Bathing Waters

Given the significantly lower magnitude of the effects on Bathing Waters arising from maintenance dredging operations compared to those from capital dredging (which were assessed as of minor adverse significance in Section 7.6.3), effects from maintenance dredging have been assessed as being of **negligible** significance, which is not significant in EIA terms. As previously discussed, increased SSCs in the water column will not have an effect on designated bathing waters and plume modelling indicates that sediment suspended would not reach nearby Bathing Waters. Therefore, the likelihood of the effect is hence deemed to be extremely unlikely, resulting in **low** risk to the environment.

Effects on RBMP Water Bodies

Effects on RBMP water bodies arising from capital dredging operations were assessed as being of negligible significance in Section 7.6.3. Given that effects arising from maintenance dredging operations will be of smaller magnitude, these have been also assessed as being of **negligible** significance, which is not significant in EIA terms. As previously discussed, Increased SSCs do not have a direct effect on the classification of designated water bodies under the Scotland RBMP. Additionally the very low levels of contaminants in the dredged sediment suggest that any increases in pollutant concentrations in the water column as a result of sediment resuspension will be negligible. Therefore, the likelihood of the effect is hence deemed to be extremely unlikely, resulting in **low** risk to the environment.

7.6.4.3 <u>Deposition of Suspended Sediments on the Seabed</u>

The sediment disturbed during maintenance dredging operations will be dispersed over a wider area due to wave and current action, before resettling on the seabed. Similar impacts will occur in the disposal area.

The volume of dredged material will be significantly smaller than that required during the construction phase, resulting in a smaller sediment plume and dispersion area, further reduced by the presence of the breakwaters in the case of the plume generated in the dredging area. Maintenance dredging will remove sediment accumulated over the previous year, therefore it is anticipated that contaminant levels in the sediment will be low given that contaminated sediments tend to be associated with historic industrial pollution (in material that has not been dredged for many years) or recent pollution events (which are rare given the strict controls on potentially polluting activities). This is the situation in the existing Aberdeen Harbour, where analysis of sediment for previous maintenance dredging works have shown sediments to present contaminant levels below the revised Marine Scotland Action Level 1 (Aberdeen Harbour, 2012). Hence, any impacts arising from maintenance dredging within the proposed development are anticipated to be of a smaller magnitude than those occurring during the construction phase, and similar to those caused by the current maintenance dredging operations at Aberdeen Harbour.

Cumulative impacts can arise from an overlap of maintenance dredging at the new harbour and the existing Aberdeen Harbour. As described in the paragraphs above, these cumulative impacts are anticipated to be of much smaller magnitude than those during the construction phase given the much smaller volumes of material involved. The operational hydrodynamic regime is predicted to mobilise sediment and sculpt the seabed morphology at the disposal site in a similar manner to the baseline conditions. Model outputs predict that seabed depth would vary between +1 mm and -7 mm across the model data extraction locations. The negative value (i.e. a reduction in seabed level) reflects the natural variation in the seabed; this effect is not a direct impact of the dredging and disposal activity. The magnitude of the impacts is considered to be **negligible**.

Effects on Sediment Quality

Effects on sediment quality arising from capital dredging operations were assessed as being of negligible significance in Section 7.6.3. Given that effects arising from maintenance dredging operations will be of lower magnitude, these have been also assessed as being of **negligible** significance, which is not significant in EIA terms. As previously discussed, the contaminant levels of the sediments to be dredged in Nigg Bay are below the revised Marine Scotland Action Level 1. Therefore, the likelihood of the effect is hence deemed to be extremely unlikely, resulting in **low** risk to the environment.

7.6.4.4 Release of Contaminants into the Water Column and Sediment due to Operational Activities

A number of activities have the potential to cause impacts on the water and sediment quality of the new harbour and surrounding coastal area. These include operational and maintenance activities in buildings, quays and vessels such as storage and transfer of materials, handling of cargo, discharges of cleaning products, the use of chemicals to prevent hull fouling, deck washing, fuelling/bunkering activities and propeller wash from vessels. Potential impacts include chemicals, residues and waste entering the water or sediment (directly or via drains). Propeller wash from vessels may result in the resuspension of sediment within the harbour, causing increases in SSC. Accidental spills are another potential source of pollution into coastal waters.

