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REPORT

Withernsea Wastewater Treatment Works Long Sea Outfall (LSO) Replacement

Environmental Statement

Client: Yorkshire Water Services

Reference: I&BPB5063R100F01
Status: 1.0/Final
Date: 15 February 2019

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Classification
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Acronyms

Acronym	Acronym description
AONB	Area of Outstanding Natural Beauty
BAP	Biodiversity Action Plan
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CIRIA	Construction Industry Research and Information Association
CWS	Country Wildlife Site
DAS	Discretionary Advice Service
DCLG	Department for Communities and Local Government
DEMP	Demolition Environmental Management Plan
EIA	Environmental Impact Assessment
ERYC	East Riding Yorkshire Council
ES	Environmental Statement
ESR	Environmental Scoping Report
HDD	Horizontal Directional Drilling
HDPE	High-density polyethylene
HGV	Heavy Goods Vehicle
HRA	Habitats Regulations Assessment
IEMA	Institute of Environmental Management & Assessment
LNR	Local Nature Reserve
LSO	Long Sea Outfall
MCZ	Marine Conservation Zone

Acronym	Acronym description
MHWS	Mean High Water Springs
MLW	Mean Low Water
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MWR	Marine Works Regulations
nm	Nautical Miles
NNR	National Nature Reserve
NPPF	National Planning Policy Framework
NPS	National Policy Statement
RHDHV	Royal HaskoningDHV
SAC	Special Area of Conservation
SMP	Shoreline Management Plan
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TCPA	Town and County Planning Act
WFD	Water Framework Directive
WwTW	Waste Water Treatment Works

1. Introduction

1.1. Background

Yorkshire Water Services Ltd. (YWS) is proposing the construction of a new long sea outfall (LSO) on the Holderness Coast in the East Riding of Yorkshire, to discharge treated wastewater (in compliance with the EA discharge consent) from Withernsea and its surrounding catchment. This one element of a wider onshore project, which comprises the demolition of the existing Withernsea WwTW, a replacement WwTW, a new rising main and a connection from the new rising main to the existing Hollym Sewage Pumping Station (SPS). A number of storm events occurring at the current site location have amplified the rates of erosion, causing the existing LSO to be under threat from the sea. This has accelerated the need for a new LSO, alongside the wider onshore project, prior to the lapse in design life (due to be 2051).

The new LSO will extend 3.4km from the new WwTW, to the east of Hollym village (**Figure 1.1**). The terrestrial section (above Mean High Water Springs (MHWS)) is approximately 2.3km in length. The intertidal and subtidal sections (below MHWS), will be approximately 1.1km in length, from the toe of the cliff (MHWS) to a point up to a maximum of 50m to the south of the permitted discharge point of the existing LSO.

The elements of the onshore project were 'screened' in January 2018 under the requirements of the Town and Country Planning (Environmental Impact Assessment) Regulations 2017. The Local Planning Authority (LPA), East Riding of Yorkshire Council (ERYC), confirmed in January 2018 that the proposed scheme did not require EIA under these Regulations (**Appendix A**).

Planning permission under Town and Country Planning Act 1990 (TCPA 1990) was subsequently granted by ERYC, in October 2018, for the new WwTW (**Appendix B**). The demolition of the existing WwTW, the terrestrial length of the LSO and the rising main will be built under YWS' Permitted Development Rights through the Town and Country Planning (General Permitted Development) (England) Order 2015, Part 13 of Schedule 2.

1.2. Purpose of the report

The works below MHWS, comprising the construction of the intertidal, and subtidal length of the LSO, were screened by the Marine Management Organisation (MMO) in January 2018 under the requirements of the Marine Works (Environmental Impact Assessment) Regulations 2007, as amended by the Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2017 (the MWRs). The MMO confirmed in February 2018 that the new LSO (with decommissioning of the existing LSO) required an Environmental Impact Assessment (EIA) under the MWRs (**Appendix C**). The purpose of this Environmental Statement (ES) is therefore to provide details for the EIA undertaken under the MWRs, covering the construction of the marine sections of the LSO (hereafter referred to as 'the proposed scheme').

Whilst impacts from the onshore project to terrestrial receptors are assessed under the application for planning permission under TCPA 1990, where relevant, this report assesses the cumulative or in-combination impacts of the terrestrial works on marine receptors.

534000
536000
538000
428000
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424000
N
0
500 Metres
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Legend

- Proposed Scheme Boundary
- LSO Section above MHWS
- Withernsea WwTW Planning Boundary
- Rising Main Boundary
- New LSO
- Existing LSO
- HDD/Microtunnelling Site Compound
- Existing Wastewater Treatment Works
- MHWS

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title: Withernsea WwTW, Rising Main and LSO Site location

Figure: 1.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid

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Consent under the requirements of Part 4 of the Marine and Coastal Access Act 2009 (as amended) (MCAA 2009) is required for works to construct the proposed scheme, below the level of MHWS (i.e. a Marine Licence). This ES is therefore submitted to the MMO in support of a Marine Licence application.

1.3. Study area

The study area is the geographic extent over which the direct and indirect potential impacts of the proposed scheme may be detected during its construction, operational and decommissioning phases. The overall study area comprises the intertidal and subtidal areas located within and adjacent to the boundary of the proposed scheme shown in **Figure 1.1**.

The maximum extent of the potential impact has been determined to be the area over which the potential effects of the proposed scheme on tidal currents and sediment transport may occur. Such effects have the potential to affect other parameters, such as marine ecology, waterbird populations and water quality. Detailed study areas for each topic are provided within the relevant section of this ES.

1.4. Structure of the ES

Section 1 outlines the background to the proposed scheme and defines the study area. **Section 2** presents a description of the proposed scheme, outlining the need and alternatives. **Section 3** discusses the relevant legislative framework, identifying the consents and licences required. **Section 4** describes the EIA process and defines the EIA methodology adopted. **Section 5** outlines the consultation undertaken. **Section 6** outlines the designated nature conservation sites.

Sections 7 to **12** contain the technical assessments of the potential impacts of the proposed scheme. These sections describe the nature of the existing (baseline) environment for the various parameters considered during the EIA process. The potential impacts of the proposed scheme during the construction, operational and decommissioning phases on each of these parameters are then identified, assessed and, where appropriate and practicable, mitigation measures are defined. The residual impacts (potential impacts remaining assuming the proposed mitigation measures are effectively implemented) are then assessed.

These sections are followed by the Cumulative Impact Assessment (CIA) in **Section 13,** which includes detail on potential impacts to the marine and coastal environmental baseline from other nearby projects and plans, including the onshore project elements**.**

Section 14 considers the implications of the proposed scheme under the requirements of the Water Framework Directive (WFD), whilst **Section 15** forms the Habitats Regulations Assessment (HRA), which considers the implications of the proposed scheme for the designated status of relevant European and internationally designated sites. Additionally, **Section 16** considers potential effects of the proposed scheme on the nearby Marine Conservation Zone (MCZ).

Finally, **Section 17** presents the summary and conclusions of this ES and **Section 18** lists the references used.

2. Description of the Proposed Scheme

2.1. Need for the proposed scheme

2.1.1. Background

The marine (intertidal and subtidal) length of the existing LSO was constructed in 1991 and due to be in place until 2051, with a 60-year design life. Although the original design of the outfall took into consideration the predicted seabed changes and cliff erosion at the time (approximately 2m per year), recent significant storm events at the site location in 2015 and 2016 have amplified the rates of erosion. This has accelerated the predicted seabed level changes and cliff erosion rates, putting the existing LSO at risk, which are now predicted to be inoperable within the next 10 to 15 years. As an indication of the rate of erosion, the cliff top has receded by 16.6m since December 2015 (Royal HaskoningDHV, 2017).

Since the production of the above information, regular monitoring of the beach levels and cliff is being undertaken until the proposed scheme has been completed. An asset inspection, undertaken in January 2017, identified that the existing LSO protection, comprising a concrete tunnel, had become exposed on the foreshore. This resulted in external damage of the concrete, from a point close to the base of the cliff edge within the intertidal zone and extending some 100m offshore. Although the pipe is not currently visible, it is anticipated that exposure is imminent, especially where segments of the concrete tunnel are broken and exposed. The pipe is therefore unstable and at risk of damage due to wave action and impact damage from cliff material - particularly boulders - as the cliff continues to erode. The likelihood of pipe collapse and damage is considered to be high, causing a high risk of pollution to the beach.

Temporary pipe protection was installed within the intertidal zone in December 2017 (under Marine Licence reference: L/2017/00420/3) to provide a short-term solution until implementation of the proposed scheme. The installation of the temporary pipeline protection works is not intended to, and will not stop erosion of the cliff adjacent to the outfall on both sides. The purpose of these works is to reduce the risk of further damage to the existing LSO and, in turn, reduce the risk of a pollution event. It is envisaged that the predicted cliff erosion rates will continue unabated where no protection is provided.

2.1.2. Consideration of alternatives

The LSO route is dictated by the relocation of Withernsea WwTW, therefore the assessment of alternative location options for the WwTW is key to understanding the placement of the LSO. The following sections describe the options assessed for the proposed scheme, through consideration of the options for the new Withernsea WwTW.

2.1.2.1. Do Nothing

The existing Withernsea WwTW is bound to the north and east by the eroding cliffs of the Holderness Coastline, the south by Holmpton Road and the west by agricultural land. The current position is less than 60m from the cliff edge. Coastal erosion investigations and predictions,

undertaken on behalf of YWS, have indicated when existing YWS' assets are expected to be compromised. The cliff is predicted to erode to such an extent that it will reach the existing Withernsea WwTW boundary within the next 10 years, and the existing LSO is predicted to be exposed on the seabed (below low water) in 2028. As such, the LSO and WwTW will not reach their required design life. Additionally, EYRC will serve a demolition notice on the existing WwTW site once the cliff edge reaches 20m from the site boundary. Therefore, there is an urgent need for a replacement WwTW before the existing becomes inoperable.

The relevant Shoreline Management Plan (SMP) for the area, Flamborough Head to Gibraltar Point SMP2, specifies 'No Active Intervention' meaning no coastal protection work can take place on this part of the coastline (Scott Wilson, 2010).

In summary, the 'do nothing' approach would not be an acceptable alternative and it is necessary to find a new location for the Withernsea WwTW and associated infrastructure.

2.1.2.2. Relocation of the WwTW

YWS considered a number of factors for a number of potential sites for the new Withernsea WwTW, including cost and landownership. However, the principal factors in the assessment of the potential location of the WwTW and associated infrastructure, were the potential for socio-economic and/or environmental impacts of the proposed scheme.

The overall location, an area to the south (and down-stream) of Withernsea, was selected to avoid the risk of any potential pollution impacts on the water quality of Withernsea bathing water. The proposed Withernsea WwTW site location options are shown in **Figure 2.1**.

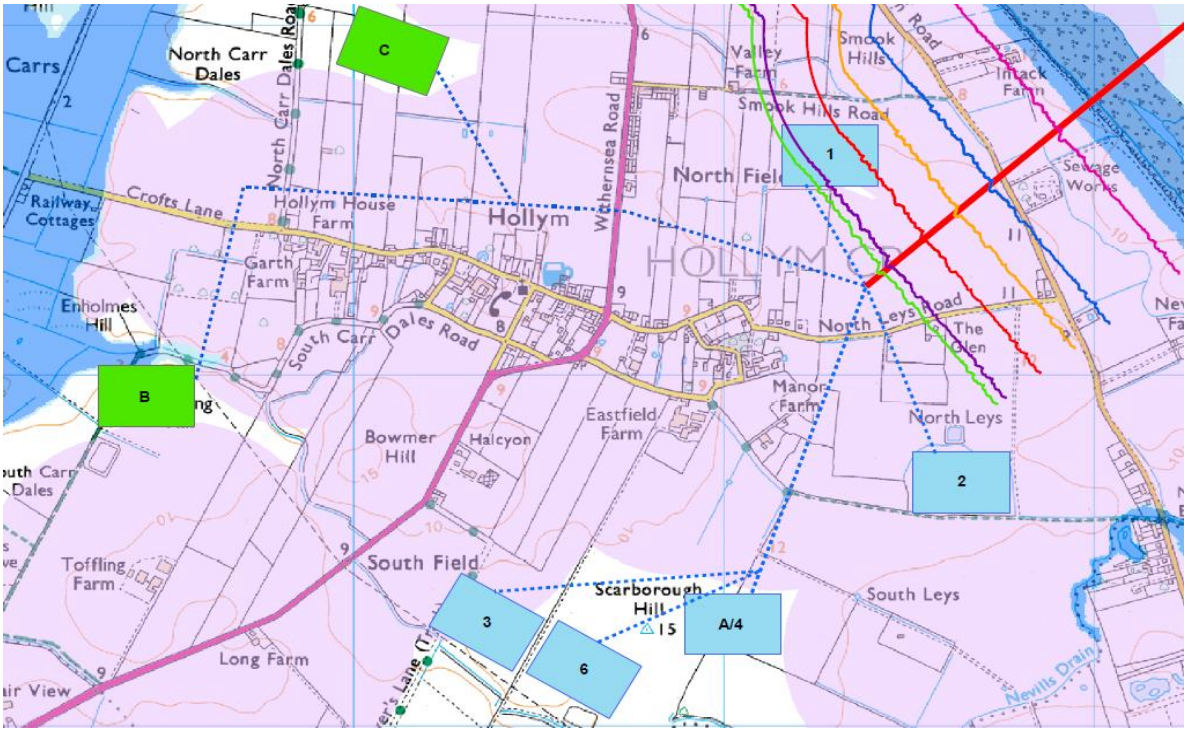

Figure 2.1 Location of alternative WwTW sites assessed by YWS. Blue shading indicates Flood Zone 3 (source: YWS)

The assessment of these alternative locations is summarised in **Table 2.1**.

Table 2.1 Assessment of alternative new WwTW site locations

Site	Progressed	Justification
1	N	In order to ensure an asset life of over 100 years, the predicted current erosion rates were used to predict the point at which the coastline would reach within the next 100 years. Site 1 is located too close to this point and therefore did not provide a suitable alternative.
2	N	In order to ensure an asset life of over 100 years, the predicted current erosion rates were used to predict the point at which the coastline would reach within the next 100 years. Site 2 is located too close to this point and therefore did not provide a suitable alternative.
3	Y	The site was taken forward to further consideration as the location adhered to the following criteria; • Over 400m from nearest residential property • Lies outwith flood zone • Higher life expectancy of site (over 100-years, linked to Coastal erosion predicted rates) • Access to existing LSO • Archaeological and ecological information
A/4	N	The site is located further than 400m away from the nearest homes, however does not have easy access to existing public roads
B	N	The site is located less than 400m away from the nearest homes and therefore poses the potential risk of disturbance during the construction and operation of the new Withernsea WwTW.
C	Y	The site was taken forward to further consideration as the location adhered to the following criteria; • Lies outwith flood zone • Higher life expectancy of site (over 100-years, linked to Coastal erosion predicted rates) • Access to existing LSO • Archaeological and ecological information
6	N	The site is located further than 400m away from the nearest homes, however does not have easy access to existing public roads

Following extensive assessment, two preferred sites were identified. These sites were shared with the communities of Withernsea and Hollym at two drop-in sessions, in September 2015. YWS assessed the feedback from the drop-in session, both in terms of the preferences expressed on the feedback forms and the questions and concerns raised during discussions. Of the respondents, 61% preferred the site to the south of Holym. When compared to the feedback from Hollym village only, the result was very similar, with 60% of residents preferring the south site.

The concerns principally concerned the potential for odour impact and construction vehicle access requirements. The location of the new works to the south of Hollym (Site 3) avoids construction traffic travelling through the village, which provides a clear benefit over the site on North Carr Dales Road (Site C). Site 3 is also located further from residential developments, reducing the risk of disturbance to local communities during construction. YWS concluded that it would be possible within the design of the new WwTW to address concerns on impacts on residents from odour.

Following the selection of WwTW location, options for installation of the LSO were assessed. This includes the potential to either re-use or replace the existing LSO. A number of construction methods were assessed for the latter option, taking into considerations environmental and geotechnical constraints.

2.1.2.3. Re-use of existing LSO

The potential re-use of the existing steel pipe for the offshore section of the LSO was considered within a feasibility study undertaken by Royal HaskoningDHV on behalf of YWS. This would involve the construction of a new pipeline on land to a connection point at the existing outfall.

Uncertainties in the internal and external condition of the existing LSO including the recent exposure of the intertidal section on the foreshore (described in **Section 2.1.1**) and the reduced cover depth below the minimum 2m required by YWS at various points along the subtidal section, meant that this would not be a feasible option. Furthermore, due to the ongoing coastal erosion at this location it was also concluded that the existing outfall would not satisfy its remaining asset life and therefore this option was discounted.

2.1.2.4. Replacement of LSO

Based on the conclusions of **Section 2.1.2.2** and **Section 2.1.2.3** above, the proposed LSO route follows the shortest distance on land from the new WwTW, with the marine (intertidal and subtidal) sections following as close as possible to the existing discharge point offshore (**Figure 2.2**).

As with the existing LSO, the preferred LSO route lies within the boundary of the Greater Wash SPA and Holderness Inshore Marine Conservation Zone (MCZ). Therefore, the assessment of construction techniques on environmental receptors, as well as the fine-scale placement for the proposed scheme, is reviewed further when considering the alternatives.

The following construction techniques were considered for the proposed scheme and assessed against for each section of the LSO:

- **Open cut/trenching**; the use of open cut techniques for both the land and marine section of the pipe is practical, subject to the design gradient, but it is not recommended for the crossing through the cliffs due to risk of further coastal erosion. The material removed would be side-cast and reinstated following the installation of the LSO. The offshore pipe section would be installed in a dredged trench using float and flood techniques

- **Tunnelling**; tunnelling the full length of the outfall, including the marine section, is not viable or cost effective. Tunnelling from the proposed WwTW site to the foreshore is practical but more expensive than open cut. The risk of encountering boulders, which could prohibit the tunnel drive, was assessed following further ground investigations.

- **Horizontal Directional Drilling (HDD)**; as above, drilling the full length of the outfall, including the marine section, is not always feasible or cost effective. The presence of boulders, which would be present within the soil stratum, in conjunction with the physical length and width of the pipeline, would reduce the length of the HDD deemed practically possible to construct with acceptable risks.

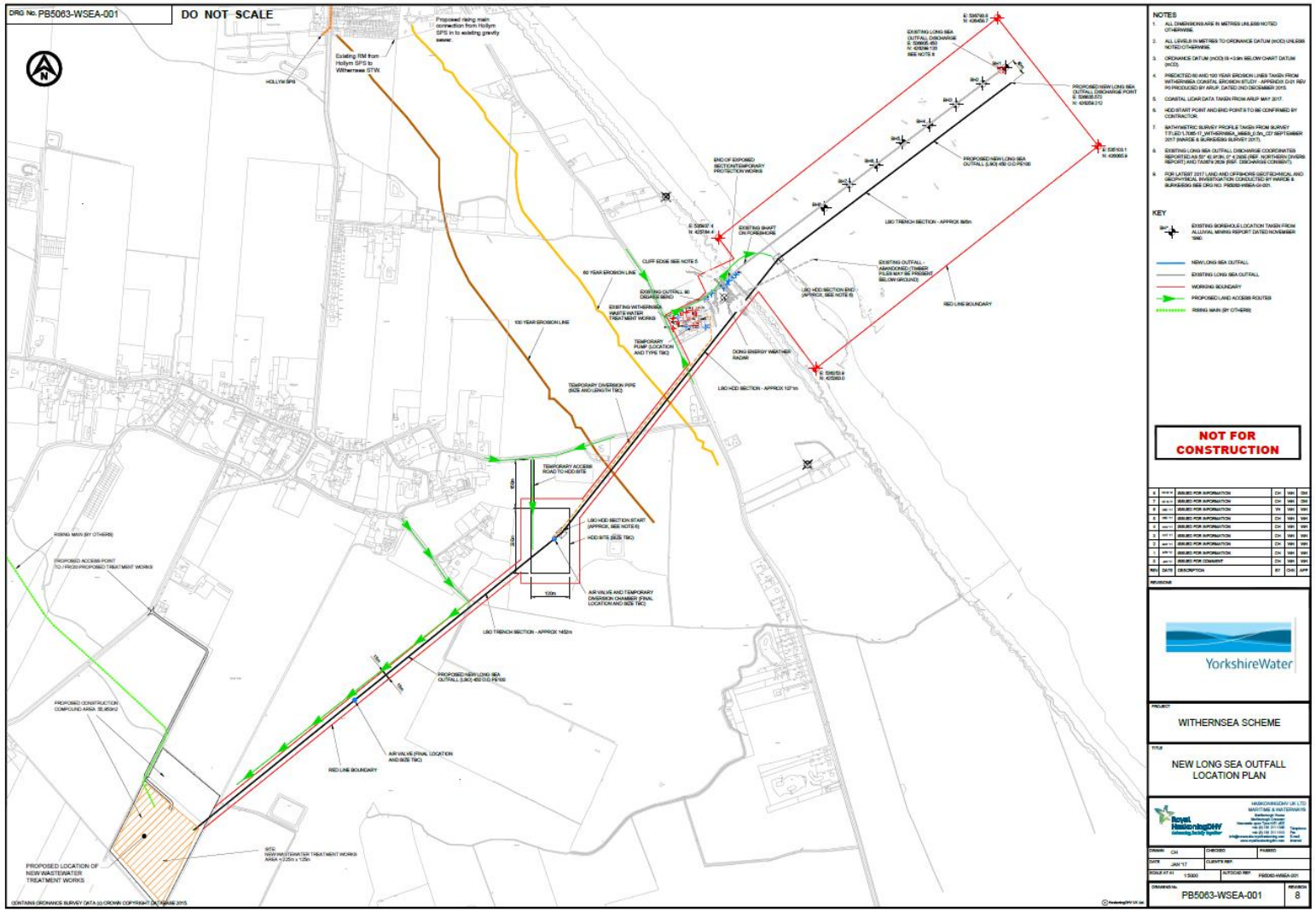

Figure 2.2 New LSO Location Plan

Following the completion of the marine and terrestrial ground investigation, the preferred construction techniques for the outfall options, considering the rate of coastal erosion apparent to the site, was confirmed (**Figure 2.2**). Given ground conditions, the most feasible construction method is as follows;

1. Conventional trenching and backfilling for the installation of the terrestrial length of the LSO, up to the 100-year predicted erosion line (approximately 2.3km in length). This does not continue to the cliff line, to minimise disturbance to the cliff line.

2. HDD/micro-tunnelling from the 100-year predicted erosion line, to a point approximately 100m above low water. This will provide protection to the LSO from future erosion risk, whilst avoiding impacts to the soft cliffs.

3. Conventional trenching and backfilling for the subtidal section due to the risk of geological hazards below the seabed. An open cut float and flood outfall installation of the pipeline is proposed. This discharge point will be as close as practicably possible to the existing discharge point.

2.2. Scheme description

The proposed scheme comprises the construction in the marine (intertidal and subtidal) environment to enable installation of a new High-density polyethylene (HDPE) LSO, as well as the decommissioning of the intertidal section and subtidal elements of the existing LSO. The new LSO will run parallel to the existing LSO, at a distance of up to 50m to the south and will be approximately 1.1km in length from MHWS to the proposed discharge point. (**Figure 2.3**).

Different construction methodologies are required for the intertidal and subtidal sections, which are described in detail in **Section 2.2.1**. A brief overview of the terrestrial section is provided in **Section 2.2.1** for context, however, these works are to be implemented under planning permission under TCPA 1990 and YWS' Permitted Development Rights.

2.2.1. Construction of new LSO

2.2.1.1. Terrestrial Section

The terrestrial section (above MHWS), comprises a length of approximately 2.3km of the LSO, between the new WwTW and the toe of the cliffs (**Figure 2.4**) and requires two construction methods;

- From the new WwTW to the 100-year predicted erosion line of the cliffs, the LSO will be installed using conventional trenching and backfilling techniques.

- From the 100-year predicted erosion line of the cliffs to the toe of the cliff, construction methods will be by HDD/micro-tunnelling.

536000

536800

426400

425600

N

Subtidal trenching section

Intertidal HDD/
micro-tunnel section

0

500 Metres

Legend

- Connection Pit
- Indicative location of temporary access ramp for pipeline protection works
- Proposed Scheme Boundary
- LSO Section above MHWS
- New LSO
- Existing LSO
- HDD/Microtunnelling Site Compound
- Existing Wastewater Treatment
- MHWS
- MLW

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title:

Proposed Scheme Layout

Figure: 2.3

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid

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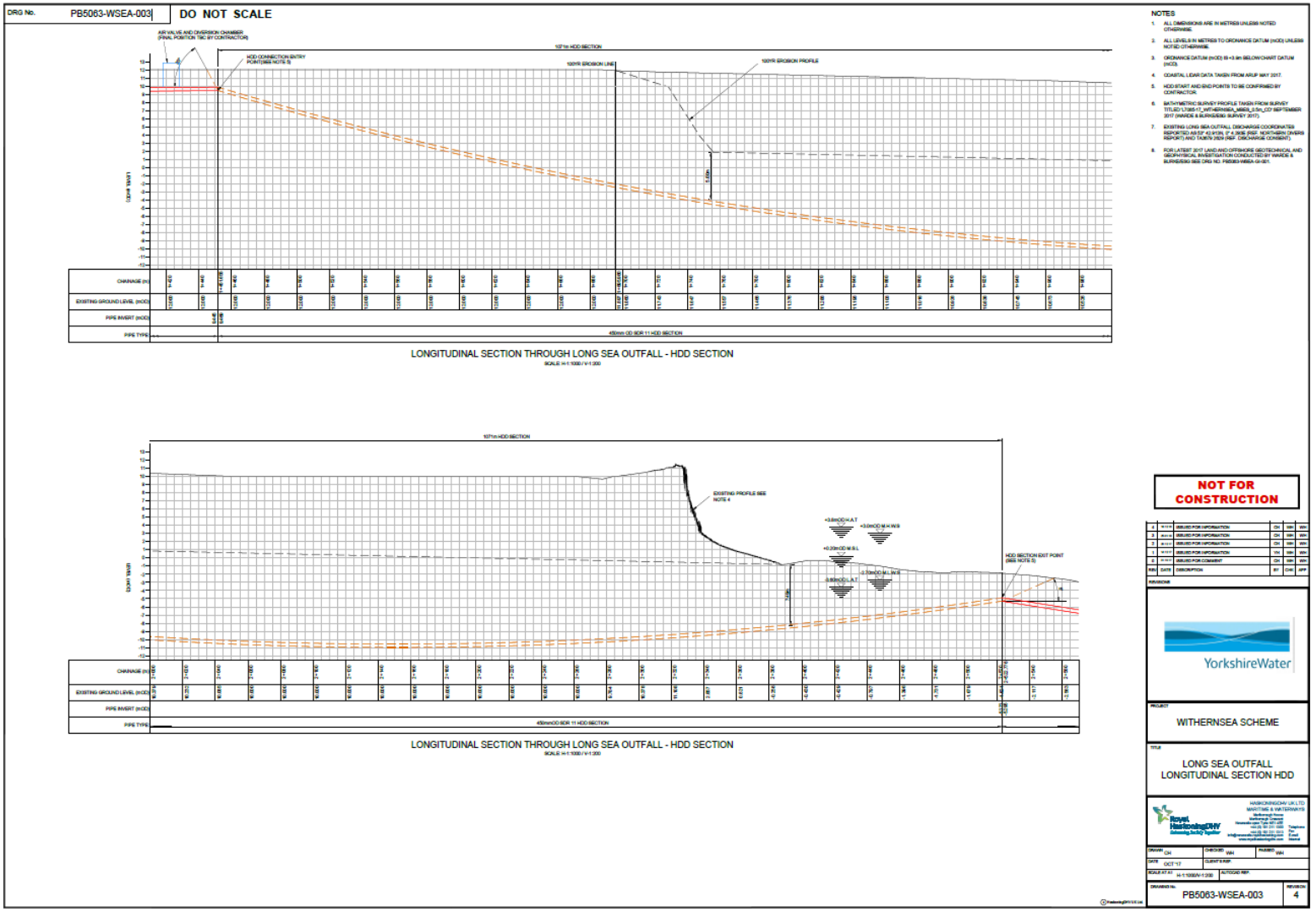


Figure 2.4 Drawing PB5063-WSEA-003: Cliff top (terrestrial) and intertidal sections of proposed scheme

It is anticipated that the construction of the terrestrial section will take place either concurrently or following the completion of the intertidal and subtidal sections, over a period of three months. As discussed in **Section 1.2**, the terrestrial length of the scheme will be implemented through YWS' Permitted Development Rights. This section is entirely above the level of MHWS and as such not subject to the need for a marine licence.

Temporary works compounds and an access ramp will be established from the cliff top (**Figure 2.5**). All temporary access/working areas will be fully removed on completion of the works. All storage of plant and materials will be kept to a minimum and stored on the cliff top, at safe distance from the edge. Once plant arrive at the site compound in April 2020, movements will be minimal, and will not spatially overlap with the vehicle movements associated with the WwTW works. The majority of vehicle movements will be cars and vans which account for the construction staff arriving and departing from site compound.

2.2.1.2. Intertidal Section

The intertidal section of the LSO is proposed to be constructed using trenchless techniques, by creating a hole for the LSO pipe to be installed through with either a Tunnel Boring Machine (TBM) for micro-tunnelling or a Drilling Rig for HDD construction techniques. The trenchless LSO section will begin from behind the predicted 100-year erosion line, on the cliff top (shown on **Figure 2.2**). The tunnel or bore reaches MHWS at a point beneath the toe of the cliff, at approximately 7m depth. The tunnel or bore will cover a length of approximately 100m of the foreshore, gradually reducing in depth, until it is approximately 4m beneath the surface, in the mid- to lower foreshore zone. A draft cross-section of the predicted HDD/micro-tunnelling route long section is presented in **Figure 2.4**.

A temporary cofferdam may be required to create a reception pit to allow recovery of the TBM or drill pipe on the foreshore and to connect to the marine section of the LSO. The temporary cofferdam would be constructed using sheet piles and will be approximately 30m long by 6m wide, with 10m wing walls. The length of the piles will be between 10m to 15m, depending on the ground conditions, with approximately 5m buried below ground. The temporary cofferdam will most likely be vibro-piled (pile hammers will only be utilised if ground conditions necessitate this) into the foreshore during low tide periods. This will be done in the dry, using land-based piling plant and constructed within one week. There will be a maximum of 6 sheet piles (of 5m length) required either side of the trench. It is intended that the temporary cofferdam would be fully removed once the pipe installation works are complete.

Additionally, to link the pipe at the end of the HDD/micro-tunnelled section to the subtidal pipe section, a trench will be excavated around the connection point, between the cofferdam and the low water limit of marine dredging equipment (i.e. backhoe or cutter suction dredger), by tracked land-based hydraulic excavators. The trench from the connection point to the low water mark will be approximately 100m long, 3m wide at the base and 3.5m deep, generating approximately 5,000m^3. The temporary cofferdam would provide protection against sedimentation of this trench.

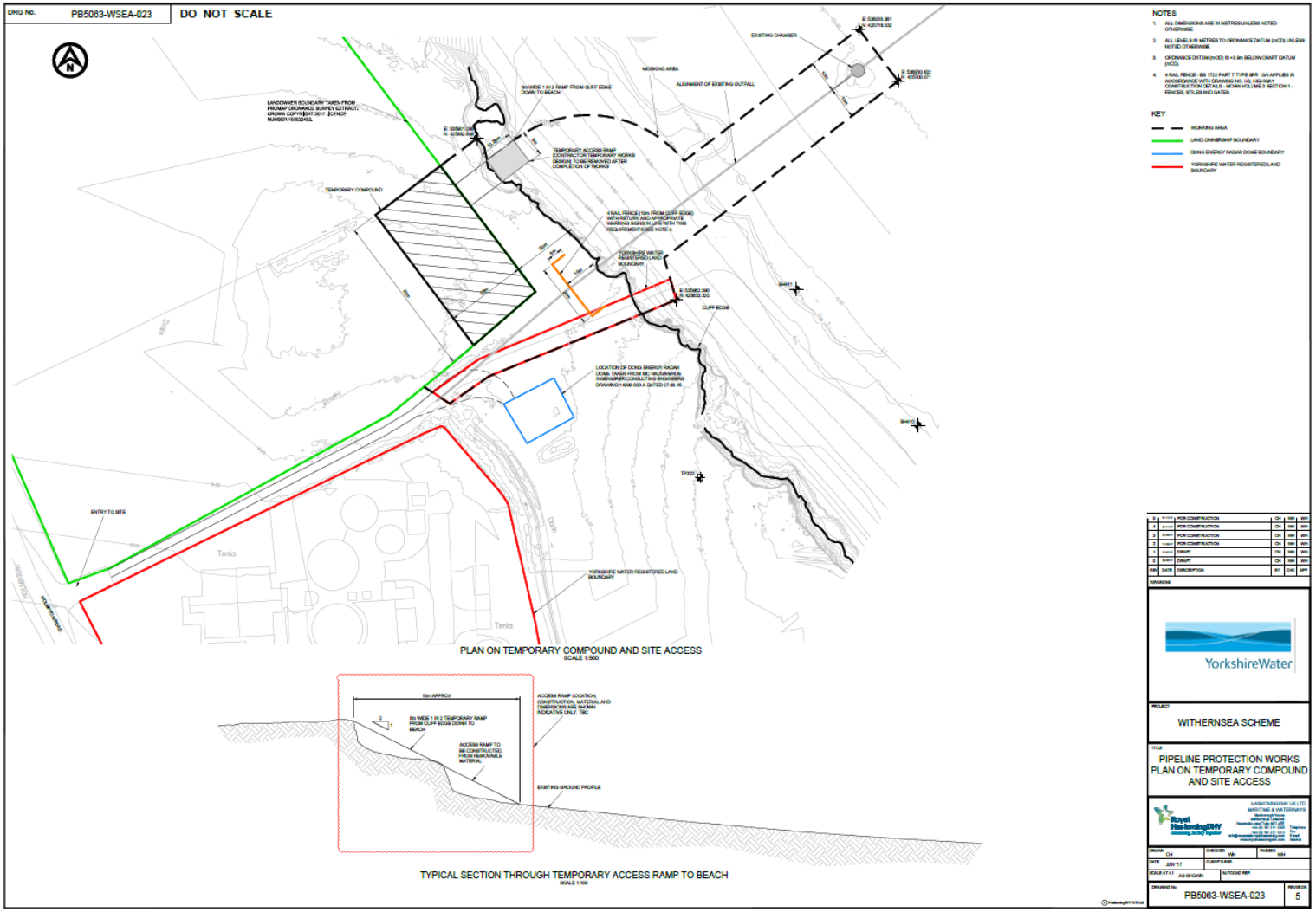


Figure 2.5 *Drawing PB5063-WSEA-023 Temporary compound and access to the foreshore for the proposed scheme*

The dredged material will be side-cast on either side of the trench until the pipeline has been installed and will then be used as backfill over the pipeline. Side-casted material will be positioned as the highest point possible along the foreshore as possible, to minimise any potential loss of material before backfilling.

Construction hours of the subtidal section will be six days per week, between the hours of 08:00 to 19:00 for approximately two months. During construction, mobile cranes may be required for installation of the pipe. The following may also be required depending on how the intertidal section is constructed:

- Drill Rig and associated equipment and site set up for construction of tunnelled section if HDD method employed; and
- TBM and associated equipment and site set up for construction of tunnelled section if micro-tunnelling method employed; and
- Land-based plant equipment for construction of HDD/micro-tunnelling reception pit in intertidal zone.

2.2.1.3. Subtidal Section

Conventional offshore trenching and backfill techniques will be used in the lower intertidal and subtidal zone. The LSO will be installed in a single length, using the float and flood method. An indicative drawing of the predicted trenching route is presented in **Figure 2.6.**

The trenched length of the LSO will be approximately 1km, from the connection pit at low water, to the discharge point, within 50m to the south of the existing LSO discharge point. The footprint of the trench is 0.024km^2; with the following likely dimensions;

- Trench base width: 3m.
- Trench top width: 24m (based on 1:3 slope).
- Trench depth 3.5m.

It is anticipated that approximately 50,000 m^3 of seabed substrate (mainly consisting of till and clay) will be required to be dredged, using a backhoe or cutter suction dredger, depending on the nature of the seabed. Following completion of the trench and installation of the pipe, the side-cast materials will be re-used as backfill.

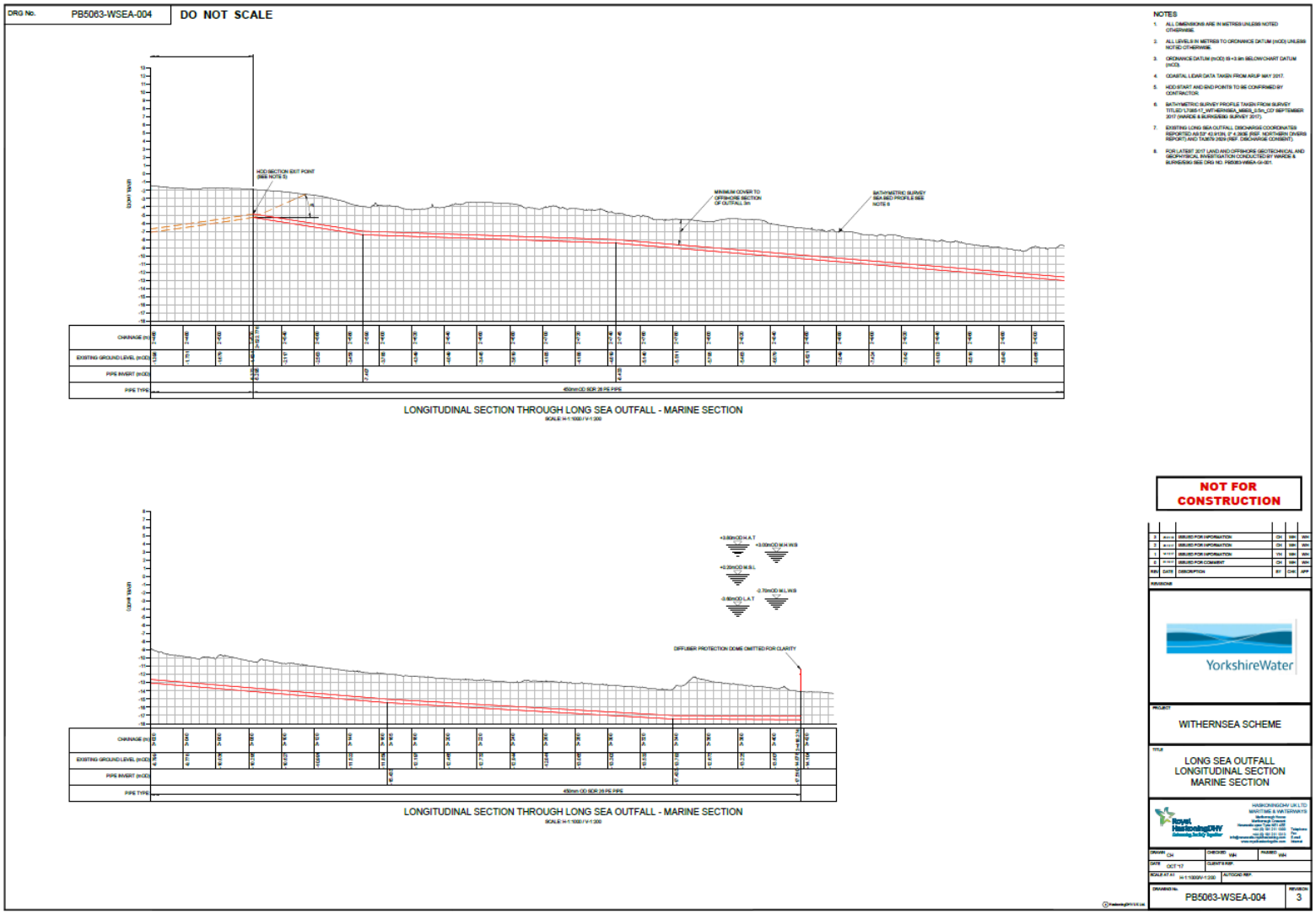


Figure 2.6 *Drawing PB5063-WSEA-004: Lower intertidal and subtidal sections of proposed scheme.*

Imported material for backfill and scour protection is not considered to be required over the main length of pipeline. Should it be necessary to import suitable fill material (e.g. due to suitable material not being available on-site) it will be selected appropriately for the location. For example, appropriately graded marine sand / gravel / stone would be imported from a licenced aggregate extraction site for placement within the excavated trench as a 'bedding' layer, prior to being completely covered with 'as dug' side-cast material of local origin.

A cross-section of the proposed discharge diffuser and trench is provided in **Figure 2.7**. Imported material (i.e. rock) to act as scour protection is proposed around the diffuser area. The diffuser riser and discharge ports will protrude up to 2m above the seabed and will be protected from physical damage with a diffuser protection dome/structure. The seabed scour protection around the diffuser dome/structure would comprise of a rock blanket, extending to the existing seabed level to a maximum of 10m in all directions from the centre of the diffuser riser. The rock blanket will be designed to be stable under a 1:100-year return period wave and current loading conditions, with use of graded rock of 40-200kg proposed. In accordance with the CIRIA Rock Manual (CIRIA, 2007), this will be installed in two layers to provide a continuous scour blanket around the diffuser structure.

Construction hours of the subtidal section will be seven days per week, 24 hours a day for approximately two months. Pipeline installation activities will only commence when a minimum 2 to 3-day window of suitable weather conditions is forecast.

Once construction, installation and testing of the new LSO is complete, the intertidal foreshore and subtidal seabed will be reinstated to as close to existing levels as reasonably practicable. In subtidal areas, this will be within an allowable construction tolerance of approximately +/- 0.5m. A marker buoy for navigation safety is also to be installed on completion of the subtidal works.

2.2.2. Decommissioning of existing LSO

Once the replacement LSO is commissioned, the decommissioning works of the existing LSO will be undertaken. It is intended that these works would also be carried out during the summer periods, however, it is possible that timings of commissioning may mean that works (decommissioning only) would be undertaken in the winter months.

Firstly, the temporary pipe protection (rock bags) installed for the existing outfall protection shall be removed from the cliff and foreshore. The decommissioning of these works is covered under marine licence (ref: L/2017/00420/2).

Following this, any above seabed structures associated with the existing LSO in the subtidal zone, including the diffuser riser to approximately 1m below the seabed level, diffuser head and protection dome shall be removed and disposed of at a suitable licensed waste disposal facility. The above works will be done by a team of divers and workboats, using lifting equipment and hand tools. The existing marker buoy and anchor may also be removed, and may be re-used/re-located (depending on condition) for the new LSO or totally removed and disposed of at a suitable licensed waste disposal site.

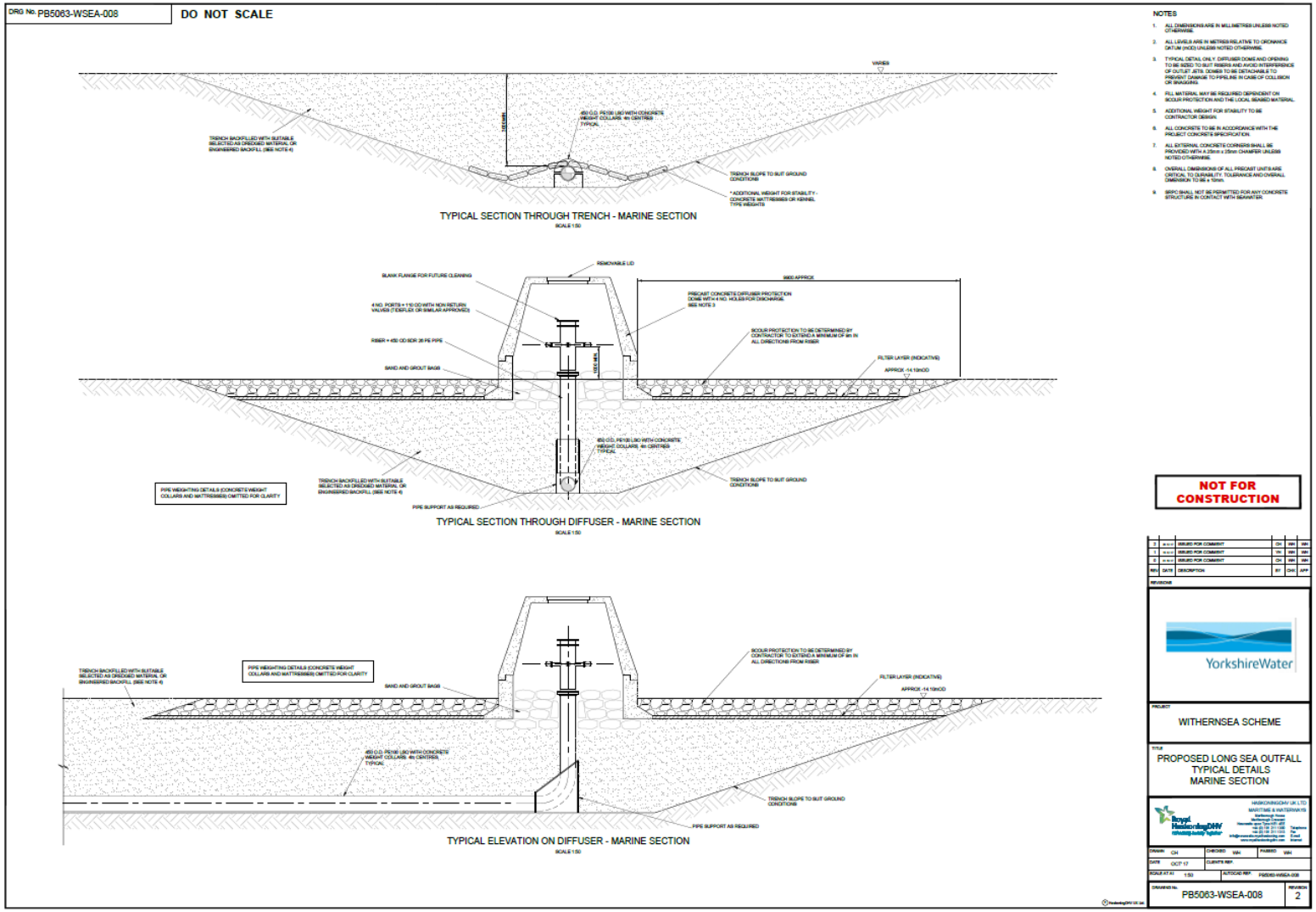


Figure 2.7 Drawing PB5063-WSEA-008: Cross section through trench and diffuser

Decommissioning may also require moving of a very small area of existing scour protection, limited to that which lies immediately adjacent to the existing diffuser. The above works will also be done by a team of divers and workboats, using lifting equipment and hand tools.

The existing LSO section from the toe of the cliff up to and including the exposed chamber on the foreshore shall be removed and disposed of at a suitable licensed waste disposal facility. The approximate length of this section of existing pipeline is 100m. The area immediately adjacent to the existing LSO will be excavated to enable removal.

This will be reinstated following removal, with 'as dug' material to be utilised if required. This will likely require approximately two tracked lifting cranes, two tracked excavators and a small generator for electric supply, to dig around the existing pipe and assist in removal of the 100m LSO section, in cut sections.

The redundant ends of the outfall at the foreshore and the offshore end shall be capped with suitable grout/concrete, or similar approved material. The nearshore end would be accessed by foot, with support from a lightweight vehicle to carry equipment if necessary. The offshore end would likely be done by a team of divers and one workboats.

The plant, when not in use, will be stored on a site compound which is located near to the cliff top, at a safe distance from the edge. Access to the beach will be provided via the temporary access ramp proposed for the new LSO construction works in the intertidal area. Site set-up and welfare facilities will be located above MHWS at a safe distance from the cliff top and will be removed once works are complete. Lighting at the cliff top if necessary will be provided, however, working hours will generally be restricted to daylight times during low tide periods at the intertidal zone, offshore decommissioning works will take place during daylight hours at any tidal state, depending on weather. The decommissioning works for removal of the existing LSO in the intertidal area will take approximately one week to complete.

Volumes of waste that will be generated during demolition activities are not currently known, however, any wastes produced will be managed and disposed of at appropriately licenced facilities. A Decommissioning Environmental Management Plan (DEMP) will be prepared by the appointed contractor prior to demolition works commencing. This will consider matters such as vehicle movement numbers, routes of access and egress for demolition traffic, the safe storage of demolition materials, noise minimisation and dust suppression to reduce potential harm to the environment and human health.

2.2.3. Access

Temporary access routes and a temporary construction compound at the cliff top are required for the construction of the LSO (as shown on **Figure 2.4**). No materials will be stored on the beach or foreshore. Access to the foreshore will be via a temporary access ramp from the cliff which will remain in-situ for the duration of the construction period. The temporary access ramp will be constructed using land-based plant to reprofile the cliff slope. Rock bags or other similar means of support will be used to stabilise the reprofiled cliff slope. The material for the rock

bags/support will be imported. The subtidal section will be accessed by vessels sailing from a nearby port, likely to be Grimsby.

There will be few vessel movements throughout the construction period, limited to those of a backhoe or cutter suction dredger, pipe-tow vessels and support vessels. Navigational best practices such as submitting a Notice to Mariners will be implemented prior to construction. This will include provision of at least three weeks' notice to ABP Humber Estuary Services (HES).

All marking and lighting of the marine works and construction equipment will be in compliance with the International Regulations for the Prevention of Collision at Sea 1972 (as amended). All areas where works are progressing will be marked with an appropriate buoyage system to indicate working areas and any obstructions on the seabed. Any anchors used during the execution of the works will be marked with appropriate buoys.

2.2.4. Programme of construction

Construction of the proposed scheme is planned to begin in April 2020. Construction works will be undertaken within the summer months (1st April to 30th September), due to the requirement to avoid poor weather conditions, and are expected to take approximately five months. It is intended that the decommissioning of the existing LSO (i.e. removal of diffuser dome, diffuser riser, marker buoy and capping of the LSO end) would also be carried out during the summer periods, however, it is possible that timings of LSO commissioning may mean that this would be undertaken in the winter months, for a period of two weeks only.

The marine (intertidal and subtidal) construction works required for the LSO would take from approximately mid-April to mid-September. It is possible that the decommissioning works will be undertaken before 30th September, however as stated above, these works may slip into October.

Table 2.2 outlines the approximate durations of the tasks required for the proposed scheme. The durations of works required for the terrestrial section of the LSO are provided for context. The construction of the WwTW, rising main and terrestrial sections of the LSO may occur concurrently or following the marine works.

Table 2.2 Programme of works for replacement LSO construction

	Task	Approximate duration
Subtidal works		
1	Offshore trench dredging	5 weeks
2	Pipe connection (3 sections) and transportation to site	1 week
3	Survey of trench and maintenance where required	5 days
4	Pipe installation	2 days
5	Diffuser installation	2 days
6	Backfill offshore trench	5 weeks
7	Diffuser dome installation	1 day
8	Scour protection installation	5 days

	Task	Approximate duration
9	Marker buoy installation	1 day
10	Decommissioning of existing LSO (removal of diffuser dome, diffuser, marker buoy and cap end of LSO)	1 week
Intertidal works		
1	Construct access to beach	4 weeks
2	Construct cofferdam and reception pit	5 weeks
3	Tunnel from 100-year erosion line to cofferdam on foreshore	8 weeks
4	Remove TBM, cofferdam and access	3 weeks
5	Decommissioning of existing LSO (removal of rock bags and removal of exposed pipeline and chamber on foreshore)	2 weeks
Terrestrial works		
1	Onshore trench	5 weeks
2	Onshore trench maintenance	2 weeks
3	Onshore trench backfill	1 week
4	TBM set up and tunnel on cliff top to 100-year erosion line	12 weeks

2.2.5. Operation of the proposed scheme

Once construction, installation and testing of the new LSO is complete, the intertidal foreshore and subtidal seabed will be reinstated to as close to existing levels as reasonably practicable. In subtidal areas, this will be within an allowable construction tolerance of approximately +/- 0.5m. The only infrastructure visible above existing seabed/foreshore levels will be the diffuser riser/ports and diffuser protection dome/structure. Operational activities will be limited to the discharge of wastewater and ad-hoc inspection and maintenance activities.

The discharge of wastewater from the new LSO will be a consented discharge as agreed with YWS and the Environment Agency. The existing discharge consent, granted by the Environment Agency in 2010 is attached in **Appendix D**. The new LSO will discharge the treated waste water from the new proposed WwTW to a discharge point as near as technically feasible to the existing LSO discharge point in the North Sea.

The expected minor maintenance activities for the existing LSO are covered by a 10-year Marine Licence (L/2017/00177/1). All potential activities are fully described with the licence documents. A request to the MMO to vary this licence to remove the decommissioned LSO and include the newly constructed LSO will be made by YWS. The maintenance activities and inspections required for the new LSO would be undertaken by divers in the subtidal area only as there are no inspection facilities available on foreshore. If more major or intrusive maintenance is required then a separate Marine Licence would be acquired by the applicant.

Typical activities which might be expected to be required during the operational life of the new LSO will include:

- Asset inspection / maintenance
    - Bolt Replacement - bolts are replaced like for like, stainless steel typically.
    - Access hatch replacements - typically mild steel plates bolted via a flange.
    - Valve fitting or replacements - typically duck billed type (Tideflex), PE or rubber coplastic type flap valves.
    - Blank flange fitting or replacement - typically mild steel bolted via a flange.
    - Cathodic protection anodes - bolted anodes replaced like for like.
    - Unblocking pipework and valves - Jetting, air lifting and lancing to mobilise any compacted sediments or material within the pipe, grill or diffuser.
- Existing scour protection repair / replacement
- Diffuser dome repair / replacement
- Navigational markers repair / replacement

2.2.6. Decommissioning of the proposed scheme

The proposed scheme has been designed to remain operational for a period of up to 60 years, however at a point in the future it is likely that it will require to be decommissioned. The decommissioning of the new LSO is expected to follow a similar methodology as the decommissioning of the existing LSO, as set out in **Section 2.2.2**. However, the exact method will be agreed upon with the regulatory authorities at the time as it will depend on the condition of the LSO. These works will be subject to a separate Marine Licence, and would be acquired by the applicant at the time.

3. Relevant Legislation, Regulation and Policy

3.1. Marine and Coastal Access Act 2009

Part 4 of The Marine and Coastal Access Act 2009 (MCAA 2009) provides a framework for the marine licensing system. The MMO is the regulatory authority for most marine licensing in English inshore and offshore waters.

A marine licence is required for the following activities associated with the proposed scheme;

- Dredging and side-casting works within subtidal zone to create a trench for subtidal section of the LSO.
- Installation of subtidal section of the HDPE LSO by float and flood method. The installation of a diffuser, diffuser riser, diffuser protection dome, scour protection and marker buoy in the subtidal area. There may also be the potential for suitable infill material to be imported, should side-casted material not be sufficient to ensure minimal cover of the buried LSO.
- Construction of temporary cofferdam and trench above MLW, to provide a reception pit for the tunnelled section of LSO and enable connection to the subtidal section.
- Decommissioning activities for the existing LSO including; removal of the intertidal LSO and concrete protection; capping of the redundant ends of the outfall at the foreshore and the offshore end; and removal of the diffuser, diffuser riser (to below seabed level), protection dome, and marker buoy.

It is understood that an exemption under Part 3 of the Marine Licensing (Exempted Activities) Order 2011 (as amended) may be applicable for the HDD/micro-tunnelling works. Article 35 covers 'Bored tunnels' and, hence, permission for this activity is not sought under the marine licence application. Article 35 states the following;

> "*35.—(1) Article 4 applies to a deposit or works activity carried on wholly under the sea bed in connection with the construction or operation of a bored tunnel.*
>
> *(2) Paragraph (1) is subject to conditions 1 and 2.*
>
> *(3) Condition 1 is that notice of the intention to carry on the activity must be given to the licensing authority before the activity is carried on.*
>
> *(4) Condition 2 is that the activity must not significantly adversely affect any part of the environment of the UK marine area or the living resources that it supports.*
>
> *(5) But article 4 does not apply to any such deposit carried on for the purpose of disposal*."

Justification regarding Paragraph (4) is provided throughout this ES.

3.2. Environmental Impact Assessment Directive

The requirement for EIA is established by the European Directive 2011/92/EU (codifying previous EIA Directives), as amended by 2014/52/EU on the assessment of the effects of certain public and private projects on the environment (the EIA Directive).

The works below MHWS (the intertidal and subtidal length of the LSO) were screened in January 2018 under the requirements of the MWRs. The MMO confirmed in February 2018 that the proposed scheme requires EIA under these Regulations (**Appendix C**).

The proposed scheme falls under Schedule A2, Other Projects, *'75. Waste-water treatment plants (unless included in Schedule A1)'* of the MWRs.

An Environmental Scoping Report was submitted to the MMO in June 2018 and the MMO provided its Scoping Opinion (**Appendix E**) in November 2018. The Scoping Opinion has been used to inform this ES.

3.3. Water Framework Directive Compliance Assessment

The Water Framework Directive (WFD) is transposed into national law by means of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. These Regulations provide for the implementation of the WFD, from designation of all surface waters (rivers, lakes, transitional (estuarine) and coastal waters and ground waters) as water bodies to the requirement for achievement of good ecological status or good ecological potential by 2021.

A WFD Compliance Assessment has been undertaken and is included as **Section 14**.

3.4. The Conservation of Habitats and Species and Regulations 2017

The Conservation of Habitats and Species and Regulations 2017 (the 'Habitats Regulations') transpose Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna (the 'Habitats Directive') and Directive 2009/147/EC on the conservation of wild birds (the 'Wild Birds Directive') into English Law.

The Habitats Regulations Assessment (HRA) process is required where new plans or projects may be capable of affecting the designated interest features of 'European Sites'. European sites are defined in Regulation 8 of the Habitats Regulations and include Special Protection Areas (SPA), as designated under the Wild Birds Directive, or a Special Area of Conservation (SAC), as designated under the Habitats Directive. HRA is also required as a matter of government policy for potential SPAs, candidate SACs and listed Ramsar sites for the purpose of considering development proposals affecting them (DCLG, 2012).

In accordance with Regulation 63 of the Habitats Regulations, an 'Appropriate Assessment' is required for any plan or project, not connected with the management of a European site, which is likely to have a significant effect on the site either alone or in-combination with other plans or projects.

The footprint of the proposed scheme lies within the Greater Wash SPA, and within 5km of the Humber Estuary SAC, SPA and Ramsar sites. The potential therefore exists for the proposed scheme to have an effect on these designated sites. Information to inform the HRA process has therefore been provided to consider the potential impacts of the proposed scheme on the Greater Wash SPA and Humber Estuary SPA, SAC and Ramsar sites (see **Section 15**).

3.5. Marine Conservation Zone Assessment

Sections 125 and 126 of the MCAA 2009 place specific duties on the MMO relating to Marine Conservation Zones (MCZ) and the marine licence decision making process. To undertake its marine licencing function, the MMO follows a two-staged sequential MCZ assessment process (MMO, 2013) to assess the potential impacts of operations or activities occurring within, or in close proximity to, an MCZ.

Due to the proposed location of the LSO within the Holderness Inshore MCZ, an MCZ assessment has been undertaken and is included as **Section 16**.

3.6. Waste Framework Directive

The Waste Framework Directive (2008/98/EC) consolidates earlier legislation regulating waste. The Directive sets out the general rules applying to all categories of waste, a key objective of which is to provide measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use.

Article 3(1) of the Directive defines waste as: "...any substance or object…which the holder discards or intends or is required to discard".

More generally, the Directive provides a general duty to ensure that waste is dealt with in an environmentally friendly way. The key to this is the 'waste hierarchy', which emphasises prevention (in the first instance) and then re-use, recycling and recovery of waste (see **Figure 3.1**). EU Member States must have regard to the waste hierarchy when dealing with waste. Disposal to landfill or at sea is the least favourable option.

Following the trenching works, the uncontaminated material can be used as backfill without recourse to waste regulation as it will be replaced within the boundary of the development from where is was excavated.

The disposal of waste associated with the decommissioning of the existing LSO (diffuser dome, diffuser, scour protection) will be minimal, however a suitable licensed waste disposal facility will be identified for these materials. The successfully appointed contractor will be required to develop an Environmental Management Plan (incorporating the Waste Management Plan) for the works.

Figure 3.1 The waste hierarchy

3.7. Relevant Policy

3.7.1. UK Marine Policy Statement (MPS)

The UK MPS (HM Government, 2012) was adopted in 2001 by the UK and devolved governments in order to work towards the UK vision for '*clean, healthy, safe, productive and biologically diverse oceans and seas'*. The MPS provides a framework to provide a consistent approach to marine planning across the UK, and ensures sustainable shared use of the marine area and strategic management of activities including fishing and coastal development.

The assessment of potential impacts on all topics areas have been made with reference to the National Policy Statement (NPS) for Waste Water (Defra, 2012). **Table 3.1** summarises the requirements of the NPS for Waste Water of relevance to each section of the ES, and signposts where these requirements have been addressed.

Table 3.1 Summary of NPS for Waste Water with regard to marine water and sediment quality (Defra, 2012)

Topic	NPS for Waste Water requirement	NPS reference	ES reference where requirement has been addressed
Marine water and sediment quality	Infrastructure development can have adverse effects on the water environment, including groundwater, inland surface water, transitional waters and coastal waters. During the construction, operation and decommissioning phases, it can lead to increased demand for water, involve discharges to water and cause adverse ecological effects resulting from physical modifications to the water environment. There may also be an increased risk of spills and leaks of pollutants to the water environment. These effects could lead to adverse impacts on health or on protected species and habitats (see	4.2.1	Section 8.5 and Section 14

Topic	NPS for Waste Water requirement	NPS reference	ES reference where requirement has been addressed
	section 4.5 on biodiversity and geological conservation) and could, in particular, result in surface waters, groundwaters or protected areas failing to meet environmental objectives established under the Water Framework Directive (WFD).		
Marine water and sediment quality	Where the project is likely to have effects on the water environment, the applicant should undertake an assessment of the existing status of, and impacts of the proposed project on water quality, water resources and physical characteristics of the water environment as part of the Environmental Statement (ES) or equivalent.	4.2.2	Section 8.5 and Section 14
Marine and coastal ecology, fish and fisheries, marine and coastal ornithology	Where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species, and on habitats and other species identified as being of principal importance for the conservation of biodiversity.	4.5.3	Section 9 - 11 and Section 15-16
Marine and coastal ecology, fish and fisheries, marine and coastal ornithology	The applicant should provide environmental information proportionate to the infrastructure where EIA is not required. The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests.	4.5.3	Section 9 - 11 and Section 15-16
Marine and coastal ecology, fish and fisheries, marine and coastal ornithology	The applicant should be particularly careful to identify any effects of physical changes on the integrity and special features of Marine Conservation Zones, candidate marine Special Areas of Conservation (SACs), coastal SACs and candidate coastal SACs, coastal Special Protection Areas (SPAs) and potential coastal SPAs, Ramsar sites, Sites of Community Importance (SCIs) and potential SCIs and Sites of Special Scientific Interest.	4.6.9	Section 9 - 11 and Section 15-16

There is no policy that is specific to the hydrodynamic and sedimentary regime *per se*, although a key tenet of the non-statutory Flamborough Head to Gibraltar Point SMP2 (Scott Wilson, 2010), is that developments in one area of the shore should not cause adverse effects, in terms of undesirable changes to hydrodynamic and sedimentary processes, in another area of the shore.

3.7.2. East Inshore Marine Plan

The MCAA 2009 divides the UK marine area into planning regions with an associated plan authority responsible for preparing plans for their region. In England, the MMO is the planning authority and the inshore and offshore waters have been split into 11 plan areas. The East Inshore and East Offshore areas were the first to be selected for marine planning and the MMO is aiming to deliver two plans every two years (MMO, 2014).

The aim of the marine plan, implemented in line with the MPS, is to help ensure the sustainable development of the marine area in the inshore zone between Flamborough and Felixstowe (Defra, 2014). It provides guidance on spatial planning to reduce the regulatory burden on users and provide greater certainty on where to invest.

The following policies are of particular importance to the proposed scheme;

Policy GOV1 states that "*provision should be made for infrastructure on land which supports activities in the marine area and vice versa*". This is integral to the overall nature of the Withernsea WwTW and the proposed scheme, outlined in **Section 2.2**

Policy MPA1 states that "any impacts on the overall Marine Protected Area network must be taken account of in strategic level measures and assessments, with due regard given to any current agreed advice on an ecology coherent network". This is relevant to the proximity of Holderness Inshore MCZ in relation to the proposed scheme, which is discussed in the MCA Assessment, **Section 16**.

Policy FISH1 refers to preventing and reducing impacts on fishing activity. This is of particular importance with regards to potential fishing locations along the Withernsea area, on which a number of small fishing boats are dependent on. This is addressed in **Section 10**, Fish and Fisheries.

Policy FISH2 refers to preventing and reducing adverse impacts upon spawning and nursery areas and any associated habitat. This is also addressed in **Section 10**, Benthic and Fish and Fisheries.

Policy ECO1 states that "Cumulative impacts affecting the ecosystem of the East marine plans and adjacent areas (marine, terrestrial) should be addressed in decision-making and plan implementation". This is addressed in the CIA in **Section 13**.

Policy ECO2 states that "the risk of release of hazardous substances as a secondary effect due to any increased collision risk should be taken account of in proposals that require an authorisation". This is to say that the where relevant that any development will not cause a deterioration in status of any water to which the WFD applies. The aim of the proposed scheme is to install a new LSO which will directly reduce the risk of any deterioration in water quality within the area.

4. Approach to EIA

4.1. Introduction

The purpose of EIA is to provide an independent assessment of a projects potential environmental impacts to enable authorities, and the public, to understand such potential impacts before making decisions on whether consent for the development should be granted.

This section sets out the approach for the assessment of impacts which has been adopted within this ES. In summary, this section presents:

- A summary of the EIA process.
- A summary of the consultation undertaken in relation to the proposed scheme and how issues raised have been addressed through the EIA process.
- The results of the scoping exercise undertaken to define the issues to be addressed by the EIA process and the approach to be taken to the assessment of these issues.
- The approach adopted to define the baseline environment (specific details are provided for each environmental topic considered in the relevant chapter).
- The generic approach taken to assess potential impacts, including the evaluation of significance (where a different approach has been adopted for a specific topic, this is set out in the relevant chapter).
- The generic approach taken to the derivation of mitigation measures and the assessment of residual impacts.
- The approach taken to the assessment of potential cumulative impacts.

4.2. EIA guidance

This EIA has been undertaken in accordance with the requirements of the MWRs and has taken into account key policies, legislation, guidance and advice, including but not limited to the following:

- Department for Communities and Local Government (DCLG) “Environmental Impact Assessment: A Guide to Good Practice and Procedures” (2006);
- Chartered Institute of Ecology and Environmental Management (IEEM) “Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal” (2016);

- Institute of Environmental Management & Assessment (IEMA) “Guidelines for Environmental Impact Assessment” (2004);
- The National Planning Policy Framework (NPPF), 2018;
- The National Planning Policy Guidance (NPPG), 2014;
- The National Policy Statement for Waste Water (Defra, 2012); and,
- The Wildlife and Countryside Act 1981.

It is noted that this list of guidance is not exhaustive and the relevant guidance adopted for the assessment of each environmental parameter is described in the relevant topic chapter.

4.3. The EIA process

EIA is an iterative tool for systematically examining and assessing the impacts and effects of the construction, operational and, if applicable, decommissioning phases of the proposed scheme on the environment.

The formal reporting mechanism for an EIA is the ES. In accordance with Schedule 3 of the MWRs, the ES should include such information as is reasonably required to assess the likely significant environmental effects of the proposed scheme and which the applicant can reasonably be required to compile, including:

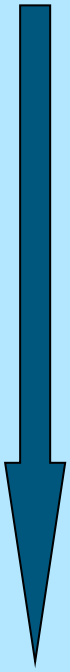
- A description of the project and of the regulated activity, including in particular:
  - a description of the location of the project and the regulated activity;
  - a description of the physical characteristics of the whole project and regulated activity, including where relevant, requisite demolition works, and the land-use requirements during the construction and operational phases;
  - a description of the main characteristics of the operational phase of the project and the regulated activity (in particular any production process):
  - an estimate, by type and quantity, of expected residues and emissions resulting from the operation of the proposed project and the regulated activity.
- A description of the reasonable alternatives
- A description of the relevant aspects of the current state of the environment (baseline scenario)

- A description of the factors likely to be significantly affected by the project and the regulated activity: population, human health, biodiversity, land, soil, water, air, climate, material assets, cultural heritage, including architectural and archaeological aspects, and landscape.
- A description of the likely significant effects of the project and the regulated activity on the environment.
- The description of the likely significant effects on the factors must cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the project and the regulated activity. This description must take into account the environmental protection objectives established at Union or member State level which are relevant to the project and the regulated activity.
- A description of the forecasting methods or evidence used to identify and assess the significant effects on the environment including details of difficulties encountered compiling the required information and the main uncertainties involved.
- A description of the measures envisaged to avoid, prevent, reduce or if possible offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements.
- A description of the expected significant adverse effects of the project and the regulated activity on the environment deriving from the vulnerability of the project and the regulated activity to risks of major accidents or disasters which are relevant to the project and the regulated activity concerned.
- A non-technical summary.
- A reference list detailing the sources used for the descriptions and assessments included in the report

EIA is a process that systematically examines and assesses the potential impacts of a project on the environment. The process is outlined in **Table 4.1**.