Although the increase in SSC associated with the passing of a vessel will be taking place frequently during the operational life of the harbour, it is anticipated to be of short duration, with the generated sediment plume being dispersed over a very localised area. Hence its magnitude has been classified as minor.

Antifouling paints used in ship hulls contain biocide agents, with copper being the biocide agent most used after the ban of TBT in 2008. Copper is a naturally occurring element, but it can have toxic effects at high concentrations, and antifouling paints can be one potential source of copper into the marine environment. These paints can enter the water column during application or removal of the paint coating, as a result of leaching from the hulls of vessels or from inappropriate discard of paint remnants (EA, 1998), resulting in increased levels of copper in the water.

Pollutant discharges within the new harbour limits are likely to be retained in the harbour basin due to the enclosure provided by the breakwaters, as reflected in ES Appendix 7-B: Water Quality Modelling Assessment, which shows that the residence time of pollutants within the proposed new harbour area will be significantly increased from the baseline stage. Although its extent is deemed to be limited to that of the new harbour boundaries, the magnitude of the impact arising from a pollutant release or accidental spill will vary depending on the type of activities taking place, the nature of the substance or material released and the volumes released.

In order to reduce the likelihood and magnitude of operational and accidental releases of substances to the water column and sediments occurring, an Environmental Management Plan (EMP) will be developed, which includes an assessment of the risks associated with operational activities and risk mitigation measures. The measures to be adopted are described in Section 7.7.1. These cover aspects such as operation and maintenance of roads, vehicles, quays and vessels, cargo handling or storage of supplies.

Effects on RBMP Water Bodies

With risk reducing measures in place to minimise releases to the environment during the operational phase of the development, any effects are deemed to be reduced to a minor magnitude. The value of the receptor has been classified as low, resulting in an effect of **minor adverse** significance, which is not significant in EIA terms. In order to reduce the likelihood of such an event occurring, an Environmental Management Plan (EMP) will be implemented during the operational phase of the new harbour to reduce the risk of pollutant releases to the environment and/or accidental spills. Contingency measures will mitigate damage should an accidental event occur. SEPA's Pollution Prevention Guidelines will be implemented during operation. The likelihood of the effect is hence deemed to be extremely unlikely, resulting in a **low** risk to the environment.

7.7 Mitigation and Residual Effects

7.7.1 Built-In Mitigation

A number of mitigation measures have been incorporated as part of the project design and are described below.

- The north and south breakwaters are likely to be (at least partially) constructed during the initial stages of the proposed development. This will provide an semi-enclosed environment for the remainder of the works (dredging operations in the basin and entrance channel, and quay construction), which will help to reduce the extent of impacts on water and sediment quality arising from these construction activities;
- An Environmental Management Plan (EMP) will be implemented during the construction and operational phase of the new harbour to reduce the risk of pollutant releases to the environment and/or accidental spills, including as a minimum the following measures:
  - Surface water drains will either drain to a sewer or be fitted with interceptors/silt-traps and shut off valves as appropriate;
  - Materials will be stored as per specifications in appropriately designed containers and staff will be trained to ensure chemicals are appropriately disposed of;
  - Staff will be trained in the prevention measures to adopt during maintenance, cleaning and repainting of vessels. Hull cleaning operations and substantial vessel maintenance will ake place within dry dock facilities within the existing Aberdeen Harbour;
  - Bunkering operations are completed only by trained personnel with constant presence at valves, sight gauges and 'stop' switches; and
  - A Spill Contingency Plan will be in place in the harbour. Dock Control Officers will patrol the area regularly for spills; stocks of absorbents will be maintained and staff will be trained to report and clean-up spills immediately.

SEPA's Pollution Prevention Guidelines as detailed in Section 7.1.4 will also be enforced during construction and operation of the proposed development.

7.7.2 Residual Effects

The majority of potential effects on water and sediment quality have been judged to be of negligible or minor adverse significance based on the localised and temporary nature of the effects, which is not significant in EIA terms. Specific mitigation in these regards is, therefore, not considered to be necessary.

The identified effects of moderate adverse significance are those related to releases or spills of contaminants during construction activities, should they be of a major magnitude (albeit the risk of these events occurring is considered to be low); and effects on the designated Don Estuary to Souter Head RBMP water body classification status as a result of the presence of the development. Development of, and adherence to, pollution prevention and contingency plans as part of overall construction and operational EMPs will reduce the risk and magnitude of spillages occurring and of the effects on water quality. The residual effects related to releases or spills of contaminants during construction activities are considered to be of **minor adverse/negligible** significance, which is not significant in EIA terms. With appropriate best practice, risk management and spill response procedures in place, it is anticipated that residual effects will be short term in nature and would be unlikely to affect RBMP water body status.

7.8 Cumulative Impacts

Table 7.10 shows a list of the developments and activities in the wider area that have been taken into consideration for assessment of potential cumulative effects. The list is a subset of that provided in Chapter 5: Environmental Impact Assessment Process, which also shows the location of these developments with regards to the project. Only these projects were considered for cumulative impact assessment as the other projects were considered too distant to have any discernible effect above background variation, and were therefore screened out.

Table 7.10: Projects considered for cumulative assessment

Development/Activity	Description	Location	Distance [km]	Planning Status
Existing AHB Maintenance Dredging	Maintenance Dredging in the mouth of the River Dee	River Dee	2	Ongoing licensed activity
European Offshore Wind Deployment Centre (EOWDC)	Offshore wind demonstrator	Aberdeen	10	Consent approved. Under legal challenge
Kincardine Offshore Wind Farm (KOWF)	Floating offshore wind farm	Aberdeen	12	Application

7.8.1 Cumulative Increased SSCs

Cumulative increases in SSC may arise from the overlapping of the sediment plumes generated by dredging activities associated with the Aberdeen Harbour Expansion Project, existing maintenance dredging in the mouth of the River Dee, and the installation of offshore wind turbine foundations and power cables of the projects listed in Table 7.10. The extent over which the sediment plumes disperse will depend on the prevalent currents at the time of dredging and the nature and amount of material being dredged.

7.8.1.1 <u>Existing AHB Maintenance Dredging</u>

As described in Section 7.6.3.1, capital dredging operations in Nigg Bay will result in a series of localised short lived episodes of increased SSC restricted to Nigg Bay itself. Figure 7.3 shows that peak SSC from TSHD overspill is not predicted to exceed 100 mg/l to 200 mg/l north of Girdle Ness, and average plumes are not predicted to extend beyond the mouth of Nigg Bay.

The disposal of the dredged material at the licensed disposal site will also result in intermittent short lived episodes of elevated SSC. However, Figure 7.5 and Figure 7.6 show that the spatial extent, maximum and average SSC of plumes caused by construction TSHD and backhoe dredge material disposal are significantly smaller that for the existing baseline of licensed maintenance dredging for the existing harbour.

The characteristics of the disposed sediment and local hydrodynamic regime predicted quick settling times and extremely localised high SSC predicted for coarse sediments for both baseline maintenance dredging and construction dredging individually. This is also the case for modelling cumulative impacts for maintenance and construction dredging combined.

Peak rates were modelled for cumulative TSHD and AHB maintenance disposal, but this is unlikely to have any relevance to real world scenarios as the peak SSC are extremely short-lived events at the point of release, and two vessel would be unlikely to release at the same time. However comparisons between the disposal site and nearby data extract points, and comparisons between peak and average SSCs demonstrates the localised and short-lived nature of these events, even when considered cumulatively.

Peak SSC for cumulative TSHD and AHB at the disposal site was 29,169 mg/l, falling more than an order of magnitude to 2,774 mg/l at 708 m to the north, and to 2,363 mg/l at 886 m to the south. Average SSC was more than 35 times lower at the disposal site, at 813 mg/l. Average SSC falls to 101 mg/l at 463 m to the north and to 106 mg/l at 463 m to the south. These cumulative average levels are within natural background variability less than 0.5 km from the disposal site.