Table 4.1 Stages of the ES preparation

Stage	Task	Aim/Objective	Work/Output (Examples)
EIA	Consultation – throughout EIA process	Consult with statutory and non-statutory organisations	Local knowledge and information
	Primary Data Collection	To identify the baseline/ existing environment	Background data including existing literature and specialist studies

Stage	Task	Aim/Objective	Work/Output (Examples)
	Specialist Studies	To further investigate those environmental parameters which may be subject to potentially significant effects	Specialist reports (e.g. hydrodynamic modelling and archaeological assessment)
	Impact Assessment	To evaluate the baseline environment in terms of sensitivity To evaluate and predict the impact (i.e. magnitude) upon the baseline To assess the resultant effects of the above impacts (i.e. determine significance)	Series of significant adverse and beneficial impacts
	Mitigation Measures and Monitoring Requirements	To identify appropriate and practicable mitigation measures and enhancement measures and outline any recommended Monitoring.	The provision of solutions to avoid offset or reduce adverse impacts (e.g. sensitive scheduling to avoid noise and traffic impacts) Feedback into the design process, as applicable.
	Draft ES	Production of the ES in accordance with EIA guidance	ES
	Finalise ES	Submission of the ES in support of the Marine Licence Application	ES

The following stages were included in this EIA:

- Scoping – to determine the issues that the EIA should address.
- Consultation with stakeholders.
- Desk-based data collection to establish the baseline environment.
- New data collection and surveys (where necessary) to supplement desk-based information and to fill any data gaps.
- Impact identification and the evaluation of significance.
- The identification of mitigation measures (where required) to reduce the significance of, or avoid, any identified adverse impacts.
- The evaluation of impacts, post-mitigation, to determine the significance of residual impacts.
- The assessment of cumulative impacts with other past, present and reasonably foreseeable future developments and plans.
- Identification of appropriate monitoring requirements (where required).

The approach adopted in the EIA process for the proposed scheme for each of these stages is summarised in the following sections. It should be noted that these stages are not necessarily

consecutive and may overlap. For example, iterative design changes may be made in light of emerging findings of the EIA process to prevent or reduce the significance of a potential impact. This would then require re-assessment of the potential impact, potentially informed by further survey work to adequately describe the baseline environment.

4.4. Screening

The works below MHWS (the intertidal and subtidal length of the LSO) were screened under the MWRs in January 2018 by the MMO. It was confirmed in February 2018 that the proposed scheme requires EIA under these Regulations (**Appendix C**). The proposed scheme falls under Schedule A2, Other Projects, *'75. Waste-water treatment plants (unless included in Schedule A1)'* of the MWRs.

4.5. Scoping

Scoping is the process of identifying the potential environmental impacts associated with the proposed scheme. It also defines the structure, focus and scope of work for the EIA, including the identification of specialist studies and surveys required.

An Environmental Scoping Report was submitted to the MMO in June 2018, and the MMO provided its Scoping Opinion (**Appendix E**) in November 2018.

4.6. Environmental Statement

4.6.1. Environmental baseline

A wide range of information has been gathered and activities undertaken to define the baseline environment and likely receptors, including but not limited to the following:

- desk-based review of existing published data;
- data provided by consultees; and,
- field survey and site investigation information.

The term *'baseline environment'* is used to describe the nature, scale, condition, and other relevant information to provide a detailed description of a given environmental receptor that falls within the scope of the ES. Within this ES, the description of the baseline environment consists of the following aspects:

- the spatial location and extent of the environmental features or receptors;
- a description of the environmental features or receptors and their character;
- the context of the environmental features or receptors in terms of rarity, function, and population at the local, regional and national level;

- the sensitivity of the environmental features or receptors in relation to physical, chemical or biological changes; and,
- the value of the environmental features or receptors (e.g. designated status).

4.6.1.1. Receptor sensitivity

All receptors will exhibit a greater or lesser degree of sensitivity to the changes brought about by the proposed scheme, and defining receptor 'sensitivity' as part of the definition of the baseline environment helps to ensure that the subsequent assessment is transparent and robust. The sensitivity of a receptor is a function of its capacity to accommodate change and reflects its ability to recover if it is affected, and is defined by the following factors:

- **Adaptability** – the degree to which a receptor can avoid, adapt to or recover from an effect.
- **Tolerance** – the ability of a receptor to accommodate temporary or permanent change.
- **Recoverability** – the temporal scale over and extent to which a receptor will recover following an effect.

In order to define the sensitivity of a receptor, the guidelines presented in **Table 4.2** have been adopted in this ES and the conclusions reached regarding the sensitivity of receptors has been presented in the baseline sections of each relevant environmental topic.

Table 4.2 Generic guidelines used in the determination of receptor sensitivity and value

Sensitivity / value	Description
Very high	Receptor has very limited or no capacity to accommodate physical or chemical changes or influences. Receptor possesses fundamental characteristics which contribute significantly to the distinctiveness, rarity and character of the resource, is of very high importance and rarity that is international in scale (e.g. designated sites such as SACs, SPAs, Ramsar Sites, World Heritage Sites, Geological Conservation Review Sites, and Habitats Directive Annex II species), and has very limited potential for substitution / replacement.
High	Receptor has a limited capacity to accommodate physical or chemical changes or influences. Receptor possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the resource, is of high importance and rarity that is national in scale (e.g. designated sites such as SSSIs, NNRs, UK Biodiversity Action Plan (BAP) habitats and species, Areas of Outstanding Natural Beauty (AONB), Heritage Coasts, Scheduled Monuments, Grade I and II* Listed Buildings, Conservation Areas, etc.), and has limited potential for substitution / replacement.
Medium	Receptor has a limited capacity to accommodate physical or chemical changes or influences. Receptor possesses key characteristics which contribute to the distinctiveness and character of the resource, is of medium importance and rarity that is regional in scale (e.g. designated sites such as County Wildlife Sites (CWSs), Regionally Important Geological Sites, Grade II Listed Buildings, Local BAP, etc.), and has limited potential for substitution / replacement.

Sensitivity / value	Description
Low	Receptor has a moderate capacity to accommodate physical or chemical changes or influences. Receptor possess characteristics which are locally distinctive only, are of low to medium importance and rarity that is local in scale (e.g. designated sites such as Local Nature Reserves(LNR)), and potentially can be substituted / replaced.
Very low	Receptor is generally tolerant of and can accommodate physical or chemical changes or influences. Receptor characteristics do not make a significant contribution to local character or distinctiveness, and are of very low importance and rarity, are not designated, and are easily substituted / replaced.

It should be noted that the sensitivity criterion is a composite one; combining value (a measure of the receptors importance, rarity and worth) with sensitivity. In some instances, the inherent value of a receptor is recognised by means of designation (see below), and the 'value' element of the composite criterion recognises and gives weight in the assessment to that designation. However, irrespective of the recognised value, all receptors will exhibit a greater or lesser degree of sensitivity to the potential changes brought about by the proposed scheme. It should be noted that the assessment of sensitivity is a matter of judgement applied by professional experts based on the receptors within the relevant study area.

4.6.1.2. Receptor value

The value of the feature or receptor is a function of a range of factors (e.g. biodiversity value, social/community value, and economic value). The value or potential value of a receptor or feature can be determined within a defined geographical context, for example, the following hierarchy to describe value is recommended by the Chartered Institute of Ecology and Environmental Management (CIEEM) (2016) with respect to ecological receptors:

- International and European;
- National;
- Regional;
- Metropolitan, County, vice-county or other local authority-wide area;
- Local (e.g. assessment within a district or borough context or within a 'zone of influence').

4.6.2. Impact assessment

The EIA has been undertaken within a framework that allows for a transparent approach to the assessment and the resulting conclusions presented within this ES. This section sets out the assigned definitions that are used in the assessment process for a number of topics considered in the ES. In addition, a description of the approach taken to the specific impact assessment for each environmental topic is provided (in each relevant chapter) so that it is clear to the reader

how impacts have been defined, particularly where such an approach differs to that described within this section.

EIA provides an assessment of the impacts on sensitive receptors as a result of the effects of a development upon the environment. The terms 'effects' and 'impacts' have, in the past, been used interchangeably, but they are in fact different and one drives the other. Effects are physical changes in the environment that are set in motion as a consequence of a particular development or activity. Effects do not impact all receptors, as some receptors are not always sensitive to them.

Effects are measurable physical changes in the prevailing environment (e.g. volume, time and area) arising from construction and operation activities. Effects can be classified as primary (e.g. the physical presence of a built element of the development) or secondary (e.g. increase in erosion due to a change in the rate of discharge of surface water). Impacts consider the possible changes in potentially sensitive receptors as a result of an effect. Impacts can be classified as direct or indirect, permanent or time-limited and beneficial or adverse.

The relationship between effects and impacts is not always straightforward. For example, a secondary effect may result in both a direct and indirect impact on a single receptor. Given this the EIA framework used herein is based on the 'source-pathway-receptor' conceptual model process used to provide a systematic and auditable approach to understanding the potential for effects to arise, the spatial extents of the effect-receptor interactions, impact pathways, and potential impact significance. The conceptual '*source-pathway-receptor'* model is effective in the identification of potential effects and the means by which these can manifest themselves on the receiving environment and its sensitive receptors.

The term 'source' describes the origin of potential effects (e.g. construction activities) and the term 'pathway' describes the means (e.g. through air, water, or ground) by which the effect reaches the receiving sensitive 'receptor' (e.g. terrestrial habitats, archaeology and human receptors). If the source, pathway or receptor is absent, no linkage exists and thus there will be no potential for an impact to manifest.

For each effect, the assessment identifies receptors within the study area that are sensitive to that effect and implements a systematic approach to understand the impact pathways and the level of impacts on given receptors. The process considers the following:

- the magnitude of the effect;
- the sensitivity of a receptor to the effect;
- the probability that an effect-receptor interaction will occur;
- the determination and (where possible) qualification of the level of impact on a receptor, considering the probability that the effect-receptor interaction will occur, the spatial and temporal extents of the interaction and the significance of the resulting impact; and,

- the level of certainty at all stages.

4.6.2.1. The magnitude of effect

The magnitude of an effect is typically defined by four factors:

- **Extent** – the area over which an effect occurs.
- **Duration** – the time for which the effect occurs.
- **Frequency** – how often the effect occurs.
- **Severity** – the degree of change relative to existing environmental conditions.

In order to help define impact magnitude, the criteria presented in **Table 4.3** have been adopted for the purposes of this EIA. While this table provides guidelines of a generic nature, it should be noted that more specific guidelines in relation to impact magnitude have been adopted for the topics assessed, where considered necessary.

Table 4.3 Generic guidelines used in the determination of magnitude of effect

Magnitude	Description
Very high	Loss of resource and/or integrity of the resource; severe damage to key characteristics, features or elements (Adverse). Permanent / irreplaceable change, which is certain to occur. Large scale improvement of resource or attribute quality; extensive restoration or enhancement (Beneficial).
High	Loss of resource, but not affecting integrity of the resource; partial loss of or damage to key characteristics, features or elements (Adverse). Permanent / irreplaceable change, which is likely to occur. Improvement to, or addition of, key characteristics, features or elements of the resource; improvement of attribute quality (Beneficial).
Medium	Minor loss of, or alteration to, one (maybe more) key characteristics, features or elements; measurable change in attributes, quality or vulnerability (Adverse). Long-term though reversible change, which is likely to occur. Minor improvement to, or addition of, one (maybe more) key characteristics, features or elements of the resource; minor improvement to attribute quality (Beneficial).
Low	Very minor loss of, or alteration to, one (maybe more) key characteristics, features or elements; noticeable change in attributes, quality or vulnerability (Adverse). Short- to medium-term though reversible change, which could possibly occur. Very minor improvement to, or addition of, one (maybe more) key characteristic, feature or element; very minor improvement to attribute quality (Beneficial).
Very low	Temporary or intermittent very minor loss of, or alteration to, one (maybe more) characteristic, feature or element; possible change in attributes, quality or vulnerability (Adverse). Short-term, intermittent and reversible change, which is unlikely to occur. Possible very minor improvement to, or addition of, one (maybe more) characteristic, feature or element; possible improvement to attribute quality (Beneficial).

The significance of an impact is determined by combining the predicted magnitude of the effect with the sensitivity of the receptor; for example, as defined in **Table 4.4**. Impact statements carry a degree of subjectivity, as they are based on expert judgement regarding the effect-receptor interaction that occurs and on available data. As such, impact statements should be qualified appropriately.

Table 4.4 Impact assessment matrix

Receptor sensitivity (inclusive of value)	Magnitude of effect				
	Very high	High	Medium	Low	Very low
Very high	Major	Major	Moderate	Moderate	Minor
High	Major	Moderate	Moderate	Minor	Negligible
Medium	Moderate	Moderate	Minor	Minor	Negligible
Low	Minor	Minor	Minor	Negligible	Negligible
Very low	Minor	Negligible	Negligible	Negligible	Negligible

The probability of an effect occurring (i.e. an effect-receptor interaction) should also be considered in the assessment process; capturing the probability that the effect will occur and also the probability that the receptor will be present. For example, the magnitude of the effect and the sensitivity of the receptor may have been established, and it may be highly probable that the effect will occur; however, the probability that the receptor will be present at the same time should also be considered.

In the context of EIA, 'significant impacts' are taken to be those of moderate or major significance (as defined above); albeit that appropriate mitigation, where available, should be sought for all impacts. It should be reiterated that, although this section sets out the overall approach adopted for this EIA (using, for example, magnitude and sensitivity to determine the level of impact), individual sections may take their own approach where industry standard methodologies are appropriate or another approach has been agreed with the relevant regulator. Where a different approach is taken, this is explained in the relevant methodology section.

4.6.3. Mitigation measures

Mitigation measures have been proposed, where available and practical, in those cases where adverse impacts have been identified. It is important to note that the mitigation measures applied should be proportionate to the scale of the impact predicted. Appropriate mitigation measures have been discussed and agreed, where possible, with the relevant regulatory authorities and stakeholders. Whilst mitigation for minor or negligible impacts may not be specifically defined as a matter of course, industry standard or 'embedded' mitigation often applies in these cases (and is set out herein). It is also recognised that minor and negligible impacts could become significant when considered cumulatively with other pressures on a receptor and, in this event, mitigation may be required.

4.6.4. Monitoring

Appropriate mitigation measures have been identified and recommended in this ES where the EIA process has identified an adverse impact and mitigation is available (see above). In some cases, in order to ensure that the mitigation measures are successful or where there is significant uncertainty with respect to important receptors, monitoring may be appropriate.

Monitoring programmes are most commonly required during and shortly after construction, but can also be prior to and during operations. Monitoring is important for this scheme during operation to record beach profiles, in order to assess performance against its intended functions. The nature of any monitoring is dependent on the nature of the effect or mitigation measure under inspection and is discussed within the relevant sections.

4.6.5. Residual Impacts

Where further mitigation measures are identified, the significance of the residual environmental impact (i.e. the post-mitigation impact) is assessed.

4.7. Assumptions and limitations

The EIA process requires an ES to provide an indication of any difficulties (technical deficiencies or lack of know-how) encountered during the assessment process. Any such assumptions or limitations are identified within the relevant topic chapter, where relevant.

The EIA process also requires that an ES is prepared by competent experts. This ES has been compiled by Royal HaskoningDHV, a company which is a corporate member of the Institute of Environmental Management & Assessment (IEMA) (number 0001189) and also a Corporate Registered Assessor for EIA under IEMA's voluntary EIA Quality Mark scheme, through which EIA activity is independently reviewed, on an annual basis, to ensure it delivers excellence in areas including EIA management, team capabilities, regulatory compliance, content, presentation, and improving practice.

4.8. Cumulative Impact Assessment

4.8.1. Impact inter-relationships

Council Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the EIA Directive) states (in Annex III) that an ES should include "*A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors*".

This ES has given due consideration to the potential for different residual impacts to have a combined impact on key sensitive receptors. The objective is to identify where the accumulation of impacts on a single receptor, and the relationship between those impacts, potentially gives rise to a need for additional mitigation. Inter-relationships have been assessed within the relevant sections of the topic chapters of the ES.

4.8.2. Cumulative impacts

In line with IEMA's Guidelines for EIA (2004), cumulative impacts are defined as: "…the impacts on the environment which result from incremental impacts of the action when added to other

past, present and reasonably foreseeable future actions …". There is no legislation that outlines how CIAs should be undertaken. However, the EIA and Habitats Directives and their associated regulations require the consideration of direct impacts and any indirect, secondary and cumulative effects of a project. Government guidance states that: "cumulative effects could refer to the combined effects of different development activities within the vicinity" (Department for Communities and Local Government, 2006, Paragraph 121).

Guidance on cumulative effects assessment is provided in a number of good practice documents (e.g. the European Commission, 1999). This guidance is not prescriptive, but rather suggests various approaches which may be used, depending on their suitability to the project (for example the use of matrices, expert opinion, consultation, spatial analysis and carrying capacity analysis).

A tiered approach has been adopted for the new proposed scheme, based upon the following definitions:

- Site-specific (or within-development) cumulative impacts - different effects associated with the proposed scheme have the potential to interact and, together, influence common receptors. Where applicable, these inter-relationships are considered in the ES and HRA.

- Project-wide cumulative impacts which arise from the combined effect (additive or interactive) of the proposed scheme with other components of the Withernsea WwTW and associated infrastructure project.

- Wider cumulative impacts which are the combined impacts (additive or interactive) that may occur between the proposed facilities, and any other relevant development(s) for which information is publicly available.

With respect to 'past' projects, a useful ground rule in CIA is that the environmental impacts of schemes that have been completed should be included within the environmental baseline; as such, these impacts will be taken into account in the EIA process and, generally, can be excluded from the scope of CIA. However, the environmental impacts of recently completed projects may not be fully manifested and, therefore, the potential impacts of such projects should be taken into account in the CIA.

5. Consultation

5.1. Approach to consultation

Formal consultation has been undertaken with the appropriate authorities (primarily the MMO, ERYC and the statutory consultees) as part of the pre-application process, both directly with statutory bodies and also through the EIA screening and scoping phase.

Further consultation with other individuals and organisations has also occurred in order to undertake additional data collection to inform the EIA and to assess the impacts and determine an appropriate mitigation and monitoring strategy. Opinions that were received within the scoping response are tabulated at the start of the relevant sections.

5.2. Consultation Undertaken

5.2.1. Discretionary Advice Service (Natural England)

5.2.1.1. DAS/11138/197263

Natural England provided advice on 6th October 2016 (DAS/11138/197263) on the potential impacts on designated sites and proposed designated sites. Natural England also advised that due to the potential impacts of the proposed scheme the benthic habitats along and adjacent to the proposed development should be surveyed in order to inform an MCZ assessment. The DAS letter is provided in **Appendix F.**

5.2.1.2. DAS/11138/204391

Natural England provided subsequent advice on 21st April 2017 (DAS/11138/204391) which set out the scope of the surveys that would be required to adequately survey the benthic habitats in order to inform the MCZ assessment. Further details on the scope of the benthic survey and the results of the survey are provided in **Section 9**. The DAS letter is provided in **Appendix F**.

5.2.2. Sediment sampling methodology (MMO)

A sediment sampling and analysis plan was requested from the MMO (reference: (SAM/2016/00063). The MMO provided a sample plan on 13th October 2016 (see **Appendix G**). The plan details the sediment sampling and analysis required to support the marine licence application for the proposed scheme, in accordance with the recommendations of the OSPAR Guidelines for the Management of Dredged Material at Sea (OSPAR, 2014). Further information on the sample plan is provided in **Section 8**, including the details of the plan and the results of the sediment survey.

5.2.3. EIA Screening

An EIA Screening Opinion Request Report ('Screening Report') for the proposed Scheme was submitted to East Riding of Yorkshire Council (ERYC) and the MMO in January 2018 (**Appendix**

A). ERYC provided a negative screening opinion (i.e. that an EIA would not be required) (**Appendix B**). The MMO provided their formal screening opinion on 28th February 2018 (EIA/2018/00001). As set out in **Section 4.4** the MMO determined the scheme would require an EIA under Schedule A2 of the MWR, specifically Article 75; *"Waste-water treatment plant (unless included in Schedule A1)."* The Screening opinion is provided in **Appendix C.**

5.2.4. EIA Scoping

The MMO provided their formal Scoping opinion on 5th November 2018 (EIA/2018/00036) (**Appendix E**). From the scoping response received from the MMO, it was confirmed that two topics scoped out within the Environmental Scoping Report (ESR), were to be scoped into EIA process; Marine Mammals and Marine Historic Environment, and as such are also included within the Environmental Statement. Based on an evaluation of the baseline environmental information that exists for the site and surrounding area, and the potential environmental effects of the proposed scheme, a number of topics have been scoped out of the EIA process, and are not considered relevant to the EIA for this proposed scheme as no significant environmental effects are anticipated to occur. The Environmental Statement includes the technical disciplines outlined in **Table 5.1**.

Table 5.1 Scope of the EIA for the proposed scheme

Topic	Screened in by ESR	Screened in by MMO Scoping Response	Scoped out of EIA process
Marine hydrodynamic and sedimentary regime	✓		
Marine sediment and water quality	✓		
Marine and coastal ecology	✓		
Marine and coastal ornithology	✓		
Fish and fisheries	✓		
Marine mammals		✓	
Marine historic environment		✓	
Commercial and recreational navigation			✓
Air quality and odour			✓
Traffic and transport			✓
Noise and vibration			✓
Cultural Heritage			✓
Ground conditions			✓
Landscape and visual amenity			✓
Hydrology and flood risk			✓
Waste resources			✓
Climate change and adaptation			✓
Populations and human health			✓
Major accidents and disasters			✓

A wide range of organisations and individuals were consulted. The points raised within the Scoping Opinion issued by the MMO are set out in **Table 5.2** and are listed against specific receptors. Responses are either provided in the highlighted relevant sections or, in the case of project wide concerns, are provided within the table.

However, one point raised by the MMO within the Scoping Opinion, on the Hydrodynamic and Sedimentary Regime, was deemed by the applicant to be inaccurate. The EIA Scoping Opinion stated that "*The MMO therefore advise that hydrodynamic and sedimentary modelling must be undertaken and used to fully inform the impact assessment of the development on coastal and sedimentary processes within the ES*." The applicant responded to the MMO and requested that the Scoping Opinion be amended to reflect that significant information had already been provided in support of the statement that hydrodynamic and sedimentary modelling would not be required.

A response was issued by the MMO on 9th November 2018 agreeing that *"the ES must fully demonstrate that the proposed development will not have a significant impact on coastal processes. If it is considered that hydrodynamic and sedimentary modelling is not required, the MMO advises that the ES must fully consider and justify the reasons why"* (**Appendix E**). The above consultation has been included in the table below.

Table 5.2 Summary of EIA Scoping Opinion (Appendix E)

Topic	Statement	Section of the ES
General	Whilst the topics outlined within the Scoping Report are considered to be appropriate, the MMO advises that all subject headings be included within the 'Contents' pages of the ES.	Noted, however topics which have been scoped out have been clearly outlined in **Section 5.2.4** to avoid any confusion of including as separate Sections in the document.
Hydrodynamic and Sedimentary Regime	Whilst the MMO agree that the impact of the project, as described, is unlikely to have a significant impact on coastal processes and geomorphology during the operational phase, given the nature of the site, which is experiencing coastal retreat, further consideration of the likely impacts of the construction phase of the project to coastal processes and geomorphology must be considered within the ES.	Noted, addressed within **Section 7**
Hydrodynamic and Sedimentary Regime	The MMO note that hydrodynamic and sedimentary modelling has yet to be undertaken with regards to informing an impact assessment of the proposed development. The MMO therefore advise that hydrodynamic and sedimentary modelling must be undertaken and used to fully inform the impact assessment of the development on coastal and sedimentary processes within the ES. To this end, it is imperative that coastal erosion and sediment movement processes are allowed to continue. Specifically, the ES must demonstrate that the proposed development will not have a significant impact on coastal processes.	The applicant does not consider it to be appropriate to undertake hydrodynamic or sedimentary modelling. This is outlined in **Section 7**
Hydrodynamic and Sedimentary Regime	With regards to the proposed development, the MMO considers that it is imperative that coastal erosion and sediment movement processes within the area are allowed to continue. Therefore, the ES must fully demonstrate that the proposed development will not have a significant impact on coastal processes. If it is considered that hydrodynamic and sedimentary modelling is not required, the	**Section 7** concludes, using desk-based assessment approaches, that there will be no significant construction phase effects or operational phase effects as a result of the proposed works. The reasons why hydrodynamic and sediment modelling are

Topic	Statement	Section of the ES
	MMO advises that the ES must fully consider and justify the reasons why.	deemed by the applicant not to be required have been justified within the section.
Hydrodynamic and Sedimentary Regime	To ensure that the beach profile has not been significantly affected by the proposed development, the MMO recommends that additional LIDAR surveys be undertaken following completion of the works."	Noted, recommendations for post-completion surveys consistent with this recommendation from the MMO have been made in **Section 7**.
Hydrodynamic and Sedimentary Regime	From the information provided within the Scoping Report, it is unclear as to what the main mechanisms and processes responsible for the erosion of the existing LSO are.	Noted, further information provided in **Section 7**.
Hydrodynamic and Sedimentary Regime	"The MMO support the proposal for beach profile monitoring and advise that that, at a minimum, monitoring be undertaken 100 metres up drift and down drift of the works."	Noted, recommendations for post-completion surveys consistent with this recommendation from the MMO have been made in **Section 7**.
Hydrodynamic and Sedimentary Regime	"When reinstating the beach profile, the MMO advise that consideration be given to the time of year to ensure that a natural profile is achieved. The ES must also consider the possibility of sediment transport as the result of storm events and detail any activities required to relocate sediment deposits, if necessary."	Timing of reinstatement works with respect to exposure conditions has been considered in the construction programme.
Marine Sediment and Water Quality	Given the nature of proposed development, the MMO considers that the removal and relocation of the existing LSO has the potential to elevate levels of bacteria (e.g. Esherichia coli) within the water environment. In light of this, the MMO considers that impacts to bathing water quality be included within the ES. Specifically, the ES should consider whether the works are likely to mobilise micro-organisms in sufficient numbers to adversely affect the water quality within designated bathing waters and subsequently have an impact users of the marine and water environment.	Noted, this is included within **Section 8**, however no risk has been identified
Marine Sediment and Water Quality	Where it is not possible to conclude no significant adverse impact to water quality within designated bathing waters, the MMO advise the works must be completed outside of the bathing season in order to reduce the likely impact to water users.	Noted, this is included within **Section 8**, however no significant risk has been identified
Marine Sediment and Water Quality	Whilst the MMO recognise and welcome the inclusion of sediment analyses, in accordance with an agreed sampling plan (Appendix H), we advise that unless the effect of contaminant release on water quality can be specifically 'scoped out', then the impact of contaminant release on the benthos must be assessed within the ES.	Noted, this is included within **Section 8**, however no significant risk has been identified
Benthic Ecology	The MMO therefore advise that the available sidescan and multibeam data must be considered within the ES for the identification of *S. Sabellaria* reef within the footprint of the works with a clear description of the investigation methods provided.	Noted, further information provided in **Section 9**, no potential *S. Sabellaria* reef within the footprint highlighted by the geophysical and ecological surveys
Benthic Ecology	To confirm whether the samples grabs and drop-down station were appropriately placed, the MMO consider that maps showing the positions of grab stations and drop-down camera stations in relation to the LSO route must be provided within the ES.	Noted, included in **Section 9**
Benthic Ecology	The MMO consider that the ES must also fully consider the likely effects of resuspended sediment by construction works.	Noted, included in **Section 9**
Marine Mammals	The MMO note that the Scoping Report proposes to 'scope out' impacts to marine mammals on the basis that any potential	Noted, included in **Section 9**

Topic	Statement	Section of the ES
	impacts are expected to be both short-term and temporary, and will only affect transiting mammals, with no known haul out areas at this location. However, given anecdotal evidence of seal sightings on Withernsea beach itself, the MMO advise that impacts to marine mammals (particularly to grey seals, a feature of the Humber Estuary Ramsar, SAC, and SSSI) should be 'scoped in' for further assessment. In particular, the MMO consider that the potential impacts to marine mammals from underwater noise must be considered within the ES.	
Marine Mammals	The MMO therefore advise that all works associated with the cofferdam be included within the ES and shadow HRA and used to fully inform the assessment. In particular, the MMO consider that the potential impacts to marine mammals from underwater noise must be considered within the ES.	Noted, included in **Section 9**, however, piling will be undertaken in the dry, on the foreshore and therefore no pathway for effects of underwater noise on marine mammals
Fish and Fisheries	The MMO note that the Scoping Report correctly acknowledges that the development is situated within a herring spawning ground. However, based on the information provided, it is unclear as to whether impacts to herring will be assessed at the species level. The MMO therefore advise that impact assessments to herring at the species level be considered within the ES. Impact assessments to herring species must be informed by habitat requirements and available stock statistics for herring at the species level.	Noted, impacts have been addressed at species level where relevant in **Section 10**
Fish and Fisheries	Herring are acoustically sensitive to noise and vibration and are therefore vulnerable to the impacts of construction activities (e.g. piling and dredging). The spawning season for Central North Sea herring is between August and October. If the works are likely to overlap with the herring spawning season, the MMO advise that the ES must demonstrate that underwater noise and vibration will not propagate into herring spawning grounds. Such considerations must be supported by suitable underwater noise assessments or modelling.	Noted, included in **Section 10**, however, piling will be undertaken in the dry, on the foreshore and therefore no pathway for effects of underwater noise on herring
Fish and Fisheries	Further to the points raised in paragraphs 4.6.2 and 4.6.3, the MMO advise that impacts to other fish species with sensitivities to construction activities (e.g. piling and dredging) must also be considered within the ES.	Noted, included in **Section 10**
Fish and Fisheries	The MMO note that the North Eastern Inshore Fisheries and Conservation Authority (IFCA) have already been consulted. However, the MMO consider that further consultation with local shell-fishers/fisherman must be undertaken and used to fully inform the ES with regard to understanding fleet behaviours and stock dynamics. Specifically, the MMO advise that consultation with local shellfisheries be undertaken to provide the best evidence base for establishing accurate environmental baselines and to reduce uncertainty in the impact assessment of the proposed development on shellfish.	Noted – attempts have been made to make contact with a local fishing group with regard to the proposed scheme, but no information was received at the time of writing this ES. Information was provided by Holderness Coast FLAG in advance of Withernsea Coastal Defence project (2018).
Marine Historic Environment	Under Section 6.3.2 of the Scoping Report, impacts to the marine historic environment have been 'scoped out'. However, the MMO consider that the there is a high potential for geoarchaeological evidence to be preserved within offshore deposits and therefore advise that impacts to the marine historic environment be 'scoped in' under the ES	Noted, included in **Section 12**

Topic	Statement	Section of the ES
Marine Historic Environment	Specifically, the MMO consider that any boreholes recovered must be made available to a geoarchaeologist for review and palaeoenvironmental sampling. The MMO also consider that a deposit model of the subsurface sediments must also be included within the ES. This model must be informed by existing and new borehole data, and considered within an geoarchaeological desk-based assessment of likely impacts of the works to the Doggerland area	Noted, further information included in **Section 12**
Marine Historic Environment	In order to fully assess the likely impacts of the development on the historic terrestrial environment, the MMO advise that a geoarchaeologist be consulted on the likely impacts to areas with deep superficial deposits related to Holocene lacustrine or alluvial sediments.	Noted, further information included in **Section 12**
Marine Historic Environment	The MMO advise that consultation advice be obtained from Historic England to ensure that an appropriate assessment is undertaken with respect to the likely impacts to the historic environment, both marine and terrestrial, from the proposed development	Noted, consultation was undertaken with Historic England during the EIA Process. Further information is included in **Section 12**
Scheme Description	In principle, the MMO has no objection to the proposed development with regards to the likely impacts to navigational safety. However, the MMO consider that the ES must present a detailed method statement for the works and provide relevant measures to ensure navigational safety and the safety of other users of the marine environment, including beach users.	Noted, included in **Section 2**
HRA	The MMO welcomes consideration of both physical disturbance and noise to the associated qualifying features of the affected sites.	Noted, included in **Section 15**
HRA	The MMO note that the Habitats Regulations Assessment (HRA) provided in support of the Scoping Report (Appendix D) states that the subtidal components of the work will be completed during the summer of 2020 and that the intertidal component of work will be carried out at low water, therefore avoiding sensitive timings for Red Throated Divers. The MMO advise that the recent People Over Wind Ruling by the Court of Justice of the European Union has determined that measures intended to avoid or reduce the likely adverse effects cannot be taken into account when determining whether a plan or a project is likely to have a significant effect on a site. Based on the information provided within the shadow HRA, without mitigation, it cannot be concluded that the works will not have a likely significant effect. Consequently, the MMO advise that information to inform an Appropriate Assessment is provided within a section of the ES.	Noted, however, the intertidal component of work will be carried out at low water due to the access required by land-based plant. Furthermore, the subtidal components of the work will be completed during the summer of 2020 due to the requirement for good weather conditions. This is assessed in **Section 15**
HRA	Based upon the information provided within the Scoping Report and the shadow HRA (Appendix D), it is not clear whether the works associated with the decommissioning of the existing long sea outfall (LSO) works have been included and assessed accordingly.	Further information on the decommissioning of the existing LSO have been provided in **Section 15**.
HRA	From the information provided, it is not clear whether activities associated with the maintenance and operation of the works have been included and assessed within the HRA (Appendix D). The	Further information on the operational activities of the existing LSO have been provided, it is assumed that the same works would be carried out for the new LSO. These

Topic	Statement	Section of the ES
	MMO therefore advise that any maintenance and operation works be fully considered within the shadow HRA.	minor maintenance activities are covered by an existing Marine Licence. A subsequent marine licence would be sought for more major works.
HRA	The MMO note that a temporary cofferdam structure is required to facilitate connection of the Horizontal Directional Drilling (HDD), to the subtidal trench. However, from the information provided in the shadow HRA and MCZ Assessment, it does not appear that the likely effects of the works associated with the cofferdam structure (including piling) have been assessed	Noted, further detail is provided on the cofferdam in **Section 2** and is assessed in **Section 15** and **Section 16**
HRA	The MMO note that a temporary ramp will be constructed to allow access from the cliff to the foreshore in order to carry out the works. From the information provided, it is not clear whether the works associated with the temporary access ramp have been considered within the shadow HRA and MCZ Assessment.	Noted, further detail is provided on the access ramp in **Section 2** and is assessed in **Section 15** and **Section 16**
HRA	The MMO considers that the proposed development is likely to have a significant effect on protected bird species, such as the Red throated diver during the overwintering period (i.e. 1 October and 31 March, inclusive).	Noted, however further information is provided in **Section 2** to detail that most works will not be undertaken within this period due to the operational constraints and H&S risks of working in poor weather.
HRA	The MMO advise that consultation advice be obtained from Natural England with respect to the assessment of the likely impact of the proposed development on sites designated for nature conservation and to ensure that the shadow HRA and MCZ is both appropriate and fit for purpose.	Noted, Natural England were consulted through a DAS request during the pre-application phase and the project was discussed in detail at this time. The results of this consultation have informed those relevant sections of the ES. **Section 15** and **Section 16**
MCZ	The MMO notes that the total area of habitat loss within the MCZ as a result of the works has been calculated at 255 m2 (0.000825% of the total area of the site designation). However, from the information provided it is not clear as to what habitats will be affected by the proposed development. The MMO therefore advise that estimates of habitat loss within the MCZ be considered at the feature level.	Further information has been provided within **Section 16**. However, note that there is no permanent habitat loss as part of the proposed scheme, the materials removed will be side-cast and used as backfill.
CIA	The MMO notes that the information on the cumulative and inter-related impact assessment within the Scoping Report is very high-level. The MMO therefore advise that any developments within the area of influence (including those in planning, construction and operational stages), be included in the assessment of cumulative and inter-related impacts. This assessment must consider activities and development occurring within both the marine and terrestrial environments.	Further information has been provided within **Section 13**

6. Designated Sites

The proposed scheme footprint is located within and adjacent to a number of internationally and nationally protected sites (**Figure 6.1**), including; Greater Wash SPA, Humber Estuary SPA/Ramsar/SAC/SSSI, Dimlington Cliffs SSSI, and, Holderness Inshore MCZ. A summary of each of these sites are provided below.

6.1. Greater Wash SPA

The proposed scheme is located within the boundary of the Greater Wash SPA. This site is designated to protect important areas of sea used by waterbirds during the non-breeding period, and for foraging in the breeding season by qualifying interest features of a number of other SPAs: Humber Estuary, Gibraltar Point, North Norfolk Coast, Breydon Water and Great Yarmouth North Denes.

The site was designated on the 28th of March 2018 and covers an area of 3,536 km^2. The SPA covers the area from MHWS along the coastline from Bridlington Bay in the north to the boundary of the Outer Thames SPA in the south. The seaward boundary of the site lies approximately 14 nautical miles from the shore at its furthest point and was determined by the distribution of red-throated diver *Gavia stellata* and sandwich tern *Sterna sandvicensis* foraging areas.

A Regulation 35 Conservation Advice package is not yet available for this site and as such the citation (Natural England, 2018) and consultation reports (Natural England, and JNCC, 2017) have been used to inform this ES. The qualifying species of this site are detailed in **Table 6.1** below.

Table 6.1 Qualifying features from the Greater Wash SPA citation (Natural England, 2018)

Species	Count	% of subspecies or population
The site qualifies under Article 4.1 of the Directive 2009/147/EC by regularly supporting populations of national importance of the following Annex I species:		
Red-throated diver *Gavia stellata*	1,407 individuals (Mean of Peak (MoP) 2002/3 – 2005/6)	8.3% of the GB non-breeding population
Little gull *Hydrocoloeus minutus*	1,255 individuals (MoP 2004/5 – 2005/6)	No current GB population estimate
Sandwich tern *Sterna sandvicensis*	3,852 breeding pairs (5-year MoP 2010-2014)	35% of the GB breeding population
Common tern *Sterna hirundo*	510 breeding pairs (5 year MoP 2010-2014)	5.1% of the GB breeding population
Little tern *Sternula albifrons*	798 breeding pairs (5 year MoP 2009-2013)	42% of the GB breeding population
The site also qualifies under Article 4.2 of the Directive 2009/147/EC by regularly supporting a population of international importance of the migratory species:		
Common scoter *Melanitta nigra*	3,449 individuals (MoP 2002/3 – 2007/8)	0.6% of the biogeographic population

Legend

- Proposed Scheme Boundary
- 5km buffer
- Special Area of Conservation (SAC)
- Site of Special Scientific Interest (SSSI)
- Ramsar Site
- Special Protection Area (SPA)
- Marine Conservation Zone (MCZ), Designated
- Marine Conservation Zone (MCZ), Recommended
- Potential Special Protection Area (pSPA)

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title: Nature conservation designations within 5km of the proposed scheme

Figure: 6.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	ES	A3	1:100,000

Co-ordinate system: British National Grid

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6.2. Humber Estuary SPA/SAC/SSSI and Ramsar site

The proposed scheme is located approximately 4.6km north of the Humber Estuary which is protected through a number of international and national designations including an SPA, Ramsar site, SAC and SSSI. The Humber Estuary is a large macro-tidal coastal plain estuary with high suspended sediment loads, which feed a dynamic and rapidly changing system of accreting and eroding intertidal and subtidal mudflats, sandflats, saltmarsh and reedbeds.

6.2.1. Humber Estuary SPA/Ramsar site

The SPA/Ramsar was classified on the 31st of August 2007 and covers an area of approximately 376.3km^2. The Humber Estuary SPA/Ramsar site extends from the mouth of the Humber and adjacent open coast, along the estuary (including the shoreline non-tidal habitats) to the limit of saline intrusion on the tidal river Ouse and to a point about 2km south of Trent Falls on the tidal river Trent. These habitats support a variety of wintering, passage and breeding birds, including internationally important populations of a number of species, which are widely distributed throughout the site (Natural England, 2018).

At high-tide, essential roost sites are limited due to the combined effects of extensive land claim, coastal squeeze and the lack of grazing marsh and grassland. A number of developing managed realignment sites are contributing to the variety of habitats available to the birds and adjacent inland terrestrial sites areas are used extensively as high tide roosts, whilst also providing important supporting habitats for some SPA bird species.

Table 6.2 reflects the most up to date information on the qualifying features of Humber Estuary SPA, as described in the new Regulation 35 package (Natural England, 2018).

Table 6.2 Qualifying features of Humber Estuary SPA from Regulation 35 Conservation Advice (Natural England, 2018)

Species	Count	% of subspecies or population
The site qualifies under Article 4.1 of the Directive 2009/147/EC by regularly supporting populations of national importance of the following Annex I species:		
Avocet *Recurvirostra avosetta*	59 wintering individuals (MoP 1996/7 – 2000/1)	1.7% of GB population
Bittern *Botaurus stellaris*	4 wintering individuals (MoP 1998/9 – 2002/3)	4% of GB population
Hen harrier *circus cyaneus*	8 wintering individuals (MoP 1997/8 – 2001/2)	1.1% of GB population
Golden plover *Pluvialis apricaria*	30,709 wintering individuals (MoP 1996/7 – 2000/1)	12.3% of GB population
Bar-tailed godwit *Limosa lapponica*	2,752 wintering individuals (MoP 1996/7 – 2000/1)	4.4% of GB population
Ruff *Philomachus pugnax*	128 passage individuals (MoP 1996-2000)	1.4% of GB population
Bittern *Botaurus stellaris*	2 breeding booming males (3 year mean 2002-2002)	10.5% of GB population

Species	Count	% of subspecies or population
Marsh harrier *Circus aeruginosus*	10 breeding females (5 year mean 1998-2002)	6.3% of GB population
Avocet *Recurvirostra avosetta*	64 breeding pairs (5 year mean 1998-2002)	8.6% of GB population
Little tern *Sternula albifrons*	51 breeding pairs (5 year mean 1998-2002)	2.1% of GB population
The site also qualifies under Article 4.2 of the Directive 2009.147/EC by regularly supporting a population of international importance of the migratory species:		
Shelduck *Tadorna tadorna*	4,464 wintering individuals (MoP 1996/7 – 2000/1)	1.5% Northwestern Europe (breeding)
Knot *Calidris canutus*	28,165 wintering individuals (MoP 1996/7 – 2000/1)	6.3% *islandica*
Dunlin *Calidris alpina*	22,222 wintering individuals (MoP 1996/7 – 2000/1)	1.7% *alpina*, Western Europe (non-breeding)
Black-tailed godwit *Limosa limosa*	1,113 wintering individuals (MoP 1996/7 – 2000/1)	3.2% *islandica*
Redshank *Tringa totanus*	4,632 wintering individuals (MoP 1996/7 – 2000/1)	3.6% *brittanica*
Knot *Calidris canutus*	18,500 passage individuals (MoP 1996-2000)	4.1% *islandica*
Dunlin *Calidris alpina*	20,268 passage individuals (MoP 1996-2000)	1.5% *alpina*, Western Europe (non-breeding)
Black-tailed godwit *Limosa limosa*	915 passage individuals (MoP 1996-2000)	2.6% *islandica*
Redshank *Tringa totanus*	7,462 passage individuals (MoP 1996-2000)	5.7% *brittanica*

In addition to those features listed above, the Humber Estuary Ramsar site is designated for the features outlined in **Table 6.3**.

Table 6.3 Humber Estuary Ramsar site - qualifying criteria (JNCC, 2007)

Ramsar Criterion	Justification
Criterion 1	The site is a representative example of a near-natural estuary with the following component habitats: dune systems and humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes, and coastal brackish/saline lagoons.
Criterion 3	The Humber Estuary Ramsar site supports a breeding colony of grey seals *Halichoerus grypus* at Donna Nook. It is the second largest grey seal colony in England and the furthest south regular breeding site on the east coast. The dune slacks at Saltfleetby-Theddlethorpe on the southern extremity of the Ramsar site are the most north-easterly breeding site in Great Britain of the natterjack toad *Bufo calamita*.
Criterion 5	Assemblages of international importance: 153,934 waterfowl, non-breeding season (MoP 1996/97 – 2000/2001)
Criterion 8	The Humber Estuary acts as an important migration route for both river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* between coastal waters and their spawning areas.

6.2.2. Humber Estuary SAC

The Humber Estuary SAC was designated in 2007 and protects an area of approximately 366.5km^2. The SAC extends about 70km from the mouth of the Humber up to the limit of saline intrusion on the rivers Ouse and Trent, as per the SPA/Ramsar site boundaries.

The estuary supports a full range of saline conditions from the open coast to the limit of saline intrusion. As salinity declines upstream tidal reedbeds and brackish saltmarsh communities fringe the estuary. Significant fish species include river lamprey and sea lamprey which migrate through the estuary to breed in the rivers of the Humber catchment. Grey seals come ashore in autumn to form large breeding colonies on the sandy shores of the south bank around Donna Nook (Natural England, 2017).

Table 6.4 lists the qualifying features of the Humber Estuary SAC, as set out in the Regulation 35 Conservation Advice (Natural England, 2017).

Table 6.4 Qualifying features of the Humber Estuary SAC (Natural England, 2017)

Qualifying features
The site is designated under article4(4) of the Directive (92/43/EEC) as it hosts the following habitats listed in Annex I:
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
Coastal lagoons *
Dunes with *Hippophae rhamnoides*
Embryonic shifting dunes
Estuaries
Mudflats and sandflats not covered by seawater at low tide
Fixed dunes with herbaceous vegetation ('grey dunes') *
Salicornia and other annuals colonising mud and sand
Sandbanks which are slightly covered by sea water all the time
Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes')
Priority features are denoted by an asterisk (*)
The site is designated under article 4(4) of the Directive (92/43/EEC) as it hosts the following species listed in Annex II:
Grey seal *Halichoerus grypus*
River lamprey *Lampetra fluviatilis*
Sea lamprey *Petromyzon marinus*

6.2.3. Humber Estuary SSSI

The Humber Estuary SSSI was notified under Section 28C of the Wildlife and Countryside Act 1981 (as amended) in 2004 as the estuary is a nationally important site with a series of important habitats supporting nationally important numbers of birds, fish and marine mammals.

The estuary itself is a nationally important habitat, with its component habitats of intertidal mudflats and sandflats and coastal saltmarsh, and the associated saline lagoons, sand dunes and standing

waters. The site is also of national importance for the geological interest at South Ferriby Cliff (Late Pleistocene sediments) and for the coastal geomorphology of Spurn. The estuary supports nationally important numbers of 22 wintering waterfowl and nine passage waders, and a nationally important assemblage of breeding birds of lowland open waters and their margins. It is also nationally important for a breeding colony of grey seal *Halichoerus grypus*, river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*, a vascular plant assemblage and an invertebrate assemblage (English Nature, 2004).

The notified features of the Humber Estuary SSSI, as described in the citation (English Nature, 2004), are presented in **Table 6.5**.

Table 6.5 Notified features within the Humber Estuary SSSI (English Nature, 2004)

Humber Estuary SSSI Notified Features (2004)	
Aggregations of non-breeding birds	Avocet, *Recurvirostra avosetta* Bar-tailed godwit, *Limosa lapponica* Bittern, *Botaurus stellaris* Black-tailed godwit, *Limosa limosa islandica* Brent goose (dark-bellied), *Branta bernicla bernicla* Curlew, *Numenius arquata* Dunlin, *Calidris alpina alpina* Golden plover, *Pluvialis apricaria* Goldeneye, *Bucephala clangula* Greenshank, *Tringa nebularia* Grey plover, *Pluvialis squatarola* Knot, *Calidris canutus* Lapwing, *Vanellus vanellus* Oystercatcher, *Haematopus ostralegus* Pochard, *Aythya ferina* Redshank, *Tringa totanus* Ringed plover, *Charadrius hiaticula* Ruff, *Philomachus pugnax* Sanderling, *Calidris alba* Scaup, *Aythya marila* Shelduck, *Tadorna tadorna* Teal, *Anas crecca* Turnstone, *Arenaria interpres* Whimbrel, *Numenius phaeopus* Wigeon, *Anas penelope*
Assemblages of breeding birds	Lowland open waters and their margins
Geology	EC – Quaternary of East England IA – Coastal geomorphology
Species	Grey seal *Halichoerus grypus* River lamprey, *Lampetra fluviatilis* Sea lamprey, *Petromyzon marinus*
Habitats	Estuaries Saline coastal lagoons Moderately exposed sandy shores (with polychaetes and bivalves) Sheltered muddy shores (including estuarine muds) Standing waters Wave exposed sandy shores (with burrowing crustaceans and polychaetes)
Sand dune habitats	SD10 - *Carex arenaria* dune community SD15 - *Salix repens - Calliergon cuspidatum* dune-slack community SD17 - *Potentilla anserina - Carex nigra* dune-slack community

Humber Estuary SSSI Notified Features (2004)	
	SD18 - *Hippophae rhamnoides* dune scrub SD2 - *Cakile maritima-Honkenya peploides* strandline community SD4 - *Elymus farctus ssp. Boreali-atlanticus* foredune community SD5 - *Leymus arenarius* mobile dune community SD6 - *Ammophila arenaria* mobile dune community SD7 - *Ammophila arenaria* - Festuca rubra semi-fixed dune community SD8 - *Festuca rubra - Galium verum* fixed dune grassland SD9 - *Ammophila arenaria - arrhenatherum elatius* dune grassland
Grassland	MG11 – *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland
Swamp	S21 - *Scirpus maritimus* Swamp S26 - *Phragmites australis - Urtica dioica* tall-herb fen S4 - *Phragmites australis* swamp and reed-beds
Saltmarsh	SM10 - Transitional low marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima* SM11 - *Aster tripolium var. discoides* - saltmarsh SM12 - Rayed *Aster tripolium* on saltmarsh SM13a - *Puccinellia maritima* saltmarsh, *Puccinellia maritima* dominant sub-community SM14 - *Atriplex portulacoides* saltmarsh SM15 - *Juncus maritimus - Triglochin maritima* saltmarsh SM16a - *Festuca rubra* saltmarsh *Puccinellia maritima* sub-community SM2 - *Ruppia maritima* salt-marsh community SM24 - *Elytrigia atherica* saltmarsh SM28 - *Elytrigia repens* saltmarsh SM6 - *Spartina anglica* saltmarsh SM8 - Annual *Salicornia* saltmarsh SM9 - *Suaeda maritima* saltmarsh
Vascular plant assemblage	
Invertebrate assemblage	

6.3. Dimlington Cliff SSSI

The proposed scheme is located approximately 3km to the north of the Dimlington Cliff SSSI. This site was notified under Section 28 of the Wildlife and Countryside Act 1981 (as amended) in 1990 (English Nature, 1990). Dimlington Cliff is a key site for Quaternary stratigraphy. The cliff section shows a sequence, from the base of the cliffs upwards of: pre-late Devensian Basement Till; organic silts and sands (Dimlington silts); Late Devension Skipsea and Withernsea Tills, locally with interbedded sands and silts; and a well-developed Flandrian weathering profile (English Nature, 1990).

6.4. Holderness Inshore MCZ

The proposed scheme footprint is located within the Holderness Inshore MCZ. The Holderness Inshore MCZ was designated in January 2016 for important intertidal and subtidal habitats. The site is 309km^2 in total and stretches along the Holderness Coast from Skipsea Sands in the north, to Spurn Head, at the mouth of the Humber Estuary, in the south (Defra, 2016a). This dynamic coastal environment supports a number of habitats of ecological importance.

The features designated within the Holderness Inshore MCZ are detailed in **Table 6.6** as listed in Schedule 2 of the Designation Order (Defra, 2016a). For each designated feature of the site, a

conservation objective is assigned (Defra, 2016b). The conservation objectives for MCZs are high level criteria describing the desired condition of the MCZ features (**Table 6.6**). There are two objectives for features within an MCZ, namely whether the features are in the desired favourable condition and need to be maintained in this condition, or, whether the features are not in the desired favourable condition and need to be recovered to that condition.

Table 6.6 Designated features of the Holderness Inshore MCZ

Feature	Conservation objective
Intertidal sand and muddy sand	Maintain in favourable condition
Moderate energy circalittoral rock	Maintain in favourable condition
High energy circalittoral rock	Maintain in favourable condition
Subtidal coarse sediment	Maintain in favourable condition
Subtidal mixed sediments	Maintain in favourable condition
Subtidal sand	Maintain in favourable condition
Subtidal mud	Maintain in favourable condition
Spurn Head (subtidal geological feature)	Maintain in favourable condition

6.5. Species and Habitats of Principal Importance

A list of species and habitats of principal importance has been developed under Section 41 (S41) of the Natural Environment and Rural Communities (NERC) Act 2006. The S41 list contains 943 species and 56 habitats of principal importance which occur in England. Marine habitats and species which have previously been identified in the vicinity of the proposed scheme include: Maritime cliff and slope (however, this does not lie within the footprint of the proposed scheme), sand and gravel intertidal foreshore substrate; and Harbour porpoise.

7. Hydrodynamic and Sedimentary Regime

7.1. Introduction

This section presents the baseline conditions for the hydrodynamic and sedimentary regime of the study area, and describes the predicted effects of the proposed scheme on the baseline conditions.

7.2. Consultation

During the pre-application phase, consultation was undertaken with Natural England regarding the potential impacts of the proposed scheme and the methodology for the marine geophysical investigation. Subsequently, as part of the EIA scoping phase, consultation was undertaken with the MMO. The MMO received individual responses to inform their decision-making from both the Environment Agency and the Centre for Environment, Fisheries and Aquaculture Science (Cefas). The issues raised are summarised in **Table 7.1**.

Table 7.1 Consultation Responses relating to the hydrodynamic and sedimentary regime

Consultee	Date /Document	Comment	Response / where addressed in the ES
Natural England	DAS/11138/197263	"It is important that the features of the [Humber] estuary are not compromised by development on the Holderness Coast as a result of the interruption of sediment supply. The supply of sediment to and beyond the Humber Estuary from the Holderness coast is of direct importance to the designated sites including the Humber Estuary SPA, SAC, Ramsar site and underpinning SSSI."	The importance of cohesive sediment supply from the Holderness coast to the general suspended sediment load in the North Sea is recognised in this section. It is considered that the features of the Humber Estuary will not be compromised by the proposed works, either during their construction phase or during their operation phase. This is discussed in **Section 7.5**.
Natural England	DAS/11138/204391	"…the Holderness Inshore area is highly turbid with high levels of suspended sediment and this is exacerbated by weather conditions e.g. strong winds".	This is noted within the description of the baseline environment contained within **Section 7.4**. This is also important in considering construction phase effects because these will be negligibly small in respect of the large variations that can occur naturally in the suspended sediment loads in the North Sea.
Natural England	DAS/11138/197263	"Where intertidal works are proposed, any preferred engineering option should consider impacts on net sediment movement and where possible designs should allow for a minimum impact to sediment movement".	The designs have considered potential effects on sediment transport during both construction and operation phases. The selection of HDD or micro-tunnelling in the inter-tidal area for installation will minimise the effects on sediment transport during construction, whilst the design ensures that the LSO will remain buried during its operational life and thus cause no effects on sediment transport during the operation phase. This is discussed in **Section 7.5**.
Natural England	DAS/11138/197263	"NE advise beach profile data is obtained to allow for the intertidal area to be reinstated post works."	Recommendations for surveys consistent with this recommendation from NE have been made in **Section 7.5**.

Consultee	Date /Document	Comment	Response / where addressed in the ES
MMO	EIA Scoping Opinion 5th November 2018	"The MMO note that Section 5.2.1 of the Scoping Reports concludes that there are no expected impacts on the coastal configuration as a result of proposed development. Whilst the MMO agree that the impact of the project, as described, is unlikely to have a significant impact on coastal processes and geomorphology during the operational phase, given the nature of the site, which is experiencing coastal retreat, further consideration of the likely impacts of the construction phase of the project to coastal processes and geomorphology must be considered within the ES."	Potential impacts on coastal processes and geomorphology during both the operational phase and the construction phase have been considered in **Section 7.5**.
MMO	EIA Scoping Opinion 5th November 2018	"The MMO note that hydrodynamic and sedimentary modelling has yet to be undertaken with regards to informing an impact assessment of the proposed development. The MMO therefore advise that hydrodynamic and sedimentary modelling must be undertaken and used to fully inform the impact assessment of the development on coastal and sedimentary processes within the ES. To this end, it is imperative that coastal erosion and sediment movement processes are allowed to continue. Specifically, the ES must demonstrate that the proposed development will not have a significant impact on coastal processes."	The applicant does not consider it to be appropriate to undertake hydrodynamic or sedimentary modelling to inform the ES for the following reasons: The LSO replacement will be completed using either Horizontal Directional Drilling (HDD) or micro-tunnelling within the intertidal zone and burial within the subtidal zone. The Scoping Report concludes a non-significant increase in suspended sediment levels during the construction phase of the proposed development.
MMO	EIA Scoping Opinion Update 9th November 2018	"With regards to the proposed development, the MMO considers that it is imperative that coastal erosion and sediment movement processes within the area are allowed to continue. Therefore, the ES must fully demonstrate that the proposed development will not have a significant impact on coastal processes. If it is considered that hydrodynamic and sedimentary modelling is not required, the MMO advises that the ES must fully consider and justify the reasons why."	The section concludes, using desk-based assessment approaches, that there will be no significant construction phase effects or operational phase effects as a result of the proposed works. The reasons why hydrodynamic and sediment modelling are deemed by the applicant not to be required have been justified within **Section 7.3.3**.
MMO	EIA Scoping Opinion 5th November 2018	"The MMO consider that the appropriate data sources have been identified with regards to the impact assessment of the proposed development to local hydrodynamic and coastal processes and welcome the use of LIDAR data to inform the assessment. To ensure that the beach profile has not been significantly affected by the proposed development, the MMO recommends that additional LIDAR surveys be undertaken following completion of the works."	Recommendations for post-completion surveys consistent with this recommendation from the MMO have been made in **Section 7.5**.

Consultee	Date /Document	Comment	Response / where addressed in the ES
MMO	EIA Scoping Opinion 5th November 2018	"From the information provided within the Scoping Report, it is unclear as to what the main mechanisms and processes responsible for the erosion of the existing LSO are. The MMO advise that the physical processes responsible for the erosion of the existing LSO must be clearly presented within the ES and accompanied by appropriate measures to be taken to ensure that the replacement LSO is not compromised by the same processes in the future. To this end, the ES must also detail how the 3 m LSO burial depth will be achieved along the entire length of the outfall and demonstrate that the burial depth it will be sufficient to ensure that additional protection (e.g. rock armour) will not be required under the influence of present and future coastal processes."	The principal mechanism causing sea cliff recession, beach fluctuations and shore platform downwearing (when the platform is exposed) in the vicinity of the existing LSO is wave action. The replacement LSO will be buried within the shore platform and will not be subject to these processes over its design life. The design has considered natural changes in cliff position, beach level and shore platform downwearing to ensure that the LSO will remain buried during its operational life and thus cause no effects on sediment transport during the operation phase.
MMO	EIA Scoping Opinion 5th November 2018	"The MMO support the proposal for beach profile monitoring and advise that that, at a minimum, monitoring be undertaken 100 metres up drift and down drift of the works."	Recommendations for beach profile monitoring surveys consistent with this recommendation from the MMO have been made in **Section 7.5**.
MMO	EIA Scoping Opinion 5th November 2018	"When reinstating the beach profile, the MMO advise that consideration be given to the time of year to ensure that a natural profile is achieved. The ES must also consider the possibility of sediment transport as the result of storm events and detail any activities required to relocate sediment deposits, if necessary."	Timing of reinstatement works with respect to exposure conditions has been considered in the construction programme.

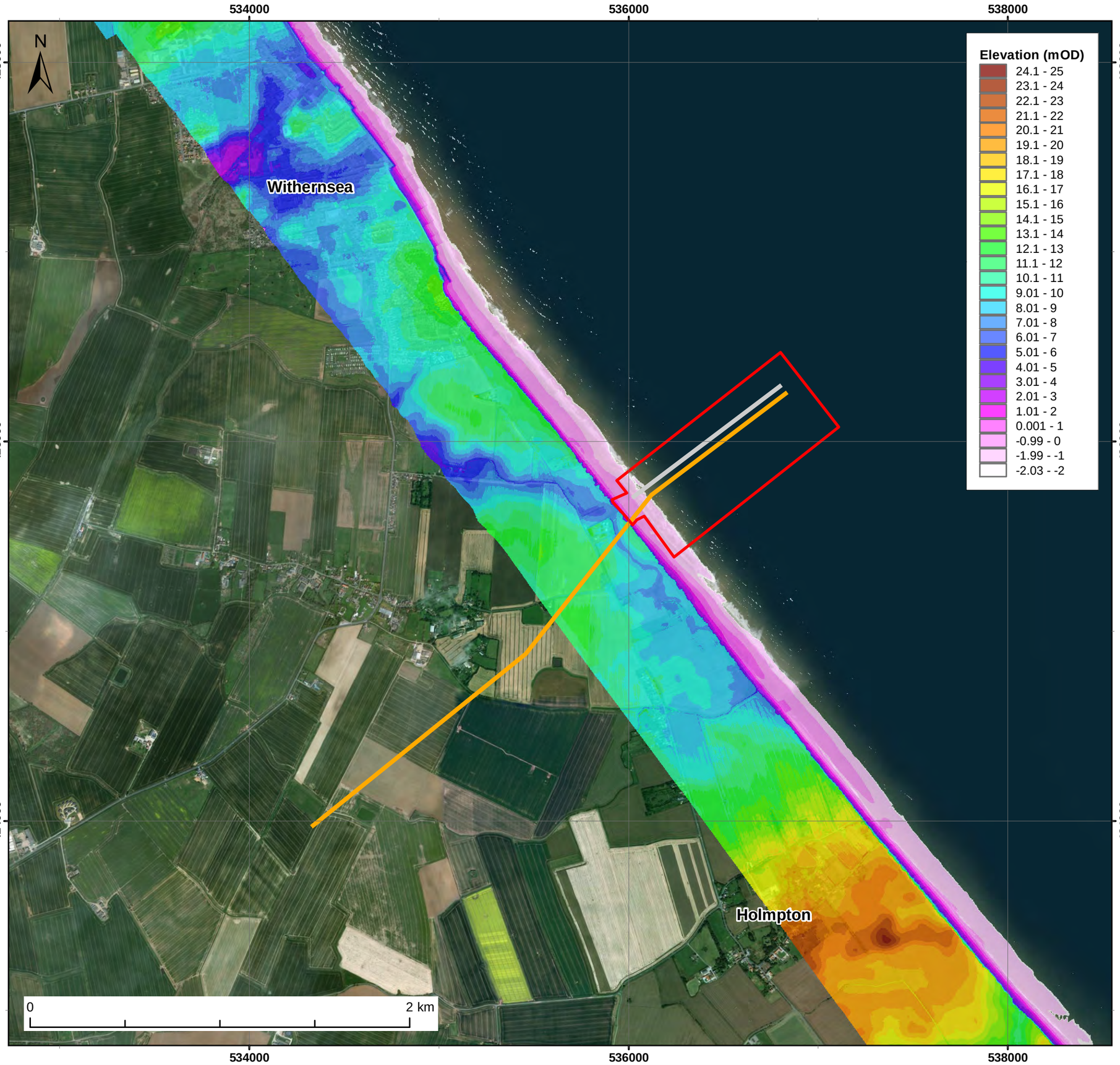
7.3. Methodology

7.3.1. Study Area

Due to the important sediment transport pathways along the Holderness coast, a suitable study area extends between the town of Withernsea in the north and the Humber Estuary in the south. The study area necessarily covers the hinterland, cliffs, inter-tidal foreshore, and nearshore seabed.

7.3.2. Data Sources

Due to the rapid historic rates of coastal erosion, the Holderness coastline is relatively well researched and monitoring has been undertaken for a long period of time by ERYC. Data arising from ERYC's monitoring programme is available from the Coastal Explorer website (ERYC, 2018) and through discussion with ERYC's Senior Coastal Engineer. This includes information on cliff erosion rates and beach profile changes. This is presently collected using Light Detection and Ranging (LiDAR) surveys and, at the time of writing, the latest available LiDAR survey from ERYC was collected in May 2018. The Environment Agency also has collected LiDAR data across the frontage from a survey in May 2017 and this is shown in **Figure 7.1**.



Legend

- Proposed Scheme Boundary
- New LSO
- Existing LSO

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title:

LiDAR Data
(source: Environment Agency)

Figure: 7.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	NJC	A3	1:20,000

Co-ordinate system: British National Grid

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In order to inform the route of the proposed LSO, a hydrographical and geophysical survey was carried out by Environmental Scientifics Group Limited (ESG) on behalf of YWS, between July and August 2017 (ESG, 2017). This comprised a variety of survey techniques to characterise the seabed levels and morphology, sub-surface bedrock levels and features, the presence of any debris/obstructions (including metallic targets which may classed as potential items of unexploded ordnance (UXO), and seabed sediments. The relevant results for assessing the hydrodynamic and sedimentary regime are presented within **Section 7.4**.

Beach monitoring data covering the vicinity of the existing and proposed LSO is also available from ongoing surveys undertaken by YWS, associated with the Marine Licence conditions for the temporary protection of the existing LSO (Ref: L/2017/00420/2). This monitoring involves walk-over inspections of the existing pipeline and its temporary protection works and LiDAR surveys along the coastline up to 5km down drift (i.e. to the south). From these data, changes in beach levels, cliff top position and condition of the pipeline are analysed and reported. These surveys commenced in December 2017 and are undertaken at monthly intervals up to January 2019, and quarterly thereafter, with additional surveys undertaken after major storm events. The latest dataset was collected in December 2018.

A benthic survey was undertaken by NIRAS Consulting Limited (NIRAS) (under sub-contract to ESG) on behalf of YWS in July 2017 (NIRAS, 2019), along the proposed scheme footprint. This included seabed grab sampling and drop-down camera imagery at four nearshore locations. Subsequent laboratory analysis of the grab samples by Cefas included, physical properties of modal size, mean, sorting, skewness and kurtosis (along with laboratory analysis by NIRAS for chemical properties).

A Phase 1 intertidal survey was undertaken on a low water neap tide (23rd November 2017). The purpose of the survey was to assess marine and coastal species present and their relative abundance. In order to gather information on key invertebrate species and sediment grain size, surface sediment samples from within each zonation or biotope identified in the walkover were processed in-situ. The results of the sediments are utilised to provide information on the beach sediment composition within **Section 7.4.9**.

A summary of the above data sources are presented in **Table 7.2**.

Table 7.2 Data Sources

Data	Year	Coverage	Notes
ERYC - Cliff erosion rates	1852 – 2017	Holderness coastline	Courtesy of Neil McLachlan, Senior Coastal Engineer at ERYC
ERYC - LiDAR Survey	Sept. 2011	Withernsea to Easington	Courtesy of Neil McLachlan, Senior Coastal Engineer at ERYC
ERYC - LiDAR Survey	Nov. 2017	Withernsea to Easington	Courtesy of Neil McLachlan, Senior Coastal Engineer at ERYC
ERYC - LiDAR Survey	May 2018	Withernsea to Easington	Courtesy of Neil McLachlan, Senior Coastal Engineer at ERYC
ERYC - Aerial Photography	Nov. 2017	Withernsea to Easington	Courtesy of Neil McLachlan, Senior Coastal Engineer at ERYC

Data	Year	Coverage	Notes
ERYC - Beach profile (CAD files)	Oct. 1997 to Nov. 2017	South of Holmpton Village to Spurn	Courtesy of Neil McLachlan, Senior Coastal Engineer at ERYC
Environment Agency - LiDAR Survey	May 2017	Withernsea to Easington	Courtesy of Environment Agency
YWS -LiDAR Survey	Jan 2018 to date	Withernsea LSO temporary protection area and extending up to 5 km down drift	Monthly surveys and post-storm surveys
YWS – Hydrographical and Geophysical Survey	July – August 2017	500 m wide corridor centred on the proposed Withernsea LSO and extending across the inter-tidal and nearshore seabed to 1,100 m offshore	Multi-beam echo sounder (MBES) swathe bathymetry survey Side-scan sonar (SSS) survey Sub-bottom profiler (seismic reflection) survey Magnetometer survey
YWS – Benthic Ecology Survey	July 2017	4 no. grab samples along the LSO corridor within the nearshore seabed	Seabed sediment grab samples Laboratory testing for physical properties Laboratory testing for chemical properties Drop-down camera imagery
YWS – Intertidal Survey	November 2017	4 no. sediment samples along foreshore surrounding the new LSO corridor	Processed through 0.5µm sieve in-situ and estimate of sediment composition provided.

Third parties, such as governmental bodies (e.g. Defra, Environment Agency, Natural England) and University and non-governmental body researchers (e.g. University of Hull, British Geology Society, etc.), have also studied and monitored aspects of the Holderness coast. A number of key literature sources have been collated and reviewed for relevant information.

All of the above sources of data and reports have been searched to identify information specifically of relevance to the proposed scheme and **Section 7.4** presents a summary of the findings.

7.3.3. Assessment Approaches

The approach to the assessment of effects on the hydrodynamic and sedimentary regime has been to utilise the existing data and information to provide a comprehensive understanding the existing baseline regime. Subsequently, an experienced coastal geomorphologist has applied professional judgement in the interpretation and assessment of potential effects that may arise during the construction and operational phases of the proposed works.

Consideration was given to the value, or otherwise, of numerical modelling to inform the assessment of effects on the hydrodynamic and sedimentary regime, in line with advice from the MMO received during the EIA Scoping stage.

During the construction phase, and similarly during the decommissioning phase, the only potential effect that could sensibly be modelled is the extent and fate of any sediment plume that may arise, particularly at the exit point of the HDD or micro-tunnelling and the trenching in the sub-tidal zone (recognising that there would be no effects on suspended sediment from the trenchless solutions under the intertidal zone). However, high levels of turbidity occur naturally along the inshore Holderness area, and these are frequently exacerbated by weather conditions (e.g. strong winds).

Due to this, it is considered that any localised small magnitude and temporary enhancement in suspended sediment concentrations due to construction effects would be negligibly small within the context of the natural baseline and therefore would not warrant detailed numerical modelling.

During the operational phase, no effects would arise on the hydrodynamic and sedimentary regime as the LSO would be buried within the clay shore platform across the intertidal and subtidal zones and would therefore not interact in any manner with the coastal processes. It is therefore not possible to undertake modelling of operational phase effects.

7.4. Existing Environment

7.4.1. The Holderness Coastline

The Holderness coastline extends between the chalk headland of Flamborough Head and the spit of Spurn Point (at the entrance to the Humber Estuary) in the East Riding of Yorkshire. It comprises one of the most rapidly eroding coastlines in Europe. Typical average erosion rates of the soft glacial till cliffs along the most rapidly eroding sections of the frontage are of the order of up to 4m per year, but severe storms can erode the cliffs by between 8 and 22m in a single event. Coastal defences are present in towns such as Bridlington and Withernsea, and at nationally important infrastructure, including the Easington Gas Terminal, but the cliffs remain undefended and actively eroding elsewhere.

The finer material (both cohesive silts and clays and non-cohesive very fine sands) released from erosion of the cliffs and shore platform contributes to the sediment supply in the North Sea and some of this material reaches the Humber Estuary, where it settles upon the inter-tidal flats and saltmarshes. The non-cohesive materials, such as sands and gravels, are more typically of local beach-building characteristics.

Longshore sediment transport is generally (except in the lee of Flamborough Head) directed towards the south and the net tidal residual is similarly to the south. This means that material released from erosion along the Holderness coast has the potential to be transported southwards and feed beaches and Spurn spit to the south, as well as entering the Humber Estuary, depending on material grain size.

The cliffs, beach and shore platform function as a coherent geomorphic system, with the rate of landward cliff recession largely dictated by the rate of shore platform downwearing. The presence of a relatively thin veneer of beach material (sands and gravels) can help protect the shore platform, but when this is absent (e.g. following storms) the downwearing occurs. Whilst the beach material may subsequently return, the vertical platform downwearing and associated landward cliff recession is an irreversible process.

7.4.2. Seabed Bathymetry

The intertidal and nearshore bathymetry (levels and features) of the Withernsea frontage were surveyed along a 500m wide corridor centred on the proposed LSO using a multi-beam echo-sounder (MBES) and side-scan sonar (SSS), extending approximately 1.1km offshore.

Seabed levels range between 3.6m above Chart datum (CD) at the upper beach to 11.3m below CD at the seaward end of the surveyed corridor (**Figure 7.2**).

The sea bed is predominantly sandy on the upper and mid foreshore, becoming more sandy clay with gravel and scattered cobbles and boulders further seawards (**Figure 7.3**).

The seabed in the inshore area of the corridor is largely flat and relatively featureless, but bars become evident approximately 200m along the corridor whilst sandy/gravelly wave-like features are evident in the deeper areas of the surveyed corridor (**Figure 7.4**).

Parts of the existing LSO were also captured in the MBES and SSS data, protruding above the foreshore surface, with buried sections being identified from the magnetometer survey **Figure 7.5**).

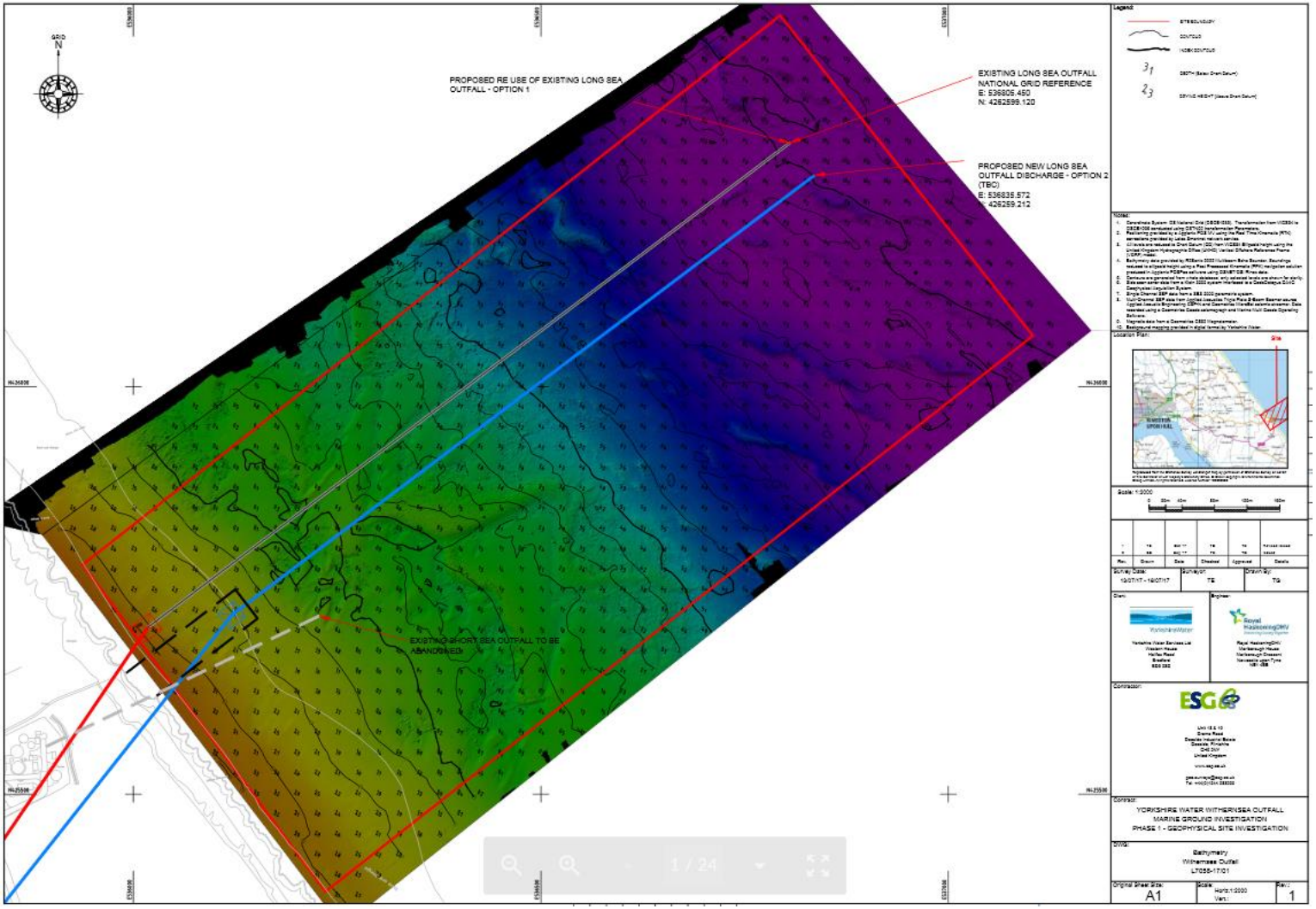


Figure 7.2 Seabed Bathymetry (reproduced with permission from ESG, 2017)

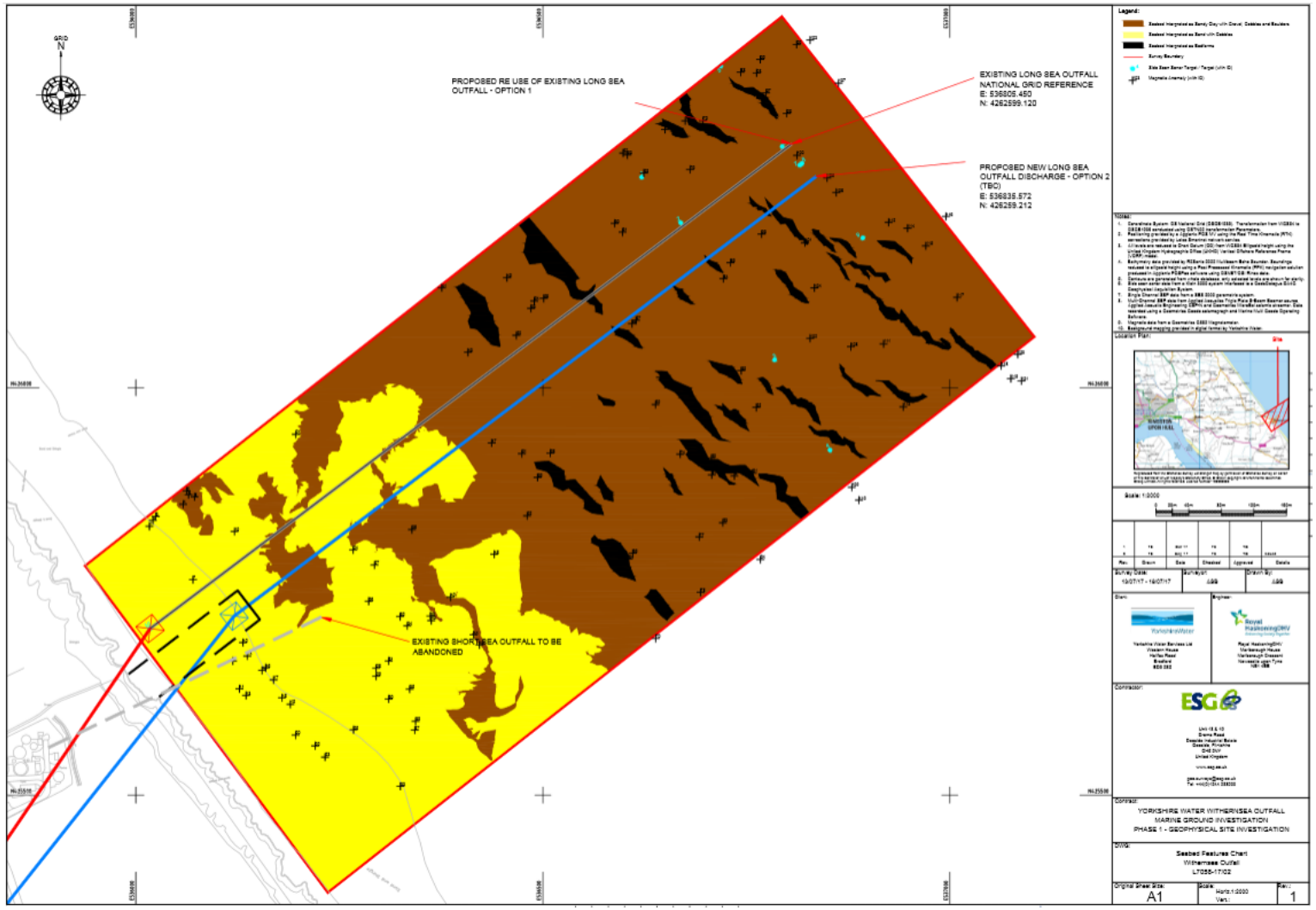


Figure 7.3 Seabed features chart (reproduced with permission from ESG, 2017)

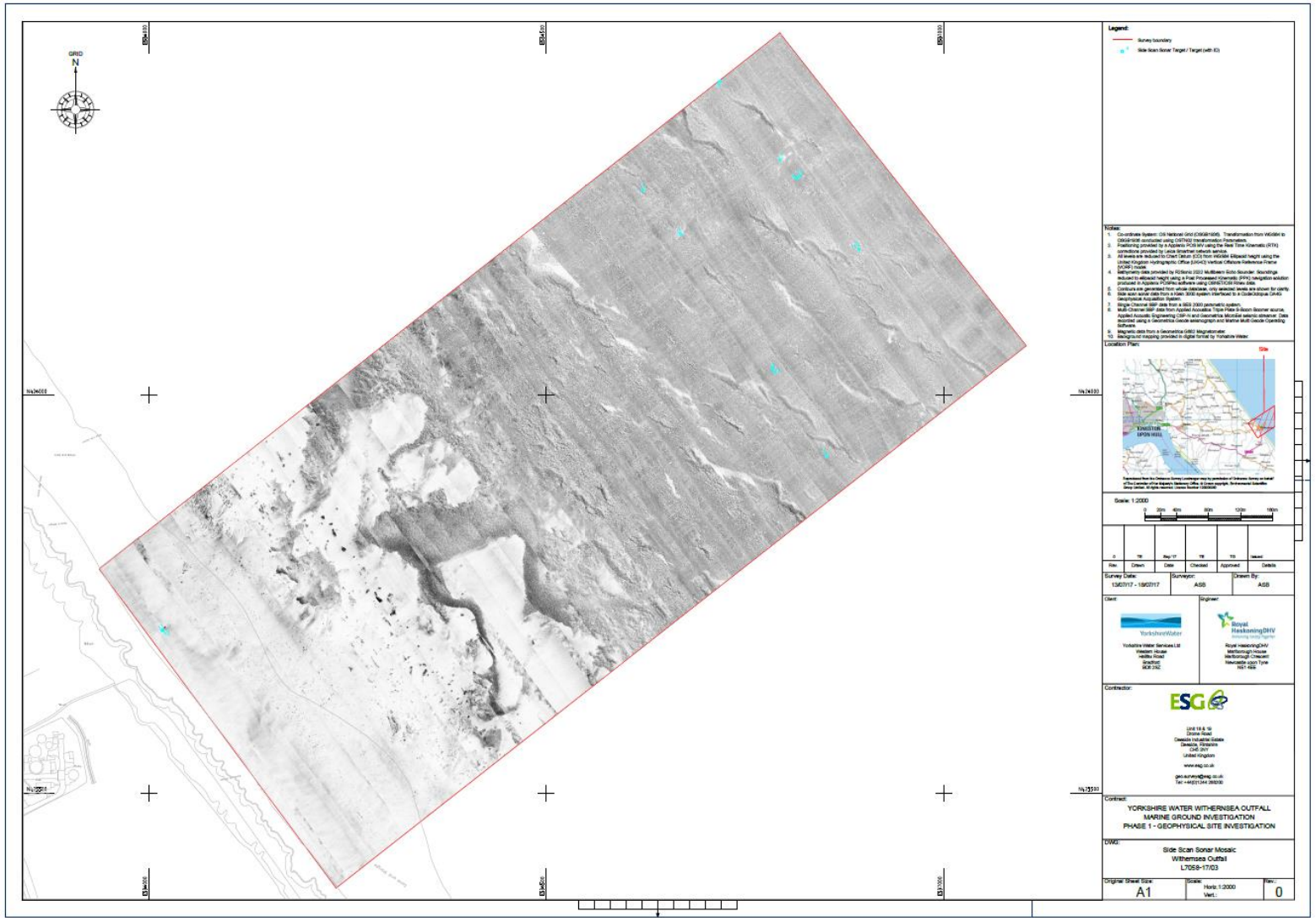


Figure 7.4 *Seabed Characteristics – side scan sonar data (reproduced with permission from ESG, 2017)*

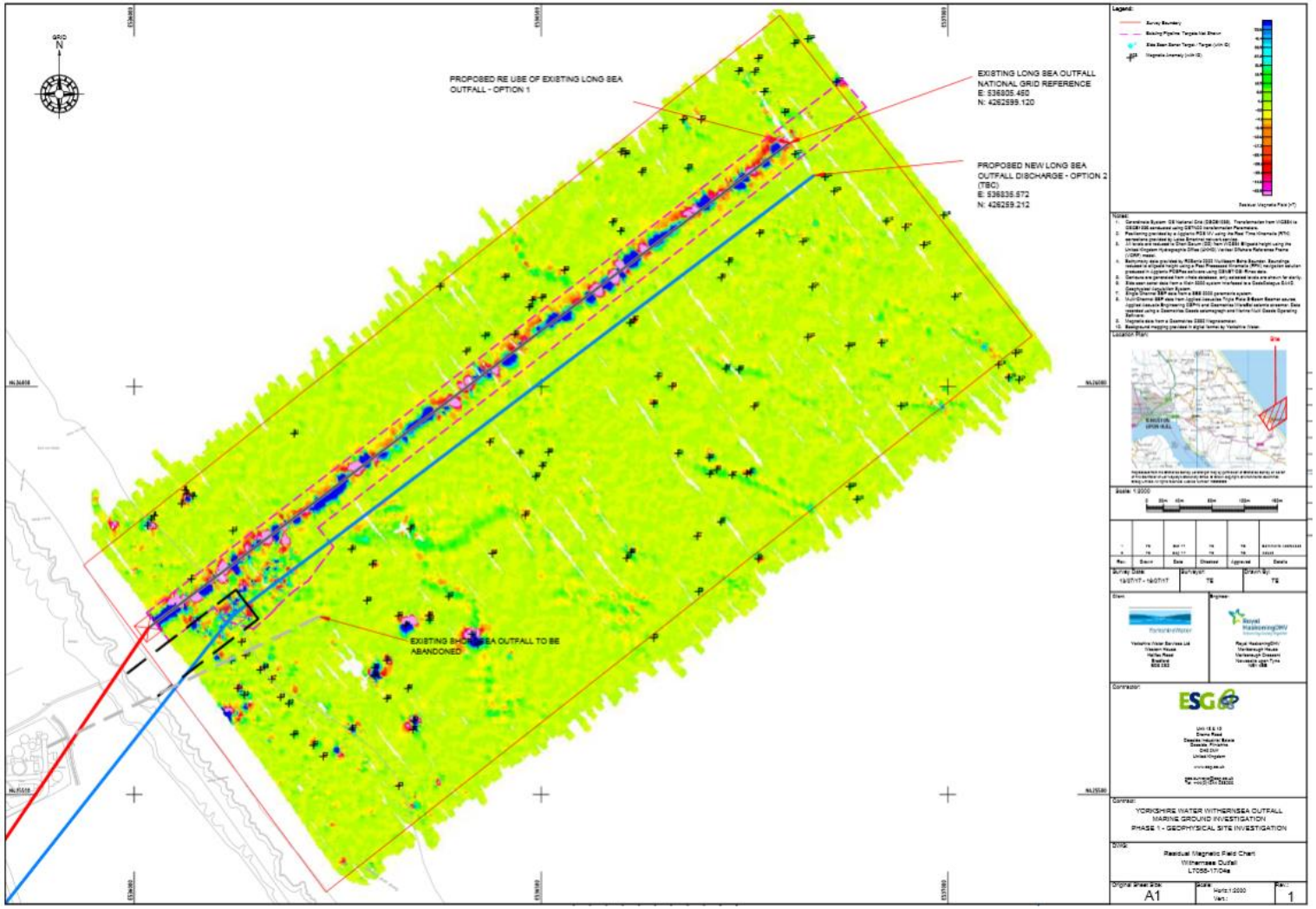


Figure 7.5 Seabed Magnetic Targets – magnetometer data (reproduced with permission from ESG, 2017)

7.4.3. Seabed Sediment Composition

The nearshore seabed sediment composition was surveyed by means of sediment grab sampling with laboratory analysis of physical properties, along with drop-down camera imagery. Sediment samples for full physico-chemical analysis were taken from locations along the route of the proposed subtidal LSO section (Stations 1, 2, 3 and 6) with two samples at reference locations (Stations 4 and 5), shown in **Figure 7.6**.

Samples for sediment analysis by Cefas were only obtained from four of the six stations shown on this figure. The seabed was of mixed sediments with a generally high proportion of coarse particles and as a result only relatively small samples were obtained, even with the Hamon grab. Results are illustrated in **Figure 7.7** and **Figure 7.8**.

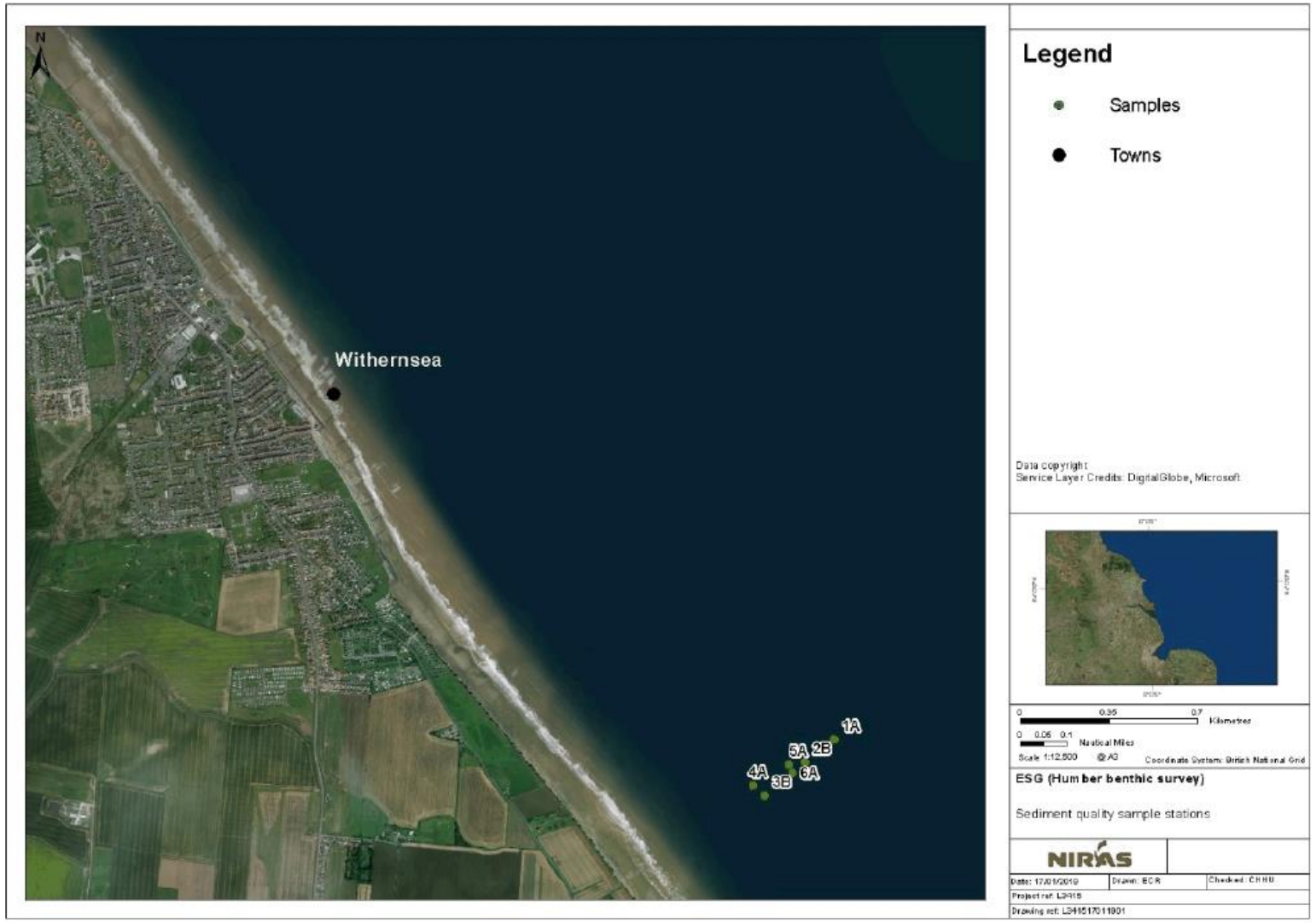


Figure 7.6 Location of Seabed Sediment Grab Samples (reproduced with permission from NIRAS, 2019)

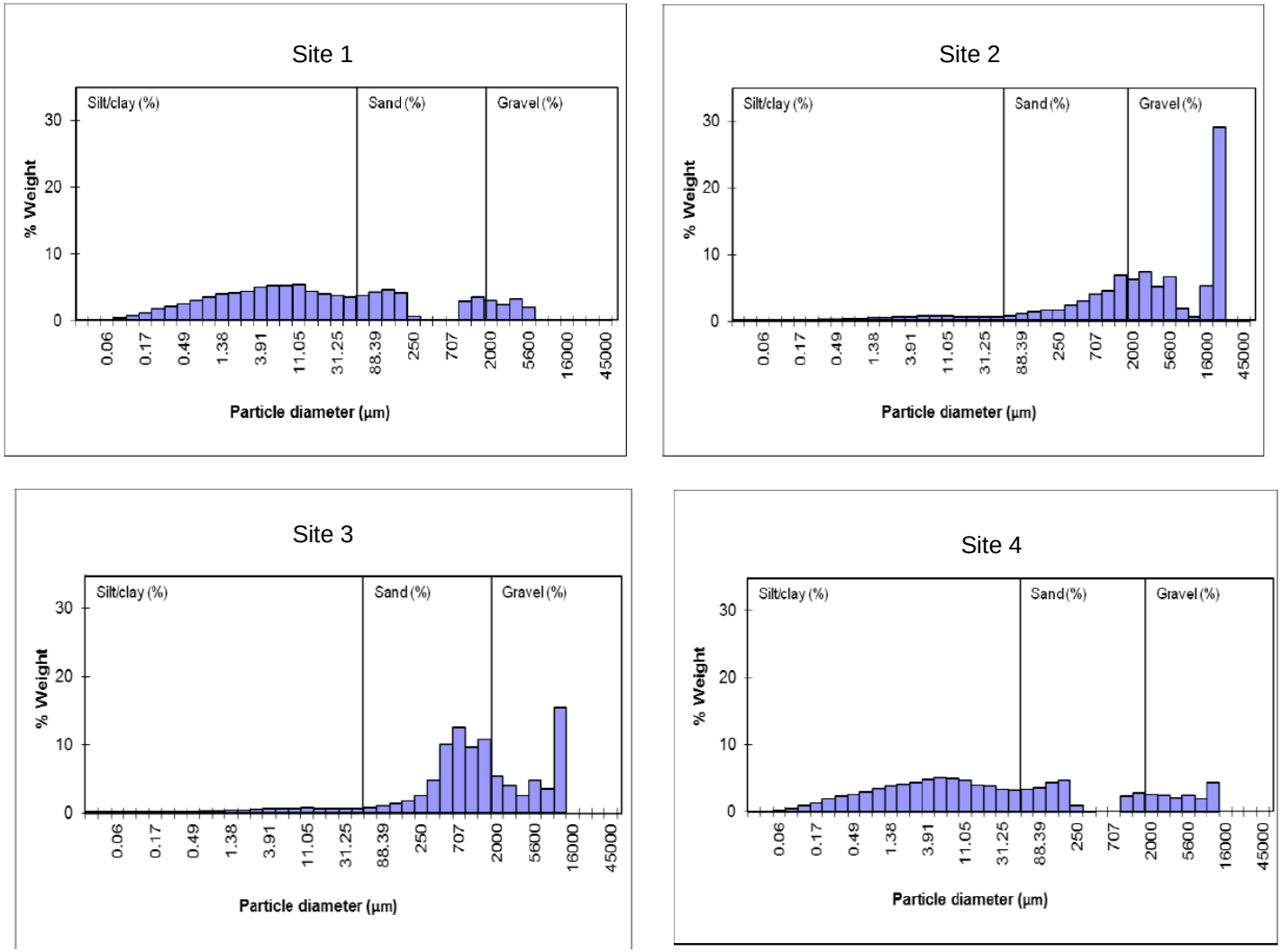


Figure 7.7 *Seabed Sediment Grab Sample Results (reproduced with permission from Cefas, 2017)*

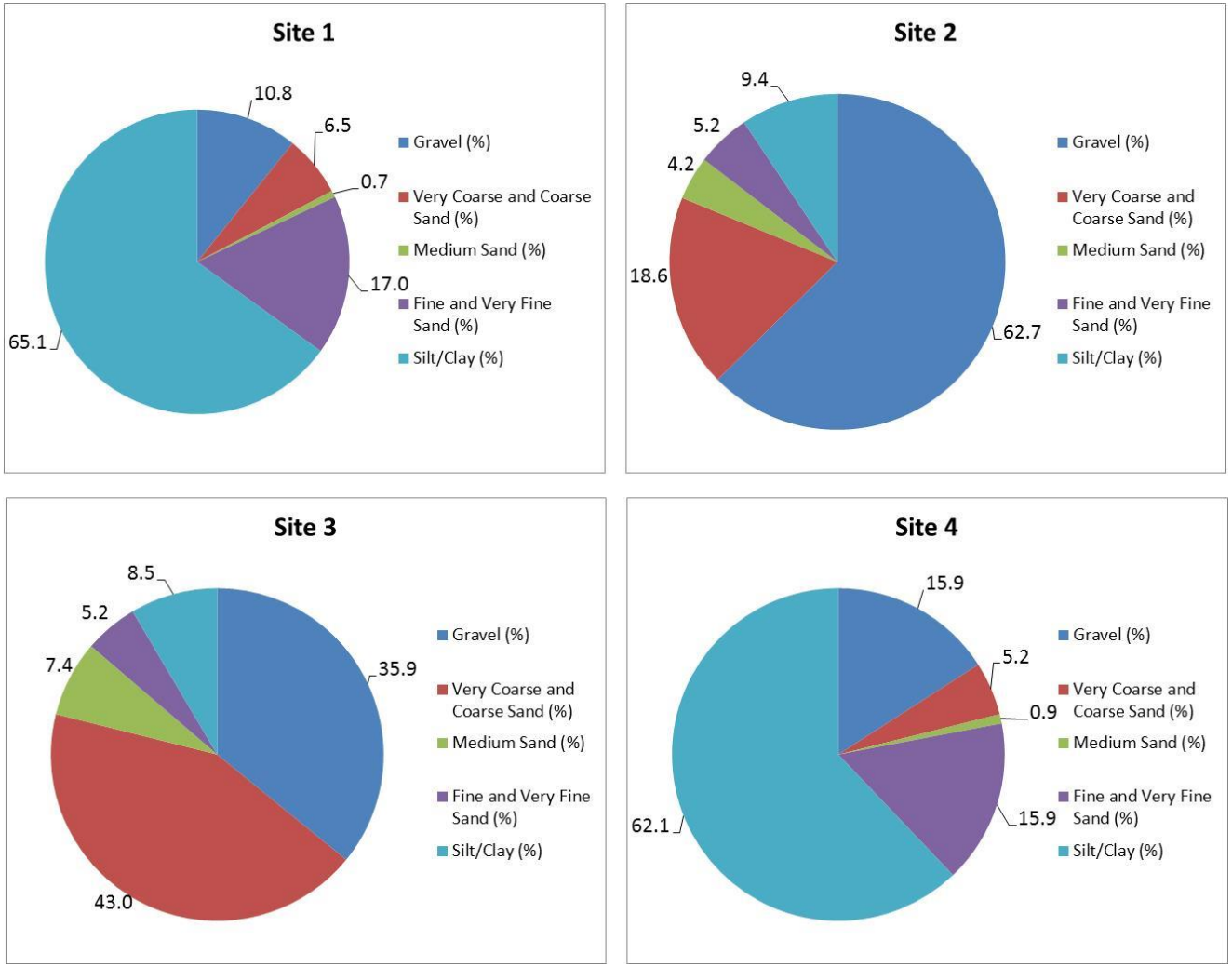


Figure 7.8 Seabed Sediment Grab Sample Results

7.4.4. Water Levels

7.4.4.1. Astronomical Tide Levels

The tidal regime of the Withernsea frontage is semi-diurnal, i.e. the water level rises and falls twice a day. The tide levels for Withernsea have been estimated using the tide levels for Bridlington and Spurn Head, each obtained from Admiralty Tide Table Volume 1A, Year 2018. The tide levels for the three sites are presented in **Table 7.3**. These results indicate that the tidal range at Withernsea, i.e. the difference between high and low water level, is 5.5m on a spring tide and 2.68m on a neap tide. These tidal levels are astronomical levels and so do not take account of meteorological surges that can have a significant effect on water levels.

Table 7.3 Tide Levels (2018)

Tidal level parameter	Bridlington		Withernsea		Spurn Head	
	mCD	mODN	mCD	mODN	mCD	mODN
Mean High Water Springs	6.1	2.75	6.67	3.32	6.9	3.55
Mean High Water Neaps	4.7	1.35	5.27	1.92	5.5	2.15
Mean Low Water Neaps	2.3	-1.05	2.59	-0.76	2.7	-0.65
Mean Low Water Springs	1.1	-2.25	1.17	-2.18	I.2	-2.15

7.4.4.2. Extreme Water Levels

Extreme water levels on the east coast are strongly influenced by tidal surges. These occur when low pressure weather systems move down the coast of the North Sea. **Table 7.4** shows the extreme water levels for a range of return periods, obtained using the method outlined in McMillan *et al.* (2011) for predicting extreme water levels. To put matters into perspective, 1 in 200-year extreme water level is 4.46m Ordnance Datum Newlyn (ODN), i.e. an increase above the predicted astronomical spring tide level of some 1.14m.

Table 7.4 Extreme Water Levels

Return Period (years)	Water Level (m ODN)
1 in 1	3.63
1 in 5	3.87
1 in 50	4.23
1 in 100	4.33
1 in 200	4.46

7.4.4.3. Climate change

Relative sea level rise, which is the change in sea level with respect to the local land mass, is due to a combination of changes in land level and absolute changes in the level of the oceans. It is important to consider predicted effects of climate change for the design life of the proposed development. Changes in sea level are the result of a combination of isostatic (a gradual and long term rebound of depressed land mass under ice during the last ice age) and eustatic (an increase in water volume due to rises in global temperatures) (Scott Wilson, 2010).

Over the last 1,000 years, relative sea levels in the Humber region dropped by 0.3-0.5mm/year due to isostatic rebound (Shennan *et al*., 2009). However, based on tidal gauge data from 1920 to 2000, Townsend et al. (2007) reported a reversal of this trend with a mean sea level rise of 1.8mm/year. This rate is believed to be similar to the Withernsea area due to its proximity to the Humber region (Brown *et al*., 2012). **Table 7.5**Figure 7.6 presents projections of sea level rise for 2050 and 2099 (relative to 2018) under three Representative Concentration Pathways (RCPs) (Met Office, 2018).

Table 7.5 Sea level rise projections for 2050 and 2100 with 5th, 50th and 95th percentile confidence (Met Office, 2018)

Representative Concentration Pathway	Year	UKCP18 projected increase in sea level (m relative to 2018 values)		
		5th percentile	50th percentile	95th percentile
RCP 2.6	2050	0.100	0.1500	0.210
	2099	0.220	0.350	0.570
RCP 4.5	2050	0.110	0.160	0.230
	2099	0.290	0.450	0.700
RCP 8.5	2050	0.140	0.200	0.280
	2099	0.450	0.660	1.000

7.4.4.4. Tidal Currents

Previous studies have indicated that tidal currents result in a net southerly drift of beach material. The mean residual current that has been used as a general value for the whole of the Holderness coast was calculated to be 0.15m/s in a southerly direction, i.e. the flood current is dominating.

7.4.5. Waves

7.4.5.1. Offshore Waves

Wave data can be derived from a number of sources, which may be measured (observed), or hindcast (computed from wind data). For the purposes of the Withernsea Coastal Defence Strategy Study (2001), wave data from the UK Meteorological Office European wave model were procured for the offshore location of 54.00°N 00.34°E. These co-ordinates fall about 54km offshore, around the 40m CD contour. The wave data contains thirteen years of information extending between 1986 and 1999. These wave data showed that the predominant offshore wave direction is from the north and that the majority of waves are less than 2m in height. The Holderness coastline is exposed to open sea conditions from all directions between north and south-east.

In June 2008, the Hornsea directional wave rider buoy was deployed in around 12m water depth. Data from this location can be considered as broadly representative of a similar location offshore from the Withernsea LSO frontage. The Hornsea buoy provides measurements of wave height, period and direction and transmits them to shore in near real time. **Figure 7.9** shows the location of the buoy and wave roses produced for the months of January, April, July and October over a ten-year period from 2008 to 2018. It can be seen that predominantly waves approach from NNE through to ENE, although waves from N, E, ESE and SE are also possible.

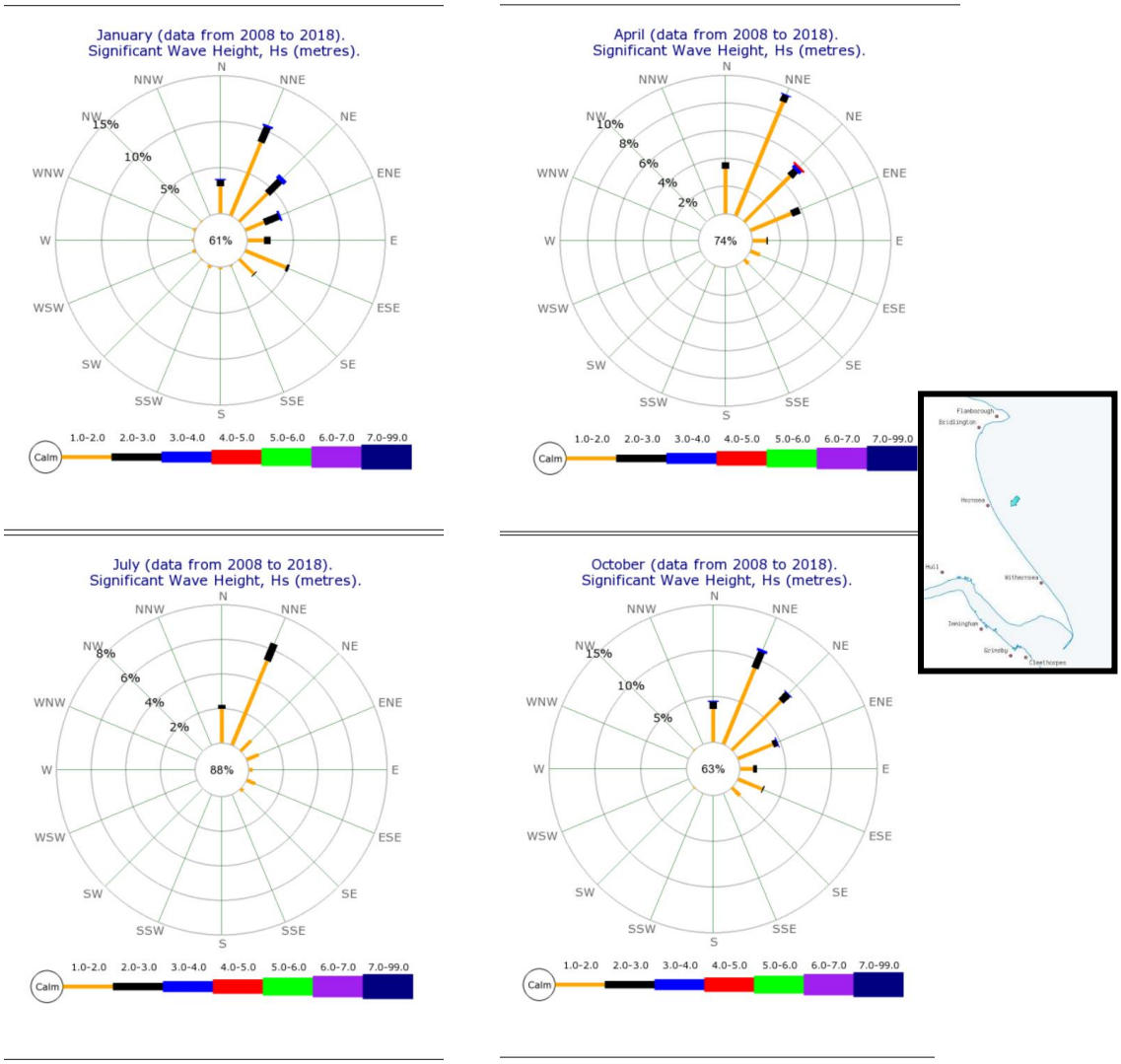


Figure 7.9 Hornsea seasonal wave roses

7.4.5.2. Nearshore Waves

Waves generated offshore are modified by the influence of the seabed bathymetry and other factors as they approach the coastline. The processes of refraction, shoaling, wave breaking, seabed friction and diffraction result in significant reductions in the height of waves reaching the coastline. Refraction is the change in direction and height of waves caused by changes in wave velocity. Shoaling is the change in wave height due to waves propagating into different water depths. Wave breaking occurs principally as a result of two criteria; depth and steepness, each limiting the maximum wave height. Seabed friction is the loss of energy due to the interaction between the seabed and the wave as it propagates. Diffraction is the effect caused when waves are obscured by an obstacle such as a headland or breakwater.

Nearshore waves are required for sediment transport calculations. The nearshore waves were computed during the Withernsea Coastal Defence Strategy Study (Posford Duvivier, 2001) using

the SWAN computer model. In that study, waves are classified according to 30° sectors centred on 0°N, 30°N, 60°N and so on. The model indicated that the offshore wave directional sectors that most significantly affect the Withernsea frontage are 30°N to 120°N. Waves originating from more northerly or southerly than this are strongly refracted by the nearshore bathymetry and are only marginally influential at the shore as a result. Thus, the most frequently occurring and the largest waves originate from the north-east.

7.4.6. Cliff Erosion

The Holderness coastline is cut into soft boulder clay which outcrops at sea level, so the erosion rates are high, forming an embayed coastline between Flamborough Head and Spurn Point. Cliff recession is known to have continued over hundreds of years and shows no signs of abating. Approximately 1,000 hectares of cliff top has been lost in the last 900 years (HR Wallingford, 2011). Estimates of the sediment yield due to erosion on the Holderness coast (from both the cliffs and the shore platform) have been made in several studies, summarised in Balson *et al.* (1998). The average yield from these studies was 3.2 million m^3/year. Around 67% of this material is slit and clay, with around 30% being very fine to medium sand. The remainder (around 3%) is gravel.

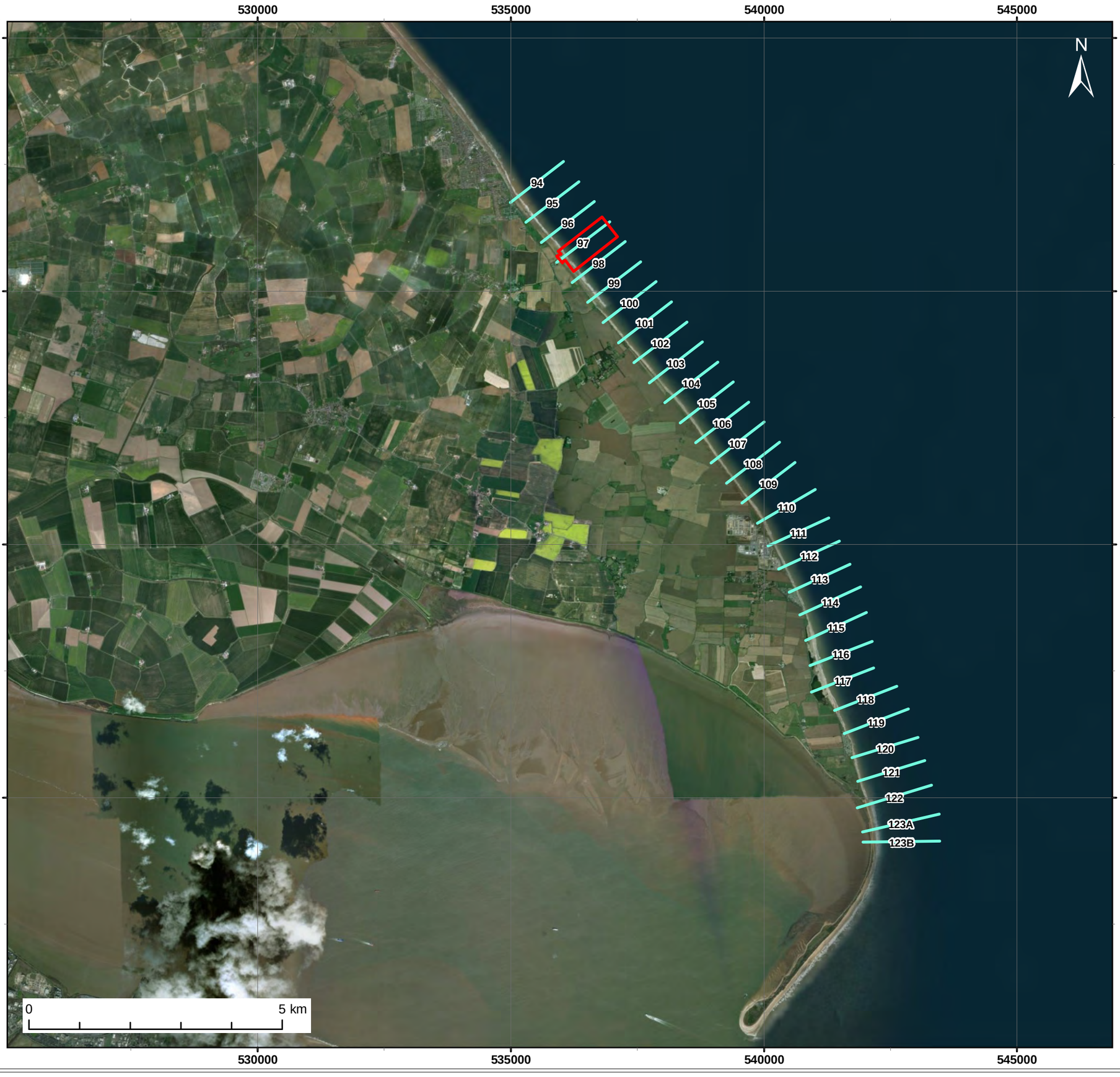
ERYC has been measuring cliff erosion rates at various points along the Holderness coastline since 1951. The average cliff erosion rates from a series of profile locations closest to, and down drift from, the proposed scheme are shown in **Table 7.6.**

Table 7.6 Historic cliff erosion rates within the Study Area (source: ERYC Coastal Explorer, 2018)

Profile		Start Coordinates		Average Annual Erosion Rates (m/year)		Maximum Erosion between Surveys	
No.	Location	Easting	Northing	1852 - 1989	1989 - 2017	Max. recorded loss (m)	Date of max. recorded loss
94	South of Turner Avenue at south end of Withernsea	534990.6	426757.6	2.14	2.89	15.61	Spring 1999
95	South of Golden Sands campsite Withernsea	535295.8	426361.5	1.81	3.70	12.43	March 2006
96	Just north of Intack Farm, Hollym	535600.9	425965.4	1.32	3.77	13.73	March 2006
97	**Opposite sewage works off Holmpton Road**	**535906.1**	**425569.4**	**1.08**	**4.06**	**13.36**	**Oct 2013**
98	Just north of Nevilles Farm, Holmpton	536211.3	425173.3	1.22	3.74	16.50	March 2007
99	Just north of The Runnell, Holmpton	536516.4	424777.2	1.50	2.16	18.74	Sept 2007
100	North of Holmpton Village	536821.6	424381.2	1.60	1.40	17.82	March 2008
101	Opposite Holmpton Village	537126.8	423985.1	1.56	1.27	11.16	March 2008

Profile		Start Coordinates		Average Annual Erosion Rates (m/year)		Maximum Erosion between Surveys	
102	South of Holmpton Village	537431.9	423589.0	1.48	1.03	11.38	April 2013
103	South of Holmpton Village	537737.1	423192.9	1.55	0.97	10.47	March 2016
104	North of Out Newton	538042.3	422796.9	1.57	0.94	10.04	March 2016
105	Opposite Out Newton	538347.4	422400.8	1.58	0.46	9.31	Nov 2017
106	South of Out Newton	538652.6	422004.7	1.62	0.72	14.02	Nov 2017
107	Dimlington High	538957.8	421608.6	1.69	0.85	14.92	March 2008
108	South of Dimlington High	539262.9	421212.6	1.63	1.17	13.85	March 2007
109	Between Dimlington High and Easington	539568.1	420816.5	1.50	1.44	9.83	March 2007
110	North end of gas terminal site, Easington	539873.3	420420.4	1.67	Defended		
111	Centre of gas terminal site, Easington	540082.8	419966.4	1.77			
112	South end of gas terminal site, Easington	540292.3	419512.4	1.75			
113	To south of Easington defences	540501.8	419058.4	1.72	1.39	14.82	Oct 2010
114	Opposite Seaside Rd to south of Easington	540711.2	418604.4	1.73	1.39	7.67	April 2010
115 116 117	Easington/ Kilnsea Dunes						
118	South end of Lagoon/Dune SSSI, Kilnsea	541375.7	416719.5	2.77	1.84	9.91	April 2009
119	North of old MOD site, Kilnsea	541569.9	416258.5	2.24	2.33	7.88	May 2010
120	South of BlueBell, Kilnsea	541714.4	415785.8	1.99	2.70	12.25	March 2008
121	Between Kilnsea and Spurn	541855.5	415324.2	2.18	2.16	13.28	March 2008
122	North end of Spurn	542001.5	414846.6	1.79	2.09		
123	Neck point Spurn peninsular - note washed away Dec 2013*	542136.7	414366.0	1.01	-		

The location of the origin of these profiles is shown in **Figure 7.10** and the scale of this figure is changed to zoom-in on the vicinity of the LSO in **Figure 7.11**. It can be seen that Profile 97 is closest to the Withernsea LSO.



Legend

- Proposed Scheme Boundary
- Profile Location

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title:

Location of origin of profiles 94 to 123B inclusive (used for analysis of historic cliff erosion rates in Table 8.7)

Figure: 7.10

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid

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Legend

- Proposed Scheme Boundary
- New LSO
- Existing LSO
- Profile Location

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title:

Location of origin of profiles 93 to 103 inclusive (in the vicinity of the Withernsea LSO)

Figure: 7.11

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	NJC	A3	1:20,000

Co-ordinate system: British National Grid

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From these cliff erosion data, it can be seen that in the closest vicinity to the existing Withernsea LSO and the proposed replacement (i.e. at profile 97), the historic long term (1852 – 1989) rate of erosion of the cliffs is recorded at 1.08m/year, but recent medium-term rates (1989 – November 2017) have been considerably higher, at 4.06m/year.

At this location, the greatest cliff loss between successive surveys has been recorded as 13.36m, in October 2013. ERYC's beach surveys between October 1997 and April 2015 show quite dramatically how the position of the cliff has changed over time due to this ongoing recession (**Figure 7.12**), with over 100 m of recession across these 17.5 years. This equates to an annual average erosion rate well in excess of 5m/year.

It is known that the 'Beast from the East' storms in March 2018 also caused extensive cliff erosion in this area, but these data are not included in **Table 7.6**, which extends to the November 2017 ERYC's beach survey (the latest available survey at the time of writing) or **Figure 7.12**, which extends to April 2015 only. However, recent monitoring at the existing LSO, undertaken as part of the temporary protection works, identified cliff erosion of between 2.00 and 4.11m between December 2017 and November 2018 (**Figure 7.13**).

7.4.7. Cliff Sediment Composition

The unprotected coastline of the study frontage is characterised by boulder clay cliffs, which run from south of Flamborough Head to Kilnsea, typically 10 – 15m in height. These cliffs comprise of approximately 70 - 75% clay, 25 - 30% sand and 1% boulders/large cobbles. The geological composition of the boulder clay varies and the composite ratios given are approximate only.

7.4.8. Beach Level Changes

The foreshore at Withernsea comprises a predominantly sandy beach overlying a glacial till (boulder clay) shore platform which is that is very susceptible to erosion when exposed. Beach levels at the Withernsea LSO are highly variable, with changes between successive surveys that are routinely undertaken by ERYC of the order of metres possible. These changes in level reflect: (i) seasonal changes in wave climate; and (ii) longer-term variations in the volume of sediment in the beach, often associated with the passage of 'ords'. These ords are obliquely aligned bar-like features on the foreshore, with troughs in between and can clearly be seen in the LiDAR survey data associated with the temporary protection works to the existing LSO (**Figure 7.14**). The troughs can locally reduce beach levels to expose the clay shore platform, and can also channel wave energy to locally increase erosion of the cliff face.

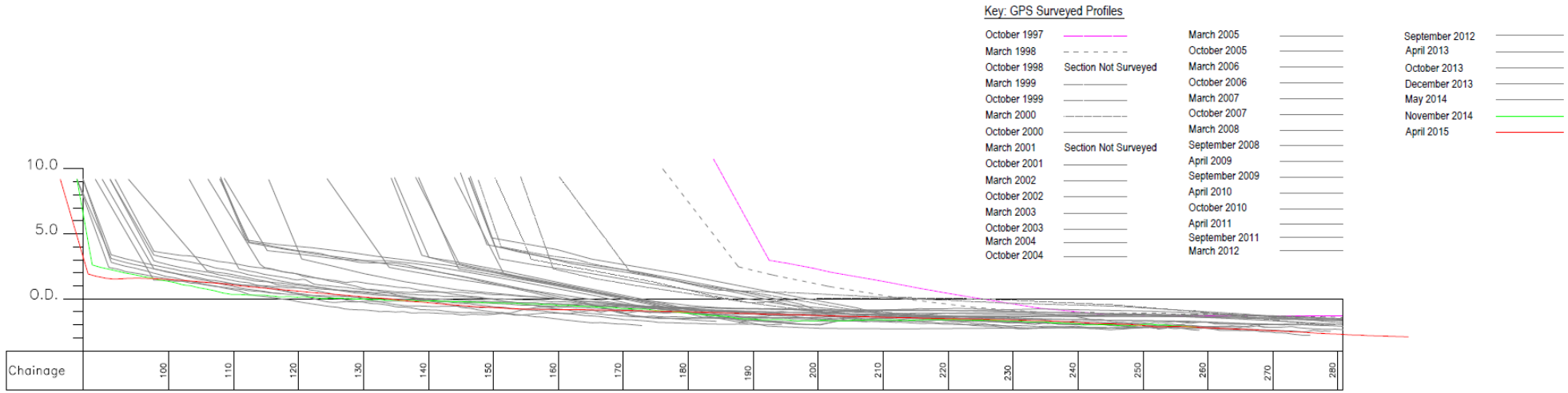
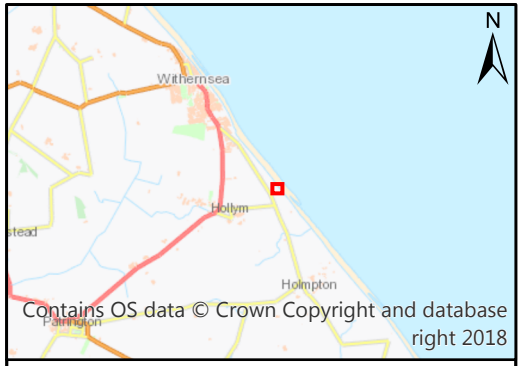


Figure 7.12 Cliff recession between October 1997 and April 2015 at profile 97, in the vicinity of the Withernsea LSO (source: ERYC Coastal Explorer)



Legend:

- January 2019 Cliff Top
- November Cliff Top
- October Cliff Top
- September Cliff Top
- August Cliff Top
- July Cliff Top
- June Cliff Top
- May Cliff Top
- April Cliff Top
- March Cliff Top
- February Cliff Top
- January Cliff Top
- December Cliff Top

Dec 18 to Nov 18 Recession (m)	Dec 18 to Jan 19 Recession (m)	Nov 18 to Jan 19 Difference (m)
Site A: 3.66m	Site A: 5.70m	Site A: 2.04m
Site B: 0.00m	Site B: 0.00m	Site B: 0.00m
Site C: 2.80m	Site C: 4.75m	Site C: 1.95m
Site D: 3.94m	Site D: 3.94m	Site D: 1.06m
Site E: 3.04m	Site E: 3.31m	Site E: 0.27m
Site F: 4.38m	Site F: 4.38m	Site F: 0.00m

Title:

Withernsea Outfall Cliff Top Change
December 2017 - January 2019

Figure:	7.13	Drawing No:	PB5063-WSEA-601		
Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	18/01/2019	PS	SB	A4	1:1,116

Co-ordinate system: British National Grid

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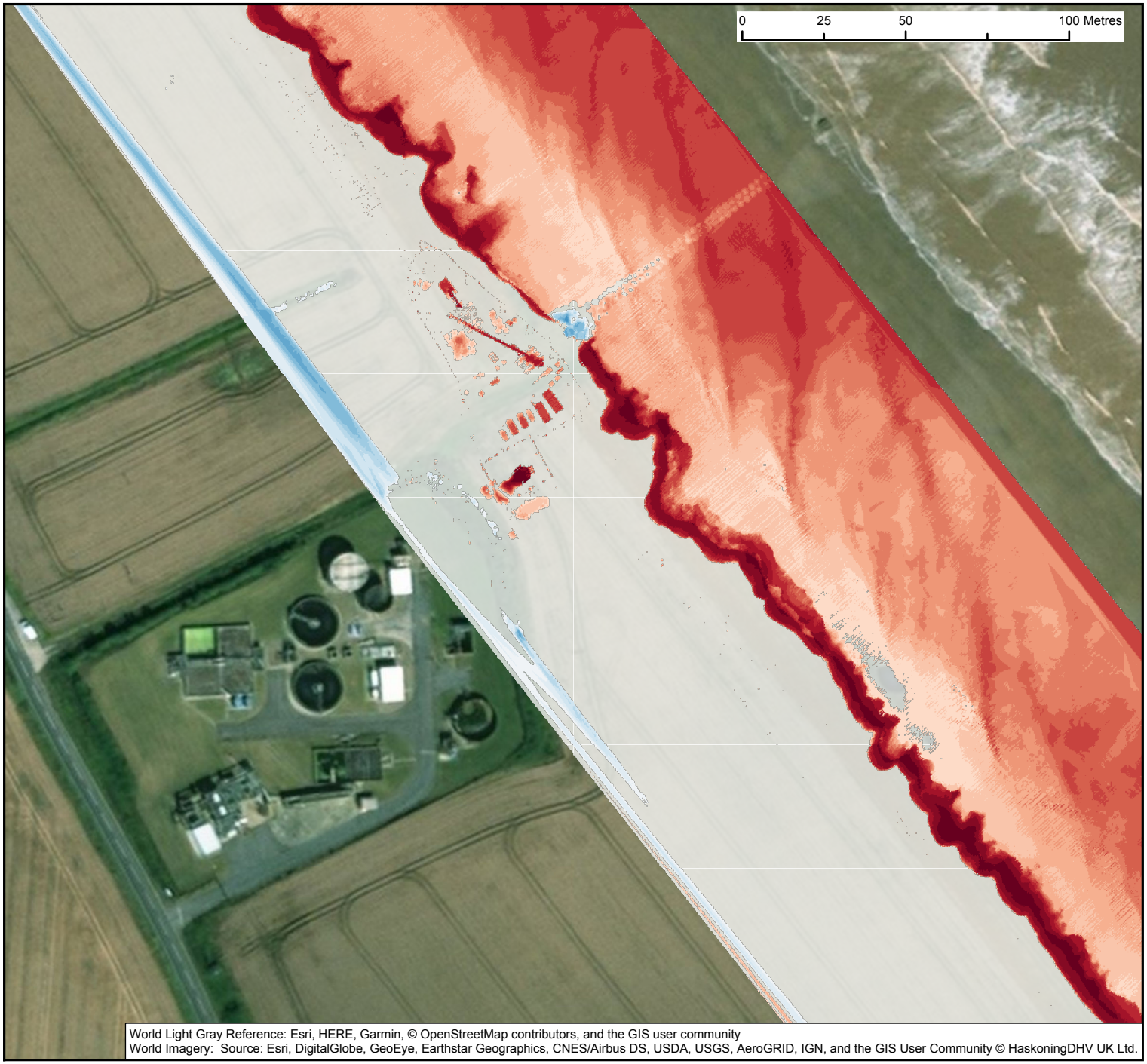

Legend:

Difference (m)

≤ 8	≤ 1.25	≤ -1.5
≤ 6	≤ 1	≤ -1.75
≤ 4	≤ 0.75	≤ -2
≤ 3	≤ 0.5	≤ -2.5
≤ 2.5	≤ -0.5	≤ -3
≤ 2	≤ -0.75	≤ -4
≤ 1.75	≤ -1	≤ -6
≤ 1.5	≤ -1.25	≤ -8

Title:

Withernsea Outfall Morphology Change
Date: 12th Decemeber 2017 - 12th Jan 2019

Figure:	7.14	Drawing No:	PB5063-WSEA-601		
Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	29/11/2018	PS	SB	A4	1:1,744

Co-ordinate system: British National Grid

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7.4.9. Beach Sediment Composition

The upper beach within the study area tends to be steep with coarse sand and shingle, while the lower section of beach tends to be shallower, consisting of medium sand.

As part of the investigations carried out during the development of the Withernsea Coastal Defence Strategy Study (Posford Duvivier, 2001), beach sediment samples were taken at four profile locations along the Withernsea town frontage. At each location, a sample was taken at the upper and lower parts of the foreshore zone. These samples were analysed to form sediment grading curves (summary results are presented in **Table 7.7**).

An intertidal survey was also undertaken for the proposed scheme, the results of which are presented in **Section 9.4.1**, but were also dominated by medium sand, with underlying layers of gravel in some areas and coarse sediment in the upper shore. The results presented in **Table 7.7** are therefore deemed to be characteristic of the beach in the vicinity of the proposed LSO.

Table 7.7 Sediment sample characteristics from the Withernsea town frontage

Profile Location	Median grain size (d_{50}) description	
	Lower beach sample	Upper Beach Sample
A – North of Seathorne Promenade	Fine gravel	Medium sand
B – North Promenade	Medium sand	Coarse sand
C – Central Promenade	Medium sand	Fine sand
D – South of Queen's Promenade	Medium sand	Medium sand

7.4.9.1. Shore Platform Downwearing

The shore platform within the study area will experience irreversible downwearing (vertical lowering due to erosion) when the thickness of covering beach veneer is low or absent. When the beach thickness is low, the movement of the sands and gravels can cause erosion by abrasion, and when it is absent entirely, the waves and currents directly cause erosion of the clay.

Whilst Balson (1998) has previously made an estimate of downwearing of the shore platform of the Holderness coast (in general) of 20mm per year, the only known measurement of downwearing rates on the intertidal shore platform arises from a Research & Development (R&D) study by the Environment Agency and Defra into *Erosion of Cohesive Shore Platforms* (Cooper *et al.* 2007; Royal Haskoning *et al.* 2007).

Over a one year period between July 2005 and July 2006, the study measured an average rate of platform downwearing at Easington (to the south of Withernsea LSO) of 42mm. The average rate at the mid platform (43mm/year) was marginally greater than at the lower platform (40mm/year). No measurements were possible at the upper platform because the datum box was buried under more than 5m of beach sediment cover (which was entirely absent when the datum box was first installed).

Whilst these results provide a useful measure of the scale of downwearing in one year, in practice the downwearing will be episodic; there will be periods when the shore platform is covered by a suitable thickness of beach sediment and thus protected against downwearing, whilst at other times it will be temporarily exposed.

Anecdotal evidence from the walk-over inspections at the existing Withernsea LSO temporary protection works, suggests that when the shore platform is exposed, downwearing can be of the order of 300mm (on the upper beach) over a few months, if the platform is subjected to a succession of major storms, such as those experienced in March 2018.

7.4.9.2. Sediment transport regime

A natural supply of sediment to the beach at the study area is predominantly derived from erosion of undefended cliffs at the site and further north, with beach-building fractions of sediment transported in a net southerly direction under wave-driven longshore drift. The finer material released from cliff erosion is predominantly transported offshore and then subsequently net southerly under tidal action in the nearshore zone.

Transport of sediment by waves and tidal currents is generally southerly in direction and longshore sediment transport rates can be high due to the high energy wave climate. Some of the fine-grained material eroded from the glacial till cliffs (and when exposed the lowering shore platform) can be transported towards the Humber Estuary, where it becomes deposited on the tidal flats and saltmarshes. Uninterrupted southerly transport of beach sand is also deemed important to the continued supply of beaches further south of Withernsea, including Spurn Point at the mouth of the Humber Estuary.

7.5. Potential Impacts

7.5.1. Scope of assessment

The terrestrial aspects of the works (Withernsea WwTW, rising mains and terrestrial section of the LSO) will have no effect on the hydrodynamic and sedimentary regime during their construction, operation and decommissioning due to their siting landward of the 100-year predicted erosion line of the cliffs. This assessment of potential effects on the hydrodynamic and sedimentary regime therefore relates to the intertidal and subtidal sections of the LSO only.

7.5.2. Prediction of potential effects during construction

For the construction phase, the main potential effects upon the baseline coastal processes regime, both at Withernsea and along the adjacent coast, are associated with: (i) sediment disturbance leading to increases in suspended sediment concentrations and sediment deposition arising from the LSO installation works in the intertidal and subtidal zones; and (ii) interruptions to longshore sediment transport. Both of these effects will be temporary, lasting for no more than the approximately five months required for construction of the intertidal and subtidal sections of the LSO.

7.5.2.1. Increased suspended sediment concentrations and sediment deposition

As set out in **Section 2.2.1.2** of this ES, the intertidal section of the LSO will be installed by a trenchless solution (either HDD or micro-tunnelling). The remaining 1km section of the LSO present within the lower intertidal / subtidal sections will be installed through shallow dredged trenching and backfill methods: approximately 100m will be trenched using land-based plant, such as long-reach hydraulic excavators, with the remaining 900m being trenched using marine-based plant, such as backhoe or cutter suction dredger.

There will be no effects on the hydrodynamic and sedimentary regime from installation of the intertidal section of the LSO because it will use a trenchless solution. There will be some minor and temporary effects as the trenchless solutions reaches its exit point (temporary cofferdam and connection pit) at the surface in the lower intertidal, but this will be negligible in the context of the high natural turbidity levels present in this section of the North Sea.

There will be unavoidable increases in suspended sediment concentrations arising locally from installation of the subtidal section (including its connection with the seaward end of the intertidal section, though this will be undertaken within a temporary cofferdam). However, these effects will be temporary (the entirety of the subtidal section of the LSO will be installed within 2 months of non-continuous working within the overall LSO programme) and the increases are likely to be well within the range of values exhibited naturally, especially when sediment is mobilised under storms. The volumes involved, in the context of the baseline conditions, will not lead to measurable increased in sediment deposition.

Approximately 50,000m^3 of material will be excavated, side-cast and then used to back-fill the trench after the LSO has been installed. The preferred methodology for dredging would be by backhoe, however if the nature of the seabed requires (i.e. consolidated clays), a cutter suction dredger would be required. A cutter suction dredger is a stationary dredger, equipped with a rotating cutter head. Clay would be extracted by means of dredge pumps, broken into smaller fragments, and discharged either side of the trench. Due to the nature of the material within the scheme footprint (predominately gravel and clay), this would not be expected to cause significantly higher turbidity than a backhoe dredger. Only a small proportion of this material will reside in suspension in the water column and therefore no significant impacts are predicted.

7.5.2.2. Interruptions to longshore sediment transport

Possible interruptions to longshore drift may arise due to: (i) the temporary presence of a 30m long cofferdam to facilitate connection between the bored tunnel and the trenched subtidal section; and (ii) the temporary presence of an open trench in the subtidal.

The possible temporary presence of a cofferdam to facilitate connection of the HDD tunnel to the subtidal trench will cause an interruption to any sediment transport that may be occurring at the interface between the inter-tidal and sub-tidal zones. However, this will be a temporary impact that is confined to only the 30m length of the cofferdam and the natural processes will be fully reinstated upon removal of the cofferdam. Whilst acknowledging that this section of beach is within the active beach profile and thus can be subjected to longshore sediment drift, the greater proportion of drift occurs along the upper beach.

Where sediment transport does occur at the interface between the intertidal and subtidal zones, it is more generally in the form of large sand bars which migrate along the coast. These are such large features that they are likely to migrate around the ends of the temporary cofferdam since it is so short in length. Furthermore, anectodical evidence from similar (but longer) temporary cofferdams at other locations along the Holderness coast in the past (e.g. York Field pipeline installation approximately 10 years ago) indicates that such temporary effects are not significant in the context of the natural variability in the baseline environment and baseline conditions are fully re-instated upon removal of the cofferdam.

The proposed dredge will increase water depth along the proposed pipeline corridor for a short period of time, prior to infill. This could potentially become a trap for sediment that is transported along the sub-tidal seabed by bedload transport processes. However, given the very localised dredge in the context of the open sea, there will likely be no discernible effect.

At the end of construction, the installation of the pipeline and infill of the trench may result in a ±0.5 m tolerance change in seabed level, but no significant barrier to sediment pathways would be created by this and no long-term impacts are predicted since any initial variation in level is likely to be short-term and reversible due to natural processes.

7.5.2.3. Assessment of impacts on baseline coastal processes

The temporary access ramp will have no effect on the hydrodynamic and sedimentary regime.

Installation of the LSO across the inter-tidal zone by means of a trenchless solution (either HDD or micro-tunnelling) will inherently minimise the potential disturbance of seabed sediment as far as is practicably achievable.

Whilst there will be some acknowledged temporary and localised effects from installation of the LSO (including trenching and backfill in the sub-tidal and the potential presence of a cofferdam for 30m at the lower inter-tidal/sub-tidal interface), these are not significant impacts on the baseline coastal processes during construction of the proposed works.

Beach profile data in this location are currently being collected on a monthly basis as required by a condition of the emergency pipe protection works to the existing LSO (MMO marine licence Ref: L/2017/00420/2). This monitoring will continue until the end of the construction of the new LSO replacement. The data will be compared to historical beach profile data collected by ERYC to reinstate the intertidal area as closely as is reasonably practicable to its original profile, thus minimising any potential change to the morphology of the inter-tidal shore and subtidal seabed. The requirement for such monitoring and re-instatement has also been mentioned by Natural England and the MMO in their consultation responses on this topic and the proposals are commensurate with these requirements.

7.5.3. Prediction of potential impacts during the operational phase

For the operational phase, the main potential effects upon the baseline coastal processes regime, both at Withernsea and along the adjacent coast, are associated with interruption of longshore

sediment transport caused by the presence of either: (i) the LSO; or (ii) the diffuser protection dome and its associated scour protection.

The LSO will be buried below the intertidal beach and subtidal seabed, with a minimum depth of cover of 3m. It will therefore remain buried over its design life and cause no effect on longshore sediment transport.

The diffuser dome will present an obstacle on the seabed, but it is only 450 mm in diameter and will therefore not present a significant blockage effect to sediment transport across the seabed; rather a small, localised obstruction that is considered the same order of size as a large boulder on the seabed. The rock blanket will be installed flush with the seabed and therefore will not stand proud. Consequently, no blockage effect will occur from the scour protection to sediment transport across the seabed.

7.5.3.1. Assessment of impacts on baseline coastal processes

There are no significant impacts predicted on the baseline coastal processes during operation of the proposed works.

Mitigation Measures

The minimum depth of cover of 3m for the LSO will make sure that it presents no effect on the baseline coastal processes regime during its lifetime. Furthermore, the placement of the rock blanket scour protection for the diffuser dome flush with the seabed will make sure that no blockage to sediment transport across the seabed occurs.