7.8.1.2 Kincardine and European Offshore Wind Farms

The KOWF will comprise floating turbines, therefore any increased SSCs from the construction activities will be limited to installation of the subsea cables. These impacts are anticipated to be very localised and temporary (Atkins, 2014), however, there is the potential for the timing of operations to overlap with dredging operations for Aberdeen Harbour Expansion Project. In addition, one of the two cable routes proposed for the KOWF lands at Nigg Bay. Installation of the turbine foundations and offshore cables at the EOWDC will disturb up to 428,100 m^3 (23,100 m^3 for foundation installation and 405,000 m^3 for cable laying) of sediment during seabed preparation works. Therefore, there is the potential for cumulative effects from these proposals.

No numerical modelling of SSC arising as a result of the proposed works at the KOWF has been undertaken, given that the ES is in preparation at the time of writing. However, modelling was undertaken to assess impacts from the EOWDC. Results show that localised maximum increases in SSC of 100 mg/l occur as a result of foundation installation works in the wind farm area and the northern side of Girdle Ness. These SSC are however short-lived, and 64 days after installation of all turbines SSC return to 4 to 16 mg/l in the Nigg Bay area and up to 60 mg/l in the northern side of Girdle Ness. SSC as a result of cable installation works reach similar levels of up to 100 mg/l in the EOWDC area, although these are also localised and short term; and SSC in the Nigg Bay area stay within background levels (Vattenfall, 2011). Similar localised increases in SSC can be anticipated from cable laying works for the KOWF given the close proximity of both proposals to Nigg Bay.

7.8.1.3 Cumulative Effects on Designated Water Bodies

Average SSCs measured at Nigg Bay ranged between 144 mg/l and 24 mg/l, with high turbidity events raising SSC to levels of between 529 mg/l and 899 mg/l (see Section 7.5.3.1). Therefore, any cumulative increases in SSC in the water bodies surrounding Nigg Bay are anticipated to be within the natural range of SSC in the area. Furthermore, should the construction activities overlap, the resulting increased high turbidity episodes will be of short duration as shown by the modelling results, before SSC fall back to background levels.

Hence, any cumulative effects on designated water bodies (Don Estuary to Souter Head and Dee (Aberdeen) Estuary) arising from increased SSCs are deemed to be of negligible magnitude, resulting in a cumulative effect of **negligible** significance, which is not significant in EIA terms. As discussed, cumulative increases in SSC in Nigg Bay can be anticipated to be within the range of natural range in the area. Therefore' the likelihood of the effect is deemed to be extremely unlikely, resulting in a low risk to the environment.

7.8.2 Cumulative Deposition of Sediment Plumes

7.8.2.1 Existing AHB Maintenance Dredging

Conservative model outputs predict a maximum combined change in the depth of the seabed of approximately 5.3 m. Whilst this is likely to be an overestimate, model outputs also show that the local hydrodynamic regime will mobilise the deposits, and reform the seabed morphology over the duration of the dredging programme, ensuring the maximum predicted change will be naturally eroded to a lower level over time.

7.8.2.2 Kincardine and European Offshore Wind Farms

The sediment re-suspended during the construction and operational activities of the project will settle back on the seabed in the area surrounding the disposal area as described in Section 7.6. This may result in an overlap with the settling areas of plumes generated by the installation of the offshore wind turbine foundations and power cables of the projects listed in Table 7.10 should they occur simultaneously.

Due to the fine nature of the sediments suspended by the construction activities at EOWDC it was found there was little potential for measurable deposition of material within the Aberdeen Bay area, but the material would instead become widely dispersed in the offshore environment (Vattenfall, 2011). Similar results can be anticipated from cable laying works at the KOWF should the Nigg Bay cable landing option be selected. Therefore, no significant deposition of material on the seabed as a result of cumulative sediment plumes is anticipated to occur. Any cumulative effects are deemed to be of negligible magnitude, resulting in a cumulative effect of **negligible** significance, which is not significant in EIA terms. As discussed, there was little potential for measurable deposition and that the material would instead become widely dispersed. Therefore, the likelihood of the effect is deemed to be unlikely, resulting in a **low** risk to the environment.