7.5.4. Prediction of potential impacts during decommissioning

7.5.4.1. Existing LSO

Upon commissioning of the new LSO, the existing LSO (which at that time will become redundant) will be decommissioned. This will involve trenching between the upper limit of the beach to an existing exposed chamber located on the foreshore immediately above MLW. It is envisaged that the trench would be excavated by land-based plant working within appropriate tidal windows. Once this section of the existing LSO has been removed, the trench would be backfilled with the side cast materials. Due to the short-term and relatively small-scale nature of this activity, no significant impacts are predicted in terms of increased suspended sediment concentrations or sediment deposition.

The sections of the existing LSO seaward of the diffuser will be capped at both ends and abandoned, with the existing diffuser and protection frame removed. The capping and abandonment of the subtidal section of the existing LSO is considered to have less potential for environmental impact than full removal of the pipeline along its route.

7.5.4.2. New LSO

The decommissioning of the new LSO is expected to follow a similar methodology as the decommissioning of the existing LSO, as set out in **Section 2.2.6**. However, the exact method

will be agreed upon with the regulatory authorities at the time as it will depend on the condition of the LSO.

As for the construction phase effects, whilst this would result in temporary and localised increases in suspended sediment concentrations, these would be negligible within the context of the natural baseline environment.

7.6. Summary of effects

The potential effects on the hydrodynamic and sedimentary regime are summarised in **Table 7.8**.

Table 7.8 Summary of impacts on hydrodynamic and sedimentary regime

Description of Effect	Significance	Mitigation	Residual Effect
Construction Phase			
Increased suspended sediment concentrations and sediment deposition	Negligible	Use of trenchless techniques in the intertidal zone	Negligible
Interruptions to longshore sediment transport	Negligible	Monitoring of effects and re-instatement of profile	Negligible
Operational Phase			
Diffuser dome and its protection measures will present an obstacle to sediment transport on the seabed	Negligible	Limit size to 450 mm in diameter (i.e. the same order of size as a large boulder on the seabed). The rock blanket around the diffuser will be installed flush with the seabed and therefore will not stand proud.	Negligible
Decommissioning Phase			
Increased suspended sediment concentrations and sediment deposition during removal	Negligible	Capping and abandonment of sub-tidal section (rather than trenching and removal).	Negligible

8. Marine Sediment and Water Quality

8.1. Introduction

This section of the ES describes the existing environment in relation to marine water and sediment quality and assesses the potential impacts of the construction, operational and decommissioning phases of the proposed scheme. Proposed mitigation measures are detailed and a discussion of the residual impacts is presented, where significant impacts have been identified.

8.2. Consultation

Table 8.1 provides a summary of the advice provided by the MMO during consultation for an EIA Scoping opinion on 5th November 2018 (**Appendix E**) and also identifies the relevant section of this ES where the comment has been addressed.

Table 8.1 Consultation Responses relating to marine water and sediment quality

Consultee	Comment	Response / where addressed in the ES
MMO	"The removal and relocation of the existing LSO has the potential to elevate levels of *E. coli* within the water environment and the report should consider the potential impacts to bathing water quality and potential impacts to users of the marine and water environment".	Noted, however, the proposed scheme is located up to 50m from the existing LSO. Furthermore, it is not expected that E. coli is present within the sediments surrounding the existing LSO (see **Section 8.5**).
MMO	"Where it is not possible to conclude no significant adverse impact to water quality within designated bathing waters, the MMO advise the works must be completed outside of the bathing season in order to reduce the likely impact to water users".	Noted, however as outlined within this Section (**Section 8.5**) and the WFD Compliance Assessment (Section 14), significant impacts on water quality from the proposed scheme are not anticipated.
MMO	"Unless the effect of contaminant release on water quality can be specifically 'scoped out', then the impact of contaminant release on the benthos must be assessed within the ES".	Noted, this topic has not been scoped out, and is discussed in **Section 8.5**).

Furthermore, a request for a sediment sampling and analysis plan (SAM/2016/00063) was submitted to the MMO. The response contained advice on the number of samples required, the sample depths and the suite of laboratory analysis required (**Appendix G**). Further information regarding the sampling and analysis undertaken is provided in the following section.

8.3. Methodology

8.3.1. Study Area

The study area for this section of the ES comprises the likely maximum extent over which potentially significant environmental impacts of the proposed scheme may occur. This was informed by the hydrodynamic and sedimentary regime chapter and is based on the maximum extent over which potential effects are predicted to occur (e.g. sediment plumes generated during capital dredging and effects on tidal currents during operation). As suggested within **Section 7**, these are expected to be minimal. As such, the study area within which effects on marine water and sediment quality is assessed, is presented in **Figure 8.1**.

530000
535000
540000
430000
425000
420000
N
0
2 km

Legend

- Study Area
- Proposed Scheme Boundary
- New LSO
- Existing LSO

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title: **Proposed Scheme Study Area**

Figure: 8.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	CG	A3	1:45,000

Co-ordinate system: British National Grid

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8.3.2. Data Sources

The description of the existing environment with regards to sediment quality has been informed through a combination of desk-based review of previous sediment quality surveys and a targeted sediment quality survey. A sampling plan for sediment collection and laboratory analysis was issued by the MMO in 2016 (SAM/2016/00063). The sampling plan provided by the MMO was based on proposals to dredge up to 50,000m^3 of material to a depth of 3.5m below seabed (required for the LSO trench).

The MMO recommended the recovery of surface sediment samples from four locations spread equally throughout the proposed dredge footprint. The MMO did not consider sampling at depth was required due to the physical nature of the materials anticipated to arise and its location in a relatively open coastal environment. In accordance with the sediment sampling and analysis plan provided by the MMO, the samples were analysed by Cefas for:

- trace metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead, zinc);
- organotins (Dibutyltin, Tributyltin);
- total hydrocarbons; and,
- particle size analysis (PSA).

The description of the existing environment with regard to water quality has been informed through desk based review only.

8.3.2.1. Impact assessment methodology

The assessment of potential impacts associated with disturbance of sediment during the construction phase has been undertaken with regard to recognised guidelines and Action Levels, namely:

- Cefas Guideline Action Levels (ALs) for the disposal of dredged material (Cefas, 2000); and,
- Canadian Sediment Quality Guidelines (CSQG) for the Protection of Aquatic Life (Canadian Council of Ministers of the Environment (CCME), 2002).

The Cefas ALs are used as part of a 'weight of evidence' approach to assessing the suitability of dredged material for disposal at sea, but are not themselves statutory standards. The current Cefas ALs are set out in **Table 8.2**.

Table 8.2 Current Cefas Action Levels

Contaminant	AL1 (mg/kg)	AL2 (mg/kg)
Arsenic	20	100
Cadmium	0.4	5

Contaminant	AL1 (mg/kg)	AL2 (mg/kg)
Chromium	40	400
Copper	40	400
Nickel	20	200
Mercury	0.3	3
Lead	50	500
Zinc	130	800
Organotins (TBT, DBT)	0.1	1
PCBs (sum of ICES 7)	0.01	None
PCBs (sum of 25 congeners)	0.02	0.2
PAHs	0.1	None
DDT	0.001	None
Dieldrin	0.005	None

Cefas guidance indicates that, in general, concentrations of contaminants within sediment which are below AL1 are not considered to be of concern and are, therefore, likely to be approved for disposal at sea. Material with concentrations of contaminants above AL2 is generally considered to be unsuitable for disposal at sea. Dredged material with contaminant concentrations between AL1 and 2 requires further consideration and testing before a decision can be made. Comparison of results from sediment quality analysis with Cefas ALs therefore provides a good indication regarding the risk of the material to the environment.

The CSQG involved the derivation of interim marine sediment quality guidelines (ISQGs), or Threshold Effect Levels (TEL) and Probable Effect Levels (PEL). These levels were derived from an extensive database containing direct measurements of toxicity of contaminated sediments to a range of aquatic organisms exposed in laboratory tests and under field conditions (CCME, 2002). As a result, these guidelines provide an indication of likely toxicity of sediments to aquatic organisms. However, these guidelines should be used with caution as they were designed specifically for Canada and are based on the protection of pristine environments. In the absence of suitable alternatives, however, it has become commonplace for these guidelines to be used by regulatory and statutory bodies in the UK, and elsewhere, as part of a 'weight of evidence' approach.

Selected Canadian guidelines are presented in **Table 8.3** and comprise two assessment levels. The lower level is referred to as the TEL and represents the concentration below which adverse biological effects are expected to occur only rarely (in some sensitive species for example). The higher level, the PEL, defines a concentration above which adverse effects may be expected in a wider range of organisms.

Table 8.3 Selected CSQG values (taken from CCME, 2002)

Contaminant	*Units*	*TEL*	*PEL*
Arsenic	mg/kg	7.24	41.6
Cadmium	mg/kg	0.7	4.2

Contaminant	Units	TEL	PEL
Chromium	mg/kg	52.3	160
Copper	mg/kg	18.7	108
Mercury	mg/kg	0.13	0.7
Lead	mg/kg	30.2	112
Zinc	mg/kg	124	247
Acenaphthene	µg/kg	6.71	88.9
Acenaphthylene	µg/kg	5.87	128
Anthracene	µg/kg	46.9	245
Benz(a)anthracene	µg/kg	74.8	693
Benzo(a)pyrene	µg/kg	88.8	763
Chrysene	µg/kg	108	846
Dibenz(a,h)anthracene	µg/kg	6.22	135
Fluoranthene	µg/kg	113	1,494
Fluorene	µg/kg	21.2	144
Napthalene	µg/kg	34.6	391
Phenanthrene	µg/kg	86.7	544
Pyrene	µg/kg	153	1,398

The assessment of potential water quality impacts has been informed using information from the Environment Agency's Catchment Data Explorer and the Humber River Basin Management Plan (RBMP) (Environment Agency, 2015). Although such information is routinely used to inform the WFD compliance assessment (**Section 14**), the data that was used to classify the chemical quality element of the water bodies within and adjacent to the proposed scheme footprint is of relevance to this section of the ES.

The methodology used to assess the significance of the potential environmental impacts associated with the proposed scheme is described in **Section 4**.

8.4. Existing Environment

8.4.1. Sediment Quality

A marine Ground Investigation (GI) was undertaken in July 2017 to inform the design of the proposed scheme. Marine investigations undertaken as part of the GI included a geophysical and bathymetric survey (**Appendix H**), a sediment quality survey (Stations 1 to 4) and a benthic ecological survey (Stations 1 to 6) (**Appendix I**). The location of each station is shown in **Figure 7.6**.

The survey team attempted to collect sediment samples from within 25m of target location but moved by up to 100m if a minimum of three initial attempts were unsuccessful. The survey was initially attempted using a Day Grab but repeated failed grabs necessitated a switch to a mini-

Hamon design more suited to collecting material from coarse ground. The position, date, time and water depth were recorded and a photograph taken of each sample along with notes of sediment character.

Insufficient sediment was collected from Station 3B for chemical analysis due to challenging ground conditions and therefore only physical analysis was undertaken for this location. All other samples were tested for arsenic, cadmium, chromium, copper, magnesium, nickel, lead, zinc, total solids and total hydrocarbon content.

A comparison of analysis results against Cefas ALs is provided in **Table 8.4**. The analysis has identified minor exceedances of Cefas AL1 in two samples for chromium and nickel, and of these, one sample also had an exceedance of arsenic (see **Appendix I**). All three samples exceeded AL1 for total hydrocarbon content. No samples were found to contain any contaminants in excess of AL2.

Table 8.4 Contamination Analysis Results (Unit: mg/kg ppm, total solids in %) compared to Cefas Action Levels (Cefas AL1 exceedances in yellow. No exceedances of Cefas AL2 were recorded)

Station	Total Solids	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	THC	Organotins (DBT)	Organotins (TBT)
1A	81.7	1.83	0.05	12.1	8.87	0.026	13.9	5.83	26.8	228	<0.001	<0.001
2B	83.5	35.1	0.07	55.8	15.7	0.03	30.2	11.6	44.3	176	<0.001	<0.001
4A	57	13.1	0.21	78.1	25.1	0.045	54.1	19.7	86.8	443	<0.001	<0.001

Comparison of the sediment quality data with the CSQG has identified locally elevated concentrations of metals above the TEL threshold. No exceedances of the PEL were recorded. The elevations of the TEL were found at station 2B and 4A. Arsenic, chromium and copper were the only metals recoded above TEL. Metals recorded between TEL and PEL are in the possible effect range within which adverse effects occasionally occur (CCME, 2002). However, the exceedances of the TEL were only marginal. The results of the contamination analysis against the CSQG are provided in **Table 8.5** below.

Table 8.5 Contamination Analysis Results (Unit: mg/kg ppm, total solids in %) compared to CSQG (TEL exceedances in orange. No exceedances of PEL were recorded)

Station	Total Solids	As	Cd	Cr	Cu	Hg	Pb	Zn
1A	81.7	1.83	0.05	12.1	8.87	0.026	5.83	26.8
2B	83.5	35.1	0.07	55.8	15.7	0.03	11.6	44.3
4A	57	13.1	0.21	78.1	25.1	0.045	19.7	86.8

Sediment samples for PSA were obtained from all four of the sample stations. The results of the PSA is detailed in **Table 8.6**, with the relative proportion of each broad sediment category (i.e. mud, sand and gravel).

Table 8.6 Particle Size Analysis statistics

Station	Gravel (%)	Sand (%)	Silt/clay (%)	Very coarse and coarse sand (%)	Medium sand (%)	Fine sand and very fine sand (%)	Description
1A	10.79	24.08	65.13	6.46	0.65	16.98	Gravelly, sandy mud

Station	Gravel (%)	Sand (%)	Silt/clay (%)	Very coarse and coarse sand (%)	Medium sand (%)	Fine sand and very fine sand (%)	Description
2B	62.66	27.96	9.38	18.62	4.19	5.15	Slightly muddy, sandy gravel
3B	38.85	55.63	8.52	43.00	7.41	5.22	Slightly muddy, sandy gravel
4A	15.86	22.02	62.12	5.15	0.94	15.93	Gravelly, sandy mud

The sediments recovered were described as either gravelly, sandy mud (Samples 1A and 4A) or slightly muddy, sandy gravel (Station 2B and 3B).

Although no mud or silt was recorded within samples, clay was present as solid aggregations which subsequently disaggregated during collection and subsequent transport. The clay content was further broken down for the purpose of PSA and so the high 'silt' levels recorded in samples 1A and 4A are not representative of actual conditions in situ.

8.4.2. Water Quality

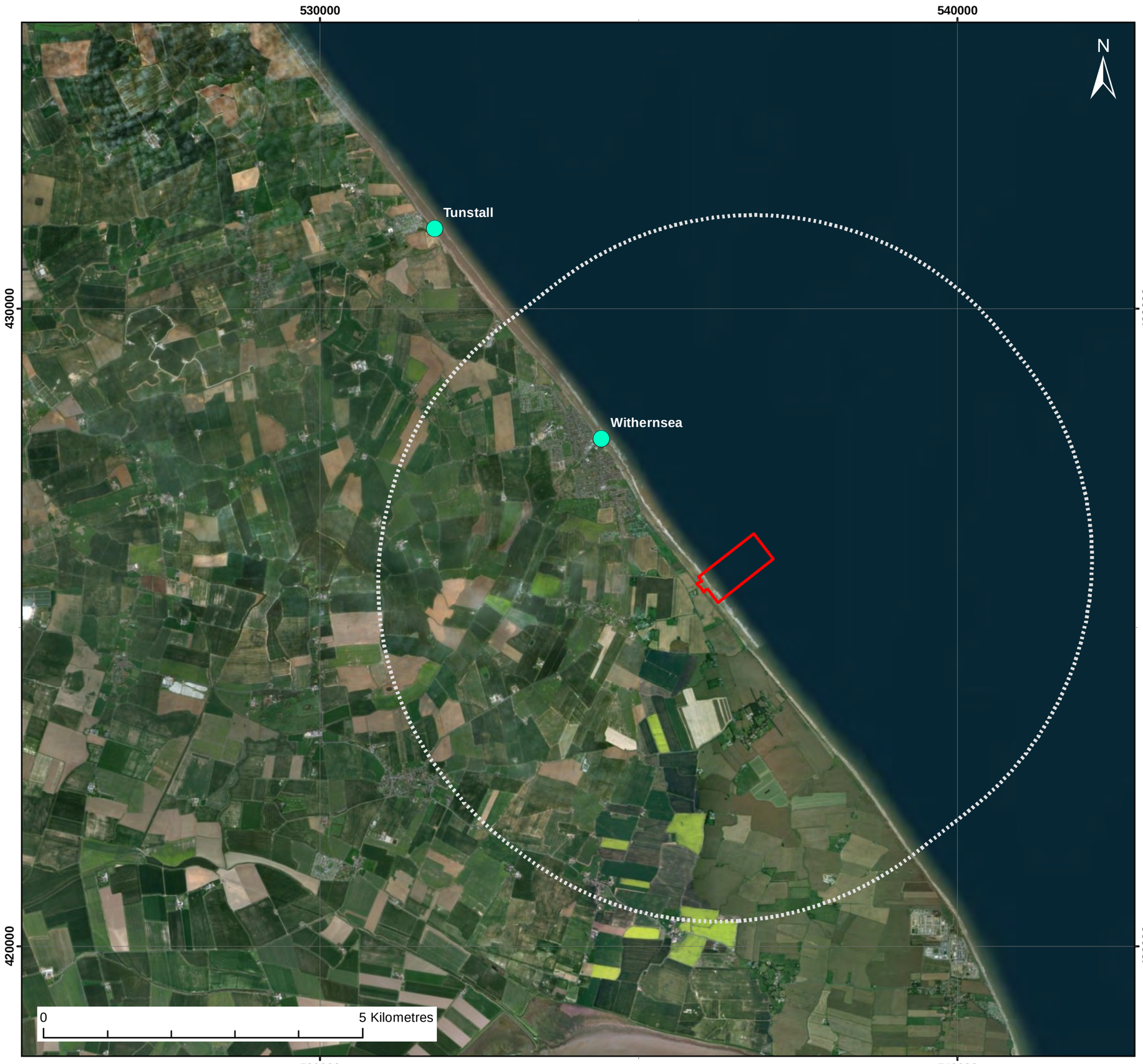
The new Bathing Water Directive (2006/7/EC) repeals Directive 76/160/EEC and is implemented in England and Wales through the Bathing Water Regulations 2013 (as amended by The Bathing Water (Amendment) (England) Regulations 2018), for which the Environment Agency is the competent authority.

The nearest designated Bathing Water to the proposed works is 'Withernsea', located approximately 3km to the north (**Figure 8.2**). The bathing waters at Withernsea have been classified as 'Good' for 2018. 'Tunstall' bathing water is located approximately 7km to the north of the proposed scheme, and was classified as 'Excellent' for the past four years where data is available.

The new Directive includes stricter microbiological standards and classifies waters into four categories - excellent, good, sufficient and poor. Regular water quality monitoring, carried out by the Environment Agency, is undertaken at all Bathing Waters throughout the bathing season (15th May to 30th September).

The samples are analysed for bacteria (including *Escherichia coli – E. coli* and *Intestinal enterococci*) that indicate the presence of faecal matter in the water. A classification for each bathing water is calculated annually based on samples from the previous four years. The classifications are:

- Excellent – the cleanest seas;
- Good – generally good water quality;
- Sufficient – the water meets minimum standards; and,
- Poor – the water has not met the minimum standards.



Legend

- Study Area
- Proposed Scheme Boundary

Bathing Waters Monitoring Locations

- Excellent
- Good
- Sufficient
- Poor
- Not assessed

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title:

Bathing waters within the vicinity of the proposed scheme

Figure: 8.2

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	ES	A3	1:60,000

Co-ordinate system: British National Grid

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E. coli concentrations recorded within the Withernsea bathing water since 2014 is presented in the graphs below in **Figure 8.3** and **Figure 8.4**. The data shows *E. coli* concentrations have not exceeded abnormal levels and predominantly have <10 colonies per 100ml.

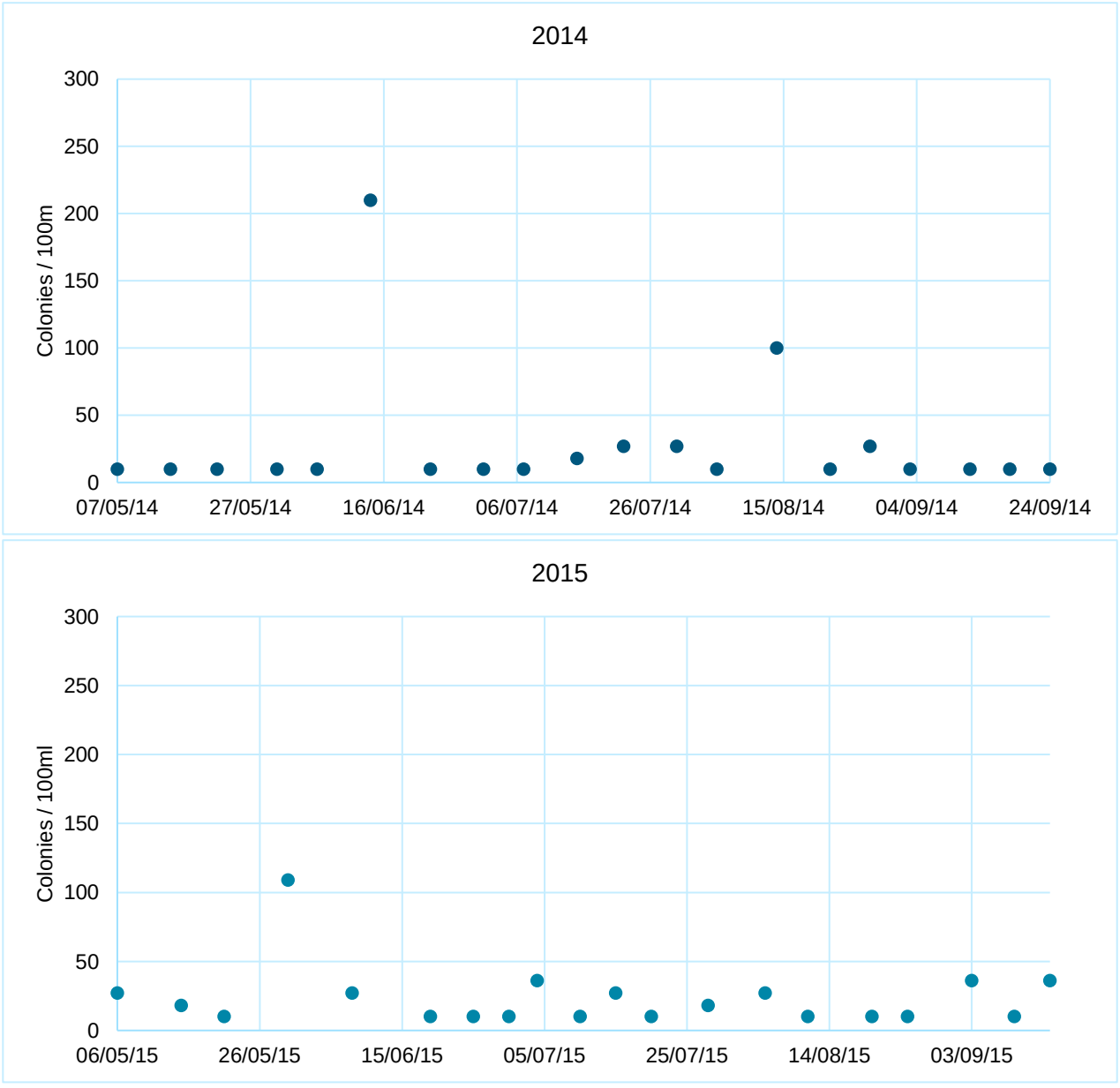
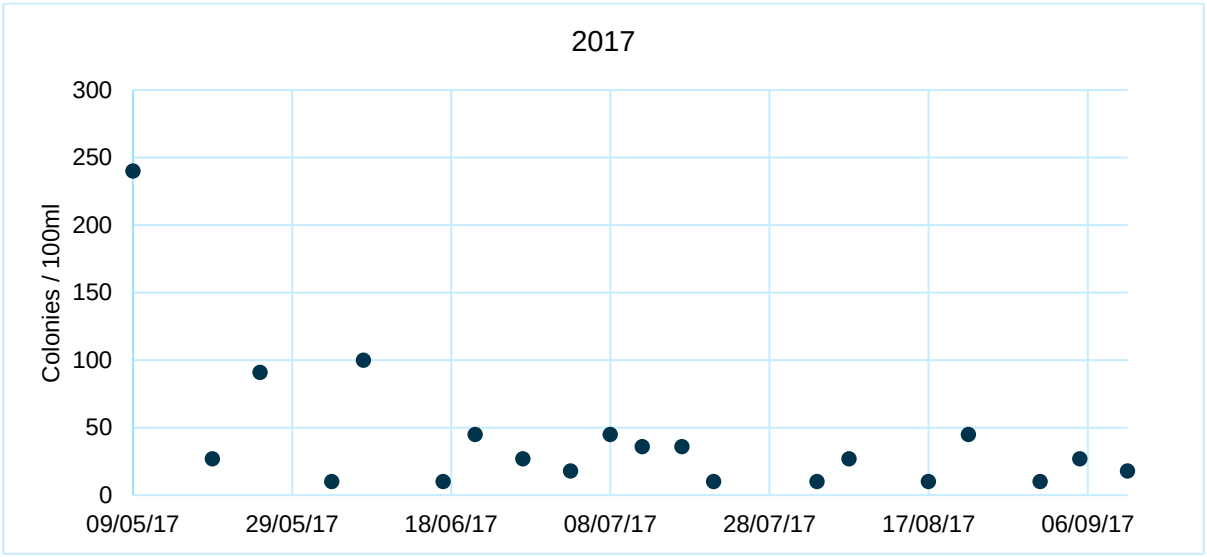
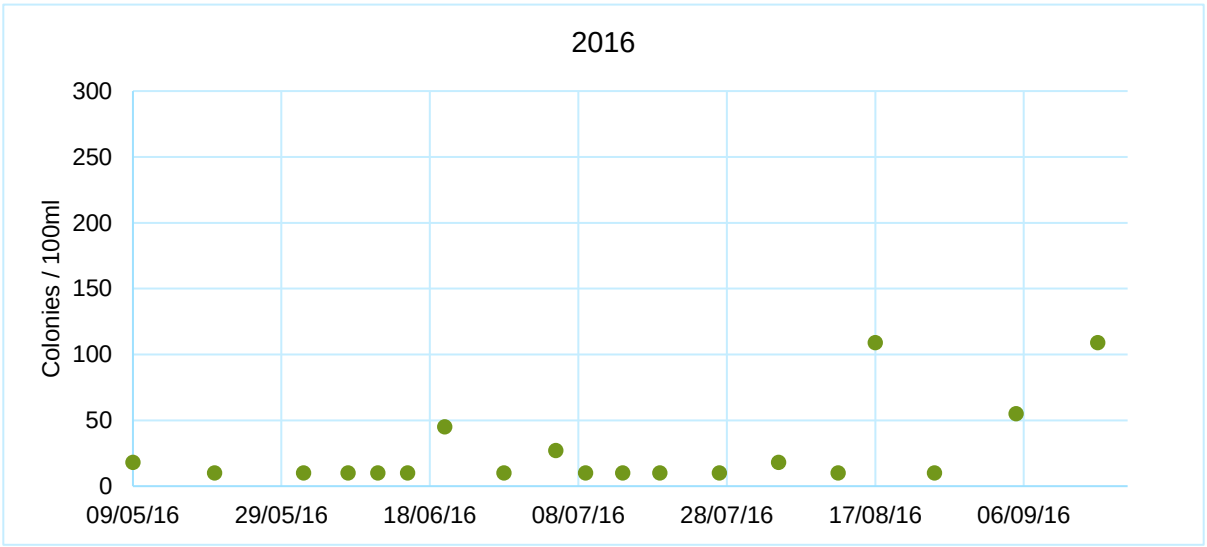


Figure 8.3 E. coli concentrations (colonies per 100ml) recorded in the Withernsea bathing water, 2014 - 2015 (Environment Agency, 2018)





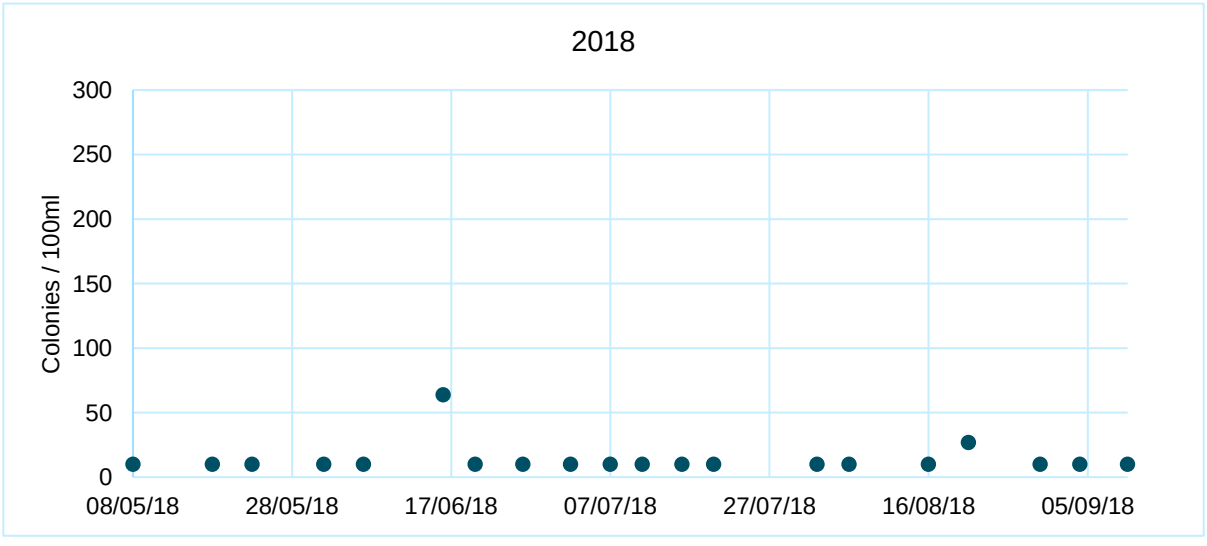


Figure 8.4 E. coli concentrations (colonies per 100ml) recorded in the Withernsea bathing water, 2016 - 2018 (Environment Agency, 2018)

8.5. Potential Impacts

8.5.1. Scope of assessment

The terrestrial aspects of the works (Withernsea WwTW, rising mains and terrestrial section of the LSO) will have no effect on the marine sediment or water quality within the study area of the proposed scheme during construction, operation and decommissioning due to their siting landward of the 100-year predicted erosion line of the cliffs. This assessment of potential effects therefore relates to the intertidal and subtidal sections of the LSO only.

8.5.2. Potential impacts during construction

8.5.2.1. Reduction in marine water quality – increased suspended sediment

A reduction in water quality can occur when sediment is released into the water column due to sediment disturbance/re-suspension during trenching and backfilling for the new LSO. The preferred methodology for dredging would be by backhoe, however if the nature of the seabed requires (i.e. consolidated clays), a cutter suction dredger would be required. A cutter suction dredger is a stationary dredger, equipped with a rotating cutter head. Clay would be extracted by means of dredge pumps, broken into smaller fragments, and discharged either side of the trench. Due to the nature of the material within the scheme footprint (predominantly gravel sand clay), this would not be expected to cause significantly higher turbidity than a backhoe dredger.

During the dredging activity, sediments will be side-cast either side of the trench. Backfilling will occur immediately once the trench has been completed, however, side-cast sediments will remain in position for a short duration. Within the intertidal zone, side-cast material will be stored adjacent to the trench, in the upper intertidal zone, to minimise disturbance by tidal movements and wave action. With increasing water depth and reduced effects of wave action, suspension of the side-cast materials will be minimal. In shallower areas, increased agitation by waves may cause infilling of the trench, which will be re-dredged where necessary prior to LSO installation. The side-cast sediment will be used to backfill the trench in the lower intertidal and subtidal zones, on completion of the installation of the LSO.

These activities have the potential to adversely impact water quality, due to increased concentrations of Suspended Sediment Concentrations (SSC) and (if present) the potential release of contaminants, which are currently adsorbed to sediment particles into the water column. Concentrations of SSC could potentially affect the dissolved oxygen concentration in the water column, particularly if the sediment has a high organic content and the activity which causes sediment disturbance is undertaken during the summer months.

The Holderness coastline is known to be particularly mobile, with the coastal waters consequently being highly turbid with high levels of suspended sediment. As described in **Section 7**, the supply of sediment from erosion of the Holderness cliffs and shore platform is over 3M m^3/year (Balson *et al*, 1998). The naturally high suspended sediment concentrations are exacerbated by weather conditions, with storm conditions transporting additional volumes sediments into coastal waters.

No contaminants were recorded above CEFAS AL2, therefore impacts to water quality and bathing waters at Withernsea, Tunstall and Hornsea due to release of contaminants is not predicted. In light of this, it is not deemed necessary to restrict works to outside of the bathing season.

Any potential increase in SSC during dredging and removal of scour protection is expected to be localised given the nature of material to be excavated (predominantly sands and gravel) and it is expected that the majority of sediment mobilised into the water column would rapidly re-settle in close proximity to the dredge area. The dredged sediment will not be brought to the surface of the water column, but side-cast at depth, also minimising the potential for resuspension. The transport of sediment along this coastline in a net southerly direction, and thus no impact on water quality is expected at Withernsea, Tunstall or Hornsea bathing waters.

It is expected that direct impacts to marine water quality as a result of increased SSC during the construction phase represents a temporary and short-term effect. The receptor is considered to be of **low** sensitivity given the existing background environment and the down-drift location from the nearest bathing water, and **low** magnitude given the short duration of construction activity and nature of sediment. Consequently, the potential impact is assessed as being of **negligible** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible**.

8.5.2.2. Reduction in marine water quality – *E. coli*

As noted in **Section 8.4.2** the mobile and highly turbid coastal waters of the Holderness coastline have exhibited very low levels of *E. coli* concentrations within the Withernsea bathing waters since 2014. As discussed in **Section 2.2.1**, the removal of the existing infrastructure will only involve removal of the diffuser (at the distal end of the LSO) and a very small area of the surrounding scour protection (both activities will be undertaken by hand), thus the release of *E. coli* during the construction phase is very unlikely.

In summary, it is expected that direct impacts to marine water quality as a result of *E. coli* during the construction phase is highly unlikely. The receptor is considered to be of **low** sensitivity given the distance from the nearest bathing water and **very low** magnitude given the likelihood of *E. coli* in the footprint of the proposed scheme. Consequently, the potential impact is assessed as being of **negligible** significance.

The impacts of resuspension of sediment and contaminants on benthic ecology are addressed in **Section 9.5**.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible**.

8.5.2.3. Reduction in marine water quality – Bentonite

For the HDD works, the use of a drilling fluid (Bentonite) is required. Only a small amount of this is used, however, there is the potential that this may be released at the punch out location on the foreshore, (within the connection point at low water). This is a mud-based fluid, bentonite, which is inert and as such is not toxic within the marine environment.

The only time that loss of bentonite to the surrounding environment may occur is during final hole punch out, otherwise the returns are contained and recycled on site and then disposed of at an authorised landfill. The receptor is considered to be of **low** sensitivity given the distance from the nearest bathing water and **low** magnitude given the nature and quantity of discharge.

Consequently, the potential impact is assessed as being of **negligible** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible**.

8.5.3. Prediction of potential impacts during the operational phase

8.5.3.1. Reduction in marine water quality (discharges from the LSO)

The LSO will be buried below the intertidal beach and subtidal seabed, with a minimum depth of cover of 3m. It will therefore remain buried over its design life and therefore the presence of the LSO will cause no effect on suspended sediments.

Once installed and commissioned, the new LSO will discharge treated waste water. The discharge of wastewater from the new LSO will be a consented discharge as agreed with YWS and the Environment Agency. Given the thorough treatment process and the discharge effluent and rates within the allowed limits of the existing discharge consent (**Appendix D**), no impacts are predicted on the baseline environment.

The receptor is considered to be of **low** sensitivity given the distance from the nearest bathing water and **low** magnitude given the quality of the discharge likely to be required by the existing Environment Agency. Consequently, the potential impact is assessed as being of **negligible** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible**.

8.5.4. Prediction of potential impacts during decommissioning

8.5.4.1. Reduction in marine water quality

The decommissioning of the new LSO is expected to follow a similar methodology as the decommissioning of the existing LSO, as set out in **Section 2.2.2**. However, the exact method will be agreed upon with the regulatory authorities at the time as it will depend on the condition of the LSO.

As noted in **Section 8.5.2.1**, any potential increase in SSC is expected to be localised given the nature of material to be excavated (predominantly clay and gravel) and it is expected that the majority of sediment mobilised into the water column would rapidly re-settle in close proximity. The levels of suspended sediment are unlikely to be perceptible due to the naturally high levels of SSC in the Withernsea area. Additionally, due to transport of sediment along this coastline in a net southerly direction, no impact is expected in Withernsea, Tunstall or Hornsea bathing waters.

Decommissioning of the new LSO is expected to take place in 60 years following commissioning of the LSO. An appropriate decommissioning plan will be developed at the time and a subsequent marine licence sought.

8.6. Summary of Impacts

The potential impacts on marine sediment quality and water quality are summarised in **Table 8.7.**

Table 8.7 Summary of impacts of Marine Sediment and Water Quality

Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase			
Reduction in marine water quality – increase in suspended sediments	Negligible	None required	Negligible
Reduction in marine water quality – *E. coli* contamination	Negligible	None required	Negligible
Reduction in marine water quality – Bentonite	Negligible	None required	Negligible
Operation Phase			
Reduction in marine water quality (discharges from the LSO)	Negligible	None required	Negligible
Decommissioning Phase			
Reduction in marine water quality (increase in SSC or *E. coli* contamination)	Negligible	Capping and abandonment of sub-tidal section (rather than trenching and removal).	Negligible

9. Marine and Coastal Ecology

9.1. Introduction

This section of the ES describes the baseline environment in relation to marine and coastal ecology, specifically benthic ecology and marine mammals. An assessment of potential impacts to marine and coastal ecology from the construction, operation and decommissioning of the proposed scheme are described. Appropriate mitigation measures are also provided along with an assessment of any residual impacts.

Potential impacts of the proposed scheme on fish and shellfish, and ornithological interests are addressed in **Section 10** and **Section 11** respectively.

9.2. Consultation

Table 9.1 provides a summary of the comments received from the MMO within its Scoping Opinion received on 5th November 2018 (**Appendix E**), as well as identifying the relevant section of this ES where the comment has been addressed.

Table 9.1 Consultation Responses relating to marine and coastal ecology

Consultee	Comment	Response / where addressed in the ES
Benthic Ecology		
MMO	The MMO note that *Sabellaria spinulosa* was recorded during the benthic survey, but that there was no evidence of 'reef-like aggregations' within the footprint of the proposed development (Appendix J; Sections 3.9 and 4.3). The MMO advise that the available side-scan and multibeam data must be considered within the ES for the identification of *S. Sabellaria* reef within the footprint of the works with a clear description of the investigation methods provided.	During the offshore survey, the side-scan sonar data was reviewed for any anomalies with potential to represent *Sabellaria* reefs. However, no such features were encountered (**Section 9.3.2.2**).
MMO	From the details provided within the Technical Report for the subtidal benthic survey (Appendix J) it is unclear where the four successful drop-camera stations were located. Moreover, the maps showing the positions of the grab sample stations (e.g. Fig. 3.1. of Appendix J) do not indicate the positions relative to the proposed LSO route. It is also stated that the grab stations 5 and 6 were located off the proposed LSO route (Appendix J; Section 2.7). However, in the aforementioned map all 6 stations appear to be positioned close together. To confirm whether the samples grabs and drop-down station were appropriately placed, the MMO consider that maps showing the positions of grab stations and drop-down camera stations in relation to the LSO route must be provided within the ES.	Clarifications were sought from Niras regarding the location and mapping of each station. This has been amended and a thorough analysis is provided in **Section 9.4.2**.
MMO	The MMO consider that the pathways to impact the benthic environment have been correctly identified with Section 5.2.3 of the Scoping Report. Specifically, the MMO agrees with the identification of "direct disturbance to benthic habitats" and "potential loss/smothering of associated species" during LSO installation as likely pathways to impact. However, the MMO consider that the ES must also fully consider the likely effects of resuspended sediment by construction works.	Noted, this has been addressed in **Section 19.5.2.3**
MMO	Whilst it is considered that the operational phase of the development works are unlikely to adversely affect the benthic environment, the MMO advise that the ES must fully consider the likely impact to benthic organisms during the	Noted, this has been addressed in **Section 9.5.4**

Consultee	Comment	Response / where addressed in the ES
	decommissioning phase of the project, including impacts to benthic organisms that have colonised the diffuser and associated scour protection structures.	
Marine Mammals		
MMO	The MMO note that the Scoping Report proposes to 'scope out' impacts to marine mammals on the basis that any potential impacts are expected to be both short-term and temporary, and will only affect transiting mammals, with no known haul out areas at this location. However, given anecdotal evidence of seal sightings on Withernsea beach itself, the MMO advise that impacts to marine mammals (particularly to grey seals, a feature of the Humber Estuary Ramsar, SAC, and SSSI) should be 'scoped in' for further assessment. In particular, the MMO consider that the potential impacts to marine mammals from underwater noise must be considered within the ES.	Noted, this has been addressed in **Section 9.5.2.4**, however note that piling works for the intertidal cofferdam will be undertaken using land-based plant at low tide and therefore there is no pathway for effects from underwater noise on marine mammals.

9.3. Methodology

9.3.1. Study Area

For marine ecology, the study area comprises the likely maximum extent over which potentially significant environmental impacts of the proposed scheme may occur. This has been informed by the hydrodynamic and sedimentary regime baseline and is based on the maximum extent over which effects are predicted to occur (e.g. sediment plumes generated during capital dredging). As suggested within **Section 7**, these are expected to be minimal. As such, the study area within which effects on marine and coastal ecology is assessed, is presented in **Figure 8.1**.

9.3.2. Data Sources

The description of the existing environment with regards to marine ecology has been informed through intertidal and subtidal surveys and laboratory analysis for the proposed scheme. Further details regarding the surveys is provided in **Table 9.2**.

Table 9.2 Data Sources

Data	Year	Coverage	Notes
Intertidal Phase 1 survey	2017	Intertidal	Survey was undertaken in November 2017. The technical report for the survey is available in **Appendix J**
Benthic Ecology survey	2017	Benthic	Survey was undertaken in July 2017. The technical report for the survey is available in **Appendix I**.

9.3.2.1. Intertidal Phase 1 survey

A Phase 1 intertidal survey was undertaken on a low water neap tide (23rd November 2017) to assess marine and coastal species present and their relative abundance.

The survey comprised a full walkover survey of the foreshore with in-situ recording of habitats and conspicuous species. Habitat zonation and biotopes were mapped using ArcGIS software on a global positioning system (GPS) device. Joint Nature Conservation Committee's (JNCC) marine habitat classification was used to classify the biotopes present at each zone (JNCC, 2017).

A sediment sample was taken within each of the four zones identified, and processed through the 0.5µm sieve in-situ. As per the JNCC marine monitoring handbook (JNCC, 2001), a spade was used to sample approximately 0.02m^2 of sediment, dug to a depth of 20cm and sieved through a 0.5µm sieve. As there were very sparse species present, a second sample was also processed, at another station at a distance of 5-10m.

Stations were selected at random across the width of the survey area. Notes were made on sediment characteristics, species were listed and their qualitative abundance recorded. Photographs were also taken for reference.

9.3.2.2. Benthic Ecology survey

Benthic ecology surveys were undertaken between the 25th and 27th of July 2017. Survey specifications were discussed and agreed with Natural England in advance via the DAS process (DAS/11138/204391). The full results of the geophysical and bathymetric survey are provided in **Appendix H**, whilst the results of the benthic ecology survey and intertidal phase 1 survey and provided in **Appendix I** and **Appendix J** respectively.

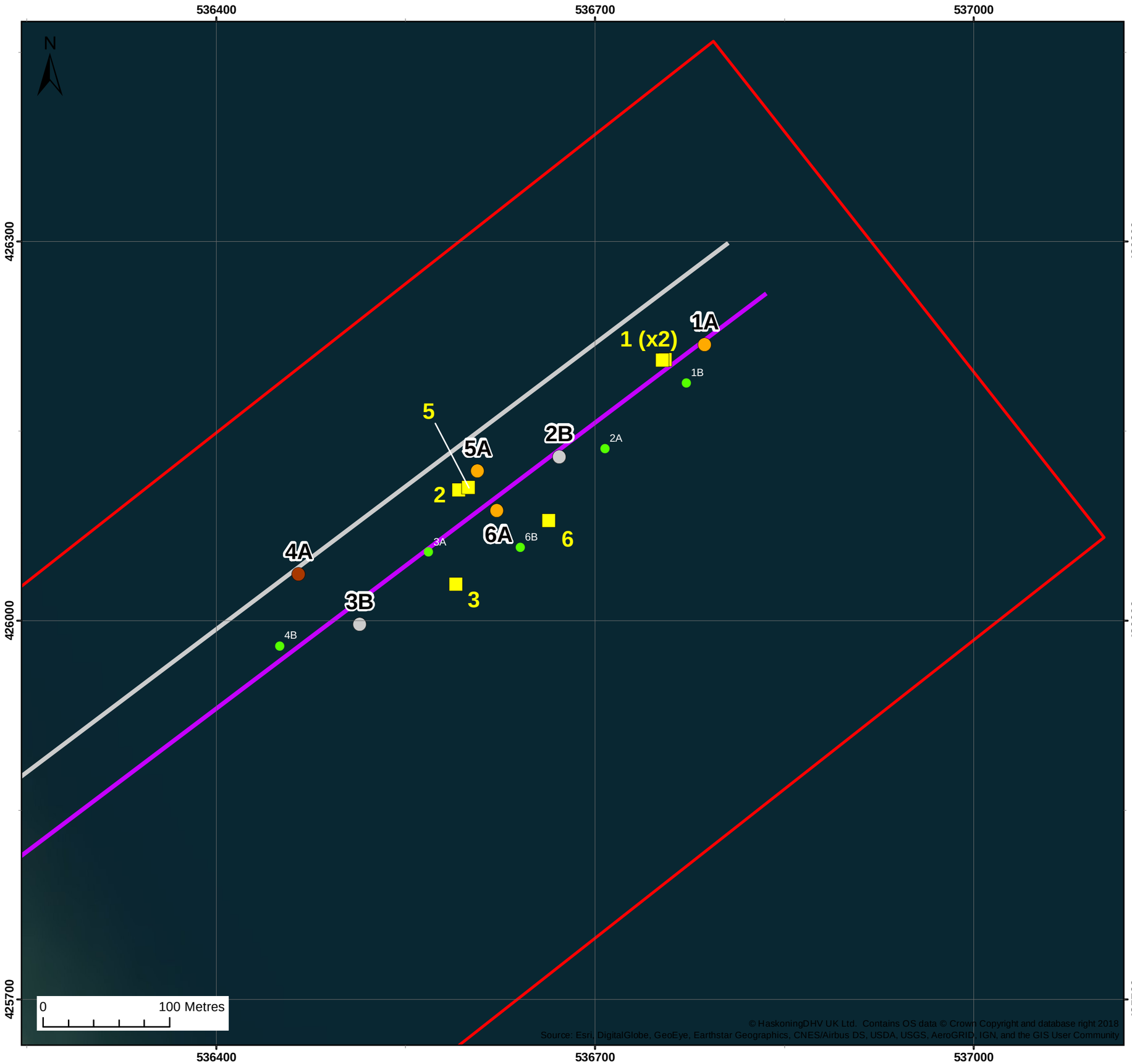
The survey specification consisted of six stations (shown in **Figure 9.1**), with two grab samples collected from each station using a mini-Hamon grab with a 0.1m^2 bucket area, where conditions allowed. Four stations were located within the proposed dredge area (Stations 1, 2, 3 and 6) and two stations (Station 4 and 5) were located to the north.

The survey was initially attempted using a Day grab but repeated failed grabs necessitated a switch to a mini-Hamon design more suited to collecting material from coarse ground. However, even with the Hamon grab, sufficient sediment could not be collected from Station 5 due to hard ground conditions.

A drop-down video survey was also conducted. The drop-down camera was deployed at six locations as close to the benthic sampling stations as possible. Clear images were not obtained from Station 4 and therefore video analysis, was not possible. The successful drop-down video locations are shown on **Figure 9.1**. The information obtained from the images was referenced against guidance on reef habitats (Gubbay, 2007; Irving, 2009; Limpenny *et al*., 2010).

9.3.3. Assessment of potential impacts

The methodology used to assess the significance of the potential environmental impacts associated with the proposed scheme is described in **Section 4**.



Legend

- Redline boundary
- Proposed outfall
- Existing outfall
- Successful drop down camera stations

Biotope (Grab sample locations with PSA results)

- SS.SMX.CMx
- SS.SCS.CCS.PomB
- SS.SMX
- Reserve grab sample locations

Client: Yorkshire Water Services	Project: Withernsea Marine Outfall (PB5063)

Title: **Benthic Survey**

Figure: 9.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	03/12/2018	TC	CG	A3	1:3,000

Co-ordinate system: British National Grid

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9.4. Existing environment

9.4.1. Intertidal benthic ecology

The Holderness Coast is a very dynamic and turbid environment, such that a significant sediment supply for Humber Estuary and Spurn Head comes from the Holderness coast (Natural England, 2018). More information on the Humber estuary EMS and the hydrodynamic and sedimentary regime is available in **Sections 6** and **Section 7** respectively.

The study area is made up of a long open beach of relatively mobile sediments, backed by soft, readily eroding cliff. Areas of cliff to the north and south of the proposed scheme are listed as Biodiversity Action Plan (BAP) priority habitat; Maritime cliff and slope. However, at its closest point to the north and south, this designation is within 350m and 1.5km respectively. Furthermore, an intertidal and coastal survey undertaken for the adjacent Withernsea Coastal Protection scheme (Royal HaskoningDHV, 2018) described these cliffs as not showing evidence of features representative of the BAP habitat. The intertidal Phase 1 survey also covered the cliffs which did not show evidence of representing the BAP habitat of maritime cliff and slope.

The study area overlaps with the recently designated Holderness Inshore MCZ. The designation covers an area of approximately 309 km^2 along the length of the Holderness Coast (Defra, 2016). The habitats protected within the MCZ are listed in **Section 6.4**.

An intertidal Phase 1 survey was carried out on the 23rd November 2017 to assess the marine and coastal species present and their relative abundance. The survey identified a relatively uniform and homogenous habitat within the survey area. The foreshore represented four distinct zones, referred to as the upper, mid, lower-mid and lower shores. The survey location and zones are shown in **Figure 9.2** below.

In most of the four zones the biotope was identified as barren littoral sand (LS.LCS.Sh.BarSa), with the upper shore recorded as barren littoral shingle (LS.LCS.Sh.BarSh). A description of these zones is presented in **Table 9.3**.

535800
536100
536400
425700
425400
N
0
100 Metres
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Proposed Scheme Boundary
- New LSO
- Existing LSO
- MHWS
- MLW

Ecology survey areas

- Upper shore
- Mid shore
- Lower mid shore
- Lower shore
- Clay lumps

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title: Intertidal ecological survey results

Figure: 9.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	CG	A3	1:2,500

Co-ordinate system: British National Grid

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Table 9.3 Classification of intertidal habitats (based on a 0.5µm sieve)

Biotope	Description	Photograph
Upper shore		
LS.LCS.Sh.BarSh	This zone consisted of cobbles, shingle and gravel overlaying a coarse sand. No benthic macrofauna or flora was identified in this zone, with sediments too coarse to pass through a sieve.	
Mid-shore		
LS.LCS.Sh.BarSa	Coarse to medium clean sand with occasional overlying shingle. Beneath the top 3cm layer of sand lies a coarser sediment layer of gravel, shingle and coarse sand. No benthic macrofauna or flora were identified.	
LS.LCS.Sh.BarSa	Dominated by medium sand, with some overlying shingle and gravel. There was no underlying layer of coarser sediment. No benthic macrofauna or flora were identified.	
Lower shore		
LS.LCS.Sh.BarSa	Along the low water mark, pebbles and stones are intermingled with the sand, and occasionally, ephemeral green algae (*Enteromorpha* spp.) was attached to these stones. There was no benthic macrofauna identified within this zone.	

Occasional green algae were found present on stones at the low shore mark, however, no other flora or fauna was present across the upper shore, mid-shore or lower mid-shore zones. The survey demonstrates a low ecological value of this intertidal area of the Holderness Inshore MCZ.

Although small areas of intertidal sand and muddy sand were identified in PSA results these are also considered to have low ecological value as no macrofauna were present.

9.4.2. Subtidal benthic ecology

Benthic ecology surveys were undertaken between the 25th and 27th of July 2017, in order to describe the habitats and species present within the proposed route for the LSO. The fauna found was mainly characterised by epifaunal organisms with relatively high abundances of barnacles and serpulid polychaetes, but also a number of colonial organisms such as hydroids and bryozoans. A description of the biotopes recorded at each survey station is provided in **Table 9.4** and shown in **Figure 9.1**.

The inshore zone of the survey area comprises sandy sediment according to the geophysical survey (**Figure 7.3**). However, it was not possible to position sediment survey stations within this area, due to vessel restrictions in this shallow depth.

Table 9.4 Description of subtidal biotopes found at survey stations (taken from JNCC, 2019))

Station	Biotope	Description
1	SS.SMX.CMx	Circalittoral mixed sediment Mixed (heterogeneous) sediment habitats in the circalittoral zone (generally below 15-20m) including well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand or gravel
2	SS.SCS.CCS.PomB	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles This biotope is characterised by a few ubiquitous robust and/or fast growing ephemeral species, which can colonise pebbles and unstable cobbles and slates which are regularly moved by wave and tidal action. The main cover organisms tend to be restricted to calcareous tube worms such as *Pomatoceros triqueter* (or *P. lamarcki*), small barnacles including *Balanus crenatus* and *Balanus balanus*, and a few bryozoan and coralline algal crusts. Scour action from the mobile substratum prevents colonisation by more delicate species. Occasionally in tide-swept conditions tufts of hydroids such as *Sertularia argentea* and *Hydrallmania falcata* are present.
3	SS.SCS.CCS.PomB	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
4	SS.SMX	Sublittoral mixed sediment Sublittoral mixed (heterogeneous) sediments found from the extreme low water mark to deep offshore circalittoral habitats. These habitats incorporate a range of sediments including heterogeneous muddy gravelly sands and also mosaics of cobbles and pebbles embedded in or lying upon sand, gravel or mud.
5	SS.SMX.CMx	Circalittoral mixed sediment
6	SS.SMX.CMx	Circalittoral mixed sediment

This aligns with the data held on the European Marine Observation and Data Network website (EMODNet)[1] which indicates that the habitats in the area of the proposed LSO are comprised of littoral coarse sediment (A5.13) and circalittoral coarse sediment (A5.14).

The biotopes described above in **Table 9.4** are characterised by impoverished fauna and dominated by fast-growing epifauna. These species will be subject to seasonal and sporadic cycles of scour through tide and storm action and so will be primarily opportunistic and ephemeral.

[1] *EMODNet data available here: https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/*

This biotope is considered to have a high recovery potential as following disturbance opportunistic species and communities would re-colonise this biotope where the underlying substratum remains the same in less than a year (Tillin and Tyler-Walters, 2016).

The drop-down video for Stations 1 and 5 showed some characteristics of rocky reef, which is not unexpected given the reasons for designation of the Holderness Inshore MCZ. Based on guidance from Irving (2009), much of the seabed in the survey area is of up to medium 'reefiness'. Images from the video survey are shown in **Appendix I** (within Appendix 5 of Niras, 2019), with an example of the images from Stations 1 and 5 shown in **Plate 9.1**.

Plate 9.1 Example seabed imagery from Station 1 (left) and Station 5 (right) (reproduced with permission from Niras, 2019)

The seabed features chart, compiled using the side-scan sonar and echo-sounder data, corroborates that the high reflectivity shown across the deeper zone of the survey area is most likely gravelly and rocky substrate (**Figure 7.3**). This is also evidenced by the fact that sediment samples across the area were frequently unsuccessful due to hard ground conditions and coarse substrate present.

Many of the grab samples suggested a dominance by epifaunal organisms which ground-truths the evidence from the geophysical investigation (see 'gravel with cobbles' area in **Figure 7.3**). Images of the grab samples taken are shown in **Appendix I** (within Appendix 3 of Niras, 2019) with an example of the images from Stations 1 and 5 shown in **Plate 9.2**.

The Ross worm, *Sabellaria spinulosa,* was present in very small numbers in samples from Station 2, 3, 5 and 6, but only as very small examples of encrusting colonies, and there was no evidence of reef-like aggregations within the survey area. The marine GI survey (geophysical and bathymetric survey) was conducted at the site in advance of the sediment quality and benthic ecology surveys. During the offshore survey, the side-scan sonar data was reviewed for any anomalies with potential to represent *Sabellaria* reefs. However, no such features were encountered. **Figure 7.4** illustrates the results of the side scan sonar data and highlights any anomalies of particularly high reflectivity. The side-scan sonar target listing is provided in **Appendix H** (on Figure B4).

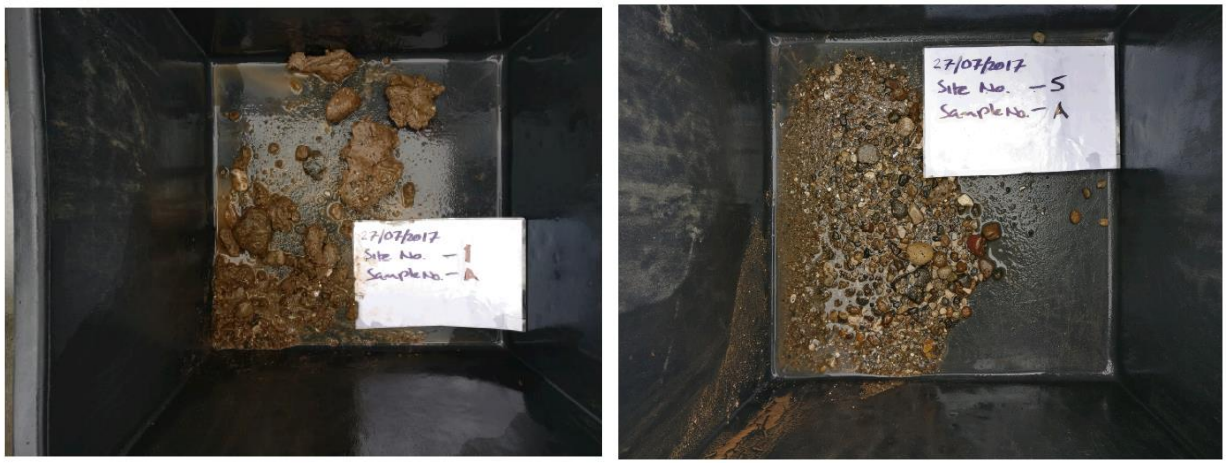


Plate 9.2 Example grab sample images from Station 1 (left) and Station 5 (right) (reproduced with permission from Niras, 2019)

9.4.3. Marine Mammals

9.4.3.1. Background

The topic of marine mammals has been scoped into this EIA, following comments received from the MMO within the EIA Scoping Response, "*…given anecdotal evidence of seal sightings on Withernsea beach itself, the MMO advise that impacts to marine mammals (particularly to grey seals, a feature of the Humber Estuary Ramsar, SAC, and SSSI) should be 'scoped in' for further assessment*".

Twenty-eight species of cetaceans (whales, porpoises and dolphins) have been recorded in British waters. Of these species, three have been frequently recorded in the Central North Sea (Reid *et al*., 2003); harbour porpoise, *Phocoena phocoena*; white-beaked dolphin, *Lagenorhynchus albirostris*; and minke whale, *Balaenoptera acutorostrata*. These species are also frequently recorded in inshore waters and are therefore have potential to be found within the vicinity of the proposed scheme.

Additionally, the two species of pinnipeds (seals) found in UK waters are regularly sighted within the Central North Sea gathering mostly around haul out and breeding sites: grey seal, *Halichoerus grypus*; and common seal, *Phoca vitulina*. Grey seal is a designated feature of the Humber Estuary SAC and also listed under 'Ramsar Criterion 3' for the Humber Estuary Ramsar site. The Humber Estuary supports a breeding colony of grey seals at Donna Nook, to the south of the estuary. Therefore, grey seal in particular has the potential to be found in the vicinity of the proposed scheme.

9.4.3.2. Harbour porpoise

The harbour porpoise is the most common cetacean species in UK waters. The latest survey conducted by the 'Small Cetaceans in European Atlantic waters and the North Sea' survey (SCANS) is from 2016 (SCANS-III). The relevant block in SCANS-III for the proposed scheme is

block O, covering the central North Sea adjacent to the UK coast (**Figure 9.3** below). The abundance of harbour porpoise within Block O was 53,485 individuals and an abundance of 0.888 animals/km^2 (Hammond *et al*., 2017).

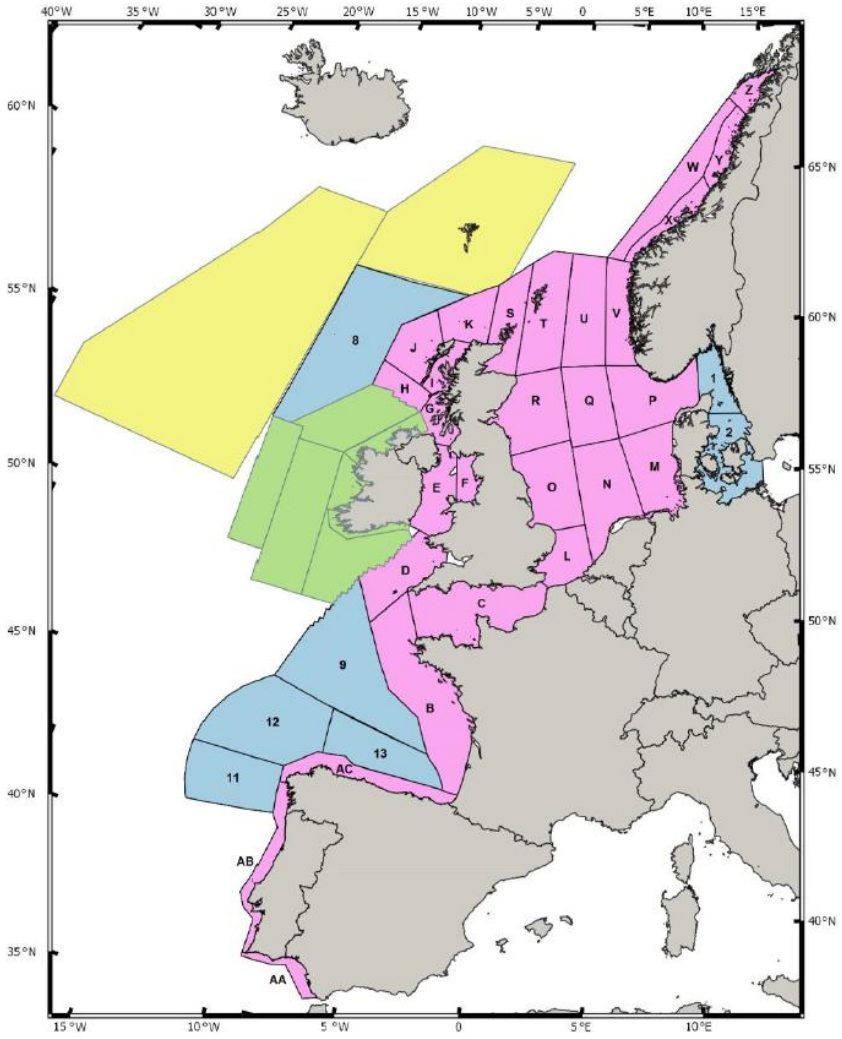


Figure 9.3 *Areas covered by SCANS III Surveys. Block O covers the proposed scheme (Hammond et al., 2017).*

9.4.3.3. White Beaked Dolphin

The white-beaked dolphin is the most abundant dolphin species found in the North Sea and they are commonly sighted in the central part of the North Sea (Hammond *et al*., 2002). White-beaked dolphins are regularly observed in coastal waters during the summer months which overlaps with their calving season (Canning *et al*., 2008). The abundance of white beaked dolphin within Block O was 143 individuals with a density of 0.002 animals/km^2 (Hammond *et al*., 2017).

9.4.3.4. Minke Whale

The minke whale is the most commonly recorded baleen whale species in the North Sea, found in coastal waters and pelagic waters (Reid *et al*., 2003). They mainly feed in shallower water over the continental shelf. Minke whales will occasionally come close to land, entering estuaries, bays and inlets (SNH, 2015). The abundance of minke whales within Block O was 603 individuals with a density of 0.010 animals/km^2 (Hammond *et al*., 2017).

9.4.3.5. Grey Seal

The UK grey seal population is approximately between 116,500 and 167,100, representing approximately 34% of the world population and 82% of the European population (SCOC, 2017). The majority of breeding sites of grey seals in Europe are located along the UK coastline, with major breeding colonies occurring on the east coast of England, the Orkney Islands, north Scotland, and Inner and Outer Hebrides (Jones *et al*., 2011).

The Humber Estuary supports a breeding colony of grey seals at Donna Nook. It is the second largest grey seal colony in England and is the furthest south regular breeding site on the east coast (RIS, 2007). Breeding season for grey seal along the east coast is typically throughout autumn and parts of winter (October – December). Grey seal haul out during the breeding season as new born pups cannot swim.

9.5. Potential Impacts

9.5.1. Scope of assessment

The terrestrial aspects of the works (Withernsea WwTW, rising mains and terrestrial section of the LSO) will have no effect on marine ecology receptors within the study area of the proposed scheme during construction, operation and decommissioning due to their siting landward of the 100-year predicted erosion line of the cliffs. This assessment of potential effects therefore relates to the intertidal and subtidal sections of the LSO only.

9.5.2. Prediction of potential effects during construction

9.5.2.1. Direct disturbance to subtidal habitats

The trenched length of the LSO will be approximately 1km, from the connection pit at low water, to the discharge point, within 50m south of the existing LSO discharge point. The footprint of the trench is 0.024km^2. During the construction phase of the proposed scheme there will be a temporary disturbance to benthic habitats during trenching activities for the replacement LSO. Approximately 50,000 m^3 of dredged sediment from the lower intertidal zone and subtidal zone will be excavated and side-cast, then reused as fill following installation of the pipe.

The subtidal habitat which will be temporarily disturbed is characterised as mixed sediments with impoverished fauna, dominated by fast-growing epifaunal species considered to have a high

recovery potential following disturbance. The benthic habitats likely to be disturbed are typical of the wider coastline at Withernsea and are not limited to the footprint of temporary disturbance.

According to the Marine Life Information Network (MarLIN), the biotope recorded within the footprint of the proposed scheme (SS.SCS.CCS.PomB) is characterised by highly resistant fauna. Bryozoans, *Balanus crenatus* and *Spirobranchus triqueter* are rapid colonizers and likely to recover quickly (MarLIN, 2019a). The biotope's sensitivity to the direct physical pressures likely to be experienced during dredging is presented in **Table 9.5**.

Table 9.5 SS.SCS.CCS.PomB sensitivity to direct physical pressures during proposed scheme construction (MarLIN, 2019a)

Physical Pressures	Resistance	Resilience	Sensitivity
Habitat structure changes – removal of substratum (extraction)	None	High	Medium
Abrasion/disturbance of the surface of the substratum or seabed	Low	High	Low

The species present are epifauna occurring on the cobbles and pebbles that characterize this biotope (Connor *et al*., 2004). Removal of the substratum would remove both the habitat (cobbles and pebbles) and therefore the characterising, attached species. In areas where large amounts of gravel have been extracted, *Balanus crenatus* has been observed to rapidly recolonize within months (Kenny and Rees, 1996). However, the substrates in this case are not being removed, only side-cast, which would likely represent the abrasion/disturbance of the surface of the substrate, recorded within the table below as low sensitivity.

The decommissioning of the existing LSO within the subtidal zone will lead to limited disturbance during removal of the existing diffuser, protection dome, and associated scour protection, through disturbance of sediments surrounding the structures and direct removal of any species that have colonised the structure. The species that are likely to have colonised the existing diffuser and protection frame are likely to be similar to those recorded within the subtidal footprint of the proposed LSO, due to the similar sediment types at the existing diffuser. Due to the smooth concrete material used for the diffuser dome, it is unlikely that this will support a high density of colonising flora and fauna. Furthermore, the presence of the diffuser dome removes the potential for colonisation of the diffuser. Decommissioning will require only the removal of some of the scour protection, limited to that which lies immediately adjacent to the diffuser. Any colonisation will be very localised and limited to the benthic communities within the scour protection and on top of the structures.

The footprint of disturbance is within the Holderness inshore MCZ which covers the subtidal zone, up to 3nm offshore. Impacts to Holderness MCZ have been considered within the MCZ assessment in **Section 16**. The MCZ assessment concluded that the proposed new LSO replacement at Withernsea, and the decommissioning of the existing LSO, will not result in a significant risk to the conservation objectives for the Holderness Inshore MCZ.

Although the proposed scheme lies within the Holderness Inshore MCZ, the overall receptor sensitivity is deemed to be **medium** for the reasons outlined above**.**

Given the substrate within the study area is predominantly coarse gravel and cobbles, the substrate utilised as the scour protection would not be unique in the context of this background. This provides a high availability of alternative hard substrate, more suitable for benthic species. Overall, the magnitude of direct disturbance is considered to be **low**.

Due to the low magnitude of impact and medium receptor sensitivity any impacts to benthic communities resulting from direct disturbance due to dredging during the construction phase is considered to be of **minor adverse** significance, with recovery of benthic communities expected following construction activities.

Mitigation measures and residual impact

It is recognised that the marine elements of the proposed scheme would have a temporary impact on biodiversity that is unavoidable during the trenching activities, although this is not predicted to represent a significant effect due to the low ecological diversity of the species present and the expected rapid recovery of those found.

There are no further measures that can be adopted to minimise the impact, and therefore the residual impact is considered to be of **minor adverse**.

9.5.2.2. Direct disturbance to intertidal habitats

Within the construction phase of the proposed scheme there will be a temporary disturbance to intertidal habitats during trenching activities for the replacement LSO in the lower intertidal zone, comprising the temporary cofferdam and trench for the connection of the HDD/micro-tunnelling and subtidal sections. However, the installation of the LSO within the majority of the intertidal zone (above MLW) will be by trenchless solution (either HDD or micro-tunnelling) running approximately 7m and 4m beneath the surface of the beach, thereby avoiding impacts to the foreshore.

The construction works include the excavation of the trench for the LSO and the installation of a cofferdam. The cofferdam will be installed using a vibro-piling technique due to the nature of the substrate on the foreshore. The temporary cofferdam would be excavated and sheet piles installed. The trench will be approximately 30m long by 6m wide and 3.5m deep generating approximately 630m^3. This material will be side-cast and reinstated upon removal of the cofferdam, as per the methodology for the subtidal works.

Additionally, to link the pipe at the end of the HDD/micro-tunnelled section to the subtidal pipe section, a trench of up to 100m located between the cofferdam and the low water limit of marine dredging equipment (i.e. backhoe or cutter suction dredger) will be excavated by tracked land-based hydraulic excavators. The temporary cofferdam could also be required to accommodate this trench around the connection point and to provide protection against sedimentation of this trench section during construction. The trench around the connection point will be approximately 100m long, 3.5m wide and 3m deep, generating approximately 1,050m^3.

Foreshore areas adjacent to the trench location and where material will be side-cast may be subjected to temporary smothering by placement of the excavated sediment. Materials are expected to be reused as fill within one month therefore any impacts will be short-term and reversible and would not result in a permanent loss of benthic habitat, which would be expected to recover rapidly.

The decommissioning of the existing LSO will lead to limited disturbance during the removal of the intertidal section of the foreshore. The removal of the rock bags, comprising the temporary pipe protection works are covered under licence, L/2017/00420/3. The existing LSO section from the toe of the cliff to the exposed chamber on the foreshore shall be removed. The approximate length of this section of existing pipeline is 100m. The redundant ends of the outfall at the foreshore and the offshore end shall be capped with suitable grout/concrete, or similar approved material. Areas of the foreshore immediately surrounding the existing LSO will be excavated to enable removal of the LSO. This will be reinstated following removal, with suitable infilling material to be utilised if required.

The intertidal habitat which will be temporarily disturbed is characterised as mixed sediments with impoverished fauna, dominated by fast-growing epifaunal species considered to have a high recovery potential following disturbance. The habitats likely to be disturbed are typical of the wider coastline at Withernsea and are not limited to the footprint of temporary disturbance.

The footprint of disturbance is within the Holderness inshore MCZ which covers the subtidal zone, up to 3nm offshore. Impacts to Holderness MCZ have been considered within the MCZ assessment in **Section 16**. The MCZ assessment concluded that the proposed new LSO replacement at Withernsea, and the decommissioning of the existing LSO, will not result in a significant risk to the conservation objectives for the Holderness Inshore MCZ.

An intertidal ecology survey was carried out in order to describe the habitats and assign biotopes present within the proposed works area. The only biotopes recorded were barren littoral shingle and barren littoral sand. This biotope has a relatively low ecological value and is not considered to be representative of the intertidal sand and muddy sand habitat described and protected within the Holderness Inshore MCZ.

Therefore, despite being within the boundary of the MCZ the sensitivity of the benthic habitats is considered to be **medium** due to the low ecological value of those within the footprint of the works. Due to the temporary and short-term nature of the works, the magnitude of the effect is considered to be **low**, resulting in a **minor adverse** impact on the intertidal habitats.

Mitigation measures and residual impact

Installation of the LSO across the inter-tidal zone by means of a trenchless solution (either HDD or micro-tunnelling) will inherently minimise the potential disturbance as far as is practicably achievable.

It is recognised that the trenching elements of the proposed scheme would have a temporary impact that is unavoidable during the cofferdam and connection pit activities, although this is not predicted to represent a significant effect due to the low ecological diversity of the species present and the expected rapid recovery of those found.

The residual impact would be **minor adverse**.

9.5.2.3. Impacts to benthic communities due to increases in suspended sediment

There is potential for sediment to be mobilised into the water column during trenching and other construction activities that may disturb the seabed, leading to increases in SSC. Increases in SSC can cause interference with feeding or respiratory apparatus of some benthic species. Additionally, benthic communities adjacent to the trench location and where material will be side-cast may be subjected to temporary smothering by placement of the excavated sediment.

During the dredging activity, sediments will be side-cast either side of the trench. The preferred methodology for dredging would be by backhoe, however if the nature of the seabed requires (i.e. consolidated clays), a cutter suction dredger would be required. A cutter suction dredger is a stationary dredger, equipped with a rotating cutter head. Clay would be extracted by means of dredge pumps, broken into smaller fragments, and discharged either side of the trench. Due to the nature of the material within the scheme footprint (predominately gravel and clay), this would not be expected to cause significantly higher turbidity than a backhoe dredger.

The side-cast sediment will be used to backfill the trench in the lower intertidal and subtidal zones, on completion of the installation of the LSO. Backfilling will occur immediately once the trench has been completed, however, until this point, side-cast sediments may remain in position for a short duration. Within the intertidal zone, side-cast material will be stored adjacent to the trench, in the upper intertidal zone, to minimise disturbance by tidal movements and wave action. With increasing water depth and reduced effects of wave action, suspension of the side-cast materials will be minimal. In shallower areas, increased agitation by waves may cause infilling of the trench, which will be re-dredged where necessary prior to LSO installation. Materials are expected to be reused as fill within one month therefore any impacts will be short-term and reversible and would not result in a permanent loss of benthic habitat.

The Holderness coastline is known to be particularly mobile, with the coastal waters consequently being highly turbid with high levels of suspended sediment. As described in **Section 7**, the supply of sediment from erosion of the Holderness cliffs and shore platform is over 3M m^3/year (Balson *et al*, 1998). The naturally high suspended sediment concentrations are exacerbated by weather conditions, with storm conditions transporting additional volumes sediments into coastal waters. Within the proposed scheme footprint, the sediments recorded during surveys were predominantly shingle, pebbles and stones intermingled with sand in the intertidal, and in the subtidal circalittoral mixed sediment and sublittoral mixed sediment were recorded.

As set out in **Section 7.5** some of this sediment will be suspended in the water column during construction activities. However, these effects will be temporary and the increases are likely to be

well within the range of values exhibited naturally, especially when sediment is mobilised during storm events. Furthermore, dredging in the subtidal zone will be relatively short-term in nature (occurring over a period of approximately two months), and in predominantly coarse mixed sediments. The volumes involved, in the context of the baseline conditions, will not lead to measurable increased in sediment deposition. Therefore, the impact is considered to be **low**.

The results from the sediment contamination analysis (**Section 8**) showed that no contaminants were recorded above CEFAS AL 1 or the CSQG PEL. Therefore, **no impacts** from contaminated sediments to benthic ecology are expected to occur due to the dredging required during the construction phase.

According to MarLIN, the biotope recorded within the footprint of the proposed scheme (SS.SCS.CCS.PomB) is characterised by highly resistant fauna. Bryozoans, *Balanus crenatus* and *Spirobranchus triqueter* are rapid colonizers and likely to recover quickly (MarLIN, 2019a). The biotope's sensitivity to the indirect physical pressures likely to be experienced during dredging is presented in **Table 9.6**.

Table 9.6 SS.SCS.CCS.PomB sensitivity to potential indirect physical pressures during proposed scheme construction (MarLIN, 2019a)

Physical Pressures	Resistance	Resilience	Sensitivity
Changes in suspended solids (water clarity)	High	High	Not sensitive
Smothering and siltation rate changes (light)	High	High	Not sensitive
Smothering and siltation rate changes (heavy)	Medium	High	Low

This biotope occurs in scoured habitats and it is likely, depending on local sediment supply, that the biotope is exposed to chronic or intermittent episodes of high-levels of suspended solids as local sediments are re-mobilised and transported (MarLIN, 2019a). A significant increase in suspended solids may result in smothering where these are deposited, however, this is not predicted to occur as a result of the proposed scheme. The biotope occurs in shallow waters where light attenuation due to increases in turbidity is probably low and the characterizing animals are unlikely to be affected by increased or decreased clarity (MarLIN, 2019a).

The benthic communities with the potential to be impacted by suspended sediment are typical of the wider coastline at Withernsea and not limited to the area where increases in SSC will be encountered. Additionally, the communities are impoverished and considered to have high recovery potential following disturbance. Therefore, receptor sensitivity is considered to be **low**.

Due to the low magnitude of impact and low receptor sensitivity any impacts to benthic communities resulting from increases in SSC during the construction phase are considered to be **negligible**.

As stated in **Section 9.5.2.1**, although the proposed scheme is within the boundary of Holderness Inshore MCZ, the habitat present has a relatively low ecological value and is not considered to be representative of the intertidal sand and muddy sand habitat described and protected within the

Holderness Inshore MCZ. Therefore, despite being within the boundary of the MCZ the significance of increases SSC to benthic habitats is still considered to be **negligible**.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible**.

9.5.2.4. Impacts to marine mammals from underwater noise

Marine mammals utilise sound in a number of ways, including to navigate, feed and to socially interact. Marine mammals are sensitive to underwater noise and vibration; therefore, the proposed scheme has the potential to disturb any marine mammals that may be present in the area during the construction phase. Typically, noisy construction activities that are most likely to disturb marine mammals include dredging and pilling.

Dredging and pilling are both required during construction, however piling will be undertaken at low water only (i.e. in dry conditions). Therefore, underwater noise from piling activities will not be generated and no impacts upon marine mammals from piling will occur.

The auditory sensitivity of marine mammals is dependent on a number of factors including species, age, habituation and sensitisation. Additionally, it is dependent on the type of noise generated such as the frequency and duration (Southall *et al*., 2007).

Sounds emitted during dredging are generally of a low frequency, mainly being emitted below 1000Hz (Thomsen *et al*., 2009; Todd *et al*., 2015). Examples of the hearing ranges of various marine mammal species is provided in **Table 9.7**.

Table 9.7 Example hearing ranges from marine mammals (Southall et al., 2007)

Functional Hearing Group	Relevant species	Estimated Auditory Bandwidth
Low frequency cetaceans	Minke whale	7Hz to 22kHz
Mid frequency cetaceans	White-beaked dolphin	150 Hz to 160 kHz
High frequency cetaceans	Harbour porpoise	200 Hz to 180 kHz
Seals in water	Grey seal	75 Hz to 75 kHz
Seals in air	Grey seal	75 Hz to 30 kHz

The estimated auditory bandwidth of marine mammals with the potential to be present overlaps with dredging frequencies, therefore receptor sensitivity is considered to be **medium**.

As outlined in **Section 9.4.3**, there is potential for marine mammals to be present in the vicinity of the proposed works during construction, however as marine mammals are mobile they would be expected to be transitory visitors along the Withernsea coast. A breeding site for grey seals is located at Donna Nook, however this is approximately 30km from the proposed scheme on the southern side of the Humber estuary mouth.

Dredging required during the construction phase will be of short-term duration over a period of approximately two months, though dredging activities will not be continuous throughout this period. Therefore, the impact significance with regards to noise is determined to be **low**.

Due to the limited likelihood of marine mammals being present within the vicinity of the proposed scheme during the construction phase (but a **medium** sensitivity), and the relatively short-term nature of the activities proposed (**low** magnitude), a potential impact of **minor adverse** significance is predicted.

Mitigation measures and residual impact

There are no further measures that can be adopted to minimise the impact, and therefore the residual impact is considered to be of **minor adverse**.

9.5.3. Prediction of potential impacts during the operational phase

Once the replacement LSO is in use there will be little to no operational activities required for maintenance. The new LSO will be buried, similar to the current LSO, with only the diffuser protection dome positioned above the seabed surface.

The discharge of wastewater from the new LSO will be a consented discharge as agreed with YWS and the Environment Agency. Given the thorough treatment process and the likely discharge effluent and rates within the allowed discharge consent, no impacts are predicted on the baseline environment.

The benthic communities present are typical of the wider coastline at Withernsea and are considered to have high resistance to disturbance. Therefore, receptor sensitivity is considered to be **low**. Given the quality of the discharge likely to be required by the discharge consent, to be granted by the Environment Agency, the magnitude of the impact is **low**. Consequently, the potential impact is assessed as being of **negligible** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible**.

9.5.4. Prediction of potential impacts during decommissioning

The existing LSO will be decommissioned and partially removed following the completion of the new LSO. It is likely that this will follow the same decommissioning activities as required for the existing LSO. This will involve the removal of the diffuser, diffuser dome, diffuser protection frame and some localised scour protection, as well as removal of the intertidal section of the existing LSO from the chamber on the foreshore up to the cliff-line. The remaining terrestrial and subtidal sections of pipeline will be capped at both ends and left *in situ*.

The removal of these elements will cause short-term, local resuspension of sediment which is not expected to be above natural background levels of suspended sediment, and impacts associated

with this are expected to be no more significant than those from the construction phase. Specifically, impacts to benthic ecology are predicted to be of negligible significance and impacts to intertidal ecology and marine mammals are predicted to be of minor significance. An appropriate decommissioning plan will be developed prior to decommissioning.

Decommissioning of the new LSO is expected to take place in 60 years following commissioning of the LSO. An appropriate decommissioning plan will be developed at the time and a subsequent marine licence sought.

9.6. Summary of Impacts

The potential impacts on marine ecology are summarised in **Table 9.8** below.

Table 9.8 Summary of impacts on Marine and Coastal Ecology

Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase – Benthic Ecology			
Temporary disturbance	Minor adverse	None required	Minor adverse
Increases in SSC	Negligible	None required	Negligible
Construction Phase – Intertidal Ecology			
Temporary disturbance	Minor adverse	None required	Minor adverse
Construction Phase – Marine Mammals			
Underwater noise	Minor adverse	None required	Minor adverse
Operational Phase			
Impacts from water quality changes	Negligible	None required	Negligible
Decommissioning Phase – Benthic Ecology			
Temporary disturbance	Negligible	None required	Negligible
Increases in SSC	Negligible	None required	Negligible
Decommissioning Phase – Intertidal Ecology			
Temporary disturbance	Minor adverse	None required	Minor adverse
Decommissioning Phase – Marine Mammals			
Underwater noise	Minor adverse	None required	Minor adverse

10. Fish and Fisheries

10.1. Introduction

This section of the ES describes the baseline environment in relation to Fish and Fisheries, specifically fish and shellfish resource and local commercial fisheries. An assessment of potential impacts to fish and fisheries from the construction, operation and decommissioning of the proposed scheme are described. Appropriate mitigation measures are also provided along with an assessment of any residual impacts.

Potential impacts of the proposed scheme on water and sediment quality, ecology species (including marine mammals) and marine ornithological interests are addressed in **Section 8**, **Section 9** and **Section 11** respectively.

10.2. Consultation

Table 10.1 provides a summary of the comments received from the MMO within its Scoping Opinion received in November 2018 (**Appendix E**), as well as identifying the relevant section of this ES where the comment has been addressed. Specific comments from Cefas, submitted to the MMO during the consultation period for the EIA Scoping Request, have also been included.

Table 10.1 Consultation Responses

Consultee	Comment	Response / where addressed in the ES
MMO	The MMO note that the Scoping Report correctly acknowledges that the development is situated within a herring spawning ground. However, based on the information provided, it is unclear as to whether impacts to herring will be assessed at the species level. The MMO therefore advise that impact assessments to herring at the species level be considered within the ES. Impact assessments to herring species must be informed by habitat requirements and available stock statistics for herring at the species level.	Noted, impacts have been addressed at species level where relevant in **Section 10**
MMO	Herring are acoustically sensitive to noise and vibration and are therefore vulnerable to the impacts of construction activities (e.g. piling and dredging). The spawning season for Central North Sea herring is between August and October. If the works are likely to overlap with the herring spawning season, the MMO advise that the ES must demonstrate that underwater noise and vibration will not propagate into herring spawning grounds. Such considerations must be supported by suitable underwater noise assessments or modelling.	Noted, included in **Section 10**, however, note that piling will be undertaken in the dry, on the foreshore and therefore no pathway for effects of underwater noise on herring
MMO	Further to the points raised in paragraphs 4.6.2 and 4.6.3, the MMO advise that impacts to other fish species with sensitivities to construction activities (e.g. piling and dredging) must also be considered within the ES.	Noted, included in **Section 10.6.1**
Cefas	Consultation with local shellfishers would provide the best evidence base for establishing an accurate environmental baseline and reducing uncertainty in impacts upon shellfish. Liaising with shellfishers will better inform the EIA with regard to understanding fleet behaviours and their understanding of stock dynamics.	Noted – attempts have been made to make contact with a local fishing group with regard to the proposed scheme, but no information was received at the time of writing this ES. Information was provided by Holderness Coast FLAG in

Consultee	Comment	Response / where addressed in the ES
		advance of Withernsea Coastal Defence project (2018).
Cefas	With the habitat requirements and stock advice for herring taken into consideration, we recommend that the impacts of noise from piling, and disturbance from dredging to herring are assessed at species level, and suitable mitigation proposed if necessary. Whilst I acknowledge that the works are small in scale, the site is situated in one of the key herring spawning grounds in the Central North Sea (CNS). The spawning season for CNS herring is between August to October, so suitable timing of works in the marine environment to avoid the herring spawning season is one form of mitigation. If works are likely to overlap with the herring spawning season, then the applicant must be able to demonstrate that underwater noise and vibration will not propagate into the herring spawning grounds.	Impacts on herring addressed at species level in **Section 10.6.1.**

10.3. Methodology

10.3.1. Study area

For fish and fisheries, the study area comprises the likely maximum extent over which potentially significant environmental impacts of the proposed scheme may occur. This has been informed by the hydrodynamic and sediment dispersion modelling and is based on the maximum extent over which effects are predicted to occur (e.g. sediment plumes generated during capital dredging and effects on tidal currents during operation). As suggested within **Section 7**, these are expected to be minimal. As such, the study area within which effects on fish and fisheries is assessed, is presented in **Figure 8.1**.

10.3.2. Data sources

The description of the existing environment with regards to fish and fisheries has been informed through desk-based review of fisheries statistics, through communication with North East Inshore Fisheries and Conservation Authority (NEIFCA) and through consultation with the Holderness Coast Fisheries Local Action Group (FLAG). A full list of data sources is presented in **Table 10.2**. The MMO scoping response also provided information on the current fishing practices.

Table 10.2 Data Sources

Data	Year	Coverage	Notes
MMO Landings data	2013 – 2017	UK-wide	Provides summaries of fishing activity for UK commercial vessels landing into the UK
Shellfish Survey of Bridlington Bay (PMSL, 2013)	2011	Holderness Coast	Surveys for crustacean species and other benthos in relation to the inshore cable corridor for the Dogger Bank Creyke Beck projects.
Spawning and nursery ground areas (Ellis *et al.*, 2012)	2012	UK-wide	Provides a high-level overview of likely spawning and nursery grounds of commercial fish species in UK waters.
NEIFCA	2018	NE Coast	Information on fishing fleets and activity.

Data	Year	Coverage	Notes
Holderness Coast FLAG	2018	Holderness Coast	Data collected by FLAG directly from the fishermen, in preparation for the Withernsea Coastal Defence project
UK government fishing fleet registry	2018	UK-wide	Provides information on registered home ports of under 10m and 10m plus fishing vessels, updated monthly.
EU Community Fleet Register	2018	EU	Provides details of the primary and secondary fishing gear registered by fishing vessels.
Vessel Monitoring System data	2016	UK	All EU fishing vessels that are ≥12m in length are required to have VMS on board. It should be noted that there are limitations associated with this data: • VMS does not provide information on vessels <12m in length • VMS does not distinguish between the activity of the vessel (i.e. if it is actively fishing, steaming or stationary) • VMS reporting frequency is every 2 hours and a vessels location between these reports is unknown. • VMS cannot provide information on weight or value of catch taken at a given location

10.4. Existing Environment

10.4.1. Fish Ecology

Lee and Ramster (1981) compiled an atlas of the seas around the British Isles, illustrating the spawning grounds of several commercial fish species. Subsequently, a collaborative project between numerous parties aimed to provide broad scale maps of the sensitive habitats of marine fish in UK waters (Coull *et al*., 1998). Since production of the broad scale maps, further survey and study has been undertaken, which has led to some of the maps produced by Coull *et al*., 1998 being updated by Ellis *et al*., 2012.

A review of the latest information on spawning and nursery grounds of selected fish species in UK waters (provided by Ellis *et al*., 2012) has therefore been undertaken to inform the sensitivity of the study area for such activities. The location of the proposed scheme overlaps with nursery grounds for plaice *Pleuronectes platessa*, lesser sandeel *Ammodytes tobianus*, cod *Gadus morhua,* herring *Clupea harengus* and whiting *Merlangius merlangus*. It should be noted that all of these species have extensive nursery grounds which encompass most of the North Sea (Ellis *et al.* 2012).

The location of the proposed scheme overlaps with spawning grounds for plaice, lesser sandeel, sole *Solea solea* and herring spawning grounds (Ellis *et al.* 2012). Detail regarding the spawning season of these species is provided in **Table 10.3** (sourced from Ellis *et al*., 2012).

Table 10.3 Spawning season for species which use the Hartlepool ICES rectangle for nursery grounds

Species	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Plaice												
Herring												

Species	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Lemon sole												
Lesser sandeel												

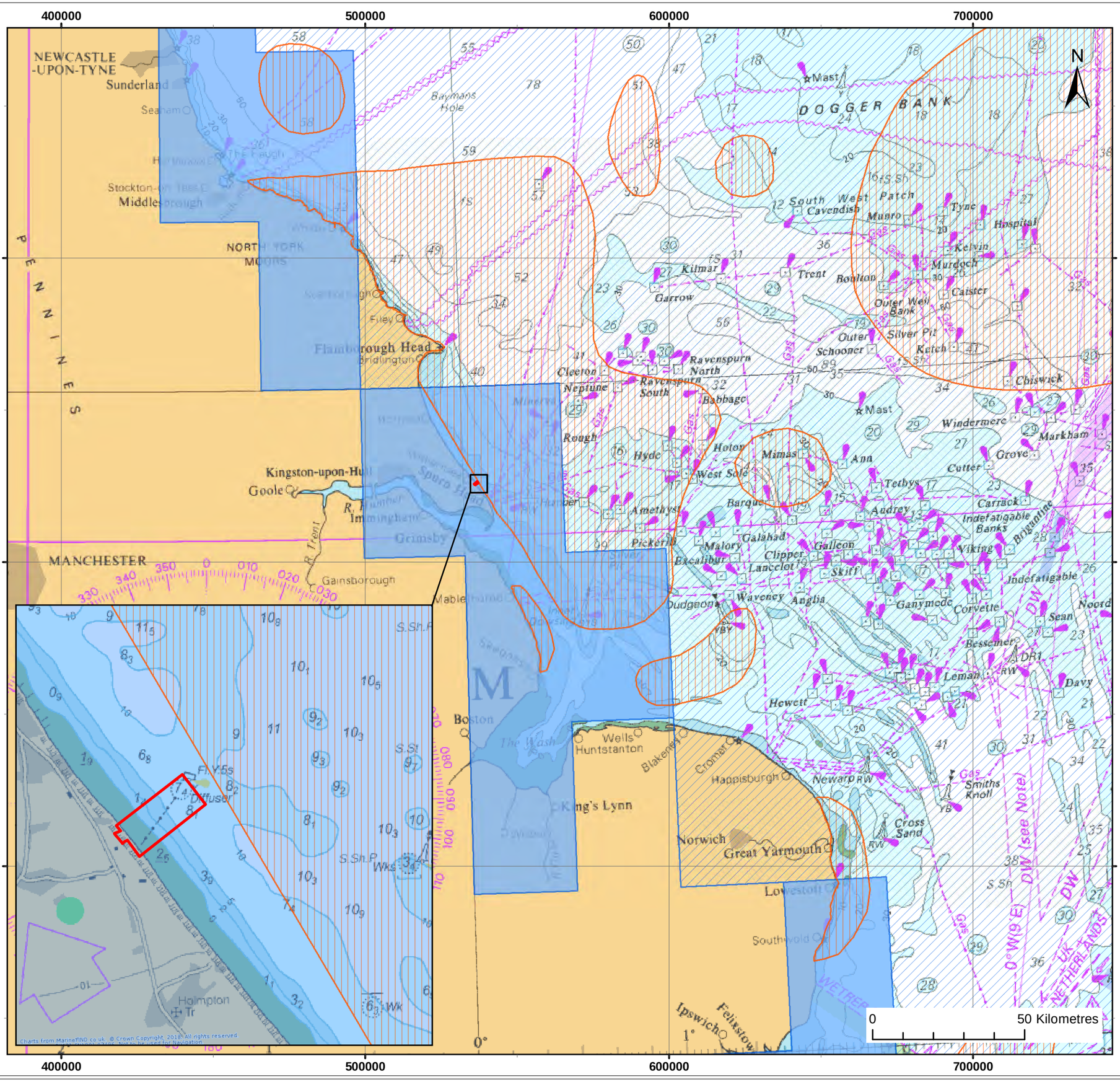
Within the EIA Scoping Opinion, the MMO highlighted the potential for impacts on herring spawning and nursery grounds, in particular. The location of these are shown in **Figure 10.1**. Herring are widely distributed throughout the north-west and north-east Atlantic, with adults generally restricted to within the 100m depth contour. Herring utilises estuarine habitats as nursery grounds. Juveniles are found along the east coast of England, generally remaining for up to two years in nursery grounds before joining adult fish migrations. Herring produce eggs which attach to coarse gravel and stony substrate, with spawning occurring in small discrete areas where there is a low proportion of fine sediment and well-oxygenated water (Ellis *et al.* 2012).

The Holderness Inshore MCZ is also designated for habitats which support fish species such as dab *Limanda limanda*, European eel *Anguilla anguilla* and wrasse *Labrus spp*., as well as commercially significant crustaceans. Shellfish surveys of the Holderness Coast suggested that the most prevalent species are brown crab *Cancer pagurus*, velvet swimming crab *Necora puber* and lobster *Homarus gammarus* (PMSL, 2013). Migratory species including eel, salmon *Salma salar* and sea trout *Salma trutta*, are not targeted commercially; there have been no landings of any of these species from the ICES rectangles in the period 2013 – 2017.

10.5. Commercial Fisheries

There are no designated Shellfish Protected Areas within the study area. The site is located within inshore fishing grounds, with the primary fishing method from Withernsea being potting for crabs and lobster, between April and September. Fishing effort tends to shift further inshore over the new shelling period for lobsters (July to September). During the bass season (late spring through to early autumn), vessels with authorisation to catch bass will do so (NEIFCA, *pers. comm., 2018*). During winter months, some vessels will also target cod and whelks. NEIFCA byelaws and emergency byelaws impose restrictions on the use of bottom-towed gear (trawling and dredging) along the Holderness coast (NEIFCA, 2019).

There are over 70 registered fishing vessels along the Holderness coast, although the inshore fishery from Withernsea is relatively small in scale, with only five to nine vessels registered each year. Communication with NEIFCA has identified that there are currently six vessels operating out of Withernsea, all of which also land their catches there (NEIFCA, *pers. comm., 2018*). According to the most recent updates to the UK government's fishing fleet registry and the EU Community Fleet Register, all vessels operating out of Withernsea are under 10m in length and list static gear such (i.e. pots and traps) as the primary gear. Withernsea-based vessels are beach-launched (NEIFCA, *pers. comm., 2018*).



Legend

- Proposed Scheme Boundary
- Spawning grounds (Coull *et al.* 1998)
- High intensity nursery grounds (Ellis *et al.* 2010)
- Low intensity nursery grounds (Ellis *et al.* 2010)

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title:

Spawning and Nursery Grounds for Herring

Figure: 10.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	CG	A3	1:1,250,000

Co-ordinate system: British National Grid

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Despite the small fleet size, an average of approximately 20 tonnes of lobster, with a value of ~£140k to over £260k, is landed at Withernsea annually (**Table 10.4**), most of which is bought by merchants in Bridlington and Scarborough (NEIFCA, *pers. comm*., 2018) Small-scale netting and angling also occurs for flatfish, bass, whiting and cod which are often caught in the winter; however, as boats launch from the beach fishing is often restricted by the weather. Advice from local fishers sought during the environmental screening for the Withernsea Coastal Defence works suggested that the fleet are capable of operating out to a distance of 8 nautical miles (nm) from shore (Royal HaskoningDHV, 2018).

Table 10.4 Landings data of lobster and crab at Withernsea 2013-17 (MMO, 2018a)

	Lobsters		Crabs	
Year	Landed weight (tonnes)	Value (£)	Landed weight (tonnes)	Value (£)
2013	25.5807	244 199.80	60.5505	61 507.73
2014	25.1701	232 569.50	67.194	78 992.45
2015	13.6433	143 309.80	66.0343	80 597.81
2016	18.8681	265 110.40	64.3747	85 904.95
2017	12.6735	168 053.10	15.0996	21 252.83

The study area for the proposed scheme is overlapped by two ICES rectangles: 36E9 and 36F0. Rectangle 36E9 covers only the inshore area between Withernsea and Barmston. Rectangle 36F0 covers offshore areas extending beyond the 12nm territorial limit. Together these ICES rectangles had a combined value of landings of £11.92 million in 2017 (36E9 = £781k and 36F0 = £11.14 million). All landings are made by vessels registered in the UK, either England, Wales or Scotland.

Although the value of fish landed at Withernsea itself is not significant, the value of fish caught in the wider inshore and offshore area is. The value of shellfisheries is particularly significant; over the last five years shellfish species have formed between 98.4% and 99.9% of the overall annual value of fish caught in 36E9 and 36F0.

As presented in **Figure 10.2**, lobster dominates the catches in 36E9 in terms of value, with much smaller proportions represented by crabs and other species. Of those species recorded as 'Other' within 36E9, nephrops (Norway lobster) represented 1.9% of the total 2017 value and cod represented 0.8%. ICES rectangle 36F0 is includes more demersal and pelagic species as it covers offshore areas. Of the species recorded as 'Other' within 36F0, almost all were whelks, with other species cumulatively totalling less than 0.03% of the total 2017 value of landings from this rectangle.

Vessel Monitoring System (VMS) data indicates that significant fishing activity is undertaken in the offshore area of the Holderness Coast. However, as discussed in **Table 10.2**, VMS is only required on vessels which have a length of 12m or more. Within the inshore area of the Holderness Coast, within the study area of the proposed scheme, the majority of fishing activity is

undertaken by local fishermen on vessels which are less than 12m in length (Holderness Coast FLAG, *pers. comm*., 2018), for which VMS does not provide sufficient information.

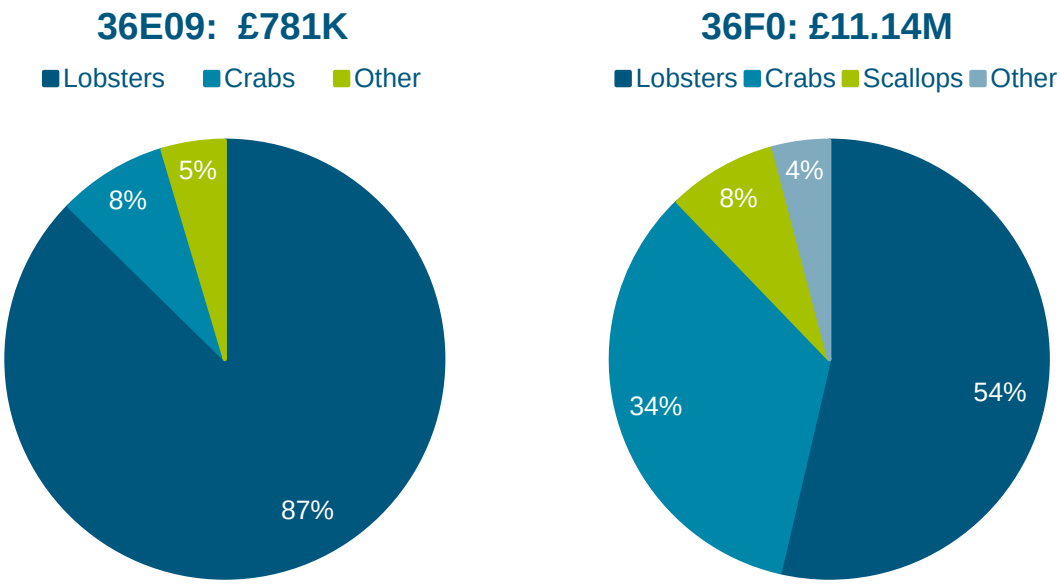

Figure 10.2 Proportion of 2017 landings value by species and ICES rectangle for landings within the Fish and Fisheries study area (36E9 and 36F0). Source: MMO, 2018a

10.6. Potential Impacts

10.6.1. Scope of assessment

The terrestrial aspects of the works (Withernsea WwTW, rising mains and terrestrial section of the LSO) will have no effect on fish and fisheries within the study area of the proposed scheme during construction, operation and decommissioning due to their siting landward of the 100-year predicted erosion line of the cliffs. This assessment of potential effects therefore relates to the intertidal and subtidal sections of the LSO only.

10.6.2. Prediction of potential effects during construction

10.6.2.1. Increased suspended sediment concentrations

Installation of the replacement LSO will require the excavation of a trench by dredging and side-casting of seabed material, which will be subsequently used to infill. These works may affect fish and shellfish species through the increase in suspended sediment within the immediate vicinity.

High concentrations of suspended sediment can impact fish through clogging of gill lamellae, which in extreme cases can lead to death of the organism. Lower concentrations – although not necessarily lethal – may result in sub-lethal stress or behavioural modifications (i.e. avoidance

reactions). High suspended sediment in the water column may also affect swimming ability, growth rates, larval development and can increase susceptibility to disease through immunosuppression (Robertson *et al.,* 2006). Although, in general, sediment plumes induced by dredging are considered to pose only a limited risk to water quality (and subsequently marine ecological species) since the affected water usually has the capacity to accommodate an increased oxygen demand, particularly where dredging takes place in open sea or estuaries (CIRIA, 2000).

In the case of crabs and lobster, larvae and juveniles are considered to be the most sensitive life stage as they are of limited mobility and may be unable to avoid areas affected by increased sediment suspension. Adult crabs and lobster are large-bodied and mobile and therefore would be expected to avoid areas of elevated suspended sediment and have low sensitivity to smothering (Appleby and Scarratt, 1989).

The Holderness inshore area is regarded as highly turbid, with naturally high suspended sediment levels that are exacerbated by storms. Fish species using this area will therefore be habituated to elevated suspended sediment that arise naturally, and as such their sensitivity to increases in concentration that fall within the natural baseline is considered to be **low**.

Subtidal ecology surveys found that the sediment in the study area was predominantly coarse, and was described as either sandy gravelly mud or slightly muddy sandy gravel, limiting the extent to which any sediment plume could migrate. The coarse nature of the sediment would accelerate resettlement.

It is expected that suspended sediment concentrations from the works will be short-term and localised. As described in **Section 7.5**, increases in suspended sediment from the construction stage of the proposed scheme will be negligible within the context of the natural baseline (to the point that modelling of sediment plumes was deemed unfeasible). The preferred methodology for dredging would be by backhoe, however if the nature of the seabed requires (i.e. consolidated clays), a cutter suction dredger would be required. A cutter suction dredger is a stationary dredger, equipped with a rotating cutter head. Clay would be extracted by means of dredge pumps, broken into smaller fragments, and discharged either side of the trench. Due to the nature of the material within the scheme footprint (predominately gravel and clay), this would not be expected to cause significantly higher turbidity than a backhoe dredger.

Furthermore, dredging in the subtidal zone will be relatively short-term in nature (occurring over a period of approximately two months), and in predominantly coarse mixed sediments. As such, the magnitude of the effect of suspended sediment is expected to be **very low**.

Given the above, the impact of increased suspended sediment on fish resources is expected to be of **negligible** significance.

Herring

Within the EIA Scoping Opinion, the MMO highlighted the potential for impacts on herring spawning and nursery grounds, in particular. A species-specific impact assessment has therefore been undertaken for herring.

Herring spawn on gravel and similar habitats (e.g. coarse sand, maerl, shell) where there is a low proportion of fine sediment and well-oxygenated water (Ellis *et al*, 2012). They require the larger grain size as they attach their eggs to the sediment. Herring spawn between August and October in the wider Doggerbank spawning zone shown on **Figure 10.1**.

Kiørboe *et al*. (1981) established that herring eggs could tolerate continuous exposure to suspended sediment concentrations as high as 300mg/l and short-term exposure at levels up to 500mg/l. Within the study, herring eggs suffered no harmful effects from suspended sediment concentrations which were far in excess of the levels expected from the proposed scheme, outside of the immediate dredge area. Therefore considered to be of **low** sensitivity to the temporary suspended sediment increase that may arise.

Predicted levels of increased suspended sediment may affect some individual herring eggs within the immediate locality of the dredging works and for a temporary period, but this is unlikely to exceed the natural variation in herring egg survivability. As such the magnitude of effect on herring eggs would be **low**.

Given the above, the impact of increased suspended sediment on herring is likely to be of **negligible** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible**.

10.6.2.2. Smothering due to suspended sediment

The proposed dredging and side-casting activities during the construction phase of the proposed scheme may cause an increase in the concentration of suspended sediments within the water column and could cause increased deposition of fine sediment in subtidal and intertidal areas. This has the potential to impact upon species such as herring, which spawn on the seabed and benthic species of shellfish.

Shellfish

The nature of this coastal area is that any species living in or near to this zone is adapted to high levels of suspended sediment and regular disturbances caused by the high degree of mobility of the sediment. These species are therefore either tolerant to high suspended sediment levels or able to move away from areas that are unsuitable. Any species present within the extent of the expected increase in suspended sediment is therefore expected to be relatively tolerant of the

small scale and temporary increases in suspended sediment that will occur due to the placement activities, given the highly mobile nature of the existing environment.

According to MarLIN, edible crab is considered to have a low sensitivity to increased SSCs (i.e. a change of 100mg/l for one month) and a high rating for recoverability (Neal and Wilson, 2008). The sensitivity of edible crab to smothering is also considered to be low. This is based on a benchmark which considers a scenario where the population of a species or an area of a biotope is smothered by sediment to a depth of 5cm for one month. This assessment is based on crabs being able to escape from under silt and migrate away from an area, and consequently, smothering is not expected to result in mortality.

There is no MarLIN benchmark assessment for lobster. Lobster do however belong to the same taxonomic family as the spiny lobster (*Nephropidae*) for which there is a benchmark assessment, thus providing a relevant comparison. MarLIN conclude that spiny lobster is tolerant to increased SSCs and not sensitive to smothering (MarLIN, 2019b). Given the physiological similarities between these species, it is reasonable to assume that sensitivities to increased SSCs and smothering will be similar for lobster.

Taking the relative tolerance of shellfish species to SSCs and smothering in the context of the small increases in SSCs and low level of re-deposition expected during the construction of the proposed scheme, shellfish are considered receptors of **low** sensitivity. This, in combination with the **low** magnitude of the effect due to the temporary nature and narrow band of change to increased suspended sediment conditions, would result in an impact of **negligible** significance

Herring

Attachment of herring eggs to the sediment may leave the eggs vulnerable to smothering. Smothering of herring eggs under a thin layer of sediment has been reported to result in substantial egg mortality (Messieh *et al*. 1981). The deposition of sediment on the seabed could potentially result in a temporary loss of spawning grounds, which has the potential to affect herring stocks assuming they are unable to locate their normal grounds and deposit their eggs on sub-optimal sites instead (De Groot, 1980). Therefore, the sensitivity of herring eggs to deposition of sediment must be considered **high**.

The above is based on the assumption that sediment deposition results in significant changes to the characteristics of the substrate. However, as described in **Section 7**, the extent of suspended sediment concentration arising from the proposed scheme is negligible in the context of the natural baseline concentration, and is therefore not expected to affect the existing substrate outside of the immediate vicinity of the proposed scheme. As such, the suitability of the substrate for spawning is unlikely to change.

Although there are spawning grounds for herring in the study area (Ellis *et al*., 2012), the fact that suspended sediment levels arising from dredging and side-casting activities will not differ significantly from the natural baseline of suspended sediment concentration means that the

magnitude of any deposition is likely to be **low**, and highly localised. Furthermore, the dredge period is anticipated to be short term (over a period of approximately two months).

Given the above, the impact of smothering through deposition of suspended sediment arising from the construction phase of the proposed scheme is expected to be of **minor adverse** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **minor adverse** for impacts to herring, and **negligible** for impacts to shellfish.

10.6.2.3. Reduced dissolved oxygen concentrations due to dredging activities

Increased suspended sediment concentrations in the water column may result in the release of organic matter. Sediment loads which have a high organic content may have an effect on dissolved oxygen (DO) levels although this is more prevalent nearer to the seabed (Appleby and Scarratt, 1989). Adult finfish and mobile shellfish species are likely to move away from areas with reduced DO concentrations. Larval and juvenile stages of fish and shellfish may be more susceptible since their sensory systems are not as well developed and less likely to react to reduced DO. The overall sensitivity of fish and shellfish species is considered to be **low** for adult fish and shellfish but **high** for larval and juvenile stages.

The magnitude of the effect is considered to be **low** due to the negligible increases in suspended sediment concentrations described in **Section 7.5**, which will fall within natural baseline concentrations. The sensitivity and low magnitude are likely to result in an impact of **negligible** significance for adult fish and shellfish and **minor adverse** significance for larval and juvenile stages.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **minor adverse** for impacts to larval and juvenile stages, and **negligible** for impacts to adult fish and shellfish.

10.6.2.4. Changes to subtidal food resources

Effects on the benthic composition resulting from sedimentation or direct removal during the construction of the LSO may result in changes to the availability of subtidal food resources for fish and shellfish species.

Communities within the sediments of the LSO footprint may be disturbed over the construction period but, in the absence of further disturbance, a gradual re-colonisation would ensure a re-establishment of the pre-works community.

As described in **Section 9.5**, the benthic community is not expected to be changed significantly outside of the immediate dredge/side-cast and scour protection footprint, therefore there is not expected to be a significant alteration to the food resources available to fish or shellfish in the

study area beyond the immediate locality of the proposed LSO. As such the impact is considered to have **minor adverse** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **minor adverse**.

10.6.2.5. Noise emissions

The main noise emissions in the construction phase associated with the LSO are associated with dredging excavation, side-casting and replacement of the dredged material, and use of dredge vessels. Piling will also be undertaken for the construction of the cofferdam, but in dry conditions in the intertidal area.

Consultation responses suggested that noise emissions from the construction phase should be considered with regard to their effect on fish species. Fish have a wide range of auditory capabilities, mostly in the range of 30 Hz to 1kHz, and detect sound through mechanosensory organs including the lateral line system and the inner ear. Most anthropogenic noises exhibit major energy below 1kHz, so noises arising from the proposed scheme are expected to fall within the frequency range of hearing of most species (Popper *et al*., 2003).

Behavioural responses may occur anywhere within the zone of audibility, which may include evasive actions or altered behaviour due to masking of natural sounds. However, the Humber Estuary to the south of the study area experiences relatively high levels of dredging activity for navigational purposes (an area of approximately 50km^2; Thomsen *et al.*, 2009), it would therefore be expected that most fish within the study area are accustomed to dredging noises and would display **low** sensitivity.

Damage to fish arising from sound pressure is restricted to those species containing air-filled swim bladders. Species lacking swim bladders, like flatfish and elasmobranchs, are unlikely to be physically harmed by increased sound pressure (Popper *et al.*, 2003). Shellfish are also largely insensitive to noise (Parvin *et al.*, 2008).

Backhoe or cutter suction dredging will be employed for dredging activities in the proposed scheme, and in general dredgers produce relatively low frequency sounds (CEDA, 2011). The sediment is largely unconsolidated, removal of which is understood to produce less intense noise levels than consolidated materials that require greater energy to remove (WODA, 2013). As the material is being side-cast there will be no requirement for transportation barges. As such, the sound pressure intensity is not expected to be of low magnitude and is unlikely to cause lasting physical damage to even the more sensitive species.

Given that the dredging period is relatively short-term, and the form of dredging to be employed produces less intense noise than other forms, it is expected that the magnitude of the effects on fish and shellfish species is likely to be **low**. Any behavioural modifications will be temporary and localised. As such, this impact is expected to be of **negligible** significance.

Herring

Clupeid species such as herring are recognised to be more sensitive to increased sound pressure as they have a complex linkage between gas-filled spaces in the head and the inner ear (Popper and Platt, 1979). This sensitivity may lead to behavioural responses to noise emission at lower levels than other species. As mentioned in the above sections, herring are understood to spawn within or near to the study area, and behavioural modification may disrupt spawning activity. Therefore, the sensitivity of herring is considered to be **high**, although the spawning area does extend to the Humber estuary (Ellis *et al.*, 2012), an area of relatively high dredging activity, so an element of tolerance is likely to have evolved.

Although sensitivity is high, the magnitude of the dredging activity is considered to be **low**, as described above. As such, the impact is likely to be of **minor adverse** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **minor adverse** for herring and other hearing specialist fish and **negligible** for other fish and shellfish species.

10.6.2.6. Displacement of commercial fishing vessel activities

The proposed construction works have the potential to disrupt any fishing activities within the footprint of the new LSO. In addition, an exclusion zone of approximately 50m will be in place around working vessels, communicated via a local Notice to Mariners. Restricted access to fishing grounds may result in vessels being forced to utilise other areas, which may result in economic loss or pressure on other ecosystems.

Fishing vessels over 12m in length

As shown in **Figure 10.3**, vessel density in 2017 was very low along the shoreline, and use of the footprint area by vessels tracked by VMS is almost non-existent. As such, fishing vessels over 12m in length (and therefore required to use VMS) very rarely (if ever) use the area and impacts are therefore expected to be of **negligible** significance**.**

Fishing vessels under 12m in length

As described in **Section 10.4**, the inshore area of Holderness coast is used by smaller vessels that primarily target crabs and lobsters using pots and traps, and net for bass if authorised to do so. The potential temporary disturbance/displacement of these vessels at the proposed LSO site during the construction phase is therefore considered to be of **medium** sensitivity, and greater than for larger vessels due to a higher local presence. Smaller vessels will generally have a limited capacity to utilise alternate sites or employ alternate gear types.

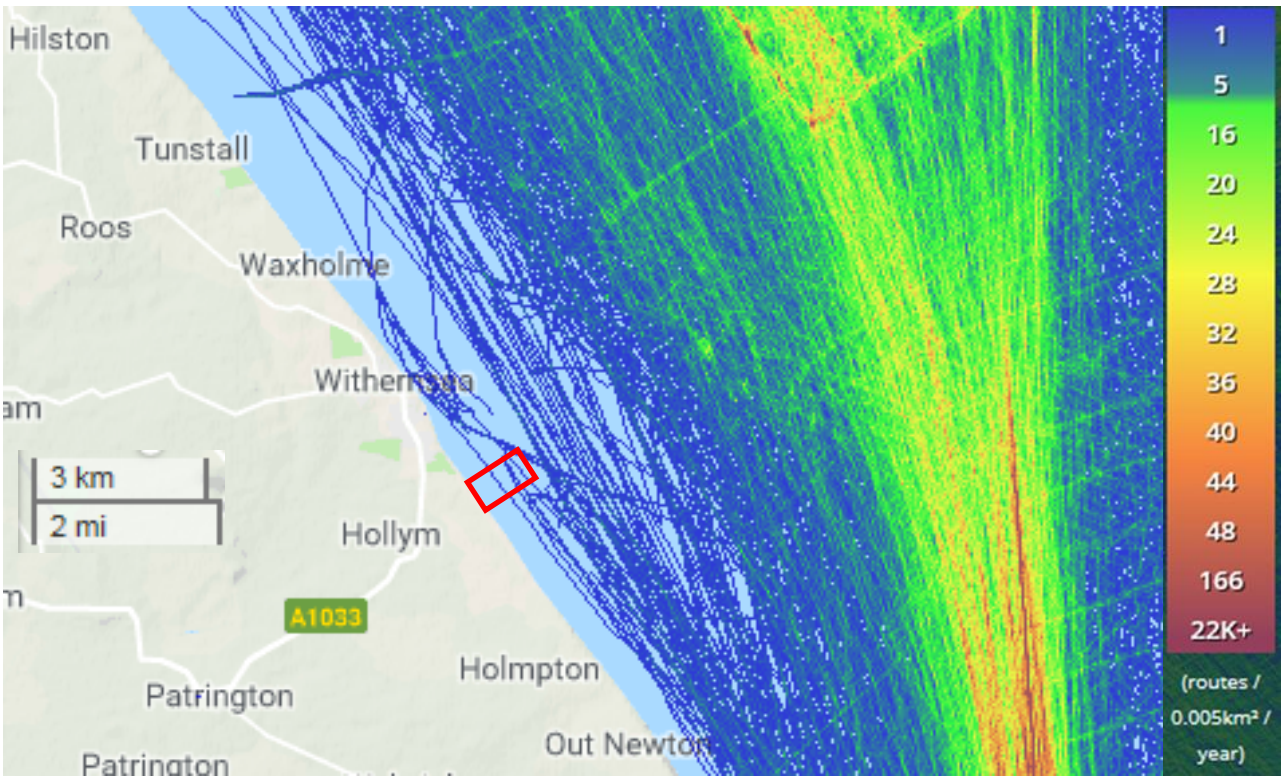

Figure 10.3 Density map showing vessel use of inshore waters along the Holderness coast in 2017 (source: MarineTraffic).

The study area covers a small area, situated in close proximity to the existing LSO (the diffuser dome and scour protection for which, already present a minor seabed obstacle for fishing activity). Shellfish surveys such as those conducted in Bridlington Bay (PMSL, 2013) suggest that lobsters and crabs are present along the Holderness coastline. As such, the area affected by the proposed scheme forms only a small proportion of the viable areas in which a vessel operating out of Withernsea could fish (the range for small vessels is up to 6nm from shore) and the magnitude of effect is considered to be **low**. Furthermore, with communication to local fishers, there would be a reduction in disruption, as fishing activities are often planned in advance.

The potential displacement of small (under 10m) fishing vessels is therefore expected to be of **minor adverse** significance. However, mitigation measures would further reduce the significance including the employment of a dedicated Fisheries Liaison Officer (FLO), who would be responsible for communicating the details of the construction phase to local fishers to allow them to plan around any activity in the area, and via the issuing of Local Notices to Mariners. With appropriate communication, the residual impact is predicted to be of **negligible** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible** for commercial fishing vessels.

10.6.3. Prediction of potential impacts during the operational phase

Once the replacement LSO is in use there will be little to no operational activities required for maintenance. Therefore, no adverse effects on fish or shellfish resources are considered likely to result from the proposed LSO.

The new LSO structure will lie in close proximity to the existing LSO, which will be decommissioned upon completion of the new, therefore there will be no additional navigational impacts on fishing vessels. As bottom-towed gear (such as demersal trawls or dredges) is rarely used, the presence of the substructure will be unlikely to affect fishing activity. Any limitations imposed on use of static gear will be similar to those already existing due to the current LSO, therefore any impacts on gear use would be of **negligible** significance.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible**.

10.6.4. Prediction of potential impacts during decommissioning

The existing LSO will be decommissioned and partially removed following the completion of the new LSO. It is likely that this will follow the same decommissioning activities as required for the existing LSO. This will involve the removal of the diffuser and the associated scour protection, as well as removal of the intertidal section of the existing LSO from the chamber on the foreshore up to the cliff-line. The remaining terrestrial and subtidal sections of pipeline will be capped at both ends and left *in situ*.

The removal of these elements will cause short-term, local resuspension of sediment which is not expected to be above natural background levels of suspended sediment, and impacts associated with this are expected to be no more significant than those from the construction phase. The decommissioning of the LSO will be short-term and temporary in nature and is unlikely to result in a significant adverse effect on fish movements or behaviour, with no lasting effect on fish populations – and consequently fisheries activities – considered likely.

Decommissioning of the new LSO is expected to take place in 60 years following commissioning of the LSO. An appropriate decommissioning plan will be developed at the time and a subsequent marine licence sought.

10.7. Summary of Impacts

Impacts identified on fisheries resources and commercial fishing activity are summarised in **Table 10.5**.

Table 10.5 Summary of impacts on fisheries resources and commercial fishing activity

Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase			

Description of Impact	Significance	Mitigation	Residual Impact
Increased suspended sediment concentration	Negligible	None required	Negligible
Suspended sediment effects on herring spawning grounds	Negligible	None required	Negligible
Smothering due to suspended sediment	Minor adverse	None required	Minor adverse
Reduced dissolved oxygen concentration	Negligible – adults Minor adverse – larvae and juveniles	None required	Negligible – adults Minor – larvae and juveniles
Changes to subtidal food availability	Minor adverse	None required	Minor adverse
Noise emissions	Negligible	None required	Negligible
Displacement of commercial fishing activities	Negligible – vessels over 12m Minor adverse – vessels under 10m	Employment of FLO and issue of local Notice to Mariners	Negligible
Operational Phase			
Obstacle for fishing at new LSO	Negligible	None required	Negligible
Decommissioning Phase			
Increased suspended sediment concentration	Negligible	None required	Negligible
Suspended sediment effects on herring spawning grounds	Negligible	None required	Negligible
Smothering due to suspended sediment	Minor adverse	None required	Minor adverse
Reduced dissolved oxygen concentration	Negligible – adults Minor adverse – larvae and juveniles	None required	Negligible – adults Minor adverse – larvae and juveniles
Changes to subtidal food availability	Minor adverse	None required	Minor adverse
Noise emissions	Negligible	None required	Negligible
Displacement of commercial fishing activities	Negligible – vessels over 12m Minor adverse – vessels under 10m	Employment of FLO and issue of local Notice to Mariners	Negligible

11. Marine and Coastal Ornithology

11.1. Introduction

This section of the ES describes the baseline environment in relation to marine and coastal ornithology. An assessment of potential impacts to birds from the construction, operation and decommissioning of the proposed scheme are described. Appropriate mitigation measures are also provided along with an assessment of any residual impacts. For completeness, in acknowledging the mobile nature of ornithological features, consideration of the impacts from Withernsea WwTW onshore project elements on marine and coastal ornithology receptors is considered within the CIA and the in-combination assessment within the HRA, **Sections 13** and **Section 15**. However, these were also considered in full within the application for planning permission (under TCPA 1990), which has been granted by ERYC (**Appendix B**).

11.2. Consultation

Table 11.1 provides a summary of the comments on marine and coastal ornithology received from the MMO within its Scoping Opinion received on the 5th November 2018 (**Appendix E**), as well as identifying the relevant section of this chapter where the comment has been addressed.

Table 11.1 Consultation Responses

Consultee	Date /Document	Comment	Response / where addressed in the ES
MMO	05/11/2018 Scoping Opinion	The MMO note that the Habitats Regulations Assessment (HRA) provided in support of the Scoping Report (Appendix D) states that the subtidal components of the work will be completed during the summer of 2020 and that the intertidal component of work will be carried out at low water, therefore avoiding sensitive timings for Red Throated Divers. The MMO advise that the recent People Over Wind Ruling by the Court of Justice of the European Union has determined that measures intended to avoid or reduce the likely adverse effects cannot be taken into account when determining whether a plan or a project is likely to have a significant effect on a site. Based on the information provided within the shadow HRA, without mitigation, it cannot be concluded that the works will not have a likely significant effect. Consequently, the MMO advise that information to inform an Appropriate Assessment is provided within a section of the ES.	The HRA is included with **Section 15**, however note that the project timing and methods have been implemented due to construction constraints (i.e. poor weather during winter and need for land based plant to reach low water) and therefore do not determine the need for an Appropriate Assessment.
MMO	05/11/2018 Scoping Opinion	Based upon the information provided within the Scoping Report and the shadow HRA (Appendix D), it is not clear whether the works associated with the decommissioning of the existing long sea outfall (LSO) works have been included and assessed accordingly. The MMO therefore advise that a detailed method statement concerning the decommissioning of the existing LSO be provided	The decommissioning of the existing LSO is included in the scheme description and has been assessed throughout the ES. The decommissioning of the new LSO is expected to follow the same methodology of that which will be undertaken for the existing LSO. However, a further marine licence will be sought for those works,

Consultee	Date /Document	Comment	Response / where addressed in the ES
		within the ES and used to fully inform the shadow HRA. Where there is uncertainty regarding the methods to be employed as part of the LSO decommissioning process, the MMO consider that a realistic Rochdale Envelope, or worst-case scenario, to be appropriate for the assessment of the likely impacts of the licensable activities.	closer to the time. The HRA is included in **Section 15** and this is also assessed in **Section 11.5**.
MMO	05/11/2018 Scoping Opinion	The MMO note that the shadow HRA provided in support of the Scoping Report (Appendix D) states that there will be little or no operational activities required to maintain the LSO, once installed. However, from the information provided, it is not clear whether activities associated with the maintenance and operation of the works have been included and assessed within the HRA (Appendix D). The MMO therefore advise that any maintenance and operation works be fully considered within the shadow HRA. However, it is acknowledged that it is difficult to quantify the necessity for maintenance. Consequently, the MMO consider a realistic Rochdale Envelope, or worst-case scenario, to be appropriate for the assessment of the likely impacts of maintenance and operation works within the shadow HRA.	Where relevant the operation of the existing LSO is included in the scheme description and has been assessed. Once construction, installation and testing of the new LSO is complete, the intertidal foreshore and subtidal seabed will be reinstated to as close to existing levels as reasonably practicable The discharge of wastewater from the new LSO will be a consented discharge as agreed with YWS and the Environment Agency. The expected minor maintenance activities for the existing LSO are covered by a 10-year Marine Licence (L/2017/00177/1). The HRA is included in **Section 15** and this is also assessed in **Section 11.5**.
MMO	05/11/2018 Scoping Opinion	The MMO note that a temporary cofferdam structure is required to facilitate connection of the Horizontal Directional Drilling (HDD), to the subtidal trench. However, from the information provided in the shadow HRA (Appendix D), it does not appear that the likely effects of the works associated with the cofferdam structure (including piling) have been assessed. The MMO therefore advise that all works associated with the cofferdam be included within the ES and shadow HRA and used to fully inform the assessment. The ES and shadow HRA must also demonstrate full consideration of the likely timings and durations over which the works associated with the cofferdam are to occur.	Noted, this is included in **Section 15** and in **Section 11.5**
MMO	05/11/2018 Scoping Opinion	The MMO note that a temporary ramp will be constructed to allow access from the cliff to the foreshore in order to carry out the works. From the information provided, it is not clear whether the works associated with the temporary access ramp have been considered within the Scoping Report and the shadow HRA (Appendix D). The MMO therefore advise that all works associated with the access ramp be included within the ES and shadow HRA and used to fully inform assessment. The shadow HRA must also fully consider the duration over which the works associated with the access ramp are to occur and their potential influence on physical processes.	Noted, this is included in **Section 15** and in **Section 11.5**

Consultee	Date /Document	Comment	Response / where addressed in the ES
MMO	05/11/2018 Scoping Opinion	The MMO considers that the proposed development is likely to have a significant effect on protected bird species, such as the Red throated diver during the overwintering period (i.e. 1 October and 31 March, inclusive). If works are to be undertaken during the overwintering period, the MMO advise that mitigation measures are required to reduce the likelihood of significantly effecting protected overwintering bird species. Any mitigation measures must be included and fully considered within the ES and shadow HRA to ensure that there will be no adverse impact to site integrity.	As discussed above, the project timing and methods have been implemented due to construction constraints (i.e. poor weather during winter and need for land based plant to reach low water) and therefore do not determine the need for an Appropriate Assessment. It is not expected that the works will have a LSE on the qualifying geatures of the Greater Wash SPA This is outlined in **Section 15** and in **Section 11.5**

11.3. Methodology

11.3.1. Study Area

For marine and coastal ornithology, the study area has been informed by the hydrodynamic and sediment dispersion modelling and is based on the maximum extent over which effects are predicted to occur (e.g. sediment plumes generated during capital dredging). As suggested within **Section 7**, these are expected to be minimal. As such, the study area within which effects on marine and coastal ecology is assessed, is presented in **Figure 8.1**.

11.3.2. Data Sources

The description of the existing environment with regards to marine and coastal ornithology has been informed through a desk-based review of data and information on the importance of the area for ornithological interests. Wetland Bird Survey (WeBS) data from the British Trust for Ornithology (BTO) was not obtained in relation to this project, as neither Core Count or Low Tide data are available for the coastal area along the Holderness Coast (Site name: South Holderness Coast – Mappleton to Easington).

The departmental brief for the classification of the Greater Wash SPA presents the evidence collected by the JNCC and NE to inform the scientific case for designation. This information has been utilised to inform the importance of the location of the proposed scheme for these features.

The main construction period is due to occur between April and September 2020. To provide an indication of potential species occurring within this period, five breeding bird surveys were undertaken between 16th April and 17th July 2018 within and adjacent to the boundary of the new Withernsea WwTW (indicated by area 'A' on **Figure 11.1**), on behalf of YWS (provided in **Appendix K**). Arising from the potential for decommissioning works to be undertaken during the overwinter period, a dedicated wintering bird survey was undertaken over the 2017/2018 winter period (Waxwings Ornithology, 2018) and covered the coastline and inshore zone (defined as the area within 1km of the coast) of the project area as well as the boundary of the WwTW, routes of the new rising main and new LSO (**Figure 11.1**).

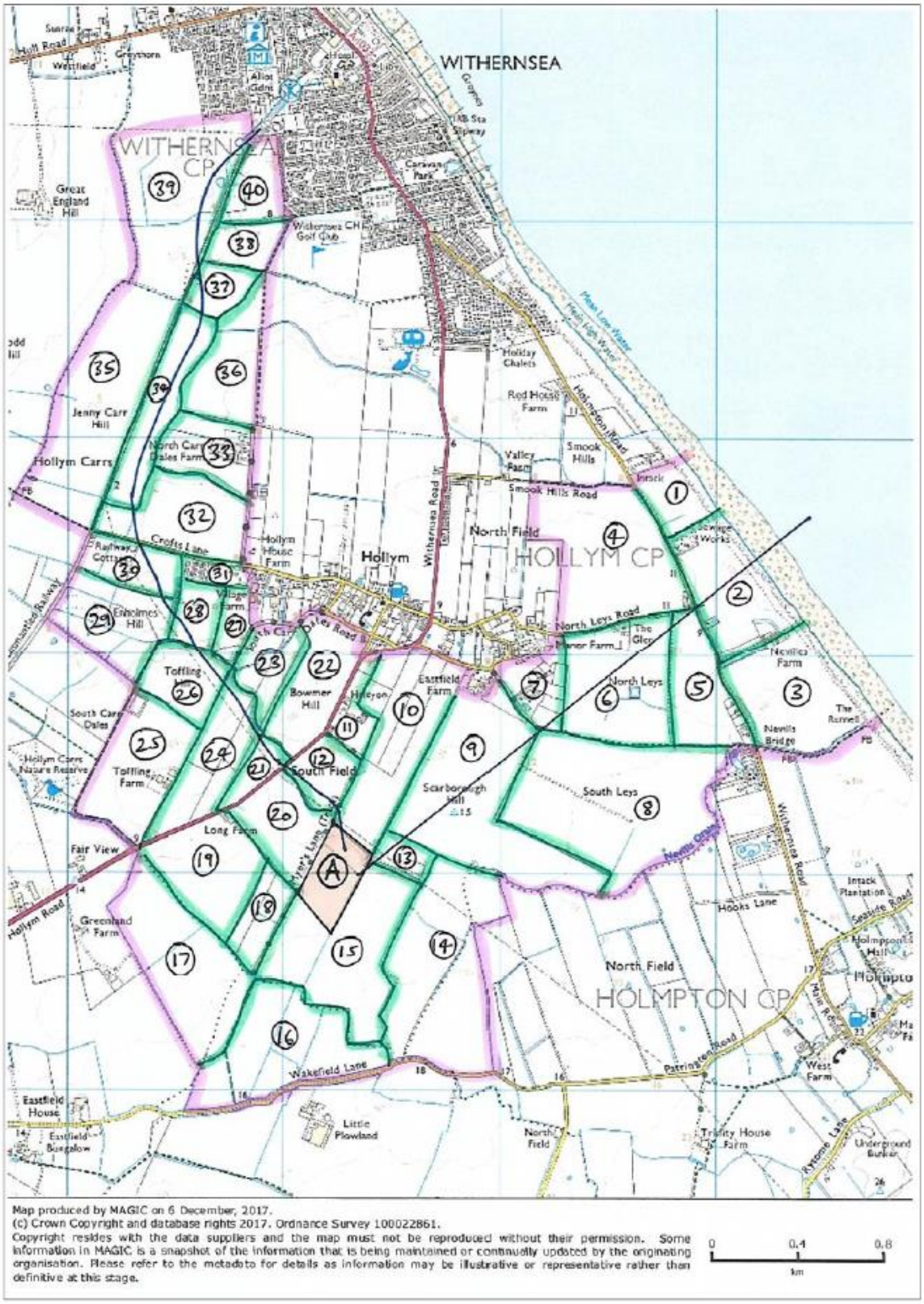

Figure 11.1 Overwintering bird survey locations (reproduced with permission from Waxwings 2018)

The relevant data sources are described in **Table 11.2** and the results are presented in **Section 11.4**.

Table 11.2 Data Sources

Data	Year	Coverage	Notes
Greater Wash pSPA departmental brief – NE and JNCC	2016	Greater Wash SPA area	The departmental brief presents the evidence collected by the JNCC and NE to inform the scientific case for the classification of the Greater Wash SPA.
Waxwings Ornithology Survey	2017-2018	Project area	Twice monthly surveys were undertaken between October 2017 and March 2018 during high tide conditions.
Breeding bird survey	2018	New WwTW	Five breeding bird surveys undertaken between 16th April and 17th July 2018 within and adjacent to the boundary of the new WwTW.

11.4. Existing Environment

11.4.1. Holderness Coastline

11.4.1.1. The Greater Wash SPA

Evidence gathered by Natural England and JNCC (2016) to inform the scientific case for the classification of the Greater Wash SPA has been used to inform the importance of the coastal and inshore area within the study area for the designated features of this site. This is presented in **Table 11.3** alongside a summary of the findings of the wintering bird survey undertaken during the winter of 2017/2018.

The full results of the overwintering survey, covering designated species and other overwintering species present within and adjacent to the proposed scheme footprint, is provided in **Section 11.4.2**.

Table 11.3 Importance of the Withernsea coastal and inshore area for the Greater Wash SPA designated features (Sources: NE and JNCC (2016) and Waxwings Ornithology (2018))

Qualifying features	Importance of the Withernsea coast and inshore area	Results of wintering bird survey
Red-throated diver	There are medium population densities in Withernsea compared to rest of the SPA, at 0.29 -0.67 birds per km^2. Given the higher figure, the amount which could be present within the footprint, would equate to 0.02% of the numbers found within the SPA. Although red-throated diver has been recorded using intertidal areas for foraging at high tide, the proposed works will be undertaken at low tide, and therefore red-throated diver would not be utilising the intertidal area during working periods. Furthermore, the adjacent cliffs are not deemed to be suitable for roosting.	This species was recorded within the inshore zone on six visits, including birds on the sea and birds transiting north and south. Most observations involved fewer than 10 birds foraging inshore during high tide conditions. A maximum of 29 was recorded on the 23rd of February 2018.
Sandwich tern *Sterna sandvicensis*	The feeding grounds of Sandwich tern that nest at Scolt Head Island NNR and Blakeney Point NNR (on the North Norfolk coast) lie predominantly in marine areas within approximately 21km of the colony, and are therefore located a significant distance from Withernsea.	This species was not recorded during the survey.

Qualifying features	Importance of the Withernsea coast and inshore area	Results of wintering bird survey
Common tern *Sterna hirundo*	The main breeding colonies and feeding areas (located within 13km of colonies) are located a significant distance away from Withernsea, at Blakeney Point NNR, Scolt Head Island NNR and Breydon Water (near Great Yarmouth).	This species was not recorded during the survey.
Little tern *Sternula albifrons*	There are little tern colonies in the Humber Estuary SPA. However, these species travel on average 6km along the shore in either direction, up to a maximum of 11km (Eglington and Perrow, 2014). Withernsea is approximately 13km away along the shore and works will be completed prior to the breeding season.	This species was not recorded during the survey.
Little gull *Hydrocoleous minutus*	None counted in Withernsea area.	This species was not recorded during the survey.
Common scoter *Melanitta nigra*	There are low population densities in Withernsea compared to rest of SPA, at 0.0 – 0.7 birds per km^2.	This species was not recorded during the survey.

11.4.1.2. The Humber Estuary SPA/Ramsar/SSSI

English Nature (2003) provides an overview of the species covered by the Humber Estuary European Marine Site and their distribution and preferred habitats within the Humber Estuary. This has been used to inform the likelihood of the species being present within and adjacent to the proposed scheme footprint. This is presented in **Table 11.4** alongside a summary of the findings of the wintering bird survey undertaken during the winter of 2017/2018.