7.8.3 Cumulative Changes to Circulation Patterns

The combined presence of the EOWDC, the KOWF and the proposed development at Nigg Bay may result in a cumulative impact to hydrodynamics in the area, which in turn could impact the dispersion characteristics of discharges to the coastal area.

Impacts on hydrodynamics arising from the presence of the EOWDC are anticipated to be negligible, with water levels, wave heights and current regime being unaffected by the development, or small modifications within the range of natural variation being confined to the boundaries of the wind farm (Vattenfall, 2011). Similarly, no significant changes to hydrodynamics are anticipated to occur as a result of the physical presence of the KOWF given the small number of floating turbines it will comprise (Atkins, 2014).

Water circulation and contaminant dispersion patterns will be most affected by the development in the area directly affected within Nigg Bay, while impacts in the offshore area will be negligible, as shown in ES Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment. Therefore, no cumulative impacts on water circulation and pollutant dispersion patterns are anticipated to occur given the distances to the EOWDC and KOWF developments, and the negligible impact these are expected to have on the hydrodynamics of the wider area.

7.9 Summary and Conclusions

This chapter provides an assessment of effects on water and sediment quality receptors as a result of the Aberdeen Harbour Expansion Project. Receptors considered are designated water bodies under the Scotland RBMP, Bathing Waters and sediment quality. The development is located within the Don Estuary to Souter Head RBMP water body, and the Dee (Aberdeen) Estuary water body is located nearby. The Aberdeen Ballroom Bathing Waters are located approximately 1 km to the north of the proposed development. The status of the designated water bodies will be unchanged by construction and operation of the development.

Effects arising from potential releases or spills of contaminants during construction activities, should they be of a major magnitude; and effects on the designated Don Estuary to Souter Head RBMP water body classification status as a result of the presence of the development are anticipated to be of moderate adverse significance. The remainder of effects on water and sediment quality are predicted to be, in general, of negligible to minor adverse significance based on their localised and temporary nature.

Mitigation options include the implementation of an Environmental Management Plan during construction and operation, which will ensure that the magnitude of any potential impacts on water and sediment quality is minimised.

Table 7.11 summarises the outcome of the assessment of potential effects on water and sediment quality receptors as a result of the Aberdeen Harbour Expansion Project.

Table 7.11: Summary of effects

Impact	Receptor	Significance of Effect	Mitigation Proposed	Residual Effect
Construction				
Sediment disturbance	RBMP designated water bodies	Negligible	Adherence to CEMP	Negligible
Release of sediment-bound substances into the water column due to sediment resuspension	Bathing Waters	Minor adverse	Adherence to CEMP	Negligible
	RBMP designated water bodies	Negligible		
Redeposition of suspended sediments on the seabed	Seabed sediments at disposal area	Negligible	Adherence to CEMP	Negligible
Increased contaminant levels in water	RBMP designated water bodies	Moderate adverse	Adherence to CEMP and PPG	Minor adverse
Operation				
Modification of water and sediment circulation patterns	Bathing Waters	Minor adverse	None	Moderate adverse
	RBMP designated water bodies	Moderate adverse		
Sediment disturbance	RBMP designated water bodies	Negligible	Adherence to risk reducing measures and PPG	Negligible
Release of sediment-bound substances into the water column due to sediment resuspension	Bathing Waters	Minor adverse	Adherence to risk reducing measures and PPG	Negligible
	RBMP designated water bodies	Negligible		
Redeposition of suspended sediments on the seabed	Seabed sediments at disposal area	Negligible	Adherence to risk reducing measures and PPG	Negligible
Increased levels of contaminants in water	RBMP designated water bodies	Minor adverse	Adherence to risk reducing measures and PPG	Negligible

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