The full results of the overwintering survey, covering designated species present within and adjacent to the proposed scheme footprint, is provided in **Section 11.4.2**

Table 11.4 Importance of the Withernsea coastal and inshore area for the Humber Estuary SPA designated features (Sources: English Nature (2003) Waxwings Ornithology (2018))

Qualifying features	Importance of the Withernsea coast and inshore area	Results of wintering bird survey
Avocet *Recurvirostra avosetta*	Avocet feed on small invertebrates such as marine worms and crustaceans, which they obtain from the intertidal flats, feeding close to Reads Island and Blacktoft Sands, their main breeding areas. Habitats within proposed scheme footprint unlikely to support these species	This species was not recorded during the survey.
Bittern *Botaurus stellaris*	When breeding, the bittern is predominantly a freshwater bird, however it will utilise areas of intertidal reedbed during the winter. This rare bird is seen regularly in the reedbeds of the inner estuary, and also at North Killingholme Haven pits. Habitats within proposed scheme footprint unlikely to support these species	This species was not recorded during the survey.
Hen harrier *Circus cyaneus*	Hen harrier will use the reedbeds as a roost, favouring the south bank of the inner estuary, although they are also seen in the dune slacks on the north Lincolnshire coast and at Humberston Fitties. Habitats within proposed scheme footprint unlikely to support these species	This species was not recorded during the survey.
Golden plover *Pluvialis apricaria*	Golden plover and regularly feed inland, on a variety of sites from wet pasture to ploughed fields. They may also feed on the intertidal	Flocks were recorded on farmland surrounding the replacement and existing Withernsea WwTW on

Qualifying features	Importance of the Withernsea coast and inshore area	Results of wintering bird survey
	mudflats and sandflats during periods of harsh weather. They occur throughout Humber estuary, but larger numbers are found around Spurn Bight and along the north Lincolnshire coast. Flocks of golden plover for example, regularly move between Reads Island and New Holland in mid winter, both within the Humber Estuary. Habitats within proposed scheme of low ecological value and unlikely to provide suitable foraging areas. However, there are arable farms along the coastline to the south of Withernsea.	five occasions during the overwintering period
Bar-tailed godwit *Limosa lapponica*	The overwintering bar-tailed godwit relies on a small number of feeding and roosting sites on the estuary. They feed on the intertidal mudflats, occur almost exclusively on the outer estuary, although smaller numbers are found around Whitton Sands, Reads Island and Barton and Barrow Claypits. Habitats within proposed scheme footprint unlikely to support these species	This species was not recorded during the survey.
Ruff *Philomachus pugnax*	Ruff breed in marshes and wet meadows. Habitats within proposed scheme footprint unlikely to support these species	This species was not recorded during the survey.
Marsh harrier *Circus aeruginosus*	Marsh harrier requiring wetlands with tall dense vegetation for nesting and particularly favouring reedbeds. Habitats within proposed scheme footprint unlikely to support these species	This species was not recorded during the survey.
Little tern *Sternula albifrons*	There are little tern colonies in the Humber Estuary SPA. However, these species travel on average 6km along the shore in either direction, up to a maximum of 11km (Eglington and Perrow, 2014). Withernsea is approximately 13km away along the shore and works will be completed prior to the breeding season.	This species was not recorded during the survey.
Shelduck *Tadorna tadorna*	Shelduck forage within intertidal mudflats. Large numbers of moulting shelduck are also found on the estuary during July and August. They are concentrated to the west of the Humber Bridge, particularly around Whitton Sands and Brough. Habitats within proposed scheme footprint unlikely to support these species	This species was not recorded during the survey.
Knot *Calidris canutus*	The intertidal sandflats of Cleethorpes are an important feeding area for knot during the winter months. The saltmarshes throughout the estuary provide an important communal roosting site. Habitats within proposed scheme of low ecological value and unlikely to provide suitable foraging areas for these species	This species was not recorded during the survey.
Dunlin *Calidris alpina*	The extensive intertidal flats and saltmarshes throughout the estuary provide feeding and low tide roosting sites for dunlin. High tide roosts are provided by lagoons on the Humber. Habitats within proposed scheme footprint unlikely to support these species	This species was not recorded during the survey.
Redshank *Tringa tetanus*	Redshank use the lagoons at Blacktoft Sands, saltmarshes and reedbeds within Humber estuaries as roosting and foraging sites. The extensive intertidal flats of the outer estuary of the Humber provide feeding and low tide roosting sites for redshank. Habitats within proposed scheme of low ecological value and unlikely to provide suitable foraging areas for these species	One individual recorded on one occasion during overwintering period

In summary, golden plover and redshank, both designated features of Humber Estuary SPA, were recorded foraging on the nearby arable farmland and pasture during the overwintering period.

Impacts to bird species protected within these designations as a result of the proposed scheme may arise through indirect impacts. These are discussed in **Section 11.5** below and are informed by the Marine and Coastal Ecology sections of this ES (**Section 9**).

11.4.2. Site-specific surveys

11.4.2.1. Overwintering Surveys

Inshore Area

Wintering bird surveys were undertaken from October 2017 to March 2018 at high tide, as agreed with Natural England (Waxwings Ornithology, 2018; **Appendix K**). This survey included the coast and the inshore area of sea within 1km of the coast in order to assess numbers of designated features of interest within the Greater Wash SPA. Analysis of data from 12 wintering bird survey visits undertaken between 23rd October 2017 and 27th March 2018 found that a total of 54 bird species were recorded. This total includes ten species recorded within the inshore zone of the coast either on the sea or in flight (presented in **Table 11.5**).

The key species recorded within the inshore zone was red-throated diver. This species was recorded on six visits, including birds on the sea and birds moving north and south. Most observations involved fewer than ten birds foraging inshore during high tide conditions, with a maximum of 29 counted on 23rd February (Waxwings Ornithology, 2018; **Appendix K**).

Table 11.5 Number of inshore bird species October 2017 – March 2018 (reproduced with permission from Waxwings Ornithology, 2018)

Species	Maximum Counts Inshore (birds on sea + birds flying N & S) on survey date											
	23/10/17	26/10/17	16/11/17	29/11/17	15/12/17	22/12/17	10/01/18	23/01/18	08/02/18	23/02/18	12/03/18	27/03/18
Curlew										6S		
Kittiwake				35N							1N	
Herring Gull												2N
Eider								1S				
Sanderling										15		
Black-headed gull					5N							5
Common gull						1N				25	7N	1N
Great black-backed gull				1				1S		1N		1N, 1S
Guillemot				1+1N				2+1N, 1S	4N	9+2N,7 S	4N,2S	
Red-throated diver			9	3N, 1S				8+1N, 7S	2	29	5+7N	
Total number of bird species recorded in inshore sea area	**0**	**0**	**1**	**4**	**1**	**1**	**0**	**4**	**2**	**6**	**4**	**4**

Species	Maximum Counts Inshore (birds on sea + birds flying N & S) on survey date											
	23/10/17	26/10/17	16/11/17	29/11/17	15/12/17	22/12/17	10/01/18	23/01/18	08/02/18	23/02/18	12/03/18	27/03/18
Total number of individual birds per visit to inshore sea area	0	0	9	42	5	1	0	22	6	57	26	10

Of the other species recorded within the inshore zone, only black-headed gull (max. 5), common gull *Larus canus* (max. 25), great black-backed gull *Larus marinus* (max. 1) and guillemot *Uria aalge* (max. 9) were observed down on the sea and foraging inshore, with additional birds in single figures recorded moving north and south. Curlew *Numenius arquata*, kittiwake *Rissa tridactyla*, herring gull *Larus argentatus*, eider *Somateria mollissima* and sanderling *Calidris alba* were only recorded in flight moving north or south within the inshore zone (Waxwings Ornithology, 2018).

Overall, the inshore recording zone, within 1km of the coastal, was found to support few wintering bird species, in insignificant numbers.

Coastal habitats

Golden plover and redshank, both designated features of Humber Estuary SPA, were recorded foraging on the nearby arable farmland and pasture on five visits. The most notable of these occasions on the 29th November 2017. A flock of c.800 birds arrived from the north-east and circled the survey area south of the A1033, touching down briefly in field no. 9 before flying south-east. The flock later separated and smaller flocks of c.400 circled field no. 4, just inland from the existing sewage works, and of c.220 were observed foraging in field no. 21 (Waxwings Ornithology, 2018; **Appendix K**).

Table 11.6 Number of overwintering birds designated by Humber Estuary SPA from October 2017 – March 2018 (reproduced with permission from Waxwings Ornithology, 2018)

Species	Maximum Counts Inshore (birds on sea + birds flying N & S) on survey date											
	23/10/17	26/10/17	16/11/17	29/11/17	15/12/17	22/12/17	10/01/18	23/01/18	08/02/18	23/02/18	12/03/18	27/03/18
Golden plover				1								
Redshank		12		800	125				45W	13		

Considering the intertidal and marine habitats found within the proposed scheme study area, it is not expected that the species recorded would be breeding, nesting or foraging within the proposed scheme footprint. There are areas of arable farm along the cliff top, however, the construction methods in this area consist of HDD/microtunnelling, which, as described in **Section 2.2**, would be approximately 10m beneath ground, and unlikely to be audible on the cliff top. Furthermore, the intertidal works (including the cofferdam construction) are of short duration and will be at a distance of at least 150m from the cliff top. The results of the survey have been provided in support

of the planning permission sought (and subsequently granted) from ERYC for the construction of the WwTW (**Appendix K**). The detailed results are therefore not presented within this ES.

11.4.2.2. Breeding bird survey

Breeding bird surveys were undertaken on five occasions in April, May, June and July 2018, the vicinity of the replacement Withernsea WwTW (**Appendix K**). In general, the species recorded on site were found to be a typical assemblage of breeding birds associated with arable land, scattered broadleaved trees, hedgerows, scrub, reedbed and drainage ditches.

Red[2] and Amber[3] Listed species (Birds of Conservation Concern 4 Listed Species of Conservation Concern) (Eaton *et al*., 2015) recorded within the survey area were associated with the following breeding habitats;

- Isolated mature trees, hedgerows, scrub, adjoining field margins (house sparrow *Passer domesticus*, tree sparrow *Passer montanus*, linnet *Linaria cannabina* and yellowhammer *Emberiza citrinella*).
- Arable land (skylark *Alauda arvensis*, reed bunting *Emberiza schoeniclus* and meadow pipit *Anthus pratensis*).
- Reedbed and drainage ditches (reed bunting).

As outlined in **Section 11.4.2.1**, it is not expected that the species recorded would be breeding, nesting or foraging within the proposed scheme footprint. There are areas of arable farm along the cliff top, however, the construction methods in this area consist of HDD/microtunnelling, which, as described in **Section 2.2**, would be approximately 10m beneath ground, and unlikely to be audible on the cliff top. Furthermore, the intertidal works (including the cofferdam construction) are of short duration and will be at a distance of at least 150m from the cliff top. The results of the survey have been provided in support of the planning permission sought (and subsequently granted) from ERYC for the construction of the WwTW (**Appendix K**). The detailed results are therefore not presented within this ES.

11.5. Potential Impacts

11.5.1. Scope of assessment

The terrestrial aspects of the works (Withernsea WwTW, rising mains and terrestrial section of the LSO) are unlikely to have an effect on the ornithological features within the study area during construction, operation and decommissioning due to their siting landward of the 100-year

[2] Red List: species that are globally threatened, whose population or range has declined rapidly in recent years, and those whose populations have declined historically and not exhibited any signs of recovery. Species that have experienced a population decline of >50%.

[3] Amber List: species with an unfavourable conservation status in Europe, whose populations have declined moderately in recent years, including species that show a historical decline but whose populations have shown a substantial increase, species that are rare, with localised populations and those species of international importance with UK populations and species that have experienced a population decline or breeding range decline of 25% to 49%.

predicted erosion line of the cliffs, however this has been assessed within the CIA and HRA. The assessment in the following section therefore relates to the intertidal and subtidal sections of the LSO only.

11.5.2. Prediction of potential effects during construction

11.5.2.1. Temporary direct disturbance from airborne noise associated with construction activities

Overwintering bird species

The construction of the intertidal and subtidal sections of the LSO will occur during the summer period due to the requirement for calm sea conditions, therefore there is no pathway for impact on overwintering species during these works. However, it is possible that the works required for the decommissioning of the existing LSO may take place during the winter, due to the requirement for this to occur once the new LSO is fully commissioned.

This will involve the removal of the diffuser, diffuser protection frame, marker buoy and a small area of scour protection, as well as removal of the intertidal section of the existing LSO from the chamber on the foreshore up to the cliff-line. The remaining terrestrial and subtidal sections of pipeline will be capped at both ends and left *in situ*. These works will be short-term and temporary in nature with the subtidal works required taking no more than 2 weeks to complete.

The proposed scheme footprint lies within the Greater Wash SPA and is known to support overwintering bird species between October and March in insignificant numbers (Waxwings Ornithology, 2018). The most abundant species present are red-throated diver, with a maximum of 29 individuals recorded.

The decommissioning activities which are considered to have the potential to impact overwintering species are:

- **Subtidal**: The removal of diffuser riser, diffuser head, diffuser protection frame, removal of marker buoy and chain/anchor weight and capping of the distal end of the LSO with grout or concrete. This will be carried out by a team of divers from one workboat, using handtools, and;

- **Intertidal**: Capping of each end of the existing LSO with grout or concrete. This will also be carried out by a team of divers from one workboat using handtools however, the nearshore end will be accessed by foot at low tide with support from a vehicle to carry equipment if necessary.

The removal of the intertidal LSO section will involve the excavation around the LSO and then removal in sections. The excavated material will be reinstated on completion. Decommissioning of the intertidal section of the existing LSO will take place when the beach is exposed at low tide, to maximise the workable area for shore-based excavation plant. Removal of the intertidal section of the LSO will likely require approximately two tracked lifting cranes, two tracked excavators and

a small generator for electric supply, to dig around the existing pipe and to cut into sections. The works would take a maximum of two weeks.

During the overwintering bird period (generally accepted to be October to March inclusive), intertidal areas can support wading birds, however due to the impoverished nature of the sediment within the proposed works area, the numbers of birds using the area around the proposed LSO route are expected to be low. This is supported by the findings of the wintering bird survey (Waxwings Ornithology, 2018).

It has been demonstrated through ornithology surveys (Waxwings Ornithology, 2018) that red-throated diver are present in the inshore area within the vicinity of the proposed scheme at high tide during the overwintering period. The works undertaken in the subtidal zone would require one workboat, with divers and hand-tools only required to remove the diffuser riser, diffuser head, diffuser protection frame, and removal of marker buoy and chain/anchor weight. Red-throated divers are notably highly sensitive to the disturbance associated with shipping traffic (Kube 1996, Garthe & Hüppop 2004; King et al. 2009). Consequently, they are likely to avoid areas in which dredging is taking place, and also associated shipping activity. The designated population of the SPA is 1,407 individuals, representing 8.3% of the GB non-population (Natural England, 2018). The peak count of 29 individuals recorded during the survey represents 2% of this population.

Red-throated diver are a designated species of a European site and as such are considered to be of **very high** value. They are recorded as being sensitive to vessel movements and disturbance (MMO, 2018b) and therefore their sensitivity is also considered to be **high**.

However, the works within the intertidal and subtidal area during decommissioning of the existing LSO represent a short term and temporary impact to foraging red-throated diver and as such the magnitude of the impact is considered to be **very low**. Therefore, a **negligible** impact is predicted.

Mitigation measures and residual impact

Due to red-throated diver sensitivity to human activities, particularly vessel movements, the following mitigation measures will be put in place during these works, as advised by Natural England (DAS/11138/197263), to minimise any potential impacts on the species:

- The use of a consistent vessel corridor;
- Maintaining appropriate vessel transit speeds, and;
- Vessel-based toolbox talks to raise awareness of the sensitivity of the species.

Following the implementation of these mitigation measures, the residual impact is considered to be of **negligible significance**.

On passage/breeding bird species

The proposed scheme footprint lies approximately 4.6km from the Humber Estuary SPA/Ramsar and SSSI. A number of breeding birds were recorded during the breeding bird survey undertaken by Arup (2018; **Appendix K**). The foreshore is of low ecological value and unlikely to support foraging or roosting bird species. The assessment of the proposed scheme and replacement Withernsea WwTW and associated infrastructure onshore project on breeding bird species has been undertaken to support the planning application under TCPA 1990, a summary of which is provided below for completeness.

The intertidal works include the excavation of the trench for the LSO and the installation of a cofferdam. The cofferdam will be installed using a vibro-piling technique due to the nature of the substrate on the foreshore. The noise produced during this activity is expected to be similar to that produced by the other machinery and excavators on the foreshore and as such will have a low potential for an adverse impact in comparison with high impact activities such as impact piling.

A noise assessment was undertaken for the construction of the WwTW (**Appendix L**), predicted a noise level of below 50dBA at a distance of 300m from the Withernsea WwTW during the earthworks. The construction methods within the assessment included activities far exceeding those to be undertaken within the intertidal/subtidal areas; the use of tracked excavators, movements of tipper trucks moving material, vibratory roller, dump trucks, road sweeper, truck mixers, lorry mounted concrete pumps and craning of materials. The installation of the intertidal section of the LSO will likely require approximately two tracked lifting cranes, two tracked excavators and a small generator for electric supply.

From the results of noise levels produced by construction activities, and research undertaken in relation to disturbance responses, it is considered that during the construction phase of the proposed scheme there is a potential for wintering birds to be disturbed at a local level (within 50m of the works). However, beyond this area noise levels are expected to fall.

Wright *et al*. (2010) investigated the effects upon waterbirds (specifically waders / wildfowl), to impulsive noise and have identified ranges in noise which cause behavioural responses (based on a measured LAeq). These are:

- no observable behavioural response: 54.9 to 71.5dBA (with a high proportion of extreme outliers);
- non-flight behavioural response: 62.4 to 79.1dBA;
- flight with return: 62.4 to 73.9dBA; and,
- flight with all birds abandoning the site: 67.9 to 81.1dBA.

The presence of approximately three vessels in the near-shore area, involved with the trenching and installation of the LSO, has the potential to disturb waterbirds foraging at sea. The subtidal

trench will be approximately 1km in length. Dredging activities are proposed take place during the summer months of 2020, to make use of the summer weather window, and will take approximately 2 months to complete.

Given the low importance of the area for marine and coastal ornithology species during the summer period, the sensitivity is recorded as **low**. Furthermore, given the **low** magnitude of the minor, short term and temporary works, a **negligible** impact is predicted.

Mitigation measures and residual impact

There are no further measures that can be adopted to minimise the impact, and therefore the residual impact is considered to be **negligible**.

11.5.2.2. Temporary direct impact from visual disturbance

During the decommissioning of the existing LSO, there would be plant present on the foreshore and one vessels during working times only. The foreshore works would be undertaken at low tide, due to the requirement for this to be done using land-based plant. Removal of the intertidal section of the LSO will likely require approximately two tracked lifting cranes, two tracked excavators and a small generator for electric supply, to dig around the existing pipe and to cut into sections. The works would take a maximum of two weeks. The works undertaken in the subtidal zone would require one workboat, with divers and hand-tools only required to remove the diffuser riser, diffuser head, diffuser protection frame, and removal of marker buoy and chain/anchor weight.

The effect of visual disturbance cannot be assessed in quantitative terms (in the same way as for the effect of noise emissions). It is considered likely that waterbirds would exhibit a behavioural response to visual disturbance and redistribute away from the immediate vicinity of the disturbance, but would be likely to become habituated to the visual disturbance over time.

Although the species with the potential to be foraging within the scheme footprint are designated under the Greater Wash SPA and are of **high** sensitivity to the presence of vessels, the short-term, temporary and minimal nature of the works, would present a **very low** magnitude visual impact. Therefore, a **negligible** impact is predicted.

Mitigation measures and residual impact

There are no further measures that can be adopted to minimise the impact, and therefore the residual impact is considered to be **negligible**.

11.5.2.3. Indirect disturbance due to reductions in water quality

Red-throated diver and other foraging seabirds may be present along the Holderness Coast in low numbers during the construction period (Waxwings Ornithology, 2018). The foraging behaviour of red-throated divers means that they are moderately sensitive to impacts on their food supply, such as changes to turbidity, sedimentation impacting on the benthos or associated fish communities.

Red-throated diver may be present within the proposed scheme footprint during the decommissioning of the existing LSO. The removal of the diffuser riser, diffuser head, diffuser protection frame, removal of marker buoy and chain/anchor weight may cause a very short-term and localised resuspension of sediment. This is not expected to be above natural background levels.

The nature of the trenching and backfilling works associated with the installation of the new LSO has the potential to create a sediment plume which could limit or prevent waterbird foraging in the vicinity of the works. The construction works will occur during the summer months, due to weather constraints. The waterbird population in the vicinity of the works area during the summer period is not expected to be significant, with the designation of the Humber Estuary SPA/Ramsar and SSSI (covering few breeding/on passage species), at a distance of 4.6km to the south. The sensitivity of the area during this time is therefore **low**.

The Holderness Coast inshore area is highly turbid, with naturally high levels of suspended sediment. Sediment samples taken during the subtidal ecology surveys were found to be predominantly coarse, and were described as either sandy gravelly mud or slightly muddy sandy gravel, which will limit the potential for a significant sediment plume to form and migrate away from the immediate works area.

The preferred methodology for dredging would be by backhoe, however if the nature of the seabed requires (i.e. consolidated clays), a cutter suction dredger would be required. A cutter suction dredger is a stationary dredger, equipped with a rotating cutter head. Clay would be extracted by means of dredge pumps, broken into smaller fragments, and discharged either side of the trench. Due to the nature of the material within the scheme footprint (predominately gravel and clay), this would not be expected to cause significantly higher turbidity than a backhoe dredger.

The coarse nature of the sediment, which will promote rapid resettlement out of suspension, and the short-term nature of the works will be unlikely to result in a significant effect on waterbird foraging success, with no lasting effect on waterbird populations considered likely, as such the magnitude of the impact is considered to be **low**.

Due to the very low probability of red-throated diver being present during the construction works (which are required to be undertaken outwith the overwintering bird period due to weather constraints), the low importance of the area to support breeding seabirds during the decommissioning works, and the short-term, temporary and highly localised predicted impacts, an impact of **negligible** impact is predicted.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be of **negligible** significance.

11.5.3. Prediction of potential impacts during the operational phase

11.5.3.1. Direct disturbance to waterbirds through operational activities

Once the replacement LSO is in use there will be little to no operational activities required for maintenance. The new LSO will be buried, similar to the current LSO, with only the diffuser protection dome positioned above the seabed surface. There would be very infrequent maintenance and/or repair work to the diffuser structures. When required the work would be undertaken by a team of divers, supported by a workboat. Despite the importance of the area for red-throated diver, recorded as **high** sensitivity to anthropogenic activities. The works would be infrequent, short term, temporary and limited in nature. Due to the **very low** magnitude of potential works (if undertaken within overwintering period), an impact of **negligible** significance is proposed.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be **negligible**.

11.5.4. Prediction of potential impacts during decommissioning

11.5.4.1. Disturbance to waterbirds, particularly red-throated diver, through decommissioning activities

The existing LSO will be decommissioned and partially removed following the completion of the new LSO. It is likely that this will follow the same decommissioning activities as required for the existing LSO. This will involve the removal of the diffuser and the associated scour protection, as well as removal of the intertidal section of the existing LSO from the chamber on the foreshore up to the cliff-line. The remaining terrestrial and subtidal sections of pipeline will be capped at both ends and left *in situ*.

The removal of these elements will cause short-term, local resuspension of sediment which is not expected to be above natural background levels of suspended sediment, and impacts associated with this are expected to be no more significant than those from the construction phase. The decommissioning of the LSO will be short-term and temporary in nature and is unlikely to result in a significant adverse effect on waterbird movements or foraging behaviour, with no lasting effects considered likely.

Decommissioning of the new LSO is expected to take place in 60 years following commissioning of the LSO. An appropriate decommissioning plan will be developed at the time and a subsequent marine licence sought.

The impacts of decommissioning the new LSO are likely to mirror the construction impacts.

11.6. Summary of Impacts

The potential impacts on marine and coastal ornithology are summarised in **Table 11.7** below.

Table 11.7 Summary of impacts on marine and coastal ornithology

Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase			
Direct disturbance to waterbirds from airborne noise	Negligible	None	Negligible
Direct impact to waterbirds from visual disturbance	Negligible	None	Negligible
Reductions in water quality	Negligible	None	Negligible
Operational Phase			
Direct disturbance to waterbirds	Negligible	None	Negligible
Decommissioning Phase			
Direct disturbance to waterbirds from airborne noise	Negligible	None	Negligible
Direct impact to waterbirds from visual disturbance	Negligible	None	Negligible
Reductions in water quality	Negligible	None	Negligible

12. Marine Historic Environment

12.1. Introduction

This section presents the historic environment baseline within the terrestrial, intertidal and marine study areas and describes the predicted effects of the proposed development on this baseline. The terrestrial baseline and associated effects have been assessed as part of the planning application for the consented WwTW, and pre-commencement archaeological works conditioned as part of the planning decision for the main terrestrial site. This included an archaeological desk-based assessment undertaken by Arup. This previous work is not repeated in full in this section and only a summary is included with a main focus upon further assessment of the baseline and potential effects below MHWS.

This section is accompanied by the following appendices:

- **Appendix M**: Heritage Desk Based Assessment (prepared by Arup and previously included as Appendix N to Scoping Report);
- **Appendix N**: Withernsea Long Sea Outfall GI, Factual Report on GI (prepared by Environmental Scientifics Group Limited (ESG)); and
- **Appendix H**: Withernsea Outfall Marine Site Investigation, Phase 1 Hydrographical and Geophysical Survey (prepared by ESG and previously included as Appendix G to Scoping Report).

12.2. Consultation

Consultation responses relevant to the assessment of the marine historic environment, and detail on how these have been addressed, are set out in **Table 12.1**.

Table 12.1 Consultation Responses

Consultee	Date /Document	Comment	Response / where addressed in the ES
MMO (Historic England)	Scoping Opinion (05/11/2018)	Under Section 6.3.2 of the Scoping Report, impacts to the marine historic environment have been 'scoped out'. However, the MMO consider that the there is a high potential for geoarchaeological evidence to be preserved within offshore deposits and therefore advise that impacts to the marine historic environment be 'scoped in' under the ES.	This section has been prepared to assess impacts to the marine historic environment.
MMO (Historic England)	Scoping Opinion (05/11/2018)	In assessing the impact to the historic marine environment, the MMO advise that primary data sources (e.g. side scan sonar, sub-bottom sonar, magnetometry, bathymetry, boreholes, and sediment	The assessment of the marine historic environment drawing upon geotechnical data and marine geophysical data acquired for the scheme is presented in **Section 12.5.3**.

Consultee	Date /Document	Comment	Response / where addressed in the ES
		samples) be considered alongside desk-based surveys to fully inform the impact assessment of the works on the historic marine environment.	
MMO (Historic England)	Scoping Opinion (05/11/2018)	Specifically, the MMO consider that any boreholes recovered must be made available to a geoarchaeologist for review and palaeoenvironmental sampling.	Borehole logs acquired for the scheme have been reviewed and demonstrate low palaeoenvironmental potential as discussed in **Section 12.5.4**.
MMO (Historic England)	Scoping Opinion (05/11/2018)	The MMO also consider that a deposit model of the subsurface sediments must also be included within the ES. This model must be informed by existing and new borehole data and considered within an geoarchaeological desk-based assessment of likely impacts of the works to the Doggerland area.	Due to the low geoarchaeological/palaeoenvironmental potential of the deposits within the study area (see **Section 12.5.4**) a descriptive 'deposit model' supported by (two dimensional) illustrations (Appendix 13.3) is provided. Potential impacts are described in **Section 12.6.1**.
MMO (Historic England)	Scoping Opinion (05/11/2018)	In order to fully assess the likely impacts of the development on the historic terrestrial environment, the MMO advise that a geoarchaeologist be consulted on the likely impacts to areas with deep superficial deposits related to Holocene lacustrine or alluvial sediments.	Borehole logs acquired for the scheme have been reviewed. Geoarchaeological potential is described in **Section 12.5.4** and likely impacts in **Section 12.6.1**.
MMO (Historic England)	Scoping Opinion (05/11/2018)	The MMO advise that consultation advice be obtained from Historic England to ensure that an appropriate assessment is undertaken with respect to the likely impacts to the historic environment, both marine and terrestrial, from the proposed development.	Preliminary consultation undertaken with Historic England Assistant Science Advisor (Yorkshire) via telephone 26th November 2018.
Historic England Assistant Science Advisor (Yorkshire)	Telephone conversation (26/11/2018)	Geoarchaeology should form part of the terrestrial site investigation and recording as required in the Written Scheme of Investigation (WSI) (planning decision, condition 4) as advised by the Humber Archaeology Partnership.	Recommended that geoarchaeology is considered as part of the programme of works for terrestrial mitigation set out in the WSI (see Section **12.6.1.1**).
Historic England Assistant Science Advisor (Yorkshire)	Telephone conversation (26/11/2018)	The ground investigation report and marine geophysical report should be made available to Historic England for review.	Reporting from surveys undertaken in 2017 have been included as sources of data to inform this assessment and are included as appendices to this ES.
Historic England Assistant Science Advisor (Yorkshire)	Telephone conversation (26/11/2018)	The deposit model must demonstrate any potential for sub-surface deposits relating to pre-Devensian interglacial (Palaeolithic) phases to be present within the glacial till. Scientific dating should be considered to confirm that the glacial till is of Devensian date and does not incorporate previous (Palaeolithic) interglacial deposits.	Geoarchaeological potential is described in Section **12.5.4.**

Consultee	Date /Document	Comment	Response / where addressed in the ES
Historic England Assistant Science Advisor (Yorkshire)	Telephone conversation (26/11/2018)	Lacustrine deposits are of geoarchaeological interest and are rarely looked at from this area. However, the presence of a possible lacustrine deposit in only a single borehole demonstrates limited potential.	Geoarchaeological potential is described in Section **12.5.4.**
Historic England Assistant Science Advisor (Yorkshire)	Telephone conversation (26/11/2018)	The potential for archaeological material eroded from the cliffs to be present should be considered, supported by the interpretation of marine geophysical survey data.	The assessment of the marine historic environment drawing upon geotechnical data and marine geophysical data acquired for the scheme is presented in Section **12.5.3.**

12.3. Methodology

12.3.1. Study Area

For the purposes of this section, the description of the known and potential baseline, and the narrative describing the potential for impact, is divided into the terrestrial study area (the scheme footprint plus the 500m buffer above MHWS) and the intertidal and marine study area illustrated in **Figure 8.1**.

A heritage desk-based assessment, undertaken by Arup, was submitted as part of the scoping report in June 2018 (Appendix M). The assessment focused on a study area comprising the footprint of the WwTW, the rising main and LSO plus a 500 m buffer. To ensure consistency, where required to discuss terrestrial impacts, this study area has been retained for the purposes of the assessment presented here (**Figure 12.1**).

12.3.2. Data Sources

The primary source of data for the terrestrial and intertidal sections of the study area is the desk-based assessment prepared by Arup (**Appendix M**) as part of scoping for the scheme. The report states that the following were consulted in preparing the assessment:

- Humber Archaeological Partnership (Humber Historic Environment Record (HER));
- East Riding local archives;
- Online historical resources;
- Archaeological Data Service (ADS); and
- Historic England Aerial Photography Archives.

534000 536000 538000

426000 424000

N

Stonebridge
Hull Road
Great England Hill
Catchwater Drain
Wingstead Drain
North Carr Dales Farm
Queen Street
Queen's Gap Heath
Red House Farm
North Field
The Haven
A1033
Hollym
Mere
North Leys Road
South Leys Road
Neville's Farm
Holmpton Road
Toffling Farm
New Farm
Fair View Farm
Hollym Road
Mile House
North Field
Greenland Farm
Scarborough Hill
Nevills Drain
Withernsea Road
Main Road
Holmpton
North Field

0 1 Kilometres

Legend

- Study Area
- Proposed Scheme Boundary
- LSO Section above MHWS
- Withernsea WwTW Planning Boundary
- Rising Main Boundary

Client: Yorkshire Water Services	Project: Withernsea LSO EIA

Title: **Historic Environment Study Area**

Figure: 12.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	VC	A3	1:20,000

Co-ordinate system: British National Grid

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Further sources accessed for the additional assessment presented below are listed in **Table 12.2**.

Table 12.2 Data Sources

Data	Year	Coverage	Notes
Information on designated heritage assets accessed via the National Heritage List for England online	2018	Whole study area	https://historicengland.org.uk/listing/the-list/
Results of ground investigations	2018	LSO	Boreholes and trial pits undertaken by ESG (**Appendix M**)
Results of historic ground investigations	1988 to 2013	WwTW main site and LSO	Specific reference to overwater cores acquired at Withernsea outfall by Norwest Holst Soil Engineering Ltd (Norwest Holst, 1988) and Alluvial Mining Co. Ltd (Alluvial Mining, 1990)
Results of marine geophysical survey	2017	Marine study area	Data acquired July to August 2017 (**Appendix H**) summarised below
Data on wrecks and obstructions from the United Kingdom Hydrographic Office (UKHO)	2018	Marine study area	OceanWise data via https://www.emapsite.com/
Data on reported losses (maritime and aviation) from the National Record of the Historic Environment (NRHE)	2018	Marine study area	https://www.pastscape.org.uk

The marine geophysical survey data acquired in July to August 2017 by ESG comprised:

- Multibeam Bathymetry (R2Sonic 2022, minimum 50% overlap between swaths);
- Side Scan Sonar (Klein system 3000, 30 m line spacing);
- Sub-Bottom Profiler (Innomar SES 2000 parametric sub-bottom profiling system (pinger) and Geometrics MicroEel (boomer), 20 m line spacing, with 100 m cross lines); and
- Magnetometer (Geometrics G-882 Caesium Vapour Marine Magnetometer, 5 m line spacing).

Full details of the technical specifications for the survey are provided in the ESG technical report (**Appendix H**). The specifications for survey area data coverage (minimum 100%), surface and sub-surface positioning and equipment are within parameters suitable for archaeological assessment in accordance with industry good practice (e.g. Plets *et al.*, 2013). Data was processed and interpreted by ESG with the objective of providing information on:

- Seabed levels;
- Bedrock level and any geomorphological features present e.g. buried channels;
- The presence of any debris or obstructions on or in the seabed sediments;

- Seabed characterisation; and
- The presence of any magnetic targets.

The results as presented in the ESG technical report (**Appendix H**) have been used to inform an assessment of the potential for previously undiscovered buried or submerged archaeology to be present within the study area (see **Section 12.5.3**).

In addition to the marine geophysical (seismic) data, ESG also utilised the information from their September 2017 borehole logs and from the overwater boreholes from Alluvial Mining acquired in November 1990, to provide an interpretation of the sub-surface geology (**Appendix N**). The geotechnical logs from all of the 2017 boreholes and trial pits have also been used to inform an understanding of archaeological potential, including a description of a deposit model within the study area (see **Section 12.5.4**).

12.4. Guidance documents

The following guidance has been used as relevant to the assessment presented within this section:

- The Historic Environment in Local Plans: Historic Environment GPA in Planning Note 1 (Historic England 2015a);
- Managing Significance in Decision-Taking in the Historic Environment: Historic Environment GPA in Planning Note 2 (Historic England 2015b);
- The Setting of Heritage Assets: Historic Environment GPA in Planning Note 3 (Second Edition) (Historic England 2017a);
- Chartered Institute for Archaeologists' Standard and Guidance for Historic Environment Desk Based Assessments (2014) and Code of Conduct (2014);
- Department for Communities and Local Government (2014). Planning Practice Guidance: Conserving and enhancing the historic environment;
- Historic England (2017b). Conservation Principles: For the Sustainable Management of the Historic Environment (Consultation Draft 10th November 2017, Historic England); and
- JNAPC Code of Practice for Seabed Development (Joint Nautical Archaeology Policy Committee and TCE, 2006).

12.4.1. Heritage Impact Assessment

12.4.1.1. Types of Impact

Potential impacts to heritage assets within the study area include both direct and indirect impacts.

Construction activities for the proposed scheme have the potential to directly impact heritage assets present within the scheme footprint. This could comprise direct damage to, or destruction of, above ground, submerged or sub-surface remains or the loss or disturbance of the relationships between assets and their wider surroundings.

Direct impacts may occur in association with intrusive ground works. The extent of any impact will depend on the presence and nature and depth of archaeological remains, in association with the depth of the proposed construction-related groundworks. The effects of such impacts are likely to be permanent and irreversible in nature. Once archaeological deposits and material, and the relationships between deposits, material and their context have been damaged or disturbed, it is not possible to reinstate or reverse those changes. As such, direct impacts to the fabric or physical setting would represent a total loss of an asset, or part of it, and the character, composition or attributes of the asset would be fundamentally changed or lost from the site altogether.

The proposed scheme also has the potential to indirectly impact the settings of both designated and non-designated heritage assets within the study area. The setting of a heritage asset is described as the surroundings in which a heritage asset is experienced (Historic England, 2017a). Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance or may be neutral.

A wide range of factors can affect whether indirect setting impacts may occur to heritage assets. This is most frequently described in terms of the visual impact of such activities. However, this is not the only factor which is relevant to the assessment of potential impacts upon setting, as described in the Planning Practice Guide (Department for Communities and Local Government, 2014):

“The extent and importance of setting is often expressed by reference to visual considerations. Although views of or from an asset will play an important part, the way in which we experience an asset in its setting is also influenced by other environmental factors such as noise, dust and vibration from other land uses in the vicinity, and by our understanding of the historic relationship between places”.

The proposed scheme also has the potential to directly and indirectly change the hydrodynamic and sedimentary process regimes, both locally and regionally. Changes in coastal processes can lead to re-distribution of erosion and accretion patterns, while changes in tidal currents, for example, may affect the stability of nearby morphological and archaeological features. Indirect impacts to heritage assets may occur if buried heritage assets become exposed to marine processes, due to increased wave/tidal action for example, as these will deteriorate faster than

those protected by sediment cover. Conversely, if increased sedimentation results in an exposed site becoming buried this may be considered a beneficial impact.

12.4.2. Approach to Impact Assessment

The heritage impact assessment identifies the known and potential heritage assets which may be impacted by the scheme (directly or indirectly), describes their heritage significance and how this significance may be subject to change during the construction and operation of the proposed scheme.

In order to allow for consistency between the assessment presented by Arup (**Appendix M**) and the assessment presented below, the factors for assessing the heritage significance of heritage assets, defined as 'environmental value' by Arup (**Appendix M**, Table 2), have been brought forward to this assessment as described in **Table 12.3**.

Table 12.3 Factors for assessing environmental value (heritage significance) of heritage assets

Value	Description
Very High	World heritage sites (including nominated sites). Assets of acknowledged international importance. Assets that can contribute significantly to acknowledged international research objectives.
High	Nationally important assets (scheduled monuments, Grade I and II* listed buildings, Grade I registered parks and gardens). Assets with the potential to contribute to national research objectives.
Medium	Designated (conservation areas, Grade II listed buildings, Grade II registered parks and gardens) or non-designated assets that are of regional importance. Assets with the potential to contribute to regional research objectives.
Low	Assets of local importance (locally listed buildings). Assets compromised by poor preservation and/or poor survival of contextual associations. Assets of limited value, but with potential to contribute to local research objectives.
Negligible	Assets with very little or no surviving archaeological interest.

Similarly, the extent of change, defined by Arup as 'magnitude of impact' (**Appendix M**: Table 3) as set out in **Table 12.4**.

Table 12.4 Magnitude of impact (extent of change)

Magnitude	Description
Major (Very High/High)	Complete destruction/demolition of site or feature. Change to the site or feature resulting in a fundamental change in our ability to understand and appreciate the resource and its historical context and setting.
Moderate (Medium)	Change to the site or feature resulting in an appreciable change in our ability to understand and appreciate the resource and its historical context and setting.
Minor (Low)	Change to the site or feature resulting in a small change in our ability to understand and appreciate the resource and its historical context and setting.
Negligible (Very Low)	Negligible change or no material change to the site or feature. No real change in our ability to understand and appreciate the resource and its historical context and setting.
No Change	No change.

Significant impacts are hereafter identified with reference to the impact assessment matrix in **Section 4**.

12.5. Existing Environment

12.5.1. Terrestrial

There are no designated heritage assets within the scheme footprint and five within the 500m buffer (**Figure 12.2**). These are all listed buildings within Withernsea:

- Church of St. Nicholas, Grade II* (List ID: 1366257);
- Withernsea Lighthouse and adjoining Keeper's House, Grade II (List ID: 1083479);
- Outbuildings, garden wall & gate at Withernsea Lighthouse, Grade II (List ID: 1310188);
- St. Matthew's Church, Grade II (List ID: 1392281); and
- War Memorial, Grade II (List ID: 1439669).

There are three further Grade II listed buildings in Hollym which are located just beyond the 500 m buffer (**Figure 12.2**): Church of St Nicholas (List ID: 1083479), gravestone to the south west of the church (List ID: 1310412) and Pinfold on Northside road (List ID: 1083480).

There are 74 non-designated heritage assets within the terrestrial study area listed in the gazetteer by Arup (**Appendix M**) comprising various find spots, indications of occupational evidence and historical refences. The locations, as provided in this gazetteer, are illustrated on **Figure 12.3**.

Only five of the records are described by Arup (**Appendix M**) as located within the terrestrial scheme footprint:

- Site of Withernsea Gas Works (HER ID: MHU11371):
- Anti-tank blockade (HER ID: MHU18876);
- Site of Withernsea Hospital (HER ID: MHU7487);
- Site of brickworks (HER ID: MHU11414); and
- Former Hull to Withernsea Railway (HER ID: MHU8830).

534000 536000 538000

426000 428000 424000

N

1392281
1083470
1310188
1439669
1366257
1083479
1083480
1310412

Stonebridge
Hull Road
Great England Hill
Catchwater Drain
Wingstead Main
North Carr Dales Farm
Red House Farm
Withernsea Road
North Field
The Haven
Holmpton Road
A1033
Hollym
North Leys Road
South Leys Road
Nevilles Farm
Toffling Farm
New Farm
Fair View Farm
Hollym Road
Scarborough Hill
Nevills Drain
Mile House
North Field
Greenland Farm
Holmpton
Withernsea Road
Main Road

0 1 Kilometres

Legend

- Study Area
- Proposed Scheme Boundary
- LSO Section above MHWS
- Withernsea WwTW Planning Boundary
- Rising Main Boundary

Listed Buildings

Grade

- II
- II*

Client: Yorkshire Water Services	Project: Withernsea LSO EIA

Title: Designated Heritage Assets

Figure: 12.2

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	VC	A3	1:20,000

Co-ordinate system: British National Grid

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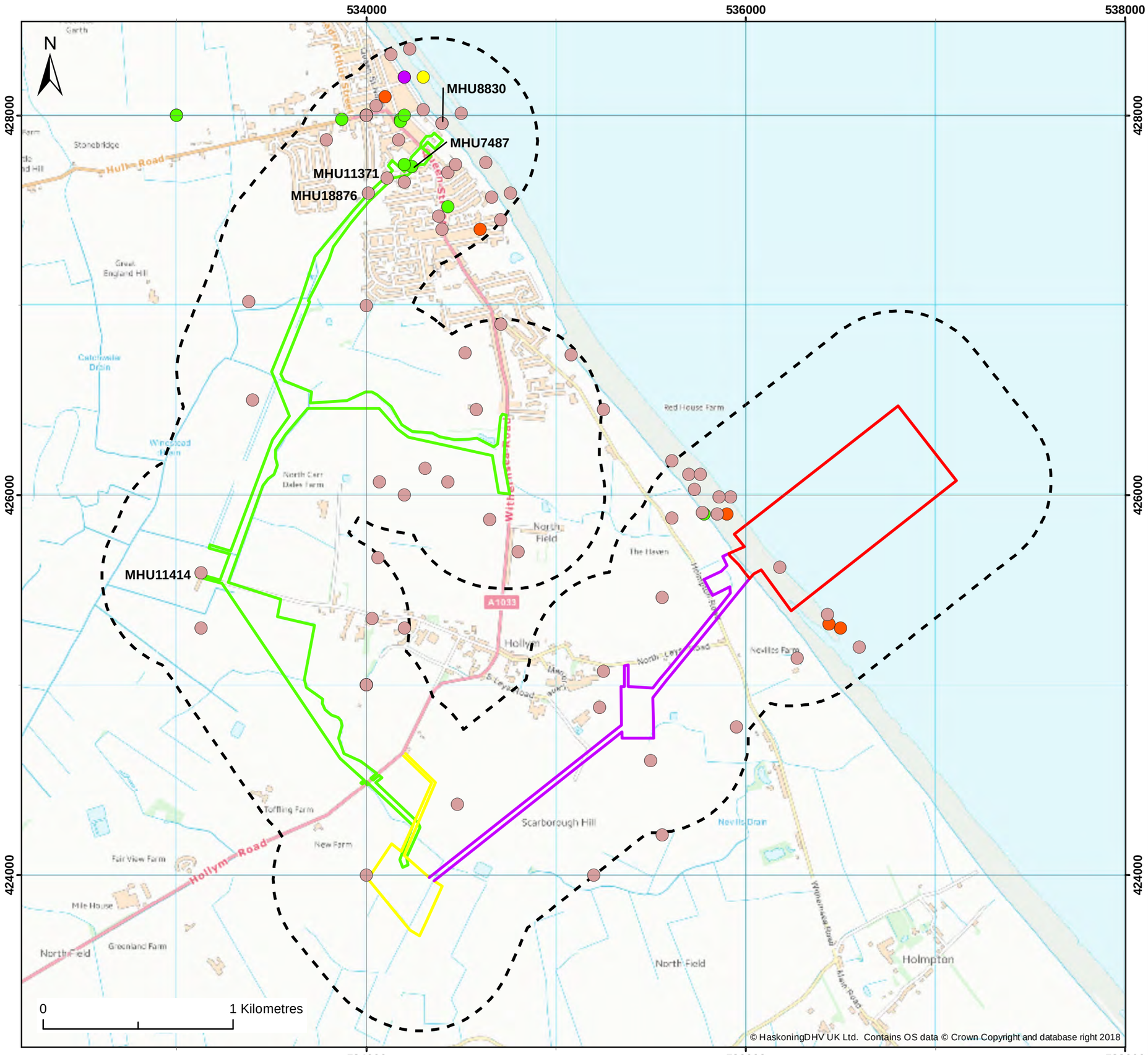

Legend

- Study
- Proposed Scheme Boundary
- LSO Section above MHWS
- Withernsea WwTW Planning Boundary
- Rising Main Boundary

Non-designated Heritage

Type

- Building
- Find Spot
- Landscape
- Maritime
- Monument

Client: Yorkshire Water Services	Project: Withernsea LSO EIA

Title:

Distribution of Non-designated Heritage Assets Recorded by Arup (2018)

Figure: 12.3

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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No visible evidence of the former anti-tank blockade (MHU18876), hospital (MHU7487) or gas works (MHU11371) remains above ground, although Arup note that buried evidence may potentially survive. The embankments and cut of the former Hull to Withernsea railway (MHU8830) are described as extant. All of these are located within the footprint of the rising main. The former 19th century brickyard (MHU14414) is recorded at the access point for the rising main and again, although no evidence is visible above ground, Arup suggest that buried evidence may survive. All of these five heritage assets are determined to be of low environmental value (heritage significance) by Arup.

Further detailed information on the heritage assets within the study area (outside the scheme footprint) can be found in the existing desk-based assessment (**Appendix M**) and is not repeated here, except where relevant to the impact assessment in **Section 12.6** below.

In additional to the recorded heritage assets described above, the potential for encountering previously unrecorded, buried archaeology within the study area is described in detail by Arup (**Appendix M**, Section 5.3). This archaeological potential is summarised in **Table 12.5**.

Table 12.5 Summary of archaeological potential

Description	Potential	Qualitative criteria described by Arup (Appendix M)
Remains associated with prehistoric activity	Medium	There is historical or indirect evidence to suggest unknown archaeological materials or features may be encountered.
Remains associated with Romano-British activity	Medium	
Remains associated with early medieval activity	Medium	
Remains associated with medieval activity	Medium	
Remains associated with post-medieval activity	Medium	
Remains associated with modern activity	Low	The site is considered to be unlikely to contain archaeological evidence, or archaeological evidence has previously been removed or severely truncated by previous development or investigation.
Remains with geoarchaeological potential	Low	

The geoarchaeological potential of the study area is discussed further in **Section 12.5.4** below.

12.5.2. Intertidal

There are no designated heritage assets within the intertidal study area.

The study area incorporates two intertidal sections (**Figure 12.1**). To the north, the study area buffer around the footprint of the rising main from Memorial Gardens incorporates Withernsea beach. To the south, the study area incorporates the intertidal area around the proposed LSO.

The records located on the beach at Withernsea include an elephants tooth (MHU2654) found on sands at the foot of Owthorne cliffs, and two Bronze Age log boats also found at Owthorne in the 18th century (MHU2655). Also from this area, spring tides of 1839 exposed a large area of a submerged forest of Mesolithic date on the shore off Owthorne, known as Noah's Wood (MHU2653). Also found were animal bones and molluscs from a freshwater lake. A further record

corresponds to Withernsea Mere (MHU8993). The Rapid Coastal Zone Assessment (RCZA) for Yorkshire and Lincolnshire (Brigham *et al*, 2008) describes that a gap in the clay cliff between Owthorne and Withernsea was probably the site of an early mere, mentioned in the 13th and 14th centuries, but breached in the 15th century. The site of the mere remained as a large bay as late as 1560, shown on Burleigh's map from this year. 'Withernsea mere' and 'Owthorne Mere' are shown on the 1st Edition Ordnance Survey (OS) map, and probably formed in the later silted up remnants of the basin.

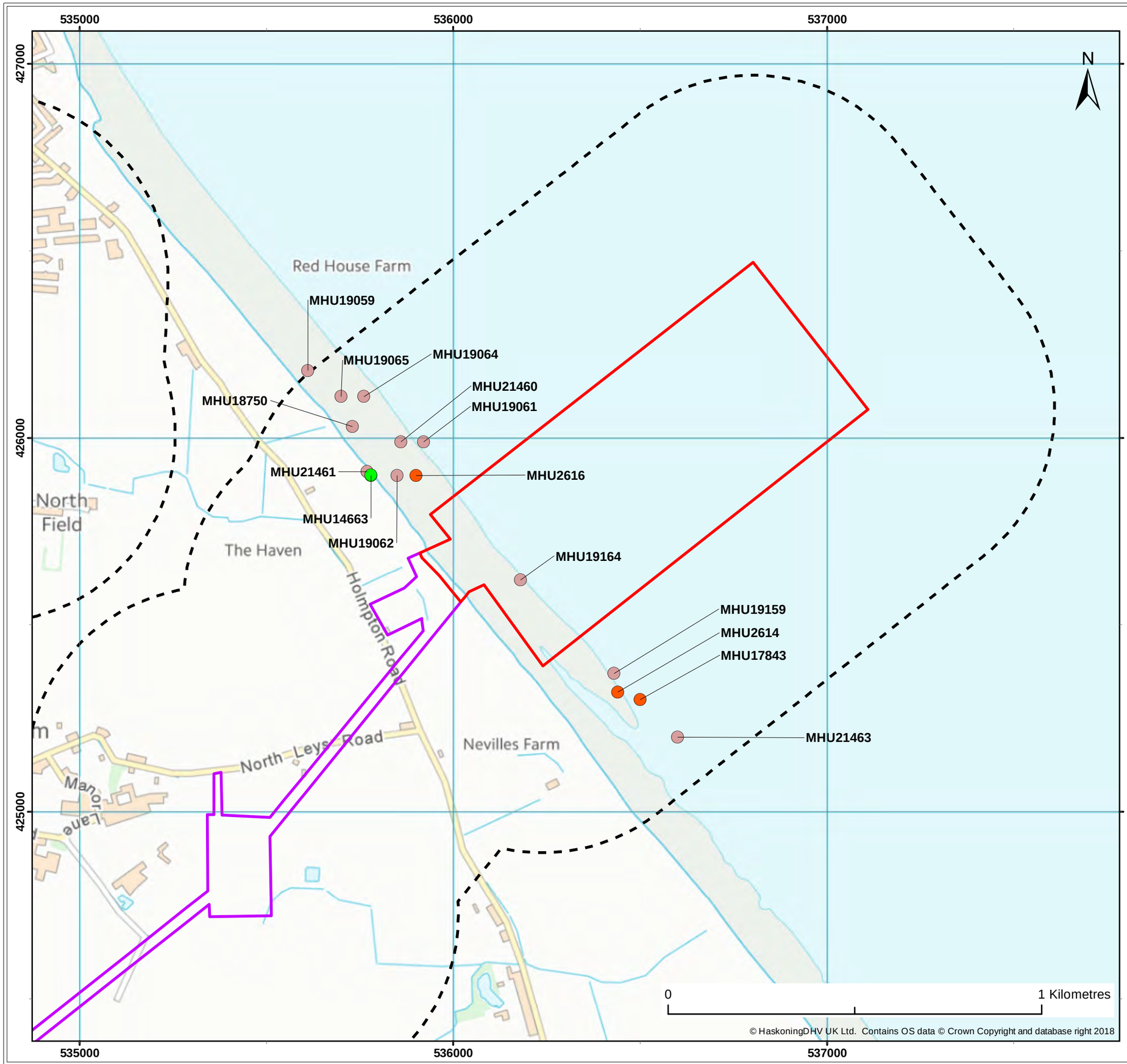
These sites within the northern intertidal section all correspond to sites and finds from areas now lost to the sea through coastal erosion. Much of medieval Withernsea had already been lost to the sea during the later medieval and post-medieval periods (Brigham *et al*, 2008) and the village of Owthorne was entirely lost to the sea in the late 18th to early 19th century. Buildings lost include the church of St. Peter (MHU2649), finally lost in 1816. No construction or related activity is planned in this intertidal area.

There are 15 previously recorded heritage assets listed in Arup's gazetteer (**Appendix M**) which are located within the intertidal zone around the proposed LSO (**Figure 12.4**). Only one of these, the site of a weapons pit and trench (HER ID: MHU19164), is located within the footprint of the LSO. Arup, however, record this as having been removed or lost to the sea.

Three of the records are findspots of coins comprising a Roman Denarius of Hadrian (MHU17843), a Roman coin hoard at Intack Farm (MHU2616) and an Iron Age bronze coin of Cunobeline (MHU2614).

One of the records corresponds to the location of the early 19th century Intack Farm (MHU 14663). The RCZA (Brigham *et al*, 2008) states that much of the farm appears to have been lost to coastal erosion and the recorded location, now seaward of the eroding cliff line, would appear to indicate that this farm has in the most part, if not in its entirety, been lost to the sea.

The remining records relate to former Second World War coastal defences. To the south east of the proposed LSO, is the site of a possible radar mast base at Neville's Farm (MHU21463) and the site of a gun emplacement (MHU19159). To the north-west side of the intertidal study area are nine further records relating to defensive installations at Intack Farm. The farm itself is recorded as having been fortified during the war with former military buildings recorded by the Humber HER (MHU21461).



Legend

- Study
- Proposed Scheme Boundary
- LSO Section above MHWS

Intertidal and Marine Heritage

- 19th century Intack Farm
- Iron Age and Roman Coins
- Second World War Coastal

Client: Yorkshire Water Services	Project: Withernsea LSO EIA

Title: Intertidal and Marine Heritage Assets

Figure: 12.4

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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The RCZA (Brigham *et al*, 2008) describes how within the parish of Hollym the northern part of the cliff was defended by a number of military installations located around the site of Intack Farm. The records described by Arup (**Appendix M**) from the Humber HER include four pillboxes (MHU19065, MHU19062, MHU19061 and MHU18750). The RCZA describes the first three of these as standard lozenge type design, and all as being destroyed by the time of the Holderness Survey undertaken in 1992 for the Royal Commission on the Historical Monuments of England. The fourth (MHU18750) is described as a lozenge shaped pillbox (east of Intack farmhouse) differing slightly from the standard design, with the recesses of the loops on this particular pillbox being cut rather than cast like the standard. The pillbox is recorded as being in good condition in 1992 but, at that time, was also considered to be at risk. It is assumed that due to coastal erosion since 1992, this pillbox is also no longer extant.

The remining four records correspond to the site of an Operation Diver anti-aircraft battery (MHU19059) consisting of four emplacements with guns mounted on 'pile' platforms, and a number of huts, the site of a searchlight battery consisting of one large and three small emplacements and two huts (MHU19064), and the site of trackways and barbed wire representing access ways and obstructions lines across coastal defences system (MHU21460). All of these are recorded as being destroyed by 1992.

Although these defensive installations are no longer extant due to coastal erosion, remains may still survive on the beach or within the nearshore area, eroded from the cliff and there is potential for isolated discoveries of archaeological material relating to these former cliff top and beach defences to occur during construction, particularly where open trenching is utilised. If present, isolated discoveries of material eroded from the cliff would be of low heritage significance in accordance with the definition provided in **Table 12.3** (assets compromised by poor preservation and/or poor survival of contextual associations, assets of limited value, but with potential to contribute to local research objectives).

The potential for *in situ* archaeological sites or material to be present within the intertidal area is anticipated to be precluded by the high levels of erosion and the high mobility of the beach deposits which overlie the glacial till. As discussed in **Section 7** (Coastal Processes and Hydrodynamics) the foreshore at Withernsea comprises a predominantly sandy beach overlying a glacial till shore platform. Beach levels at the Withernsea LSO are highly variable, with changes between successive surveys that are routinely undertaken by ERYC of the order of metres possible. Beach levels are often locally reduced to levels which expose the underlying clay and boreholes acquired at the base of the cliff show the presence of only 0.25 m (BH410), 0.20 m (BH410A), 0.13 m (BH411) and 0.90 m (BH411A) of beach deposits overlying the glacial till at the time of survey in 2017 (**Appendix N**).

Potential archaeological discoveries within the intertidal zone are, therefore, anticipated to comprise secondary context, isolated finds, most likely associated with the former Second World War defences.

The geoarchaeological potential of the study area is discussed in **Section 12.5.4** below.

12.5.3. Marine

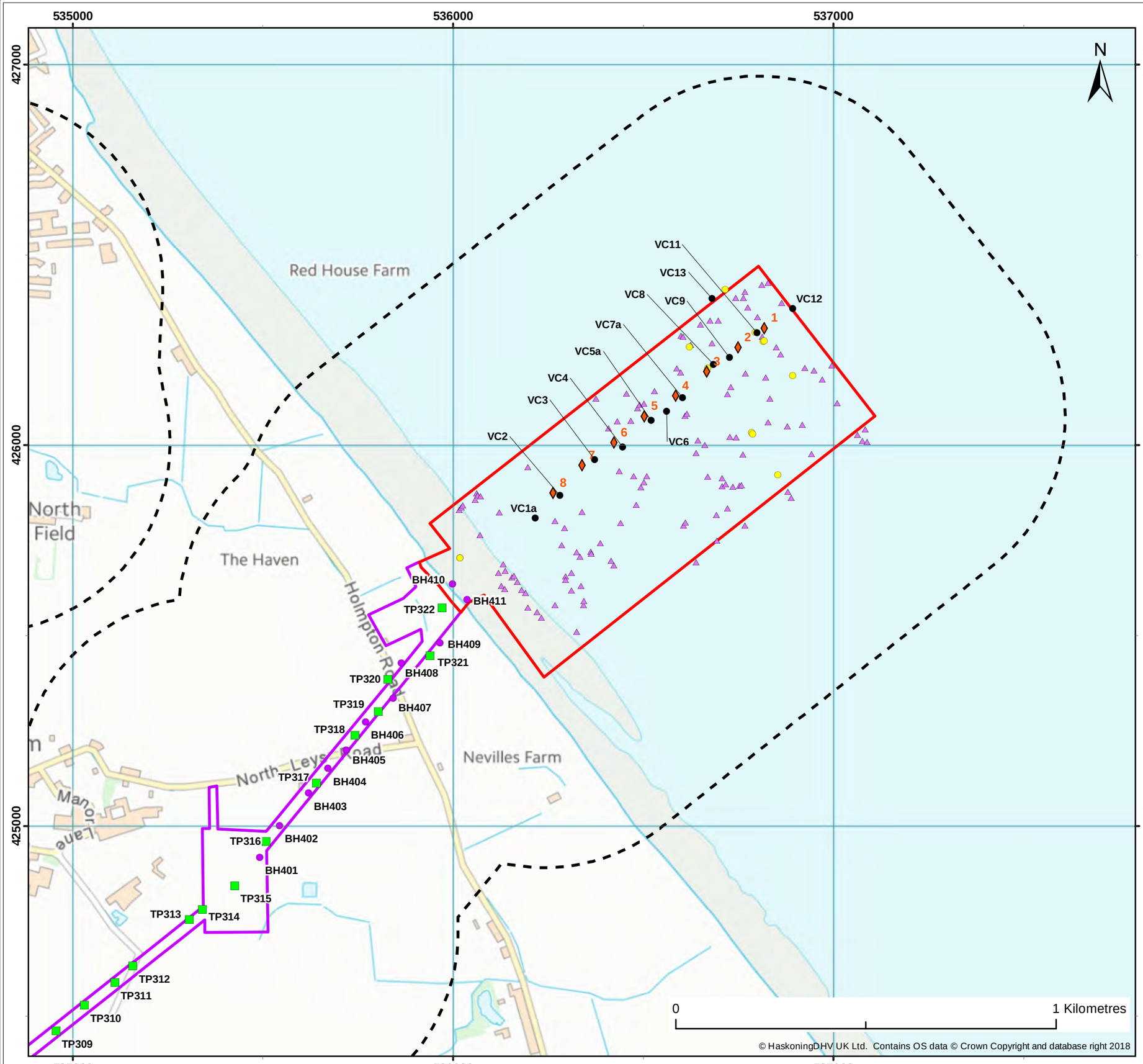
There are no designated heritage assets, nor any non-designated heritage assets within the marine study area.

The closest wreck recorded to the study area is located c. 765 m to the north west of the end of the proposed LSO. The location of the wreck *Crux* recorded by the UKHO (ID 9032) corresponds to a very small wreck known locally as the *Crux*, described as probably originally a wooden hull, as nothing remains other than boiler, engine, prop shaft and cast-iron propeller, which all lie in a line at about 90 degrees to the shore line (NRHE 907874). The *Crux* is recorded in the NRHE record as stranded at Out Newton in 1912. An associated loss record (NRHE 1374609) describes the vessel as a trawler owned by the Grimsby and North Sea Steam Tug Company, built in 1896 at Govan and stranded at Holmpton on a fishing and return trip.

No further losses are recorded by the NRHE within 2 km of the seaward end of the proposed LSO, further indicating that the potential for encountering previously undiscovered maritime remains within the study area is low. As described in **Section 12.5.2** above, however, isolated discoveries of material associated the remains of Second World War defences, specifically those associated with Intack Farm, may be encountered within the nearshore area, eroded from the cliff and beach deposits.

The bathymetric survey data acquired by ESG shows that the inshore portion of the study area is characterised by a featureless sandy seabed with the seabed becoming gravelly with scattered boulders from approximately 200 m offshore with wave-like features, likely to be gravely in nature, also evident (**Appendix H**, Drawing L7058-17/02). A number of objects indicative of cobbles and small boulders were also noted. The outfall diffuser and redundant inshore concrete inspection hatch are visible in the data and there is an indication that the existing outfall is near the surface from approximately 500 m to 800 m offshore, as a linear feature is evident in the data.

The route of the current outfall pipeline was clearly seen in the magnetometer data with 121 further magnetic targets identified by ESG (**Appendix H**, Magnetometer Contact Listing in Appendix B) and described as most likely associated with small items of debris from fishing and other sources (**Figure 12.5**). ESG also conclude that the calculated depth (mean 2.63 m) from sensor for many of the targets identified would indicate that they are on the surface or shallowly buried. Only two of these are located within 10m either side of the proposed LSO (Target ID 65 and 67).



Legend

- Study Area
- Proposed Scheme Boundary
- LSO Section above MHWS
- ESG Side Scan Sonar Targets
- ESG Magnetic Targets

Locations of Historic Marine Borehole and Vibrocores

- Alluvial Mining 1990
- Norwest Holst

ESG Ground Investigations

- Boreholes
- Trial Pits

Client: Yorkshire Water Services	Project: Withernsea LSO EIA

Title: Ground Investigation Locations and Geophysical Anomalies

Figure: 12.5

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid

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Twelve targets were recorded in the side scan sonar data (**Appendix H**, Side Scan Sonar Target Listing in Appendix B), including the pipeline (Anomaly Number 2) and the outfall diffuser (Anomaly Number 10) and an item of linear debris, c. 5.40 m long (Anomaly Number 3). There is no magnetic target associated with this linear anomaly, which could represent a length of rope, possibly fishing debris. The remaining targets are described as debris or suspected debris and only one (Anomaly Number 1) is located in proximity to a recorded magnetic target (Target ID 68) which could indicate a ferrous item. None of the side scan sonar anomalies are located within 10m of the proposed LSO.

At present, it is not possible to determine if these anomalies represent modern or archaeological debris. However, the available data does not indicate the presence of a wreck, for example, but rather isolated, small items of debris, which could be of potential maritime origin. Closer to the shore, where the bathymetry data indicates a sandy seabed, there may be potential for small items of debris to be buried, although the historic core logs (Norwest Holst Soil Engineering Ltd 1988, Alluvial Mining Co. Ltd. 1990) indicate only a thin veneer of sand (less than 0.5 m) with gravel or clay layers (till) outcropping further offshore (**Appendix H**, Drawing L7058-17/02). The potential for buried archaeological remains is, therefore, concluded to be low.

If present, isolated discoveries of maritime origin, or those associated with the former coastal defences eroded from the beach or cliff, would be of low heritage significance in accordance with the definition provided in **Table 12.3** (assets compromised by poor preservation and/or poor survival of contextual associations, assets of limited value, but with potential to contribute to local research objectives).

The geoarchaeological potential of the study area is discussed in **Section 12.5.4** below.

12.5.4. Geoarchaeology

As described in **Table 12.5** above, Arup (**Appendix M**) concluded that the potential for remains with geoarchaeological potential to be present within the study area is low. In their scoping opinion provided to the MMO, however, Historic England drew attention to alluvial and lacustrine deposits that may be related to prehistoric archaeology mapped within the area. It was recommended, therefore, that a geoarchaeologist be consulted on the areas with deep superficial deposits related to Holocene lacustrine or alluvial sediments. It was also suggested that there is a high potential for geoarchaeological evidence to be preserved within offshore deposits.

A review of historic geotechnical data undertaken for the scheme indicates that the ground conditions across study area comprise localised deposits of made ground (terrestrial study area) or marine sands (intertidal and marine study areas), overlying glacial deposits, which overlie the Flamborough Chalk (Royal HaskoningDHV 2015). The Devensian glacial till, directly overlying the chalk bedrock, was laid down during the last ice age when humans would have been absent from this part of Britain. The till itself, therefore, is of low archaeological and geoarchaeological potential, although archaeological material may be present within secondary contexts, as isolated

finds within the till comprising material from terrestrial phases that may have been reworked by glacial processes, for example.

Arup (**Appendix M**) describe that relatively small and sporadic pockets of lacustrine deposits of sand, silts and clay are distributed within the study area, with one lacustrine deposit recorded by the British Geological Survey (BGS) in the north-east corner of the proposed main site. While it is noted that this lacustrine deposit is likely, depending on the degree of waterlogging, to provide good survival of palaeoenvironmental remains and possibly also of artefactual remains, samples taken close by the BGS do not record any geoarchaeological evidence and Arup conclude that there is a low potential for geoarchaeological remains.

In the most westerly sections of the proposed rising main it anticipated that the glacial till may in part be overlain by alluvium. The superficial deposits recorded by the BGS record a spur of alluvium entering the study area from the south west associated with the course of the Winestead Drain. The mapped extant of the alluvium, likely to be composed of clay, silt, sand and gravel, passes to the north of the new WwTW site and LSO, but corresponds to the westerly section of the rising main, specially between Crofts Lane and the Withernsea Golf Club. If encountered during works, this alluvium should be considered of potential geoarchaeological interest.

Nine cable percussion boreholes and 23 trial pits carried out along the LSO route by ESG in 2017 (Figure 13.5). The exploratory hole logs are included in **Appendix M** (Appendix B). These show that glacial till is overlain by topsoil in all but one of the locations above MHWS. In Borehole BH409, located on the cliff top above the beach, a 0.7m layer of brown gravelly clayey fine to medium SAND was observed between the topsoil and till. The chalk bedrock was not encountered at 25m depth in any of the boreholes, which all terminated in glacial till. This supports the conclusion by Arup that the potential for geoarchaeological remains is low within the terrestrial section of the proposed LSO.

Exploratory holes (dynamic sampling) were also undertaken at two locations between the tides on the upper part of beach, at the base of the cliff close to the existing WwTW (Figure 13.5). Four logs (two from each location BH410, BH410A, BH411, BH411A) are recorded by ESG (**Appendix M**, Appendix B). All but BH410 record beach deposits overlying till. In BH410, a 1 m deep deposit described as firm to stiff thinly and thickly laminated dark brown slightly sandy slightly gravelly CLAY is recorded underlying the upper 0.25m of sand. This lamination indicates a lacustrine origin, forming within a cold climate low energy environment within a glacial pond or lake. This likely cold climate origin suggests that, as for the till, the geoarchaeological potential is low corresponding to a phase of human absence from the study area.

Within the marine study area, both geophysical data (sub-bottom profiler) and historic core data (see **Figure 12.5** for locations) was drawn upon by ESG (**Appendix H**, Section 4.4.4) in determining the sub-surface geology. The pinger (single channel) data penetrated to around 8 m below the seabed and four horizons were identified. The boomer (multi-channel) data penetrated up to 23m with three additional horizons below those identified from the pinger data. These horizons are described by ESG as follows:

- Horizon 1: base of the reworked surface sediments / top of Glacial Till (reflector SC01, **Appendix H**, Drawings L7058-17/05 and L7058-17/09);
- Horizon 2: base of a Glacial Till layer (reflector SC02/MC01, **Appendix H**, Drawings L7058-17/06, L7058-17/10, L7058-17/13 and L7058-17/18);
- Horizon 3: interface between Clay rich and Sand rich materials (reflector SC03, **Appendix H**, Drawings L7058-17/07 and L7058-17/11);
- Horizon 4: top of a sand and gravel layer (reflector SC04/MC02, **Appendix H**, Drawings L7058-17/08, L7058-17/12, L7058-17/14 and L7058-17/19);
- Horizon 5: change in Glacial Till composition (reflector MC03, **Appendix H**, Drawing L7058-17/15 and L7058-17/20);
- Horizon 6: change in Glacial Till composition (reflector MC04, **Appendix H**, Drawing L7058-17/16 and L7058-17/21);
- Horizon 7: change in Glacial Till composition (reflector MC05, **Appendix H**, Drawing L7058-17/17 and L7058-17/22).

The materials above Horizon 1 are interpreted as reworked surface sands, extending only to Chainage[4] (Ch.)500 and reducing in depth from 1m at Ch.0 to 0 m at Ch.500.

The base of the underlying glacial till layer (Horizon 2) has only been observed up to approximately Ch.750 in the pinger data (SC02) with the depth reducing from 6 metres at Ch.50 to less than 1 metre at Ch.750. In the boomer data (MC01) Horizon 2 has only been observed from Ch.100 (5m depth) up to approximately Ch.350 (4m depth).

Horizon 3, observed across the majority of the site in the pinger data only, and reducing from 7.2 m at Ch.50 to c. 1m at Ch 1100, is described as an interface between clay rich (overlying Horizon 3) and sand rich (underlying Horizon 3) materials.

Horizon 4 has been observed between Ch.475 (7.3m depth) and Ch.1100 (1.7m depth) in the pinger data (SC04) and represents the top of a sand and gravel layer. In the boomer data (MC02) Horizon 4 has been observed from Ch.100 (10m depth) up to approximately Ch.700 (3m depth).

The remaining horizons were seen in the boomer data only and are all located beneath the 3m depth of burial proposed for the LSO:

- Horizon 5 has been observed from Ch.100 across the majority of the survey area. Isopachyte thickness above Horizon 5 is interpreted to reduce from 15 metres at Ch.100 to 6 metres at Ch.1100;

[4] Chainage extends from 0 at the shore end of the geophysical survey area, to 1100 at the seaward extent of the geophysical survey area (See for example, Drawing L7058-17/05 (**Appendix I**, Appendix B)

- Horizon 6 has been observed from Ch.100 across the majority of the survey area. Isopachyte thickness above Horizon 6 is interpreted to reduce from 19.5 metres at Ch.100 to 8.5 metres at Ch.1100; and

- Horizon 7 has been observed from Ch.100 to the offshore survey extents. Isopachyte thickness above Horizon 7 is interpreted to reduce from 24 metres at Ch.100 to 12.5 metres at Ch.1100.

Geological cross sections through these interpreted horizons are illustrated in Drawing L7058-17/23 (**Appendix H**, Appendix B).

ESG (**Appendix H**) describe the glacial till as comprised of varying quantities and compositions of sand, gravel and clay, incorporating layers of sand or layers with an increased percentage of sand in the composition, within the layers interpreted as glacial till. This correlates with historic core data, including Alluvial Mining's BH7 (**Figure 12.5**), which reported several alternating, thin layers of sand and clays within the top 6 metres of sediment, and "lenses of sand" being reported in nearly all other borehole reports (Norwest Holst Soil Engineering Ltd, 1988 / Alluvial Mining, 1990). Similarly, within the beach boreholes undertaken by ESG in 2017, layers of sand are recorded within the glacial till:

- BH410, dense to very dense brown gravelly very silty fine to coarse SAND occurs from 8.70 m to the end of the borehole at 11.40 m;

- BH411, medium dense to dense dark greyish brown very gravelly silty fine to coarse SAND recorded from 3.30 m to 5.55 m depth; and

- BH411A, brown very gravelly clayey fine to coarse SAND recorded from 9.50 m to 9.90 m depth, and a layer of greyish brown slightly clayey SAND and GRAVEL from 10.50 m to the end of the borehole.

The till of the Holderness region is traditional divided into three, the lowest being termed the Basement Till, which rests on the underlying chalk, overlain by the Skipsea Till and Withernsea Till. A recent study of the provenance of Pleistocene till in east Yorkshire (Busfield *et al*, 2015) refers to Optically Stimulated Luminescence (OSL) age determinations of deposits between the Skipsea and Withernsea Tills, which show the Skipsea Till laid down during an initial glacial advance at c. 21.7 to 16.2 ka and a second advance and the deposition of the Withernsea Till occurring between c. 16.2 ka and 15.5 ka. The Basement Till is interpreted variously as either of Devensian age, or of earlier, pre-Ipswichian, Wolstonian age. These tills are separated by shallow marine sediments, which may be correlated within the study area to the sands observed in the boreholes described above.

The geophysical and geotechnical data from the intertidal and marine study areas, therefore, shows that the sub-surface deposits below MHWS comprise glacial till and associated cold climate layers or lenses of marine sand and gravel within the till, which are also considered to be of low geoarchaeological potential. Pre-Devensian interglacial (Palaeolithic) phases of human habitation

are not anticipated to be present at depths which would be reached during construction (proposed 3m burial depth). Any overlying, post-Devensian, Holocene deposits, associated with former terrestrial and inhabitable surfaces (during the Mesolithic), are also absent from the intertidal and marine study area having been eroded by marine processes, a key characteristic of the Holderness coast.

12.6. Potential Impacts

12.6.1. Prediction of potential effects during construction

12.6.1.1. Terrestrial

Potential impacts to known and potential heritage assets from the demolition of the existing WwTW and the construction of the new WwTW, the rising mains and LSO and temporary construction infrastructure were assessed by Arup (**Appendix M**) as set out in **Table 12.6**.

*Table 12.6 Summary of potential terrestrial impacts (**Appendix M**,Table 9)*

Heritage asset	Impact derived from	Magnitude of change	Significance of effects	Proposed mitigation	Residual effects
Direct Impacts					
Site of Withernsea Hospital, Queen Street South	Excavation of trenches for the installation of rising main.	Minor / Moderate	Slight Adverse	Watching brief and archaeological recording during construction ground works.	Slight Adverse
Site of Withernsea Gas Works	Excavation of trenches for the installation of rising main.	Minor / Moderate	Slight Adverse	Watching brief and archaeological recording during construction ground works.	Slight Adverse
Grade II Church of St. Nicholas, Hollym (MHU2612)	Pollutants concentrated from high quantity of heavy duty vehicles travelling in close proximity during main site construction.	Negligible	Neutral/ Slight Adverse	Monitor and manage traffic through Hollym appropriately in accordance with CoCP.	Neutral/ Slight Adverse
Grade II Pinfold on Northside Road, Hollym	Pollutants concentrated from high quantity of heavy duty vehicles travelling in close proximity during main site construction.	Negligible	Neutral/ Slight Adverse	Monitor and manage traffic through Hollym appropriately in accordance with CoCP.	Neutral/ Slight Adverse
As yet unknown archaeological or palaeoenvironmental remains deposits within the construction footprint	Excavation of trenches for the installation of rising main, LSO and main site.	Moderate	Moderate Adverse	Watching brief and archaeological recording during geotechnical works (if required) and	Moderate Adverse

Heritage asset	Impact derived from	Magnitude of change	Significance of effects	Proposed mitigation	Residual effects
	Shallow excavations/ foundations for the installation of temporary construction infrastructure.	Minor	Slight Adverse	construction ground works.	Slight Adverse
	Demolition of existing WwTW.	Neutral	Neutral	Consider appropriate measures in accordance with the CoCP.	Neutral
Setting Impacts					
Church of St. Nicholas, Hollym	Noise during construction of the pipelines and main site (temporary).	Minor	Slight Adverse	Monitor noise levels during construction.	Slight
Pinfold on Northside Road, Hollym	Noise during Construction of the pipelines and main site (temporary).	Minor	Slight Adverse	Monitor noise levels during construction.	Slight
Lighthouse, Withernsea	Visual impact During construction phase of rising main (temporary).	Negligible/ Minor	Slight Adverse	Consider screening and other appropriate actions in accordance with the CoCP to limit the visual impacts of construction.	Slight

As outlined in **Section 1.2**, the planning application for the new WwTW was granted by ERYC in October 2018 while the new rising mains and LSO are to be constructed using YWS's Permitted Development Rights. In order to address potential direct impacts from the consented works for the WwTW, condition 4 of the planning decision specifies that no demolition or development shall commence until an archaeological Written Scheme of Investigation (WSI) has been submitted to and approved by the Local Planning Authority.

Potential impacts to terrestrial heritage assets, therefore, will be addressed through a programme of site investigation and recording, to include geoarchaeological recording, sampling and analysis where appropriate to ensure proportionate assessment of the alluvial deposits which may be encountered, particularly during trenching for the westerly sections of the rising main where these deposits are considered most likely to be preserved.

The programme and methodology for all archaeological and geoarchaeological works will be determined through consultation with Humber Archaeology Partnership as the historic

environment adviser to the Local Planning Authority and will be set out in a WSI in accordance with condition 4 of the planning decision for the main site.

12.6.1.2. Intertidal

The 'intertidal' section of the LSO will be constructed using trenchless techniques from behind the 100-year erosion line to the intertidal zone for approximately 1 km using either HDD or micro-tunnelling. In order to connect the intertidal LSO to the marine LSO a cofferdam will be installed to allow for the recovery of the tunnel boring machinery, and a trench of approximately 100 m will be excavated by land-based hydraulic excavators from the cofferdam to the low water limit of the offshore dredging equipment.

As described in **Section 12.5.2**, there are no known extant heritage assets within the intertidal zone in the study area around the proposed LSO. There is potential for previously undiscovered remains relating to eroded archaeological remains from the cliff, particularly associated with Second World War costal defences. However, the shallow depth of beach deposits overlying the glacial till suggests that the potential for burial of such remains would be limited. Geoarchaeological potential is also **low**, with glacial till the predominant sub-surface deposit, and only one borehole log recording a potential lacustrine deposit of probably glacial origin.

No impacts are anticipated to occur through HDD or micro-tunnelling beneath the beach deposits and through the glacial till.

Installation of the cofferdam, and excavation of the trench to connect the intertidal section to the marine section of the LSO have the potential to directly impact secondary context archaeological material, if present. Due to the fragmentary nature of such archaeological material, the heritage significance is considered to be **low**.

It is proposed that a formal protocol for archaeological discoveries is implemented during works to allow construction teams working on site to report any material of potential archaeological interest which they may encounter during installation of the cofferdam or during excavations to install the LSO. The protocol will allow for the effective reporting of discoveries of archaeological material in order to ensure that advice, concerning measures to address discoveries, is received and implemented in a timely and efficient manner. The approach would be set out in a WSI to be prepared and agreed in consultation with Historic England, as the MMO's statutory adviser on the historic environment, and be based upon existing industry protocols such as:

- Protocol for Archaeological Discoveries: Offshore Renewables Projects (The Crown Estate, 2014); and
- Protocol for reporting finds of archaeological interest (BMAPA and English Heritage, now Historic England, 2005).

The protocol will be supported by a programme of archaeological monitoring and tool box talks to on site construction teams, to be agreed in advance of construction commencing with Historic England and set out in the WSI.

With the application of the protocol to ensure that any archaeological discoveries are reported and recorded (i.e. dealt with appropriately), the magnitude of change to heritage significance will be negligible, representing no real change in our ability to understand and appreciate the resource and its historical context and setting. Any direct impact will, therefore, be of **negligible** significance.

With regard to setting impacts, as there are no extant heritage assets within the intertidal study area, and none for which setting represents a key part of heritage significance, setting impacts are not anticipated to occur.

Similarly, there is no potential for indirect impacts associated with changes to coastal processes and hydrodynamics within the intertidal zone during the installation of the LSO due to the use of trenchless techniques. **Section 7** concludes that there will be some minor and temporary effects as the trenchless solutions reaches its exit point at the surface in the lower intertidal, but this will be negligible in the context of the high natural turbidity levels which are present in this section of the North Sea. Possible interruptions to longshore drift may arise due to the temporary presence of the cofferdam and temporary presence of an open trench although this is not considered significant in the context of the natural variability in the baseline environment and baseline conditions will be fully reinstated upon removal of the cofferdam and reinstatement of the trench. Indirect impacts upon archaeological material within the intertidal zone, associated with changes to coastal processes and hydrodynamics, are not, therefore, anticipated to occur.

12.6.1.3. Marine

Within the marine study area, dredged trenching and backfill techniques (most likely using a backhoe or cutter suction dredger, with side-casting during excavation and subsequent re-use of side-cast materials as backfill) will be used in the lower intertidal and marine area to install c. 1.1km of pipeline in a shallow dredged trench in the marine area.

As described in **Section 12.5.3**, there are no known extant heritage assets within the marine study area and the potential for *in situ* remains to be buried within the veneer of seabed sediments overlying the glacial till is anticipated to be low. Isolated discoveries of material associated the remains of Second World War defences, specifically those associated with Intack Farm, may be encountered within the nearshore area, eroded from the cliff and beach deposits, although the potential for maritime remains is also anticipated to be low.

Within the study area there are 121 magnetic targets identified by ESG (**Appendix I**), either on the surface or shallow buried, described as most likely associated with small items of debris from fishing and other sources (**Figure 12.5**). Only two of these are located within 10 m either side of the proposed LSO. Twelve targets were recorded in the side scan sonar data, none of which are located within 10m of the proposed LSO. At present it is not possible to determine if these

anomalies represent modern or archaeological debris, although the heritage significance of isolated items of debris is anticipated to be low.

As stated above, only two of the anomalies are located within 10m either side of the proposed LSO and it is recommended that, as far as possible, the anomalies should be avoided in determining the final route for the LSO. Following finalisation of the LSO footprint, consideration should be given, in consultation with Historic England, to further investigation of any anomalies which fall within this footprint. This may include ground truthing of the anomalies to determine their origin (through the use of drop-down camera, or diver for example). Alternatively, monitored removal or relocation of debris within the footprint may also be undertaken as part of a seabed clearance campaign, if required. As also recommended for the intertidal area, a formal protocol for archaeological discoveries should be implemented during works to allow for any unexpected discoveries of archaeological material to be addressed in an appropriate, timely and efficient manner.

The approach to further investigation, relocation or removal, if required, and the archaeological protocol, should be agreed in consultation with Historic England and the approach set out in a WSI to be agreed with the MMO prior to works commencing.

If anomalies can be avoided, then there will be no impact. For any anomalies which remain in the footprint of the LSO trenching, however, with the application of further measures to investigate, relocate or remove the material, and implementation of the protocol to ensure that any archaeological discoveries are recorded, the magnitude of change to heritage significance will be negligible, representing no real change in our ability to understand and appreciate the resource and its historical context and setting. Any direct impact will, therefore, be of **negligible** significance.

With regard to setting impacts, as there are no extant heritage assets within the marine study area, and none for which setting represents a key part of heritage significance, setting impacts are not anticipated to occur.

Similarly, there is no potential for indirect impacts associated with changes to coastal processes and hydrodynamics within the marine zone during the installation of the LSO. **Section 7** concludes that the proposed dredge will increase water depth along the proposed pipeline corridor for a short period of time, prior to infill. This could potentially become a trap for sediment that is transported along the seabed by bedload transport processes. However, given the very localised dredge in the context of the open sea, there will be no discernible effect likely. Any initial variation in level is likely to be short-term and reversible due to natural processes.

12.6.2. Prediction of potential impacts during the operational phase

During operation there will be no further ground works associated with the scheme and no potential for direct impacts to known or potential heritage assets, nor to the setting of heritage assets.

The minimum depth of cover of 3 m for the LSO will make sure that it presents no effect on the baseline coastal processes regime during its lifetime and consequently there is no potential for indirect impacts to heritage assets.

12.6.3. Prediction of potential impacts during decommissioning

The existing LSO will also be demolished from the existing WwTW to an existing exposed chamber located on the foreshore immediately above MLWS. The remainder of the LSO will be capped at both ends and abandoned, with the existing diffuser and protection frame removed, at 1 m below seabed level.

The proposed decommissioning will impact deposits previously disturbed during the construction of the existing LSO only and no new direct impacts to known or potential heritage assets are anticipated to occur. Any buried archaeology would likely have been removed during the construction phase of the existing WwTW therefore the potential to produce physical impacts to buried archaeology within the existing WwTW sites footprint is considered negligible.

Potential impacts on the setting of heritage assets during decommissioning would be as for construction, and will be temporary and of negligible significance.

As for the construction phase, whilst the works would result in temporary and localised increases in suspended sediment concentrations, these would be negligible within the context of the natural baseline environment and no indirect impacts to heritage assets from changes to coastal processes or hydrodynamics are anticipated to occur.

12.7. Summary of Impacts

The impacts to terrestrial heritage assets, as assessed by Arup (**Appendix M**), are summarised in **Table 12.6** above. Impacts below MHWS are summarised in **Table 12.7** below.

Table 12.7 Summary of impacts relating to the marine historic environment

Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase			
Direct impacts to known heritage assets	No impact	None	No impact
Direct impacts to potential heritage assets (intertidal)	Negligible	Protocol for reporting archaeological discoveries	Negligible
Direct impacts to potential heritage assets (marine, anomalies of possible archaeological interest)	Negligible	Avoidance of anomalies of archaeological potential.	No impact
		Archaeological monitoring during seabed preparation/UXO clearance	Negligible
		Protocol for reporting archaeological discoveries	Negligible
Impacts to the setting of known heritage assets	No impact	None	No impact

Description of Impact	Significance	Mitigation	Residual Impact
Indirect impacts associated with changes to coastal processes and hydrodynamics	No impact	None	No impact
Operational Phase			
Direct impacts to known heritage assets	No impact	None	No impact
Direct impacts to potential heritage assets	No impact	None	No impact
Impacts to the setting of known heritage assets	No impact	None	No impact
Indirect impacts associated with changes to coastal processes and hydrodynamics	No impact	None	No impact
Decommissioning Phase			
Direct impacts to known heritage assets	No impact	None	No impact
Direct impacts to potential heritage assets	No impact	None	No impact
Impacts to the setting of known heritage assets	No impact	None	No impact
Indirect impacts associated with changes to coastal processes and hydrodynamics	No impact	None	No impact

13. Cumulative Impact Assessment

13.1. Introduction

In addition to identifying and assessing the potential impacts of the proposed scheme in isolation, the MWRs require an assessment of its potential cumulative impacts (CIA). A CIA assesses the potential impacts of a project with other past, present (current) and reasonably foreseeable (proposed) projects.

With respect to past projects or existing/completed projects, it is accepted practice in CIA that the environmental impact of schemes that have been completed should be included within the environmental baseline. As such, these impacts are already taken into account in the EIA process for the proposed scheme. Consequently, completed projects can be excluded from the scope of CIA. However, the environmental impacts of recently completed projects may not be fully manifested and, therefore, care is needed in respect of how the potential impacts of such projects are taken into account.

Projects that are currently being constructed or that are in the planning process (where sufficient information is publicly available), as well as ongoing activities that have the potential to influence the same environmental parameters as the proposed scheme, are the focus of this CIA. Future plans or projects for which sufficient information is not available on which to base a reliable assessment, which are unlikely to be submitted or receive consent until after the proposed scheme has been completed, cannot reasonably be assessed as part of a CIA. However, the applicants for such projects will be required to take the effect of the proposed scheme into account in their own application.

13.2. Guidance on cumulative impacts and cumulative effects assessment

The IEMA 'Guidelines for Environmental Impact Assessment' (IEMA, 2004) define cumulative impacts as: "…the impacts on the environment which result from incremental impacts of the action when added to other past, present and reasonably foreseeable future actions…"

Cumulative impacts can be therefore additive or interactive. Typically, additive impacts occur when different project activities have an impact on the same environmental receptor at the same time. Interactive impacts are assessed in relation to a specific receptor but are caused by the interaction of different types of impacts from project activities even if individually these are insignificant (e.g. the interaction of increased suspended sediments on fish).

To be considered within the CIA, other plans and projects should meet the following criteria. They should:

- generate their own residual impacts of at least minor significance;

- be likely to be constructed or operate over similar time periods to the proposed scheme (or their environmental consequences have the potential to be realised over the same time period);
- be spatially linked to the predicted zone of influence of the proposed scheme (for example, influencing the same area as affected by the sediment plume); and,
- be either consented (but not operational) or the subject of consent applications with the statutory authorities in the study area or part of another statutory procedure.

13.3. Assessment methodology

13.3.1. Definition of temporal boundaries

Temporal boundaries provide the timescales over which a project and, therefore, the assessment are undertaken and they give temporal limits to the CIA. When determining temporal boundaries, it is necessary to consider the longevity of effects, the potential nature of effects over time and the importance of seasonal variations in populations and sensitivities.

The temporal boundary for this assessment includes present plans and projects where the impacts are still occurring, or where mitigation measures are still operating; and reasonably foreseeable future plans and projects with which there could be a temporal or spatial overlap.

The construction of the proposed scheme is currently scheduled to commence in Spring 2020 with the main period of construction will be undertaken during the summer months (1st April to 30th September), however it is possible that the two weeks required for the decommissioning of the existing LSO may extend outwith this period, due to the requirement for this to follow the commissioning of the new LSO. For more information on the construction programme, see **Section 2.2.4**.

13.3.2. Definition of spatial boundaries

Spatial boundaries define the area likely to be affected by the proposed scheme. The study area has been defined for each of the relevant environmental receptors in **Section 7** to **Section 12**.

13.3.3. Identification of relevant plans and projects

Based upon the temporal and spatial boundaries described above and through consultation with relevant parties (i.e. the MMO during the scoping phase), a comprehensive list of plans and projects relevant or potentially relevant to the CIA has been compiled and is provided in **Section 13.4.2**. This includes an explanation as to why plans/projects were taken forward for detailed assessment in the CIA or why they were screened out of the need for further assessment.

The MMO's Marine Information System contains interactive mapping which shows the locations of marine licence applications. This has been reviewed to determine projects which could result in cumulative impacts with the proposed scheme. In addition, the National Infrastructure Planning website for Nationally Significant Infrastructure Projects (NSIPs) under the Planning Act 2008 has also been consulted where necessary. A review of EYRC's planning application website has also been undertaken to identify any relevant plans or projects for inclusion in the CIA.

13.4. Cumulative impact assessment

As set out in **Section 4.8** a tiered approach has been adopted for the new proposed scheme, based upon the following definitions:

- Site-specific (or within proposed scheme) cumulative impacts - different effects associated with the proposed scheme have the potential to interact and, together, influence common receptors (i.e. impacts to water quality effecting marine and benthic ecology). Where applicable, these inter-relationships are considered in the ES and HRA (**Section 7** to **Section 12** and **Section 13**).

- Project-wide cumulative impacts which arise from the combined effect (additive or interactive) of the proposed scheme with other components of the replacement Withernsea WwTW and associated infrastructure (shown in **Figure 1.1**). These are considered below in **Section 13.4.1**.

- Wider cumulative impacts which are the combined impacts (additive or interactive) that may occur between the proposed LSO, and any other relevant development(s) for which information is publicly available. These are considered below in **Section 13.4.2**.

13.4.1. Project-wide cumulative impact assessment

There is potential for cumulative impacts to occur from construction of the full Withernsea WwTW and associated infrastructure. The replacement Withernsea WwTW project will consist of a new WwTW, demolition of the existing WwTW located off Holmpton Road, a new rising main from Memorial Gardens Sewage Pumping Station (SPS) to the proposed WwTW; a connection from the new Rising Main to the existing Hollym SPS and the LSO (the marine section of which is considered as the proposed scheme for the purposes of this ES) (**Figure 1.1**).

13.4.1.1. Withernsea WwTW project

Replacement WwTW

It is anticipated that construction of the proposed WwTW will start in Spring 2020 and take approximately 18 months, with the earthworks elements being completed within the first six months. Construction of the proposed WwTW will therefore take approximately 12 months following the earthworks.

The site will be accessed via the publicly accessible Myer's Lane. Some temporary realignment of the sharp bend may be required to accommodate large Heavy Goods Vehicles (HGVs) and surface reinforcement (stoning) will be required.

Piling is not anticipated to be required. Construction will largely be bulk earthworks, with some conventional reinforced concrete required. The treatment cells will be designed to be cut-and-fill neutral (i.e. all excavated subsoil will be utilised in the construction of the embankments). There may be some surplus topsoil which may be used by adjacent landowners or taken off site.

During construction, earthmoving and compaction equipment, for example bulldozers, excavators and sheep's foot rollers, will be used. Mobile cranes will be required for construction of concrete structures and for the installation of mechanical and electrical equipment. Construction works will predominantly be undertaken during the hours of Monday to Friday 07:30 – 17:30.

Rising Mains

It is anticipated that construction of the rising main will commence in Spring 2020, with an anticipated duration of 12 to18 months.

The rising main will be constructed using both open cut and trenchless methods. It is anticipated that trenchless methods, such as directional drilling, will be used where the route pass through Withernsea and open cut will be used where the rising main passes across agricultural fields. Construction equipment will likely comprise excavators, dumpers and equipment required for trenchless installation.

Standard construction hours are proposed (Monday to Friday 07:30 – 17:30) unless agreed otherwise with ERYC. There will be no working within Withernsea town centre during the summer school holidays (July to September).

Terrestrial LSO

The terrestrial section of the LSO will be constructed using conventional trenching and backfilling techniques and is expected take three months, working six days per week, between the hours of 08:00 and 19:00 unless otherwise agreed with ERYC. It is anticipated that construction of the terrestrial section will take place either concurrently or following the completion of the intertidal and subtidal sections.

Existing WwTW demolition

The existing WwTW will be demolished. Demolition will take place once the new WwTW is commissioned, currently anticipated to be 2022. However, depending on the rate of coastal erosion, there is potential that the existing WwTW would need to be demolished earlier than this to prevent it collapsing into the sea.

Each of these aspects of the project are located above MHWS. As such, only certain environmental receptors have the potential to be subject to cumulative impacts, due to the lack of a pathway between the marine environment and the construction activities. Those which have been considered in **Section 13.4.1.2** and **Section 13.4.1.3** below. However, the following receptors have been scoped out of the project wide CIA due to there being no pathway for cumulative effects with the works above MHWS:

- Hydrodynamic and Sedimentary Regime;
- Marine Sediment and Water Quality;
- Marine and Coastal Ecology; and,
- Fish and Fisheries.

13.4.1.2. Marine and Coastal Ornithology

There is potential for birds to be disturbed by the construction of the proposed LSO and rising mains. The closest works required for the replacement WwTW project comprise the section of LSO installed with HDD/micro-tunnelling and is therefore over 10m underground. The closest above ground works (trenching of the LSO from the WwTW to the 100-year erosion line) is over 600m away.

During the construction works for the proposed scheme there will be a small increase in construction traffic. During the 10-hour working day (i.e. excluding staff trips) there will be approximately five vehicles, equating to approximately one two-way movement per hour. The noise associated with which is not considered to have a significant impact on ornithological features. The plant required for the LSO construction will consist of the following;

- Drill Rig and associated equipment and site set up for construction of tunnelled section if HDD method used; and
- Micro-tunnelling machine (for either HDD or micro-tunnelling) and associated equipment and site set up for construction of tunnelled section if thrust boring method used; and
- Mobile cranes and land-based plant equipment for construction of HDD/micro-tunnelling reception pit in intertidal zone.

Once plant arrive at the site compound in April 2020, movements will be minimal, and will not spatially overlap with the vehicle movements associated with the WwTW works. The majority of vehicles will be cars and vans which account for the construction staff arriving and departing from site compound for both project. Each project not expected to cause a significant impact to marine and coastal ornithology alone as a result of construction traffic and therefore there is no potential for a cumulative impact.

A noise assessment was undertaken for the construction phase of the WwTW (Arup, 2018), and from the results of noise levels produced by construction activities, and research undertaken in relation to disturbance responses, it is considered that during the construction phase of the proposed scheme there is a potential for wintering birds to be disturbed at a local level (within 50m of the works). This disturbance is likely through sudden noises or larger pieces of machinery which exceed 70 dBA. Beyond 100m the noise levels are expected to fall to approximately, or below, ambient levels. Therefore, cumulative impacts to marine and coastal ornithology are not expected.

During the operational phase there will be no further ground works associated with the sections of LSO above MHWS therefore no cumulative impacts are predicted.

13.4.1.3. Marine Historic Environment

As set out in **Section 12.6.1** an archaeological WSI has been submitted to and approved by ERYC. Therefore, potential impacts to terrestrial heritage assets, will be addressed through a programme of site investigation and recording, to include geoarchaeological recording, sampling and analysis where appropriate to ensure proportionate assessment of the alluvial deposits which may be encountered. No significant impacts are predicted to the marine historic environment from installation of the intertidal and marine sections of the LSO. Therefore, as impacts will be appropriately managed during the construction phase no cumulative impacts are predicted.

As set out in **Section 2.2** during operation there will be no further ground works associated with the scheme and no potential for direct impacts to known or potential heritage assets, nor to the setting of heritage assets. Therefore, no cumulative impacts are predicted.

13.4.2. Wider cumulative impact assessment

13.4.2.1. Screening of plans and projects

Plans and projects identified within the vicinity of the proposed scheme which could potentially have a cumulative effect with the proposed LSO are outlined **Table 13.1** and shown in **Figure 13.1** below. Where data is available, details of project type, construction dates, duration of works and other relevant data are provided along with the distance from the proposed works.

Table 13.1 Plans and projects identified in the vicinity of the proposed scheme

Plan or project	Description	Distance from proposes scheme	Status	Screen in/out	Information sources
East Inshore Marine Plan	Marine plans, together with the MPS, underpin the planning system for England's seas. The East Marine Plan provides a clear approach to managing the East Inshore and East Offshore areas, their resources, and the activities and interactions that take place within them.	0km	Active	The proposed scheme is in line with the East Inshore Marine Plan. For more information on the specific policies relevant to the proposed scheme see **Section 3.7** **Screened out of CIA**	MMO website
Flamborough Head to Gibraltar Point SMP2	SMP's provide a large-scale assessment of the risks associated with coastal processes and presents a long-term policy framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner. This SMP covers the coastline from Flamborough Head to Gibraltar Point which	0km	Active	The SMP specifies 'No Active Intervention' for the coastline overlapping the current WwTW and LSO, meaning no coastal protection work can take place on this part of the coastline. The existing WwTW is at risk of collapsing into the sea as a result of erosion along the coast. Therefore, due to the No Active Intervention set out in the SMP, coastal defence is not an option for protection of the current WwTW. Therefore, by providing a new location for the proposed WwTW and LSO, the proposed scheme is in adherence to the SMP (see **Section 2.1.2.1**). **Screened out of CIA**	Scott Wilson (2010)
Withernsea LSO Temporary Protection Works (MLA/2017/00249/2)	Temporary pipe protection was installed within the intertidal zone in December 2017 (under Marine Licence reference: L/2017/00420/3) to provide a short-term solution until implementation of the proposed scheme. The installation of the temporary pipeline protection works is not intended to, and will not stop erosion of the cliff adjacent to the outfall on both sides, it's purpose is to reduce the risk of further damage to the existing LSO, and in turn reduce the risk of a pollution event. It is envisaged that the predicted cliff erosion rates will continue unabated where no protection is provided.	0.05km	Approved	The Withernsea LSO Temporary Protection Works are currently in place and will not be removed until construction of the proposed replacement LSO has been completed. Therefore, there is no pathway for cumulative impacts to occur as a result of the proposed scheme and the Temporary Protection Works. **Screened out of CIA**	MMO public register

Plan or project	Description	Distance from proposes scheme	Status	Screen in/out	Information sources
Withernsea South Coastal Defence (EIA/2018/00054)	ERYC is proposing to construct a coastal defence scheme in south Withernsea. This will involve the construction of a rock armour revetment, which will extend the existing rock revetment to the south, providing coastal erosion protection to the existing infrastructure. It is not intended to extend the rock revetment further south beyond the limit of the town's infrastructure.	1km	Application not submitted	The construction phase of the Withernsea South Coastal Defence has the potential to overlap with the construction phase of the proposed scheme. Therefore, there is potential for cumulative impacts during the construction phase. The operational phase of both the Withernsea South Coastal Defence and the proposed scheme will overlap. Therefore, there is potential for impacts during the operational phase. It is not anticipated that the South Coastal Defence will be decommissioned. Additionally, decommissioning of the proposed scheme would be subject to a separate Marine Licence and would be acquired by the applicant at the time. Therefore, cumulative impacts for the decommissioning phase have not been considered in this CIA. **Screened into CIA for construction and operation phase only.**	Royal HaskoningDHV (2018)

Legend

- Proposed Scheme Boundary
- New LSO
- Existing LSO
- Location of temporary pipeline protection works
- Withernsea Coastal Protection Scheme
- MHWS
- MLW

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title:

Plans and projects relevant to the CIA for the proposed scheme

Figure: 13.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	ES	A3	1:8,000

Co-ordinate system: British National Grid

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13.4.2.2. Hydrodynamic and sedimentary regime

The Withernsea South Coastal Defences are located over 1km from the proposed LSO. Construction dates for the coastal defences are not yet known, but even if the construction programme coincided with that of the LSO, under a worst-case scenario, the maximum potential increase in suspended sediment concentrations from one scheme would not coalesce with that from the other scheme due to the physical separation between them. Also, due to the highly turbid waters in the North Sea, any temporary increases from these schemes cumulatively would remain insignificant in the context of the baseline environment.

In conclusion, there are no cumulative effects on the baseline hydrodynamics across the wider study area, and therefore **no** significant cumulative effects on the sedimentary regime or sea bed or shore morphology due to the construction or operational phase of the proposed scheme and the Withernsea South Coastal Defence.

13.4.2.3. Marine water and sediment quality

The Withernsea South Coastal Defences are located over 1km to the north of the proposed replacement LSO. Transport of rock to the site by barge and deposition on the intertidal zone during high tide will be required, and may have the potential to overlap with construction of the replacement LSO.

Construction dates for the coastal defences are not yet known, but even if the construction programme coincided with that of the proposed scheme, under a worst-case scenario, the maximum potential increase in suspended sediment concentrations from one scheme would not coalesce with that from the other scheme due to the physical separation between them. Any impacts to water quality are low as ERYC are committed to using rock with a low fines content to minimise the potential risk of transport of suspended sediment into the water during offloading. Any temporary increases of sediment would remain insignificant in the context of the baseline environment due to the highly turbid waters in the North Sea.

In summary, the receptor is considered to be of low sensitivity and no impact on water quality will occur as a result of cumulative impacts (very low magnitude), therefore the potential cumulative impacts from the construction phase are assessed as being of negligible significance

No negative impacts to sediment quality were identified for the operational phase of the Withernsea South Coastal Defence or the proposed scheme therefore there is no potential for cumulative impacts to occur. Sediment erosion cause by the Withernsea South Coastal Defence was identified as a potential to impact water quality. However, as this would be from natural coastal erosion the impact was not determined to be significant. Operational impacts in relation to water quality from the proposed scheme are expected to be negligible. The discharge of wastewater from the new LSO will be a consented discharge as agreed with YWS and the Environment Agency.

Therefore, no cumulative impacts are predicted in relation to water quality during the operational phase.

13.4.2.4. Marine and Coastal Ecology

Benthic Ecology

Construction impacts in relation to benthic ecology for both the Withernsea South Coastal Defence and the proposed scheme are in relation to increased suspended sediments and direct disturbance. In both instances, the impacts are small scale and local in nature. As the coastal defence is over 1km away no cumulative impacts are predicted.

The operational phase of the Withernsea South Coastal Defence will result in a loss of 7,100m^2 of intertidal sandy habitat, however this is a small-scale loss of barren littoral shingle and barren littoral sand, limited to the footprint of the scheme. Additionally, as no impacts are predicted during the operational phase of the proposed scheme in relation to benthic ecology no cumulative impacts are predicted.

Marine Mammals

Impacts to marine mammals in relation to the proposed scheme during construction were identified as disturbance due to underwater noise from dredging. Impacts to marine mammals in relation to the Withernsea South Coastal Defence were identified as collision risk, reduced water quality and generation of underwater noise in relation to transportation of rock to the site by barge. The only impact with a potential for in-combination effects is therefore underwater noise.

Underwater noise impacts from dredging of the proposed LSO were predicted to be minor adverse significance. Impacts from underwater noise during the construction phase of the South Coastal Defences were determined to be not significant. Due to the minor impact significance and the 1km distance between the two schemes, no cumulative impacts are predicted in relation to marine mammals during construction of the proposed scheme.

Impacts to marine mammals were identified for the construction phase only for both the Withernsea South Coastal Defence and the proposed scheme therefore no cumulative impacts are predicted for the operational phase in relation to marine mammals.

13.4.2.5. Fish and Fisheries

Fish Ecology

Impacts to fish due to the proposed LSO are in relation to increased suspended sediment, reduced DO concentrations, changes to subtidal food resources and noise emissions. Impacts to fish due to the Withernsea South Coastal Defence are in relation to increased suspended sediment concentrations. Therefore, a potential in-combination effect to fish could occur due to increased suspended sediment.

Increases in suspended sediment concentrations from the proposed LSO would be restricted to the vicinity of the proposed scheme and the increases are likely to be well within the range of values exhibited naturally, especially when sediment is mobilised under storms. The volumes involved, in the context of the baseline conditions, will not lead to measurable increased in sediment deposition. As the Withernsea South Coastal Defence is located over 1km away from the proposed LSO there is no pathway for cumulative impacts in relation to increased suspended sediment concentrations.

No operational phase impacts have been identified in relation to fish during the operational phase of the Withernsea South Coastal Defence therefore no cumulative impacts are predicted.

Commercial Fisheries

The Withernsea South Coastal Defence is located over 1km from the proposed LSO. Construction dates for the coastal defences are not yet known, however the only pathway for disturbance to fisheries interests from the works is the occasional use of barges to transport material to shore for use which would require nets and traps to be cleared temporarily. Under the worst-case scenario (should the construction phase of the coastal defence scheme coincided with construction of the proposed LSO) there is unlikely to be any pathway for cumulative impacts to occur in relation to fisheries interests. This is due to the local nature of potential effects from construction of both the proposed LSO and the defence works and the fact that the cumulative area temporarily restricted to fishing vessels is very small relative to the total area in which the vessels can operate. Use of an FLO will minimise potential disruption.

No operational phase impacts have been identified in relation to commercial fisheries during the operational phase of the Withernsea South Coastal Defence Scheme therefore no cumulative impacts are predicted.

13.4.2.6. Marine and Coastal Ornithology

Both the Withernsea South Coastal Defence and the proposed scheme have potential to impact marine and coastal ornithology during construction. Depending on the programme of construction disturbance could occur to breeding birds or overwintering birds. However, both schemes determined impacts would be temporary, highly localised and would not lead to significant impacts. Due to the nature of the disturbance no cumulative impacts are predicted.

Both schemes are within the Greater Wash SPA however cumulative impacts with regards to the SPA have been considered in the HRA. See **Section 15.5** of the HRA for the in-combination assessment.

The Withernsea South Coastal Defence scheme will lead to a loss of feeding ground and a loss of feeding resource for birds. However, no loss of feeding ground or resource is predicted for the proposed scheme therefore no significant cumulative impacts are predicted.

No operational phase impacts have been identified in relation to Marine and Coastal Ornithology during the operational phase of the Withernsea South Coastal Defence Scheme therefore no cumulative impacts are predicted.

13.4.2.7. Marine Historic Environment

Consultation was conducted with Humber Archaeology Partnership in support of the Withernsea South Coastal Defence who determined that the area had low archaeological potential and therefore assessment was not required. Additionally, any impacts to potential heritage assets or setting of heritage assets in relation to the proposed scheme is limited to the construction phase only and limited to the area surrounding the LSO. Therefore, no cumulative impacts are predicted.

13.5. Summary of impacts

In summary, there are no cumulative impacts predicted with the replacement WwTW and associated works, or with any nearby projects or plans, either during construction or operation.

14. WFD Compliance Assessment

14.1. Introduction

The Water Framework Direction (WFD) is transposed into national law by means of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. These Regulations provide for the implementation of the WFD, from designation of all surface waters (rivers, lakes, transitional (estuarine) and coastal waters and ground waters) as water bodies to the requirement for achievement of good ecological status or good ecological potential by 2021.

The WFD applies to all water bodies, including those that are man-made. The consideration of the proposed refurbishment works under the WFD will, therefore, apply to all water bodies that have the potential to be impacted by the proposed works.

Classification schemes for both estuarine and coastal waters from Mean High Water Springs (MHWS) out to one nautical mile (nm) have been developed in response to the WFD. The scheme classifies the status of Transitional and Coastal Waters (TRaC) using information on the ecological, chemical and hydromorphological quality of a body of water. For TRaC water bodies that have been designated as heavily modified (HMWB), the Environment Agency must classify according to their ecological potential rather than status.

14.2. Methodology

There is no designated methodology for the assessment of the construction and operational phases of projects against WFD compliance parameters. The guidance considered to be the most relevant to these proposals is "Clearing the Waters for All" (Environment Agency, 2016). The activities screened in for consideration have been compared to the scoping criteria outlined in the Clearing the Waters for All guidance for the surface water bodies. For the groundwater body the WFD compliance parameters have been listed and any potential risks considered. This guidance recommends a four-stage process, as follows:

14.2.1. Stage 1 – Screening

For the assessment of dredging (and disposal), this stage only applies to pre-existing activities. In this context this means activities which started or were ongoing during the period 2006-2008. New projects (commencing after 1 January 2009) progress straight to the scoping stage (i.e. Stage 2). However, initial screening information is necessary as part of the scoping stage and, therefore, this stage is still often completed in practice in order to inform Stage 2. Additionally, screening the construction and operational activities of projects enables a high level initial assessment of those activities that could impact on compliance parameters within WFD water bodies.

14.2.2. Stage 2 – Scoping

The scoping stage enables regulators and operators to determine the scope of the assessment required to establish whether an activity will have a non-temporary effect on water status at water body level. Scoping therefore assists in agreeing an appropriate level of assessment to meet WFD requirements and which activities should be carried through to Stage 3.

14.2.3. Stage 3 – Assessment

This stage aims to assess whether the activity will have a significant non-temporary effect on the status of one or more WFD parameters at water body level. The test is therefore to determine whether the activity is likely to affect a parameter sufficiently to lower its existing class status. For priority substances, the process requires the assessment to consider whether the activity is likely to cause the parameter to achieve good chemical status.

14.2.4. Stage 4 - Identification and Evaluation of Measures

If it is established that an activity is likely to affect water status at water body level (that is, by causing deterioration or by preventing achievement of the WFD objective), or that an opportunity may exist to contribute to improving status at a water body level, potential measures to achieve either of these must be investigated. This stage considers these measures and, where necessary, evaluates the measures in terms of cost and whether it is disproportionate.

14.2.4.1. General in-built scheme control measures

During the various activities there is the potential for pollution from spills or leaks of fuel and oil. The risk of this arising can be minimised by following standard good practice with regard to pollution prevention guidance. Construction works will be undertaken in accordance with the Environment Agency's Pollution Prevention Guidelines (PPG) No. 5 on works in, near and liable to affect watercourses. Whilst it is noted that these guidelines have been withdrawn, they still provide good reference material for protection of water courses when working in and around water.

A Construction Environmental Management Plan (CEMP) will be put in place by the successful contractor which will include organisational structure, planning activities, responsibilities, processes, procedures and resources. It details measures against spills and leakages; impacts on sediment and water quality and benthic habitats; re-suspension of contaminated sediment; marine pollution. In the unlikely event of a spill, appropriate spill kits will be available on board the dredging vessel and all crew will be trained to use them. In addition, all vessels will ensure that suitable bunding and storage facilities are employed to prevent the release of fuel oils, lubricating fluids associated with the plant and equipment into the marine environment. Any risks to water quality in terms of accidental spills or leaks will therefore be reduced as far as possible and therefore this issue is not considered further within this assessment.

In the event of a collision at sea all vessels used for dredge operations shall comply with the International Regulations for Preventing Collision at Sea with respect to the display of lights,

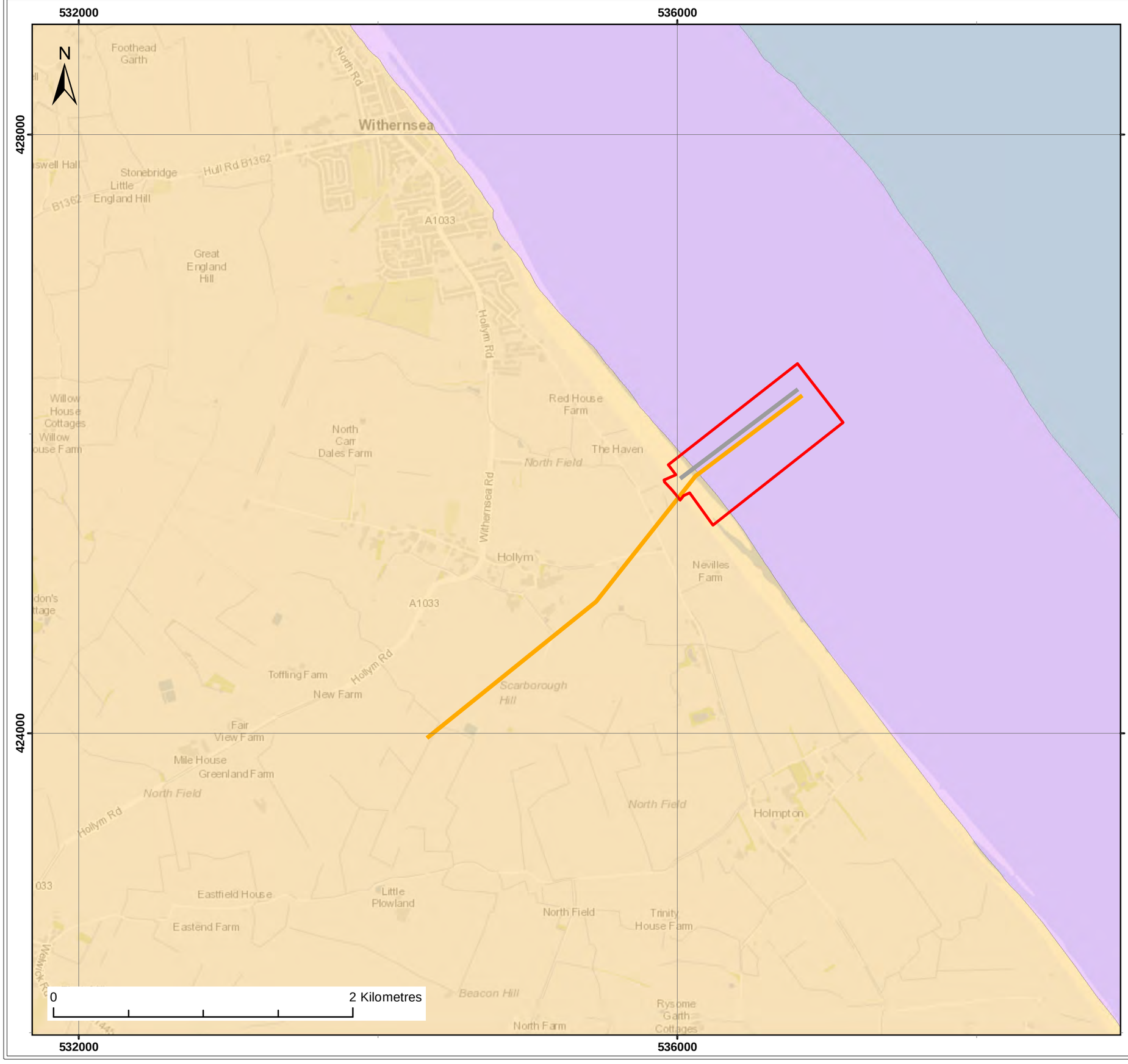
shapes and signals. Furthermore, a Local Notice to Mariners (NtM) will be issued prior to the commencement of any marine works activities.

14.3. The proposed scheme

In parallel with the production of the ES under the requirements of the MWRs, a 'shadow WFD Compliance Assessment' has been undertaken, the results of which are presented below.

14.3.1. Stage 1 - Screening of the proposed project

Due to the location of the proposed scheme in relation to the location of waterbodies (see **Figure 14.1**), the waterbodies considered to have the potential to be affected by the proposed works are the 'Yorkshire South' coastal waterbody (GB640402491000) and the 'Hull and East Riding Chalk' Groundwater body (GB40401G700700).



Legend

- Proposed Scheme Boundary
- New LSO
- Existing LSO
- WFD Coastal Waterbody: Yorkshire South (GB640402491000)
- WFD Ground Waterbody: Hull & East Riding Chalk (GB40401G700700)

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title: Proposed scheme activities against WFD water bodies

Figure: 14.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	ES	A3	1:25,000

Co-ordinate system: British National Grid

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The Screening tables for both waterbodies are provided in **Table 14.1** and **Table 14.2**.

Table 14.1 Characteristics of water body ID: GB640402491000 Yorkshire South Coastal Water Body

Water body	Description, notes or more information
WFD water body name	Yorkshire South
Water body ID	GB640402491000
River basin district name	Humber
Water body type (estuarine or coastal)	Coastal
Water body total area (hectares)	15836.867
Overall water body status (2015)	Moderate
Ecological status	Moderate
Chemical status	Good
Target water body status and deadline	Good by 2027
Hydromorphology status of water body	Supports good
Heavily modified water body and for what use	Yes (Coastal Protection, Flood Protection, Navigation Ports and Harbours)
Higher sensitivity habitats present	Mussel beds, including blue and horse mussel (0.29ha); Subtidal kelp beds (349.12ha)
Lower sensitivity habitats present	Cobbles, Gravel and Shingle (299.38ha); Intertidal soft sediments (680.83ha); rocky shore (7.59ha); subtidal rocky reef (860.94ha); subtidal soft sediments (20779.33ha).
Phytoplankton status	High
History of harmful algae	Not monitored
WFD protected areas within 2km	There are a number of designated sites within 2km. European designated sites have been considered within the shadow HRA to this ES (**Section 15**) and therefore are not considered further in this assessment.

Table 14.2 Characteristics of water body ID: GB40401G700700 Hull and east Riding Chalk' Groundwater body

Water body	Description, notes or more information
WFD water body name	Hull and East Riding Chalk
Water body ID	GB40401G700700
River basin district name	Humber
Water body type (estuarine or coastal)	Ground Water
Water body total area (hectares)	196732.641
Overall water body status (2015)	Poor
Quantitative status	Poor
Chemical status	Poor
Target water body status and deadline	Poor by 2015

Water body	Description, notes or more information
WFD protected areas within 2km	There are a number of designated sites within 2km. European designated sites have been considered within the shadow HRA to this ES (Appendix C) and therefore are not considered further in this assessment.

The following activities have been identified as having the potential to impact upon WFD parameters:

- Excavation (dredging) of a trench for the proposed Long Sea Outfall (LSO) and side-casting of excavated materials within 1nm, with reuse of side-cast materials as trench infill.
- Installation of protection dome and scour protection at the diffuser.
- horizontal directional drilling (HDD)/micro-tunnelling in the intertidal zone.
- Removal of the diffuser on the existing LSO.

As excavated material from the trench will not be disposed of, but will be side-cast and reused as infill, the effects from this activity have been considered under assessment of the dredging process.

14.4. Stage 2 – Scoping of the proposed project

The activities screened in for consideration have been compared to the scoping criteria as outlined in the Clearing the Waters for All Guidance (Environment Agency, 2016) for the surface water bodies. The output of this assessment is provided in **Section 14.4.1** and summary tables are provided in **Table 14.3** and **Table 14.4** below. Sediment data collected in 2017 is provided in **Appendix J**.

Table 14.3 Summary of the findings of the scoping phase for the Yorkshire South coastal WFD water body

Activity	Hydromorphology	Biological: Habitats	Biological: Fish	Water Quality	Protected areas	Invasive species
Dredging	No	No	No	No	No	No
Scour protection and concrete protection dome	No	No	No	No	No	No
HDD/ Micro-tunnelling	No	No	No	No	No	No
Removal of diffuser	No	No	No	No	No	No

Table 14.4 Summary of the findings of the scoping phase for the groundwater WFD water body

Activity	Quantitative	Chemical	Supporting elements
HDD / Micro-tunnelling	No	No	No

14.4.1. Completed scoping tables per activity

14.4.1.1. Dredging

The following tables summarise the information relevant to the consideration of the requirements of the Water Framework Directive for dredging (tables taken from Clearing the Waters for All; Environment Agency, 2016). *Note that although the answer to the question is yes in some instances, the evidence provided in the notes column allows the issue to be scoped out*.

Table 14.5 Activity Information

Your activity	Description, notes or more information
Applicant name	Yorkshire Water
Application reference number (where applicable)	TBC
Name of activity	Dredging with side-casting to create a trench for a Long Sea Outfall (LSO) and dredging required for removal of the existing LSO.
Brief description of activity	It is anticipated approximately 50,000m^3 of sediment (mainly consisting of till and clay) will be dredged to create a trench for the new LSO, using a backhoe or cutter suction dredger, applying the side-casting method for excavation and backfill operations. No barges are required for this process; the side-casting method involves excavating the material and placing it to the side for subsequent re-use as backfill. The offshore section of pipe is approximately 1km. It is currently unknown how much sediment will be dredged for removal of the existing LSO however, it will be very small-scale as only partial removal of the intertidal section is proposed.
Location of activity	See **Figure 14.1**
Footprint of activity	During construction, footprint of trench is 0.024km^2. Dimensions of trench for installation of the new LSO: Bottom Trench Width – 3m Top Trench Width - 24m based on (1:3 slope) Trench Length – 1km Depth – 3.5m During operation the LSO will be buried within the trench. The footprint of activity is currently unknown for the removal of the existing LSO.
Timings of activity (including start and finish dates)	The programme for the proposed scheme is not currently finalised. Dredging for the proposed LSO is expected to occur intermittently over approximately two months in summer. Construction hours of the offshore section will be 7 days per week, 24 hours a day in order to maximise

Your activity	Description, notes or more information
	utilisation of the equipment and minimise both costs and the duration of any impacts. Crew changes will be made every 12 hours. Dredging for the removal of the existing LSO is currently planned for after the new LSO is commissioned which is anticipated to start in 2020. .
Extent of activity (for example size, scale frequency, expected volumes of output or discharge)	As above.
Use or release of chemicals (state which ones)	None. Operation of the treatment works are being dealt with through consultation with the Environment Agency with the aim of securing an environmental permit for discharges.

Table 14.6 Surface water compliance criteria: Hydromorphology (Yorkshire South)

Consider if your activity:	Yes	No	Hydromorphology risk issue(s)
Could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status		✓	No, the water body is not at high status.
Could significantly impact the hydromorphology of any water body		✓	The area over which the dredging will occur is unlikely to impact on hydromorphological parameters of the WFD water body.
Is in a water body that is heavily modified for the same use as your activity		✓	Yes, the water body is modified for Navigation, Ports and Harbours. However, the area over which the dredging will occur is unlikely to impact on hydromorphological parameters of the WFD water body at a water body scale.

Table 14.7 Surface water compliance criteria: Biology (Yorkshire South)

Consider if the footprint of your activity is:	Yes	No	Biology habitats risk issue(s)
0.5km^2 or larger		✓	The area of the proposed dredge is approximately 0.024km^2. The area of dredge for the removal of the existing LSO is not known however it will be very small-scale as only partial removal of the intertidal section is proposed. The total footprint of the activities will therefore not be larger than 0.5km^2 neither will they impact on 1% or more of the WFD water body.
1% or more of the water body's area			

Consider if the footprint of your activity is:	Yes	No	Biology habitats risk issue(s)
Within 500m of any higher sensitivity habitat		✓	
1% or more of any lower sensitivity habitat		✓	No, the proposed dredging will not impact upon 1% or more of a lower sensitivity habitat. The dredge and sidecasting operation will impact a small area of subtidal soft sediment and a small area of cobbles, gravel and shingle which are present in large areas within the WFD water body. This will however be temporary and reversible.

Table 14.8 Surface water compliance criteria: Fish (Yorkshire South)

Consider if your activity:	Yes	No	Biology fish risk issue(s)
Is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary		✓	The area to be dredged is limited to the open coast and could not prevent fish migration through an estuary. As a result, it is not anticipated that significant effects on fish will occur.
Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)		✓	
Could cause entrainment or impingement of fish		✓	The works would not cause entrainment or impingement of fish.

Table 14.9 Surface water compliance criteria: Water Quality (Yorkshire South)

Consider if your activity:	Yes	No	Water quality risk issue(s)
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)		✓	No, although the dredging for the proposed LSO will occur intermittently over approximately two months in summer. Any potential increased suspended sediments would be expected to be localised given the nature of material to be excavated (predominantly sands) and it is expected that sediment mobilised into the water column would rapidly re-settle in close proximity to the dredge area. There is therefore no identified way in which the proposed dredging and side-casting/reuse of dredged material could have a non-temporary effect on status at water body level.

Consider if your activity:	Yes	No	Water quality risk issue(s)
Is in a water body with a phytoplankton status of moderate, poor or bad		✓	No, status is high.
Is in a water body with a history of harmful algae		✓	No.
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if:	**Yes**	**No**	**Water quality risk issue(s)**
The chemicals are on the Environmental Quality Standards Directive (EQSD) list		✓	No
It disturbs sediment with contaminants above Cefas Action Level 1		✓	Sediment sampling available indicates that the sediments to be dredged do not contain levels of contamination significantly above Cefas Action Level 1 (see results in **Appendix D**).

Table 14.10 Surface water compliance criteria: Protected Areas (Yorkshire South)

Consider if your activity is:	Yes	No	Protected areas risk issue(s)
Within 2km of any WFD protected area		✓	There are two designated sites for conservation interest within 2km however they have been considered within separate preliminary Habitats Regulations Assessment (HRA) and Marine Conservation Zone (MCZ) assessments, therefore are not considered further here. The capital dredging will occur within 2km of the following Protected Areas: Greater Wash Special Protection Area (SPA) Holderness Inshore Marine Conservation Zone (MCZ)

Table 14.11 Surface water compliance criteria: Invasive Species (Yorkshire South)

Consider if your activity could:	Yes	No	INNS risk issue(s)
Introduce or spread INNS		✓	The activities have the potential to release invasive species if the materials and equipment used in the process have not been properly cleaned after use at a previous location that may have had invasive species present. The International Convention for the Control and Management of Ships Ballast Water and Sediments (BWM Convention) was adopted in 2004 and entered into force on 08/09/17.This introduces global regulations to control the transfer of potentially invasive species. With the treaty now in force the dredging company will be expected to adhere to the convention and manage their ballast water appropriately.

Table 14.12 Surface water summary – Yorkshire South coastal water body

Receptor	Potential risk to receptor?	Note the risk issue(s) for impact assessment
Hydromorphology	No	No risks identified
Biology: habitats	No	
Biology: fish	No	
Water quality	No	
Protected areas	No	
Invasive non-native species	No	

14.4.2. Scour protection and protection dome

The following tables summarise the information relevant to the consideration of the requirements of the WFD for the scour protection and dome protection (tables taken from Clearing the Waters for All; Environment Agency, 2016). *Note that although the answer to the question is yes in some instances, the evidence provided in the notes column allows the issue to be scoped out*.

Table 14.13 Activity Information

Your activity	Description, notes or more information
Applicant name	Yorkshire Water

Your activity	Description, notes or more information
Application reference number (where applicable)	TBC
Name of activity	Scour protection and protection dome at diffuser
Brief description of activity	Scour protection is required around the diffuser area at the end of the LSO in the subtidal area. The scour protection will comprise a rock blanket around the diffuser structure. This blanket will extend to a minimum of 9m in all directions from the centre of the diffuser riser and will be designed to be stable under 1:100 year return period wave and current loading. A graded rock of 40-200kg is therefore proposed. In accordance with the CIRIA Rock Manual, this will be installed with a minimum thickness of 2 layers to provide a continuous scour blanket around the diffuser structure, with due consideration to construction tolerances. A filter layer is applied underneath the armour layer for sufficient filter capacities with the underlying backfill material. A concrete protection dome will also be used at the diffuser site.
Location of activity	See **Figure 14.1**
Footprint of activity	Approximately 20m^2
Timings of activity (including start and finish dates)	The programme for the proposed scheme is not currently finalised. The scour protection placement around the diffuser will take approximately four days.
Extent of activity (for example size, scale frequency, expected volumes of output or discharge)	As above.
Use or release of chemicals (state which ones)	None. A CEMP will be produced for the project which will detail measures against spills and leakages. Operation of the treatment works are being dealt with through consultation with the Environment Agency with the aim of securing an environmental permit for discharges

Table 14.14 Surface water compliance criteria: Hydromorphology (Yorkshire South)

Consider if your activity:	Yes	No	Hydromorphology risk issue(s)
Could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status		✓	No, the water body in which the activities will occur is not at high status.
Could significantly impact the hydromorphology of any water body		✓	The small area over which the activity will occur is unlikely to impact the hydromorphological parameters of the WFD water body.

Consider if your activity:	Yes	No	Hydromorphology risk issue(s)
Is in a water body that is heavily modified for the same use as your activity		✓	No

Table 14.15 Surface water compliance criteria: Biology (Yorkshire South)

Consider if the footprint of your activity is:	Yes	No	Biology habitats risk issue(s)
0.5km^2 or larger		✓	The footprint of the scour protection and dome protection is approximately 20m^2 i.e. it will not be larger than 0.5km^2 neither will it impact on 1% or more of the WFD water body.
1% or more of the water body's area			
Within 500m of any higher sensitivity habitat		✓	
1% or more of any lower sensitivity habitat		✓	No, the proposed dredging will not impact upon1% or more of a lower sensitivity habitat. The dredge and sidecasting operation will impact a small area of subtidal soft sediment and a small area of cobbles, gravel and shingle which are present in large areas within the WFD water body.

Table 14.16 Surface water compliance criteria: Fish (Yorkshire South)

Consider if your activity:	Yes	No	Biology fish risk issue(s)
Is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary		✓	The area to covered with scour protection and dome protection is limited to the coast and could not prevent fish migration through an estuary or normal fish behaviour or movement. As a result, it is not anticipated that significant effects on fish will occur.
Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)		✓	

Consider if your activity:	Yes	No	Biology fish risk issue(s)
Could cause entrainment or impingement of fish		✓	No

Table 14.17 Surface water compliance criteria: Water Quality (Yorkshire South)

Consider if your activity:	Yes	No	Water quality risk issue(s)
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)		✓	The scour protection and dome protection will be constructed offsite. Additionally, the period of works is expected to be only four days.
Is in a water body with a phytoplankton status of moderate, poor or bad		✓	Status is high.
Is in a water body with a history of harmful algae		✓	The proposed activities are not anticipated to impact on parameters which could exacerbate algal growth.
If your activity uses or releases chemicals consider if:	**Yes**	**No**	**Water quality risk issue(s)**
The chemicals are on the Environmental Quality Standards Directive (EQSD) list		✓	
It disturbs sediment with contaminants above Cefas Action Level 1		✓	Sediment sampling available indicates that the sediments to be dredged do not contain levels of contamination significantly above Cefas Action Level 1 (see results in **Appendix D**).

Table 14.18 Surface water compliance criteria: Protected Areas (Yorkshire South)

Consider if your activity is:	Yes	No	Protected areas risk issue(s)
Within 2km of any WFD protected area		✓	There are two designated sites for conservation interest within 2km however they have been considered within preliminary HRA and MCZ assessments, therefore are not considered further here. The capital dredging will occur within 2km of the following Protected Areas: Greater Wash SPA Holderness Inshore MCZ

Table 14.19 Surface water compliance criteria: Invasive Species (Yorkshire South)

Consider if your activity could:	Yes	No	INNS risk issue(s)
Introduce or spread INNS		✓	The activities have the potential to release invasive species if the materials and equipment used in the process have not been properly cleaned after use at a previous location that may have had invasive species present. The International Convention for the Control and Management of Ships Ballast Water and Sediments (BWM Convention) was adopted in 2004 and entered into force on 08/09/17.This introduces global regulations to control the transfer of potentially invasive species. With the treaty now in force the dredging company will be expected to adhere to the convention and manage their ballast water appropriately.

Table 14.20 Surface Water Summary – Yorkshire South coastal water body

Receptor	Potential risk to receptor?	Note the risk issue(s) for impact assessment
Hydromorphology	No	No risks were identified.
Biology: habitats	No	
Biology: fish	No	
Water quality	No	
Protected areas	No	
Invasive non-native species	No	

14.4.3. HDD / Micro-tunnelling

The following tables summarise the information relevant to the consideration of the requirements of the WFD for HDD / micro-tunnelling (tables amended from Clearing the Waters for All; Environment Agency, 2016). *Note that although the answer to the question is yes in some instances, the evidence provided in the notes column allows the issue to be scoped out*.

Table 14.21 Activity Information

Your activity	Description, notes or more information
Applicant name	Yorkshire Waters
Application reference number (where applicable)	TBC
Name of activity	HDD / Micro-tunnelling
Brief description of activity	The intertidal section of the LSO will be installed using either HDD or micro-tunnelling techniques rather then trenching and backfilling. The area of HDD / Microtunelling starts onshore crosses through the cliff face and finished mid-way through the intertidal zone. The length of LSO to be installed using HDD or micro-tunnelling techniques will be approximately 1km long.
Location of activity	See **Figure 2.4**
Footprint of activity	The activity will be below ground therefore there is no footprint of the proposed. The length of LSO to be installed through HDD / micro-tunnelling will be approximately 1km.
Timings of activity (including start and finish dates)	The programme for the proposed scheme is not currently finalised. The HDD/micro-tunnelling will occur over approximately 25 weeks in 2020..
Extent of activity (for example size, scale frequency, expected volumes of output or discharge)	As above.
Use or release of chemicals (state which ones)	There is the potential that a small amount of bentonite-containing fluid is released at the end of the HDD section. A CEMP will be produced for the project which will detail measures against spills and leakages. Operational discharges from the new Waste Water Treatment Works (WwTW) are being dealt with through consultation with the Environment Agency with the aim of securing an environmental permit for discharges.

Table 14.22 Surface water compliance criteria: Hydromorphology (Yorkshire South)

Consider if your activity:	Yes	No	Hydromorphology risk issue(s)
Could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status		✓	No, the water body in which the activities will occur is not at high status.
Could significantly impact the hydromorphology of any water body		✓	The small area over which the activity will occur is unlikely to impact the hydromorphological parameters of the WFD water body.
Is in a water body that is heavily modified for the same use as your activity		✓	No

Table 14.23 Surface water compliance criteria: Biology (Yorkshire South)

Consider if the footprint of your activity is:	Yes	No	Biology habitats risk issue(s)
0.5km^2 or larger		✓	The HDD will be below ground. It will not be larger than 0.5km^2 neither will it impact on 1% or more of the WFD water body.
1% or more of the water body's area			
Within 500m of any higher sensitivity habitat		✓	No. The proposed HDD/micro-tunnelling is not within 500m of any higher sensitivity habitats.
1% or more of any lower sensitivity habitat		✓	No, the proposed HDD/micro-tunnelling will not impact more than 1% of a lower sensitivity habitat. The works where they come to the surface within the intertidal zone will impact a small area of soft sediment is present in large areas within the WFD water body.

Table 14.24 Surface water compliance criteria: Fish (Yorkshire South)

Consider if your activity:	Yes	No	Biology fish risk issue(s)
Is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary		✓	The area of HDD/microtunelling is limited to the open coast and could not prevent fish migration through an estuary or normal fish behaviour or movement. As a result, it is not anticipated that significant effects on fish will occur.
Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)		✓	
Could cause entrainment or impingement of fish		✓	No

Table 14.25 Surface water compliance criteria: Water Quality (Yorkshire South)

Consider if your activity:	Yes	No	Water quality risk issue(s)
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)		✓	HDD/micro-tunnelling will be conducted onshore underground. Where it comes to the surface in the intertidal zone, works will be undertaken within a piled cofferdam, thus limiting any potential for impacts upon the marine environment.
Is in a water body with a phytoplankton status of moderate, poor or bad		✓	Status is high.
Is in a water body with a history of harmful algae		✓	The proposed activities are not anticipated to impact on parameters which could exacerbate algal growth.
If your activity uses or releases chemicals consider if:	**Yes**	**No**	**Water quality risk issue(s)**

Consider if your activity:	Yes	No	Water quality risk issue(s)
The chemicals are on the Environmental Quality Standards Directive (EQSD) list		✓	Small quantities of bentonite may be released into the environment at the end of the HDD section however this is not on the EQSD list and is an inert and non-toxic chemical.
It disturbs sediment with contaminants above Cefas Action Level 1		✓	Sediment sampling available indicates that the sediments with the potential to be disturbed at the end of the HDD section do not contain levels of contamination significantly above Cefas Action Level 1 (see results in **Appendix I**).

Table 14.26 Surface water compliance criteria: Protected Areas (Yorkshire South)

Consider if your activity is:	Yes	No	Protected areas risk issue(s)
Within 2km of any WFD protected area		✓	There are two designated sites for conservation interest within 2km however they have been considered within preliminary HRA and MCZ assessments, therefore are not considered further here. The capital dredging will occur within 2km of the following Protected Areas: Greater Wash SPA Holderness Inshore MCZ

Table 14.27 Surface water compliance criteria: Invasive Species (Yorkshire South)

Consider if your activity could:	Yes	No	INNS risk issue(s)
Introduce or spread INNS		✓	The activities have the potential to release invasive species if the materials and equipment used in the process have not been properly cleaned after use at a previous location that may have had invasive species present. A CEMP will be produced for the project detailing measures against spills and leakages; impacts on sediment and water quality and benthic habitats; re-suspension of contaminated sediment; marine pollution; disposal at sea of man-made material and environmental damage. Prior to work commencing on site, a pre-start check for invasive species will be undertaken.

Table 14.28 Surface Water Summary – Yorkshire South coastal water body

Receptor	Potential risk to receptor?	Note the risk issue(s) for impact assessment
Hydromorphology	No	No risks were identified.

Receptor	Potential risk to receptor?	Note the risk issue(s) for impact assessment
Biology: habitats	No	
Biology: fish	No	
Water quality	No	
Protected areas	No	
Invasive non-native species	No	

Table 14.29 Groundwater Quantitative Status (Hull and East Riding Chalk)

Consider if your activity:	Yes	No	Risk issue(s)
Quantitative Dependent Surface Water Body Status		✓	The proposed HDD/Microtunnel will occur for approximately 1km and will only cause temporary disturbance, therefore the impacts are not likely to impact the quantitative status of the entire groundwater body.
Quantitative GWDTEs test		✓	
Quantitative saline intrusion		✓	
Quantitative Water Balance		✓	

Table 14.30 Groundwater Chemical Status (Hull and East Riding Chalk)

Consider if the footprint of your activity is:	Yes	No	Risk issue(s)
Chemical Dependent Surface Water Body Status		✓	There is potential for existing contamination to be present in the near surface soils associated with the previous use of the existing WwTW site, the disuse railway line, in Withernsea town and agricultural activities, although existing information has not identified any potentially significant contamination. However, the proposed HDD/Microtunnel will only occur for approximately 1km and will only cause temporary disturbance, therefore the impacts will not impact the chemical status of the entire groundwater body.
Chemical Groundwater dependent terrestrial ecosystem (GWDTEs) test		✓	
Chemical Saline intrusion		✓	
General Chemical Test		✓	

Table 14.31 Groundwater supporting elements (Hull and East Riding Chalk)

Consider if your activity:	Yes	No	Risk issue(s)
Prevent and Limit Objective		✓	No pathway for effect
Trend Assessment		✓	

Table 14.32 Groundwater Summary – Hull and East Riding Chalk

Receptor	Potential risk to receptor?	Note the risk issue(s) for impact assessment
Quantitative	No	No risks were identified.
Chemical	No	
Supporting elements	No	

14.4.4. Removal of the diffuser

The following tables summarise the information relevant to the consideration of the requirements of the Water Framework Directive for removal of the diffuser from the existing LSO (tables taken from Clearing the Waters for All; Environment Agency, 2016). *Note that although the answer to the question is yes in some instances, the evidence provided in the notes column allows the issue to be scoped out*.

Table 14.33 Activity Information

Your activity	Description, notes or more information
Applicant name	Yorkshire Water
Application reference number (where applicable)	TBC
Name of activity	Removal of the diffuser at the existing LSO
Brief description of activity	Once the replacement LSO is commissioned the existing LSO will be demolished in the intertidal areas from the chamber on the foreshore up to the cliff line. The remaining sections of pipeline in both the subtidal and terrestrial, will be capped at both ends and left. The existing diffuser at the end of the subtidal section of the remaining LSO will be removed, at 1 m below seabed level

Your activity	Description, notes or more information
Location of activity	See **Figure 2.3**
Footprint of activity	The diffuser is at the end of the existing LSO. The diffuser discharges waste water through two 200mm diameter duck-billed rubber valves, designed to prevent the ingress of seawater.
Timings of activity (including start and finish dates)	The programme for the proposed scheme is not currently finalised. Removal of the existing LSO is currently planned for after the new LSO is commissioned which is anticipated to begin in 2020.
Extent of activity (for example size, scale frequency, expected volumes of output or discharge)	As above.
Use or release of chemicals (state which ones)	None.

Table 14.34 Surface water compliance criteria: Hydromorphology (Yorkshire South)

Consider if your activity:	Yes	No	Hydromorphology risk issue(s)
Could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status		✓	No, the water body is not at high status.
Could significantly impact the hydromorphology of any water body		✓	The area in which the diffuser will be removed will not impact on hydromorphological parameters of the WFD water body.
Is in a water body that is heavily modified for the same use as your activity		✓	Yes, the water body is modified for Navigation, Ports and Harbours. However, the area in which the removal of the diffuser will occur is unlikely to impact on hydromorphological parameters of the WFD water body at a water body scale.

Table 14.35 Surface water compliance criteria: Biology (Yorkshire South)

Consider if the footprint of your activity is:	Yes	No	Biology habitats risk issue(s)
0.5km^2 or larger		✓	Given that the waste water that is discharged through the existing LSO and out of the diffuser is of a sufficient standard, there is a very low risk of collection of particulate matter surrounding the release point and thus the

Consider if the footprint of your activity is:	Yes	No	Biology habitats risk issue(s)
1% or more of the water body's area			removal of the diffuser is very unlikely to elevate levels of *E. coli* during the removal process. Additionally, the mobile and highly turbid coastal waters of the Holderness coastline would cause immediate dilution and mixing of sediments which may contain *E.coli* should they be disturbed during the removal process of the diffuser. The footprint of the activity is very small, and far smaller than 0.5km^2 . In addition, the activity has no potentialneither will it impact on 1% or more of the WFD water body.
Within 500m of any higher sensitivity habitat		✓	
1% or more of any lower sensitivity habitat		✓	No, the proposed diffuser removal will not impact upon 1% or more of a lower sensitivity habitat. Any seabed that may be disturbed would be subtidal soft sediment which is present in large areas within the WFD water body.

Table 14.36 Surface water compliance criteria: Fish (Yorkshire South)

Consider if your activity:	Yes	No	Biology fish risk issue(s)
Is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary		✓	The diffuser removal is limited to the open coast and outside of any estuaries therefore it is not anticipated that significant effects on fish will occur.
Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)		✓	
Could cause entrainment or impingement of fish		✓	The works would not cause entrainment or impingement of fish.

Table 14.37 Surface water compliance criteria: Water Quality (Yorkshire South)

Consider if your activity:	Yes	No	Water quality risk issue(s)
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns		✓	Given that the waste water that is discharged through the existing LSO and out of the diffuser is of a sufficient standard, there is a very low risk of collection of particulate matter surrounding the release point and thus the

Consider if your activity:	Yes	No	Water quality risk issue(s)
continuously for longer than a spring neap tidal cycle (about 14 days)			removal of the diffuser is very unlikely to elevate levels of *E. coli* during the removal process. Additionally, the mobile and highly turbid coastal waters of the Holderness coastline would cause immediate dilution and mixing of sediments which may contain *E.coli* should they be disturbed during the removal process of the diffuser. The footprint of the activity is very small, and far smaller than 0.5km^2 . In addition, the activity has no potentialneither will it impact on 1% or more of the WFD water body.
Is in a water body with a phytoplankton status of moderate, poor or bad		✓	No, status is high.
Is in a water body with a history of harmful algae		✓	No.
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if:	**Yes**	**No**	**Water quality risk issue(s)**
The chemicals are on the Environmental Quality Standards Directive (EQSD) list		✓	No chemicals will be released as part of the proposed works.
It disturbs sediment with contaminants above Cefas Action Level 1		✓	Removal of the diffuser is not expected to disturb sediments. Additionally, sediment sampling available indicates that the sediments to be dredged do not contain levels of contamination significantly above Cefas Action Level 1 (see results in **Appendix X**).

Table 14.38 Surface water compliance criteria: Protected Areas (Yorkshire South)

Consider if your activity is:	Yes	No	Protected areas risk issue(s)
Within 2km of any WFD protected area		✓	There are two designated sites for conservation interest within 2km however they have been considered within separate HRA and MCZ assessments, therefore are not considered further here. The activity will occur within 2km of the following Protected Areas: Greater Wash Special Protection Area (SPA) Holderness Inshore Marine Conservation Zone (MCZ)

Table 14.39 Surface water compliance criteria: Invasive Species (Yorkshire South)

Consider if your activity could:	Yes	No	INNS risk issue(s)
Introduce or spread INNS		✓	

Table 14.40 Surface water summary – Yorkshire South coastal water body

Receptor	Potential risk to receptor?	Note the risk issue(s) for impact assessment
Hydromorphology	No	No risks identified
Biology: habitats	No	
Biology: fish	No	
Water quality	No	
Protected areas	No	
Invasive non-native species	No	

14.5. Conclusion

The comparison of the activities against the WFD scoping criteria has not identified any risk to WFD compliance receptors. As a result, no further assessment is considered necessary.

15. Habitats Regulations Assessment

15.1. Introduction

The following section presents the information to support the HRA process. The proposed scheme comprises the construction of a new LSO and the decommissioning of the existing LSO, within the intertidal and subtidal environment. Full details of the construction methodology for the proposed scheme can be found in **Section 2**.

This shadow HRA supports the marine licence application for the proposed scheme and therefore considers impacts only below MHWS. A HRA has also been undertaken in relation to terrestrial impacts, covering the terrestrial and marine works related to the Withernsea WwTW project, which has previously been submitted to ERYC for the planning application for the onshore development. The construction of the WwTW has received planning permission, and the associated infrastructure, including the rising main and the terrestrial section of the LSO, are to be implemented under Permitted Development Rights.

Two international statutory designated sites are located within 5km of the proposed Withernsea replacement LSO (as shown on **Figure 15.1**); Greater Wash SPA and Humber Estuary SAC/SPA/Ramsar. The proposed LSO works are located within the boundary of the Greater Wash SPA, therefore there is the potential for direct impacts to occur.

It is Natural England's role as SNCB to advise the relevant Competent Authority(s) on the potential significance of effects on European sites. This section of the report is intended to present all of the information necessary to assist Natural England (and the relevant Competent Authority(s)) in reaching a conclusion regarding potential impacts on designated sites.

This section should be read in parallel with other sections of the report which provide further detail. Relevant sections are as follows:

- **Section 7**: Hydrodynamic and Sedimentary Regime.
- **Section 9**: Marine and Coastal Ecology.
- **Section 11**: Marine and Coastal Ornithology.

15.2. HRA Process

The Conservation of Habitats and Species Regulations 2017 (the 'Habitats Regulations') implement the requirements of the Habitats and Birds Directives into English law. The Habitats Regulations make the 'Appropriate Assessment' (AA) process a mandatory requirement for plans and projects that, either alone or in combination with other plans or projects, are likely to have significant effects on European sites. AA is however only one part of the wider HRA process.

Legend

- Proposed Scheme Boundary
- 5km buffer
- Special Area of Conservation (SAC)
- Ramsar Site
- Special Protection Area (SPA)
- Potential Special Protection Area (pSPA)

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title:

European designated sites within 5km of the proposed scheme

Figure: 15.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	ES	A3	1:100,000

Co-ordinate system: British National Grid

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In accordance with UK Government policy (MHCLG, 2018)), candidate SACs (cSACs), proposed SPAs (pSPAs) and sites designated under the 'Convention on Wetlands of International Importance' ('Ramsar sites'), are also subject to the provisions of the Habitats Regulations.

Regulation 63 of the Habitats Regulations defines the procedure for the assessment of the implications of plans or projects on European sites. Under this Regulation, if a proposed development is unconnected with site management (for nature conservation purposes) and is likely to significantly affect the designated site, the competent authority must undertake an AA (Regulation 63(1)). The HRA process follows a four-staged approach, which is outlined in the following sections.

15.2.1. Stage 1 – HRA Screening

Screening is the process of identifying potentially relevant European sites, and determining whether the proposed project is likely to have a significant effect (LSE) on the qualifying interest features of the European site, either alone or in-combination with other plans and projects. If it is concluded at this stage that there is no potential for LSE, there is no requirement to carry out subsequent stages of the HRA.

In respect of Stage 1, a recent ruling (April 2018) by the Court of Justice of the European Union (CJEU) referred to as People Over Wind and Sweetman v Coillte Teoranta (C-323/17) has provided a judgement that "…it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site". As such, no mitigation measures (out with those that form a fundamental part of the proposed scheme design) have been taken into account when undertaking the LSE screening exercise.

15.2.2. Stage 2 – Appropriate Assessment (AA)

Where a LSE for a European site(s) cannot be ruled out, either alone or in-combination with other plans and projects, assessment of the potential effects of the project on the integrity of the European site(s), in view of its qualifying interest features and associated conservation objectives, is required.

Where it is concluded that there would be an adverse effect on site integrity (or where such an effect cannot be discounted) an assessment of mitigation options is carried out and mitigation measures (where available) are proposed to address the effects. If, having considered mitigation, the potential for adverse effect on integrity remains, the HRA must progress to Stages 3 and 4.

In respect of Stage 2, the integrity of a European site is defined as "the coherence of the site's ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or populations of species for which the site has been designated" (European Community (EC), 2001). An adverse effect on integrity, therefore, is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of designation.

15.2.2.1. Stage 3 – Assessment of alternative solutions

Stage 3 involves identifying and examining alternative ways of achieving the objectives of the project to establish whether there are solutions that would avoid, or have a lesser effect, on the European site(s).

15.2.2.2. Stage 4 – Imperative Reasons of Overriding Public Interest (IROPI)

Where no alternative solution exists, the next stage of the process is to assess whether the project is necessary for IROPI and, if so, the identification of compensatory measures needed to maintain the overall coherence of the Natura 2000 network.

15.2.3. Consultation and responses received

The competent authority (MMO) undertaking the AA must consult with Natural England and must have regard to any representations made by Natural England.

Section 5 of the ES summarises the consultation undertaken through the EIA Scoping stage and the responses received. **Table 15.1** summarises the information provided by the MMO in its Scoping Opinion that is of relevance to the HRA.

Table 15.1 Scoping Opinion comments

Organisation	Comment	Section where addressed
MMO	The MMO welcomes consideration of both physical disturbance and noise to the associated qualifying features of the affected sites.	Noted, included in **Section 15**
MMO	The MMO note that the Habitats Regulations Assessment (HRA) provided in support of the Scoping Report (Appendix D) states that the subtidal components of the work will be completed during the summer of 2020 and that the intertidal component of work will be carried out at low water, therefore avoiding sensitive timings for Red Throated Divers. The MMO advise that the recent People Over Wind Ruling by the Court of Justice of the European Union has determined that measures intended to avoid or reduce the likely adverse effects cannot be taken into account when determining whether a plan or a project is likely to have a significant effect on a site. Based on the information provided within the shadow HRA, without mitigation, it cannot be concluded that the works will not have a likely significant effect. Consequently, the MMO advise that information to inform an Appropriate Assessment is provided within a section of the ES.	Noted, however, the intertidal component of work will be carried out at low water due to the access required by land-based plant. Furthermore, the subtidal components of the work will be completed during the summer of 2020 due to the requirement for good weather conditions. This is assessed in **Section 15**
MMO	Based upon the information provided within the Scoping Report and the shadow HRA (Appendix D), it is not clear whether the works associated with the decommissioning of the existing long sea outfall (LSO) works have been included and assessed accordingly.	Further information on the decommissioning of the existing LSO have been provided in S**ection 15**. However, these works will not be included under the proposed scheme and subsequent consent will be gained for this activity.
HMO	From the information provided, it is not clear whether activities associated with the maintenance and operation of the works have been included and assessed within the HRA (Appendix D). The MMO	Further information on the decommissioning of the existing LSO have been provided. However, these works will not be included under the

Organisation	Comment	Section where addressed
	therefore advise that any maintenance and operation works be fully considered within the shadow HRA.	proposed scheme as minor maintenance activities are covered by an existing Marine Licence. A subsequent marine licence would be sought for more major works.
MMO	The MMO note that a temporary cofferdam structure is required to facilitate connection of the Horizontal Directional Drilling (HDD), to the subtidal trench. However, from the information provided in the shadow HRA and MCZ Assessment, it does not appear that the likely effects of the works associated with the cofferdam structure (including piling) have been assessed	Noted, further detail is provided on the cofferdam in **Section 2** and is assessed in **Section 15** and **Section 16**
MMO	The MMO note that a temporary ramp will be constructed to allow access from the cliff to the foreshore in order to carry out the works. From the information provided, it is not clear whether the works associated with the temporary access ramp have been considered within the shadow HRA and MCZ Assessment.	Noted, further detail is provided on the access ramp in **Section 2** and is assessed in **Section 15** and **Section 16**
MMO	The MMO considers that the proposed development is likely to have a significant effect on protected bird species, such as the Red throated diver during the overwintering period (i.e. 1 October and 31 March, inclusive).	Noted, however further information is provided in **Section 2** to detail that works will not be undertaken within this period due to the operational constraints and H&S risks of working in poor weather.
MMO	The MMO advise that consultation advice be obtained from Natural England with respect to the assessment of the likely impact of the proposed development on sites designated for nature conservation and to ensure that the shadow HRA and MCZ is both appropriate and fit for purpose.	Noted, Natural England were consulted through a DAS request during the pre-application phase and the project was discussed in detail at this time. The results of this consultation have informed those relevant sections of the ES. **Section 15** and **Section 16**

15.2.4. Information on Designated Sites and Conservation Objectives

The international statutory designated sites which have been identified within 5km of the site and which will be considered within this document are:

- Greater Wash SPA; and
- Humber Estuary SAC/SPA/Ramsar site.

15.2.4.1. Greater Wash SPA

Greater Wash SPA is designated to protect important areas of sea used by waterbirds during the non-breeding period, and for foraging in the breeding season by qualifying interest features of a number of other SPAs: Humber Estuary, Gibraltar Point, North Norfolk Coast, Breydon Water and Great Yarmouth North Denes. The designated features of the SPA and the importance of the Withernsea coastal area to each species are detailed in **Section 6.1 and Section 11.4** respectively.

15.2.4.2. Humber Estuary SPA/SAC/Ramsar site

The Humber Estuary is designated for its wintering and breeding bird assemblage (amongst other features) which may also rely on the wider landscape for foraging resources. The designated features and the importance of the Withernsea coastal area to each species are detailed in **Section 6.1** and **Section 11.4** respectively.

15.2.4.3. European Site Conservation Objectives

Under Regulation 37(3)(a) of the Habitats Regulations, Natural England has a duty to advise other relevant authorities as to the conservation objectives of European sites. A site's conservation objectives apply to the site and the individual species, assemblage of species and/or habitats for which the site has been classified. The conservation objectives which apply to all the designated sites listed above are provided below.

The objectives are to ensure that, subject to natural change, the integrity of the sites is maintained or restored as appropriate, and that the sites contribute to achieving the Favourable Conservation Status of their qualifying features, by maintaining or restoring:

- the extent and distribution of qualifying natural habitats and habitats of the qualifying species;
- the structure and function (including typical species) of qualifying natural habitats;
- the structure and function of the habitats of the qualifying species;
- the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- the populations of qualifying species, and;
- the distribution of qualifying features within the site.

The conservation objectives and accompanying supplementary advice provide a framework to inform the management and measures needed to conserve or restore the European site, and the prevention of deterioration and significant disturbance of its qualifying features.

15.2.5. Potential for in-combination effects

A review of the ERYC website and the MMO public register has been undertaken to determine any plans or projects which could result in in-combination effects with the proposed scheme. The projects which could potentially have an in-combination effect with the proposed LSO on European designation sites are:

- Withernsea LSO temporary protection works.

- Withernsea south coastal defences.

The CIA concluded that there was no potential for cumulative impacts to occur from construction of the full Withernsea WwTW and associated infrastructure (**Section 13.4.1**). The potential for these works to have an in-combination effect on the qualifying features of the Greater Wash SPA and the Humber Estuary SPA/Ramsar and SAC is presented in **Section 15.5.**

In summary, the replacement Withernsea WwTW project will consist of a new WwTW, demolition of the existing WwTW located off Holmpton Road, a new rising main from Memorial Gardens Sewage Pumping Station (SPS) to the proposed WwTW; a connection from the new Rising Main to the existing Hollym SPS and the LSO (the marine section of which is considered as the proposed scheme for the purposes of this ES) (**Figure 1.1**). .

15.3. Stage 1: Screening

'HRA screening' is the process of identifying (a) whether the activity is taking place within or near an area being put forward for, or already designated as, an SPA/pSPA/SAC/cSAC/Ramsar site, and (b) whether the plan or project is directly connected with or necessary to the management of a European site for nature conservation.

The proposed scheme is not directly connected with or necessary to the management of a site or conservation features. It is therefore necessary for the competent authority to determine whether this project will have a LSE on the relevant sites.

Evidence to assist the MMO in reaching a conclusion is provided in the following section.

15.4. Stage 2: Test of LSE

Evidence to assist the MMO in reaching a conclusion on whether this project will have a LSE on European designated sites is detailed within the tables and corresponding footnotes that follow. The evidence itself draws upon the various assessments undertaken to inform the EIA for the proposed scheme, as well as the ES itself. Where appropriate, relevant cross references to other sections of the ES are provided.

The matrices that are provided below set out whether a LSE is considered likely. These have been provided for information and with the aim of assisting the MMO in reaching a conclusion. The matrices are based upon an approach set out within the Planning Inspectorate's Advice Note 10 on Habitats Regulations Assessment[5] relating to Nationally Significant Infrastructure Projects (NSIP). Although this project is not an NSIP, the matrix approach used is considered to be a convenient and helpful way in which information can be drawn together and conclusions presented.

[5] *The Planning Inspectorate (2017). Advice Note 10: Habitats Regulations Assessment relevant to nationally significant infrastructure projects. Version 8. November 2017*

The key for reading the matrices is as follows:

- ✓ = A likely significant effect cannot be excluded.
- X = A likely significant effect can be excluded.
- C = Construction.
- O = Operation.
- D = Decommissioning (of the existing LSO[6])

Where effects are not applicable to a particular feature or construction activity, they are greyed out. Explanatory text for each of the potential effects on a feature are provided in subsequent paragraphs.

The new LSO is expected to have a lifespan of 60 years. When it is decommissioned this will follow the same methodology as that of the new LSO and as such the impacts identified in the tables below will also apply to the decommissioning of the new LSO.

15.4.1. The Greater Wash SPA

Table 15.2 below presents the LSE assessment of the proposed scheme on the designated features of the Greater Wash SPA site.

Table 15.2 LSE assessment table for the Greater Wash SPA

Greater Wash SPA												
Distance to project: Within												
European site features	**Likely Effects of project**											
	Noise and disturbance			**Increase in suspended sediments**			**Loss of supporting habitat**			**Hydromorphological changes**		
	C	**O**	**D**	**C**	**O**	**D**	**C**	**O**	**D**	**C**	**O**	**D**
Red-throated diver	X a	X b	✓ c	X a		X d	X f		X f	X a		X d
Sandwich tern	X d	X b	X d	X d		X d	X f		X f	X d		X d
Common tern	X d	X b	X d	X d		X d	X f		X f	X d		X d
Little tern	X e	X b	X d	X e		X e	X f		X f	X e		X e
Little gull	X d	X b	X c	X d		X d	X f		X f	X d		X d
Common scoter	X d	X b	X c	X d		X d	X f		X f	X d		X d

[6] *The new LSO is expected to have a lifespan of 60 years. When it is decommissioned this will follow the same methodology as that of the new LSO and as such the impacts identified in the tables below will also apply to the decommissioning of the new LSO.*

15.4.1.1. Explanatory text: Table 15.2 (a)

Evidence for the designation of the Greater Wash SPA, demonstrates that red-throated diver are present during the overwintering period (November to March, inclusive) in the vicinity of the proposed scheme footprint, although, predicted to be very low usage (0.29 - 0.67 birds per km^2) (Natural England and JNCC, 2016). An overwintering survey undertaken on behalf of YWS, recorded a maximum of 29 recorded during the overwintering 2017/18 period (Waxwings Ornithology, 2018).

Construction activities within the intertidal and subtidal will include subtidal dredging, intertidal trenching, the installation of a cofferdam by push piling, and the installation of the LSO and associated infrastructure (see **Section 2.2** of the ES). The installation of the cofferdam will be completed using a vibro-piling technique which will not produce levels of noise above that of the surrounding noises associated with the movement of construction vehicles and excavators.

Due to weather restrictions within the winter period, the necessary time of year to undertake the construction of the LSO is during the summer months and as such the intertidal and subtidal components of these works will be completed during the summer of 2020. These works will be completed before red-throated diver arrive to the area and as such no LSE on red-throated diver is predicted.

15.4.1.2. Explanatory text: Table 15.2 (b)

Potential operational maintenance activities include: asset inspection and maintenance, and repair/replacement of the scour protection, diffuser dome and navigational markers. These will not represent a change from the operational activities at the existing LSO and will be covered by the existing long-term marine licence, once a variation has been submitted. Works within the subtidal will comprise of infrequent use of a dive team and a single supporting workboat. Due to the small scale, temporary and infrequent nature of the works, it is not anticipated that there will be no LSE on qualifying features of the Greater Wash SPA during operation.

The operation of the replacement LSO will represent no change from the existing LSO in either the quantity or quality of the discharge. Therefore, no LSE on designated species are considered likely as a result of the operational phase of the proposed LSO.

15.4.1.3. Explanatory text: Table 15.2 (c)

There is the potential for direct impacts through noise and disturbance during the decommissioning of the existing subtidal and intertidal section of LSO as this has the potential to take place at the beginning of the overwintering period. Although, the works will be minor and temporary in nature and very short-term, involving up to two tracked excavators, two cranes and a generator on the foreshore, and one vessel at the distal end of the LSO, for a period of two weeks only.

As such the decommissioning of the existing LSO has been screened in to the AA.

15.4.1.4. Explanatory text: Table 15.2 (d)

As detailed in **Section 11** and according to density maps submitted as the evidence base for the SPA, the inshore and offshore area surrounding the LSO is not used by Sandwich tern, common tern, little gull or common scoter in significant numbers in any season (Natural England and JNCC, 2016). As such no LSE is predicted on these designated features during construction or decommissioning.

15.4.1.5. Explanatory text: Table 15.2 (e)

Little tern use the Holderness Coast for foraging in small numbers during the summer breeding season. According to the evidence collected for the designation of this site, the foraging range of little tern does not extend as far north as Withernsea as it is outside their 6km foraging range (Natural England and JNCC, 2016). The dredging works are small in scale and represent a short-term, temporary impact. The installation of the cofferdam will be completed using a 'push' piling technique which will not produce levels of noise above that of the surrounding noises associated with the movement of construction vehicles and excavators. Impacts on suspended sediment concentrations are not expected to be discernible above natural levels as the Holderness Coast is a naturally highly turbid region and due to the coarse nature of the sediment it will rapidly resettle. As a result, impacts to foraging little tern are considered to be of negligible significance, with no LSE predicted during construction or decommissioning (should the latter occur during the summer period).

15.4.1.6. Explanatory text: Table 15.2 (f)

There will be a temporary disturbance to the intertidal and subtidal habitats during construction and decommissioning. However, materials will be dredged and side-cast to be infilled following the installation of the LSO. An intertidal survey of the foreshore was undertaken on behalf of YWS and was shown to be of low ecological value. It is not expected that the intertidal zone supports foraging species of the Greater Wash SPA during the overwintering period therefore no LSE is predicted during decommissioning works. The construction works will occur during the

15.4.2. The Humber Estuary SPA

Table 15.3 below presents the LSE assessment of the proposed scheme on the designated features of the Humber Estuary SPA site.

Table 15.3 Shadow LSE assessment - Humber Estuary SPA

Humber Estuary SPA												
Distance to project: 4.6km												
European site features	**Likely Effects of project**											
	Noise			**Increase in suspended sediments**			**Loss of supporting habitat**			**Hydromorphological changes**		
	C	**O**	**D**	**C**	**O**	**D**	**C**	**O**	**D**	**C**	**O**	**D**
Avocet	X b	X d	X e	X c		X e	X b		X e	X b		X e
Bittern	X b	X d	X e				X b		X e			
Hen harrier	X a	X d	X e				X a		X e			
Little tern	X b	X d	X e	X c		X e	X b		X e	X b		X e
Golden plover	X a	X d	X e	X c		X e	X a		X e	X a		X e
Bar-tailed godwit	X a	X d	X e	X c		X e	X a		X e	X a		X e
Ruff	X b	X d	X e	X c		X e	X b		X e	X b		X e
Marsh harrier	X b	X d	X e				X b		X e			
Shelduck	X a	X d	X e	X c		X e	X a		X e	X a		X e
Knot	X b	X d	X e	X c		X e	X b		X e	X b		X e
Dunlin	X b	X d	X e	X c		X e	X b		X e	X b		X e
Black-tailed godwit	X b	X d	X e	X c		X e	X b		X e	X b		X e
Common redshank	X b	X d	X e	X c		X e	X b		X e	X b		X e

15.4.2.1. Explanatory text: Table 15.3 (a)

No qualifying bird species of the Humber Estuary SPA were recorded using the proposed scheme footprint during the overwintering period (Waxwings Ornithology, 2018).

The construction of the new LSO will take place during the spring/summer months due to the requirement to avoid poor weather conditions. It is therefore concluded that no disturbance impacts will occur during the construction of the new LSO on the overwintering qualifying features of the Humber Estuary SPA.

15.4.2.2. Explanatory text: Table 15.3 (b)

The Humber Estuary SPA covers these breeding or on passage species. The construction of the new LSO will take place during the spring/summer months due to the requirement to avoid poor weather conditions.

However, the supporting foraging and breeding habitats required for each of these species are not found with the proposed scheme footprint. Therefore, there is no likelihood of an LSE from the construction, operation or decommissioning works

15.4.2.3. Explanatory text: Table 15.3 (c)

The proposed dredge will increase water depth along the proposed pipeline corridor for a short period of time, prior to backfilling. However, given the very localised dredge in the context of the open sea, there will be no discernible effect likely. Any variation in suspended sediment concentrations is likely to be short-term and reversible due to natural processes and will not have an LSE on the features of this SPA. The proposed development is located approximately 4.6km from the Humber Estuary.

15.4.2.4. Explanatory text: Table 15.3 (d)

Potential operational maintenance activities include: asset inspection and maintenance, and repair/replacement of the scour protection, diffuser dome and navigational markers. These will not represent a change from the operational activities at the existing LSO. It is therefore not anticipated that there will be no LSE on qualifying features of the Humber Estuary SPA during operation.

The operation of the replacement LSO will represent no change from the existing LSO in either the quantity or quality of the discharge. Therefore, no LSE on designated species are considered likely as a result of the operational phase of the proposed LSO.

15.4.2.5. Explanatory text: Table 15.3 (e)

The proposed decommissioning works are considered to have a similar impact to that of the construction works and are small in scale, nature and will be temporary. As a result it is not anticipated that any direct or indirect effects will impact the features of the Humber Estuary SPA and as such no LSE is predicted.

15.4.3. The Humber Estuary SAC

Table 15.4 below presents the LSE assessment of the proposed scheme on the designated features of the Humber Estuary SAC site.

Table 15.4 Shadow LSE assessment - Humber Estuary SAC

Humber Estuary SAC												
Distance to project: 4.6km												
European site features	Likely Effects of project											
	Noise and disturbance			**Increase in suspended sediments**			**Loss of supporting habitat**			**Hydromorphological changes**		
	C	**O**	**D**	**C**	**O**	**D**	**C**	**O**	**D**	**C**	**O**	**D**
Estuaries				X a		X a				X a	X a	X a

Humber Estuary SAC												
Distance to project: 4.6km												
European site features	Likely Effects of project											
	Noise and disturbance			Increase in suspended sediments			Loss of supporting habitat			Hydromorphological changes		
	C	O	D	C	O	D	C	O	D	C	O	D
Mudflats and sandflats not covered by seawater at low tide				X a		X a				X a	X a	X a
Atlantic salt meadows (*Glaucopuccinellietalia maritimae*)				X a		X a				X a	X a	X a
Coastal lagoons*				X a		X a				X a	X a	X a
Dunes with *Hippophae rhamnoides*				X a		X a				X a	X a	X a
Embryonic shifting dunes				X a		X a				X a	X a	X a
Mixed coastal dunes with herbaceous vegetation (‘grey dunes’)*				X a		X a				X a	X a	X a
Salicornia and other annuals colonising mud and sand				X a		X a				X a	X a	X a
Sandbanks which are slightly covered by sea water all the time				X a		X a				X a	X a	X a
Shifting dunes along the shoreline with *Ammophila arenaria* (`white dunes’)				X a		X a				X a	X a	X a
Grey seal	X b	X c	X d	X b	X c	X d	X b	X c	X d	X b	X c	X d
River lamprey	X b	X c	X d	X b	X c	X d	X b	X c	X d	X b	X c	X d
Sea lamprey	X b	X c	X d	X b	X c	X d	X b	X c	X d	X b	X c	X d

15.4.3.1. Explanatory text: Table 15.4 (a)

The installation of the proposed LSO, including the intertidal and subtidal trenches and temporary cofferdam, and the decommissioning of the existing LSO will cause very localised changes in seabed level and sediment transport, which will be short-term and temporary. Natural processes will be fully reinstated upon completion of the works.

There are no significant impacts predicted on the baseline coastal processes during construction or operation of the proposed works. The Humber Estuary SAC is located over 4.6km along the coast from the proposed scheme location. It is therefore considered unlikely that any significant

impacts would arise from the small-scale nature of the installation of the proposed LSO. Therefore, no LSE is predicted on the SAC habitat features.

15.4.3.2. Explanatory text: Table 15.4 (b)

The proposed marine works are not predicted to have an adverse effect on pinniped or fish movements or feeding behaviours, given the short-term nature of the works in question (dredging is programmed to take approximately two months to complete) and the predicted localised effects relating to the dredging of the LSO trench, side-casting and its eventual reinstatement. The open coast environment means that seals and fish will be able to avoid the area. Underwater noise will be limited to that associated with the dredging plant and associated supporting vessels. Due to the limited likelihood of seals being present within the vicinity of the proposed scheme during the construction phase and the relatively short-term nature of the activities proposed, no LSE on grey seal is therefore predicted. No LSE on fish species is predicated either.

15.4.3.3. Explanatory text: Table 15.4 (c)

The maintenance activities for the existing LSO by a 10-year Marine Licence (L/2017/00177/1), which will be varied appropriately to include the new replacement LSO. These activities will take place infrequently and will not be discernible above the background level of activities in the area. The operation of the replacement LSO will represent no change from the existing LSO in either the quantity or quality of the discharge. Therefore, no LSE on designated marine mammal and fish species are considered likely as a result of the operational phase of the proposed LSO.

15.4.3.4. Explanatory text: Table 15.4 (d)

The decommissioning of the existing LSO will take place following the commissioning of the new LSO and will involve the capping of both ends of the LSO and the removal of the diffuser and the associated scour protection to 1m below the sea bed. The intertidal section of LSO will be demolished from the existing chamber on the foreshore up to the cliff. The removal of these elements will cause short-term, local resuspension of sediment which is not expected to be above natural background levels of suspended sediment. These works will be short-term and temporary in nature and are unlikely to result in a significant adverse effect on marine mammals or fish or, due to the distance from the project, the habitats within the Humber Estuary SAC.

15.4.4. Humber Estuary Ramsar site

Table 15.5 below presents the LSE assessment of the proposed scheme on the designated features of the Humber Estuary Ramsar site.

Table 15.5 Shadow LSE assessment - Humber Estuary Ramsar site

Humber Estuary Ramsar												
Distance to project: 4.6km												
European site features	**Likely Effects of project**											
	Noise and disturbance			**Increase in suspended sediments**			**Loss of supporting habitat**			**Hydromorphological changes**		
	C	**O**	**D**	**C**	**O**	**D**	**C**	**O**	**D**	**C**	**O**	**D**
Criterion 1 estuary				X a		X a				X a		X a
Criterion 3 seals	X b	X c	X d	X b		X d	X b		X d	X b		X d
Criterion 5 birds	X e	X f	X g	X e		X g	X e		X g	X e		X g
Criterion 6 birds	X e	X f	X g	X e		X g	X e		X g	X e		X g
Criterion 8 fish	X b	X c	X d	X b		X d	X b		X d	X b		X d

15.4.4.1. Explanatory text: Table 15.5 (a)

The installation of the proposed LSO, including the intertidal and subtidal trenches and temporary cofferdam, and the decommissioning of the existing LSO will cause very localised changes in seabed level and sediment transport, which will be short-term and temporary. Natural processes will be fully reinstated upon completion of the works.

There are no significant impacts predicted on the baseline coastal processes during construction or operation of the proposed works. The Humber Estuary Ramsar is located over 4.6 km along the coast from the LSO works location. It is therefore considered unlikely that any significant impacts would arise from the small-scale nature of the installation of the proposed LSO. Therefore, no LSE is predicted on the Ramsar habitat features.

15.4.4.2. Explanatory text: Table 15.5 (b)

The proposed marine works are not predicted to have an adverse effect on pinniped and fish movements or feeding behaviours, given the short-term nature of the works in question (dredging is programmed to take approximately two months to complete) and the predicted localised effects relating to the dredging of the LSO trench, side-casting and its eventual reinstatement.

The open coast environment means that seals and fish will be able to avoid the area and the proposed works are not located close to a known breeding location. Underwater noise will be limited to that associated with the dredging plant and associated supporting vessels.

Due to the limited likelihood of seals being present within the vicinity of the proposed scheme during the construction phase and the relatively short-term nature of the activities proposed, no LSE on grey seal or migratory fish is therefore predicted.

15.4.4.3. Explanatory text: Table 15.5 (c)

The maintenance activities for the existing LSO by a 10-year Marine Licence (L/2017/00177/1), which will be varied appropriately to include the new replacement LSO. These activities will take place infrequently and will not be discernible above the background level of activities in the area. The operation of the replacement LSO will represent no change from the existing LSO in either the quantity or quality of the discharge. Therefore, no LSE on designated marine mammal and fish species are considered likely as a result of the operational phase of the proposed LSO.

15.4.4.4. Explanatory text: Table 15.5 (d)

The decommissioning of the existing LSO will take place following the commissioning of the new LSO and will involve the capping of both ends of the LSO and the removal of the diffuser and the associated scour protection to 1m below the sea bed. The intertidal section of LSO will be demolished from the existing chamber on the foreshore up to the cliff. The removal of these elements will cause short-term, local resuspension of sediment which is not expected to be above natural background levels of suspended sediment. These works will be short-term (two weeks) and temporary in nature and are unlikely to result in a significant adverse effect on marine mammals or fish or, due to the distance from the project, the habitats within the Humber Estuary Ramsar.

15.4.4.5. Explanatory text: Table 15.5 (e)

The number of qualifying bird species using the area of the proposed LSO were not found to be significant (Waxwings Ornithology, 2018). No qualifying bird species of the Humber Estuary Ramsar were recorded using the proposed LSO site. The majority of works will take place during the spring/summer months and therefore outside of the winter period. It is therefore concluded that disturbance impacts will likely be insignificant on qualifying features of the Humber Estuary Ramsar site.

The proposed dredge will increase water depth along the proposed LSO corridor for a short period of time, prior to backfilling. However, given the very localised dredge in the context of the open sea, there will be no discernible effect likely. Any variation in suspended sediment concentrations is likely to be short-term and reversible due to natural processes and will not have an LSE on the features of this Ramsar. The proposed development is located approximately 4.6km from the Humber Estuary. No direct or indirect impacts on the Humber Estuary Ramsar site or its conservation objectives have been identified due to the distance between the locations.

15.4.4.6. Explanatory text: Table 15.5 (f)

The LSO will be buried below the inter-tidal beach and sub-tidal seabed, with a minimum depth of cover of 3 m. It will therefore remain buried over its design life and cause no effect on longshore sediment transport. As such no LSE on the Humber Estuary Ramsar is predicted.

15.4.4.7. Explanatory text: Table 15.5 (g)

The proposed decommissioning works are considered to have a similar impact to that of the construction works and are small in scale, nature and will be temporary. As a result, it is not anticipated that any direct or indirect effects will impact the features of the Humber Estuary SPA and as such no LSE is predicted.

15.5. In-combination effects

15.5.1. Withernsea LSO Temporary Protection Works

The Withernsea LSO Temporary Protection Works are currently in place and will not be removed until construction of the proposed LSO has been completed. Therefore, there is no potential for significant in-combination effects to occur as a result of the proposed scheme and removal of the Temporary Protection Works.

15.5.2. Withernsea South Coastal Defences

The Withernsea South Coastal Defences are located over 1km from the proposed LSO. Construction dates are not yet known though it is anticipated this may be undertaken in Autumn 2019 for a period of six months. However, as a worst-case scenario should the construction phase of the coastal defence scheme coincide with construction of the proposed LSO there would be no pathway for in-combination impacts to occur in relation to the features protected within the European sites. It was considered that the Withernsea South Coastal Defences project will not have a LSE on the Humber Estuary and would not contravene any of the conservation objectives for the site. As no LSE has been concluded for the proposed scheme on the Humber Estuary SPA/Ramsar/SAC, it follows that there is no potential for an 'in-combination' LSE with the Withernsea South Coastal Defences project. No further assessment is therefore considered necessary.

The Withernsea South Coastal Defences scheme was considered not to have a LSE on the Greater Wash SPA. The main construction works for the proposed replacement LSO will not be undertaken during the overwintering period, with only minor and very short term (two weeks) decommissioning works of the existing LSO to be undertaken between October and March. It is unlikely that this would occur at the same time as the above project, due to the requirement to be undertaken once the new LSO is fully commissioned, likely to be following September 2020, six months following the construction of the Withernsea South Coastal Defences scheme.

15.5.3. Replacement Withernsea WwTW and associated infrastructure project

The Replacement Withernsea WwTW and associated infrastructure project was considered not to have a LSE on the Greater Wash SPA or the Humber Estuary SPA/Ramsar/SAC. Although a LSE is predicted on the Greater Wash SPA for the decommissioning of the existing LSO as part of the

proposed scheme, it is unlikely that the works will be undertaken at the same time. The new LSO will be required to be commissioned prior to the decommissioning works beginning.

15.5.4. Summary

Given the prediction of no LSE from the above nearby projects or the proposed scheme, it is considered that the proposed scheme will not have a LSE on the interest features of the Humber Estuary SPA/Ramsar/SAC in-combination with the projects outlined above. No further assessment under the requirements of the Habitats Regulations is deemed necessary.

Although a LSE is predicted on the Greater Wash SPA for the decommissioning of the existing LSO as part of the proposed scheme, it is unlikely that the works will be undertaken at the same time. It is concluded there is no potential for an 'in-combination' LSE with other plans or projects. No further assessment is therefore considered necessary.

15.6. Summary of HRA LSE Test

The HRA LSE stage has determined that the proposed scheme has the potential to result in a LSE on the following European site feature (alone):

- Greater Wash SPA (construction phase; decommissioning of existing LSO only)

The following potential effect during decommissioning has been screened in and will be assessed within the AA:

- Direct effects of noise and disturbance during the decommissioning of the existing subtidal and intertidal sections of the LSO on red throated diver.

All other potential impacts on the Greater Wash SPA during construction, operation and decommissioning activities associated with the proposed scheme have been screened out of AA.

The HRA LSE stage concluded that there is no LSE predicted on the features designated within the Humber Estuary SPA, SAC or Ramsar site. As such there is no requirement for an AA of the project to be undertaken on these sites.

In addition, it was concluded that there are no other plans or projects that have the potential to result in in-combination effects with the proposed scheme and therefore an in-combination assessment is not required at the AA stage.

15.7. Provision of information to inform the Appropriate Assessment

15.7.1. Introduction

This section of the HRA provides the information required to inform an AA of the proposed scheme. With reference to the information presented in **Section 11** (Marine and Coastal Ornithology), this

section describes the potential effects of the proposed scheme insofar as they are relevant to the qualifying interest features / criteria of the designated site screened into the assessment. The potential effects identified are then considered in the context of the defined conservation objectives (**Section 15.2.6.1**) for the designated site and a view is given on whether or not the proposed scheme (alone) would have an adverse effect on the integrity of the European site.

15.7.2. Approach to assessment of potential adverse effects

Determining whether, in view of a European site's conservation objectives, the plan or project, either alone or in-combination with other plans and projects would have an adverse effect (or risk of this) on the integrity of the site has been assessed considering:

- site-specific information obtained from surveys undertaken to inform this AA;
- the advice of statutory bodies; and,
- professional judgement.

The following definitions and approach were used to determine whether the proposed scheme would result in an adverse effect on the European sites screened into the assessment.

15.7.2.1. Site integrity

The assessment of adverse effects on the integrity of a site is undertaken considering the conservation objectives for each site. The integrity of a site is defined as the *"coherence of the site's ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or populations of species for which the site has been designated"* (ODPM Circular, 06/2005).

EC guidance (European Commission, 1999) emphasis that site integrity involves its ecological functions and that the assessment of adverse effects should focus on and be limited to the site's conservation objectives.

15.7.2.2. Adverse effect

The potential effects of the proposed scheme during the construction and operational phases have been considered in the context of their effects on the qualifying interest features and criteria (the species and their supporting habitats) of the European sites. An adverse effect on site integrity is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of designation. In addition, an adverse effect would be one which caused a detectable reduction in the species for which the sites are designated, at the scale of the site rather than the scale of the impact.

Article 1 of the Habitats Directive defines the conservation status of a natural habitat as 'favourable' when "the specific structure and functions which are necessary for its long-term

maintenance exist and are likely to continue to exist for the foreseeable future". An adverse effect on site integrity will not occur if it can be shown that, in the long term, the habitat or population of the species in question as a viable component of the site will be maintained despite potential impacts.

'Long term' is considered to be a period of at least five years. This is considered to be an appropriate timescale for the assessment of adverse effect on site integrity, because, for example, SPAs are usually designated in the UK on the basis of five-year population estimates. A five-year rolling mean is used because it is considered to take account of sufficient data to demonstrate that birds use sites regularly, smoothing out any short-term peaks and troughs in numbers.

Using the same argument, it is, therefore, logical to continue to review populations over the same timescale to demonstrate that observed use or 'non-use' of habitat is typical, and not a chance event. In addition, bird breeding performance and productivity varies between species and between years, and many species have long life spans. Population dynamics data therefore need to consider the possible short-term fluctuations in the numbers of any species. European Commission (1999) also recommends that, when considering the 'integrity of the site', it is important to consider a range of factors, including the possibility of effects manifesting themselves in the short, medium and long term.

15.7.3. Assessment of potential effects of the proposed scheme

15.7.3.1. Potential direct effects on red-throated diver through noise and disturbance during decommissioning of the subtidal section of the existing LSO

It has been demonstrated through ornithology surveys (Waxwings Ornithology, 2018) that red-throated diver are present in the inshore area within the vicinity of the proposed scheme at high tide during the overwintering period. This species was recorded on six visits, including birds on the sea and birds moving north and south. Most observations involved fewer than ten birds foraging inshore during high tide conditions, with a maximum of 29 counted on the 23rd of February

Table 15.6 Counts of red-throated diver within the inshore area in the vicinity of the proposed scheme during the overwintering period 2017/2018 (Waxwings, 2018)

Date	Number of birds			
	On the sea	Flying north	Flying south	Total
16/11/2017	9	-	-	9
29/11/2017	-	3	1	4
23/01/2018	8	1	7	16
08/02/2018	2	-	-	2
23/02/2018	29	-	-	29
13/03/2018	5	7	-	12

The designated population of the SPA is 1,407 individuals, representing 8.3% of the GB non-population (Natural England, 2018). The peak count of 29 individuals represents 2% of this population.

The decommissioning activities which have the potential to take place during the overwintering period and therefore are considered to have the potential to adversely impact red-throated diver are:

- The removal of the intertidal section of the LSO, using two tracked cranes and two tracked excavators, over a one week period;
- The removal of diffuser riser, diffuser head, diffuser protection frame, and removal/movement of marker buoy and chain/anchor weight in the subtidal zone. This will be carried out by a team of divers from one workboat, using handtools, and;
- Capping of each end of the existing LSO with grout or concrete. This will also be carried out by a team of divers from one workboat using handtools however, the nearshore end will be accessed by foot at low tide with support from a vehicle to carry equipment if necessary.

Decommissioning of the intertidal section of the existing LSO will take place when the beach is exposed at low tide, due to the requirement to use land-based plant down to the exposed inspection chamber above MLW. These works will be undertaken over a period of one week. Red-throated diver have not been recorded in the inshore area during low tide and the intertidal surveys have shown that the foreshore would not provide a suitable foraging ground for other overwintering species covered by the Greater Wash SPA designation. The decommissioning works in the intertidal area will require up to five plant/machinery and would be present for up to one week. The potential impacts are considered to be negligible and as such the decommissioning of the intertidal section of LSO is not predicted to have an adverse effect on the integrity of the Greater Wash SPA designation.

Decommissioning activities in the subtidal zone will be undertaken at all states of the tide during daylight hours for a period of one week. This will be undertaken by a team of divers, with support by one workboat. As such this represents a short term and temporary impact to foraging red-throated diver. However, due to their sensitivity to human activities, particularly vessel movements, the following mitigation measures will be put in place during these works, as advised by Natural England (DAS/11138/197263), to minimise any potential impacts on the species:

- The use of a consistent vessel corridor;
- Maintaining appropriate vessel transit speeds, and;
- Vessel-based toolbox talks to raise awareness of the sensitivity of the species.

Given the short-term and temporary nature of the works, and the mitigation measures set out above designed to minimise potential disturbance impacts on red-throated diver, it is predicted that these activities would not compromise the conservation objectives of the European site, and an adverse effect on site integrity would not occur.

15.8. Conclusion

Considering the conservation objectives for the Greater Wash SPA, it is predicted that the proposed scheme, when assessed alone or in-combination with nearby projects and plans, would not result in an adverse effect on the site integrity of the Greater Wash SPA.

Furthermore, the proposed scheme, when assessed alone and in-combination with nearby projects and plans, would not result in a LSE on the Humber Estuary SPA/Ramsar/SAC designation.

16. Marine Conservation Zone Assessment

16.1. Introduction

Sections 125 and 126 of the Marine and Coastal Access Act (MCAA) (2009) place specific duties on the MMO relating to MCZs and marine licence decision making. To undertake its marine licencing function, the MMO has introduced a two-staged sequential MCZ assessment process (MMO, 2013) to assess the potential impacts of operations or activities occurring within, or in close proximity to, an MCZ.

In parallel with the production of this ES under the requirements of the EIA Regulations and Marine Works Regulations, a 'shadow MCZ Assessment' has been undertaken, the results of which are presented below.

16.2. The Holderness Inshore MCZ

The Holderness Inshore MCZ was designated in January 2016 for important intertidal and subtidal habitats (**Figure 16.1**). The site is 309km^2 in total and stretches along the Holderness Coast from Skipsea Sands in the north, to Spurn Head, at the mouth of the Humber Estuary, in the south (Defra, 2016). The area of intertidal habitat within the MCZ is approximately 5.2km^2, and the area of subtidal habitat as 303.7km^2. This dynamic coastal environment supports a number of habitats of ecological importance. The MCZ is entirely within the Greater Wash SPA, however features protected through the MCZ designation are not duplicated in the SPA designation. The features designated within the Holderness Inshore MCZ are detailed in **Table 16.1**. For each designated feature of the site, a conservation objective is assigned. The conservation objectives for MCZs are high level criteria describing the desired condition of the MCZ features. There are two objectives for features within an MCZ, namely whether the features are in the desired favourable condition and need to be maintained in this condition, or, whether the features are not in the desired favourable condition and need to be recovered to that condition.

Table 16.1 Designated features of the Holderness Inshore MCZ

Feature	Conservation Objective
Intertidal sand and muddy sand	Maintain in favourable condition
Moderate energy circalittoral rock	Maintain in favourable condition
High energy circalittoral rock	Maintain in favourable condition
Subtidal coarse sediment	Maintain in favourable condition
Subtidal mixed sediments	Maintain in favourable condition
Subtidal sand	Maintain in favourable condition
Subtidal mud	Maintain in favourable condition
Spurn Head (subtidal geological feature)	Maintain in favourable condition

All the features within the Holderness Inshore MCZ are currently deemed to be in a favourable condition, with a maintain conservation objective.

16.3. Supplementary Advice on Conservation Objectives

The Supplementary Advice on Conservation Objectives (SACOs) included in the Holderness Inshore MCZ draft Conservation Advice Package (UKMCZ0035) by Natural England (Natural England, 2018) present attributes which are ecological characteristics or requirements of the designated species and habitats within a site. The listed attributes are considered to be those which best describe the site's ecological integrity and which, if safeguarded, would enable achievement of the conservation objectives. These attributes have a target which is either quantified or qualified depending on the available evidence. The attributes and targets for features of the MCZ, within which the proposed scheme footprint is located, are presented in **Table 16.2** below.

530000
540000
550000
430000
420000
410000
N
Holderness Offshore MCZ (Recommended)
Holderness Inshore MCZ (Designated)
0
5 Kilometres

Legend

- Proposed Scheme Boundary
- 5km buffer
- Marine Conservation Zone (MCZ), Designated
- Marine Conservation Zone (MCZ), Recommended

Client:	Project:
Yorkshire Water Services	Withernsea LSO EIA

Title:

Marine Conservation Zones within 5km of the proposed scheme

Figure: 16.1

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	16/01/2019	TC	ES	A3	1:100,000

Co-ordinate system: British National Grid

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Table 16.2 Attributes and targets for features of the Holderness Inshore MCZ

Feature	Attribute	Target	Supporting notes
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Distribution: presence and spatial distribution of biological communities	Maintain the presence and spatial distribution of the feature	A variety of communities make up the habitat. Listed component communities reflect the habitat's overall character and conservation interest. Communities are described as biotopes using EUNIS or the Marine Habitat Classification. Communities include, but are not limited to, those that are notable or representative of the feature. Representative communities include, for example, those covering large areas and notable communities include those that are rare, scarce or particularly sensitive to pressure. Changes to the spatial distribution of communities across the feature could highlight changes to the overall feature.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Extent and distribution	Maintain the total extent and spatial distribution of the feature	The extent describes the presence and area of the habitat. It's the total area of the habitat across the site as a whole, even where it's patchy. The distribution describes the more detailed location(s) and pattern of habitat across the site. The distribution will influence the component communities present, and also help increase the health and resilience of the feature. A reduction in extent would alter the biological and physical functioning of the feature. It's difficult to put an extent objective on a mobile, changing feature. An understanding of the supporting processes will be more helpful in determining site integrity. However, the extent can also be defined where the proportion of sediment-sensitive invertebrates (PSI) indicates a change to the sediment character. If there is insufficient evidence, the existing extent occurring at any one time should be the focus of an assessment due to the natural variation, and a fresh survey is likely to be required at the point of assessment, to ascertain what the existing extent is.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Structure and function: presence and abundance of key structural and influential species	[Maintain OR Recover OR Restore] the abundance of listed species, to enable each of them to be a viable component of the habitat.	Natural England has included an attribute for the abundance of key structural and influential species for habitat features. **Structural species** are those that form part of the habitat structure or help to define a key biotope. **Influential species** are those that are likely to have a key role affecting the structure and function of the habitat (such as bioturbators (mixers of sediment), grazers, surface borers, predators or other species with a significant functional role linked to the habitat). These will be identified at a national level in accordance with the criteria defined in the key structural and influential species paper. *For each species listed the reason for its inclusion as structural or influential and the information supporting its presence within the community of this site will be provided.

Feature	Attribute	Target	Supporting notes
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Structure: non-native species and pathogens	Restrict the introduction and spread of non-native species and pathogens, and their impacts.	Non-native species may become invasive and displace native organisms by preying on them or out-competing them for resources such as food, space or both. In some cases this has led to the loss of indigenous species from certain areas. A pathogen causes disease or illness to its host. Pathogens include bacteria, viruses, protozoa and fungi. Site-specifics: There are no known records of non-native invasive species or pathogens affecting this feature. However, the Humber/Holderness area is considered to be at risk from non-native invasive due to the high levels of shipping in the estuary and an associated risk that invasive species could establish easily in the local habitat.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Structure: sediment composition and distribution	Structure: sediment composition and distribution	Sediment character is important in determining the biological communities present. Varied sediment type and grain size ensure structural complexity and connectivity. Intertidal sediments (ranging from highly stable mudflats and saltmarshes, to highly mobile shingle and sand beaches) are subject to a range of deposition and erosion processes, which human activity can influence. Most intertidal sediments stabilise over time so maintaining the sediment composition supports natural succession of the habitats and communities. Where they are subject to constant (net) erosion, the natural processes will be adversely affected.
Intertidal sand and muddy sand	Structure: sediment total organic carbon content	Maintain total organic carbon (TOC) content in the sediment at existing levels.	Total Organic Carbon (TOC) content can be used for measuring change in the organic input to the mudflat / sandflat. TOC content of the sediment can influence community structure and contaminant levels.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Structure: species composition of component communities	Maintain the species composition of component communities.	Species composition of communities includes a consideration of both the overall range of species present within the community, as well as their relative abundance. Species considered need not be restricted to sessile benthic species but could include mobile species associated with the benthos. Species composition could be altered by human activities without changing the overall community type. Within each component community, species composition and population structure should be taken into consideration to avoid diminishing biodiversity and affecting ecosystem functioning within the habitat. The sediment community composition will change when the habitat is subjected to pollutants and other forms of disturbance, but will also be subject to significant natural variation annually.

Feature	Attribute	Target	Supporting notes
			Benthic invertebrate communities are a good indicator of the health of the feature, if assessed over time.
Intertidal sand and muddy sand	Structure: topography	Maintain the presence of topographic features, while allowing for natural responses to hydrodynamic regime, by preventing erosion or deposition through human-induced activity.	Topography is considered an essential structural component for this feature. Alterations in topography can cause changes in the slope angle of the foreshore or result in increases or decreases in surface elevation. Topographic changes can alter the way the sediment drains and holds water, and can also alter the tidal exposure, meaning areas can be covered by the tide for longer or shorter periods. This can influence the animal and plant communities supported and reduce the areas available to coastal birds for feeding. Such changes could occur through direct interaction, such as sand extraction, or indirect impacts, such as changes in wave height or tidal flow regime, which cause erosion or deposition.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Supporting processes: energy / exposure	Maintain the natural physical energy resulting from waves, tides and other water flows, so that the exposure does not cause alteration to the biotopes and stability, across the habitat.	The amount of energy received across the site significantly affects the communities present. Physical energy can be received through wave energy and / or tidal flow, and can be altered through human activity. Any such alterations to energy should be avoided. Ambient energy levels related to wave and tidal action influence the amount of physical disturbance experienced by seabed sediments. Physically stable or immobile sediments often support different animal and plant communities when compared with mobile or disturbed sediments. Therefore, understanding the site's baseline conditions is very importance. However, due to the complexity of measuring the energy and disturbance levels of an area, it's unlikely that a quantifiable objective could be determined.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Supporting processes: physico-chemical properties	Maintain the natural physico-chemical properties of the water.	The physico-chemical properties that influence habitats include salinity, pH and temperature. They can act alone or in combination to affect habitats and their communities in different ways, depending on species-specific tolerances. In coastal habitats they can vary widely and can influence the abundance, distribution and composition of communities at relatively local scales. Changes in any of these properties, as a result of human activities, may impact habitats and the communities they support.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Supporting processes: sediment contaminants	Restrict surface sediment contaminants (<1cm from the surface) to below the OSPAR Environment Assessment Criteria (EAC) or Effects Range	Various different contaminants are known to affect the species that live in or on the surface of sediments. These include heavy metals (Hg, As, Zn, Ni, Ch, Cd, etc), poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs), organotins (TBT) and pesticides such as hexachlorobenzene. These can impact species sensitive to particular contaminants, degrading the community structure (eg heavy metals) and bioaccumulating within organisms, entering the marine food chain (eg PCBs).

Feature	Attribute	Target	Supporting notes
		Low (ERL) where they are not adversely impacting the infauna of the feature.	
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Supporting processes: sediment movement and hydrodynamic regime	Maintain all hydrodynamic and physical conditions such that natural water flow and sediment movement are not significantly altered or prevented from responding to changes in environmental conditions	Sedimentary habitats are often influenced by tide and wave-driven water flow that drives the movement or stability of sediment on and in areas surrounding the feature. These flow regimes can control both the shape and size of the feature, in addition to its sedimentary characteristics and biological composition. It's important that these hydrodynamic and sedimentary processes persist and are allowed to change in response to environmental conditions without hindrance. Hydrodynamic conditions include the speed and direction of wave and tidal currents, seabed shear stress and wave exposure.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Supporting processes: water quality - contaminants	Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels.	Contaminants may impact the ecology of the Marine Protected Area by having a range of biological effects on different species within the habitat, depending on the nature of the contaminant.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Supporting processes: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg per litre (at 35 salinity) for 95 % of the year),	Dissolved Oxygen (DO) levels affect the condition and health of features. Excessive nutrients and / or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities. However, there's a significant amount of natural variation that needs to be considered

Feature	Attribute	Target	Supporting notes
		avoiding deterioration from existing levels.	
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Supporting processes: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. These seaweeds can smother the sediment, preventing aeration and causing anoxia (lack of oxygen). This can impact sensitive fish, epifauna and infauna communities. The aim is to seek no further deterioration or improve water quality. Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore, opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (<500g/m²) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15%. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions.
Intertidal sand and muddy sand Subtidal coarse sediment Subtidal sand Subtidal mud Subtidal mixed sediments	Supporting processes: water quality - turbidity	Maintain natural levels of turbidity (eg concentrations of suspended sediment, plankton and other material) across the habitat.	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter washed into the sea from land sources. In coastal environments turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg coastal development) factors. Prolonged changes in turbidity may influence the amount of light reaching the seabed, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting seabed sedimentation rates.

16.4. Baseline environment

16.4.1. Intertidal habitats

An intertidal Phase 1 survey was carried out on the 23rd November 2017 to assess the marine and coastal habitats and species present within the works area. The survey identified a relatively uniform and homogenous habitat within the survey area with four distinct zones referred to as upper, mid, lower-mid and lower shore.

In each of the four zones the biotope was identified as barren littoral shingle consisting of coarse sand, gravel and shingle. No benthic macrofaunal were identified in any of the samples demonstrating the low ecological value of this area within the Holderness Inshore MCZ. It is considered that the intertidal habitats within the work area for the proposed scheme are not representative of the habitat designated within the Holderness Inshore MCZ.

Further details of the survey can be found in **Section 9**.

16.4.2. Subtidal habitats

Subtidal benthic ecology surveys were undertaken between the 25th and 27th July 2017 in order to describe the habitats and species present within the work area of the proposed LSO. The majority of samples were characterised as coarse sediment, with two samples comprising cobbles and pebbles. This aligns with the data held on the European Marine Observation and Data Network website (EMODNet) which indicates that the habitats in the area of the proposed LSO are comprised of littoral coarse sediment (A5.13) and circalittoral coarse sediment (A5.14).

Further details of the survey can be found in **Section 9**.

16.5. MCZ Assessment Methodology

16.5.1. Screening

Under Section 126 of the MCAA, duties are placed on the MMO in relation to marine licence decision making and the consideration of MCZs. This applies where:

> *"a) A public authority has the function of determining an application (whenever made) for authorisation of the doing of any act, and*
> *b) The act is capable of affecting (other than insignificantly) –*
> *i) The protected features of an MCZ;*
> *ii) Any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependent alone or in-combination with other plans or projects."*

The MMO uses a risk based approach when considering the proximity of the plan or project to a MCZ. This will consider the risks associated with impacts from plans and projects outside of MCZ

boundaries, e.g. the maximum likely zone of impact from a dredge plume or noise and vibration impacts from piling works. The MMO undertake a screening assessment without formally consulting with the Statutory Nature Conservation Bodies (SNCBs) at this stage. If, following screening, the MMO consider that a plan or project has the potential to impact on a MCZ, the application will proceed to be considered under Stage 1 of the assessment process.

16.5.2. Stage 1 Assessment

The Stage 1 assessment considers the extent of the potential impact of the plan or project on the MCZ in more detail. At this stage the conservation objectives for the MCZ need to be considered. The conservation objectives for MCZs are high level criteria describing the desired condition of the MCZ features. There are two objectives for features within a MCZ, namely whether the features are in the desired favourable condition and need to be maintained in this condition, or, whether the features are not in the desired favourable condition and need to be recovered to that condition.

The Stage 1 assessment looks at whether the plan or project could potentially affect these objectives, that is, impact the site so that the features are no longer in favourable condition, or prevent the features from recovering to a favourable condition. The MMO also needs to be satisfied that they can meet their requirements under the MCAA to further the conservation objectives for the site. This requirement sits with the MMO as the licensing authority to ensure that the condition of the site is improved and enhanced wherever possible.

The MMO use information supplied by the applicant submitted in support of a marine licence application, advice from the SNCBs and any other relevant information to determine whether (as set out in MMO guidance);

- There is no significant risk of the activity hindering the achievement of the conservation objectives stated for the MCZ; and,
- The MMO can exercise its functions to further the conservation objectives stated for the MCZ.

If neither of the above criteria can be met, the Stage 1 assessment then considers whether:

- There is no other means of proceeding with the act which would create a substantially lower risk of hindering the achievement of the conservation objectives state for the MCZ. This should include proceeding with is (a) in another manner, or (b) at another location.

If mitigation to reduce identified impacts cannot be secured, and there are no other alternative locations, then the project will proceed to be considered under Stage 2 of the assessment process.

16.5.3. Stage 2 Assessment

The Stage 2 assessment considers the socio-economic impact of the plan or project together with the risk of environmental damage. There are two parts to the Stage 2 assessment process:

> *"Does the public benefit in proceeding with the project clearly outweigh the risk of damage to the environment that will be created by proceeding with it?*
>
> *If so,*
>
> *Can the applicant satisfy that they can secure, or undertake arrangements to secure, measures of equivalent environmental benefit for the damage the project will have on the MCZ features?"*

Guidance from the MMO on what constitutes measures of equivalent environmental benefit states that measures can be based on those considered appropriate when securing compensatory habitat for projects deemed to have an adverse effect on internationally designated sites under the Habitats Regulations.

16.6. Consultation

A scoping report was submitted to the MMO and ERYC in June 2018, supported by an MCZ assessment. Natural England reviewed the MCZ assessment and provided comments to the MMO. **Table 16.3** presents a summary of the comments received.

Table 16.3 Summary of scoping opinion responses

Scoping Opinion responses	Where addressed
The MMO notes that the total area of habitat loss within the MCZ as a result of the works has been calculated at 255 m2 (0.000825% of the total area of the site designation). However, from the information provided it is not clear as to what habitats will be affected by the proposed development. The MMO therefore advise that estimates of habitat loss within the MCZ be considered at the feature level. Such estimates should be informed by both available primary (e.g. sidescan sonar, sub-bottom sonar, and sediment samples) and secondary data sources (e.g. desk-based surveys). This will enable the MMO to appropriately consider the likely impacts of the works on the conservation objectives of Holderness Inshore MCZ.	The habitat features of the MCZ are not mapped to feature level, and therefore quantification of the habitats potentially impacted is not possible. We have therefore refined the MCZ area by quantifying the intertidal and subtidal areas. – Section 5.2 However, note that there is no permanent habitat loss as part of the proposed scheme, the materials removed will be side-cast and used as backfill.
Similar to the comments detailed under **paragraph 4.2.5**, from the information provided it does not appear that the likely effects of the works associated with the cofferdam structure (including piling) have been assessed within the shadow MCZ Assessment (Appendix E). The MMO therefore advise that all works associated with the cofferdam be included within, and used to fully inform the, the shadow MCZ assessment.	Section 5.2
The MMO note that a temporary ramp will be constructed to allow access from the cliff to the foreshore in order to carry out the works. From the information provided, it is not clear whether the works associated with the temporary access ramp have been considered within the Scoping Report and the supporting MCZ assessment (Appendix E). The MMO therefore advise that all works associated with the access ramp be included within, and used to fully inform the shadow MCZ assessment. The MCZ assessment must also fully	Section 5.2

Scoping Opinion responses	Where addressed
consider the duration over which the works associated with the access ramp are to occur and their potential influence on physical processes.	

16.7. MCZ Assessment

16.7.1. Screening

Following guidance from the MMO, **Table 16.4** below provides details of the screening process.

Table 16.4 Screening for the MCZ Assessment

MMO Screening Criteria	Holderness Inshore MCZ
Is the plan or project taking place within or near an area being put forward for, or already designated as, an MCZ?	Yes – The proposed Scheme is located within the Holderness Inshore MCZ.
Is the plan or project capable of affecting (other than insignificantly) either: The protected features of an MCZ; or Any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependant?	Yes – The proposed LSO marine works will directly impact the MCZ as it will require the excavation of a 130m trench within the intertidal zone. The proposed LSO marine works will directly impact the MCZ as dredging will take place in the subtidal area for the installation of the pipeline. Dredging will create a small sediment plume which could lead to indirect impacts on the designated features of the MCZ not within the works area. Decommissioning of the existing LSO will directly impact the MCZ as it will involve the removal of a section of pipeline within the intertidal zone. Decommissioning of the existing LSO will involve the removal of the diffuser, diffuser riser, protection frame, and a small amount of scour protection in the subtidal zone, by divers using handtools.

The screening criteria set out in **Table 16.4** clearly identify why the proposed scheme has been screened in to the MCZ assessment process.

16.7.2. Stage 1 Assessment

This stage of the assessment considers the potential impacts of the proposed Scheme that were screened in (as identified in **Section 16.7**) in more detail. **Table 16.5** and **Table 16.6** set out the interest features, their current conservation objectives and any potential impacts through construction of the new LSO (**Table 16.5**) and decommissioning of the existing LSO (**Table 16.6**) of the proposed scheme on these features. Distribution data for features within the MCZ has been taken from the MCZ Feature Map available on the Defra website.

Table 16.5 and **Table 16.6** below provide evidence to allow the MMO to undertake a Stage 1 assessment. It is anticipated that the information presented in **Table 16.5** and **Table 16.6** would allow the MMO to conclude that a Stage 2 assessment is not required, on the basis that there is no significant risk of the proposed activity hindering the ability of the conservation objectives to be met[7].

[7] *https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492319/mcz-holderness-feature-map.pdf*

Table 16.5 Stage 1 MCZ Assessment – Construction of the new LSO

Feature name	Conservation Objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
Intertidal sand and muddy sand	Maintain	An intertidal ecology survey was carried out in order to describe the habitats and assign biotopes present within the proposed works area. The survey identified a relatively uniform and homogenous habitat with four distinct zones; upper, mid, lower-mid and lower. In all these zones the sediment was coarse and mixed with shingle and gravel. No flora and fauna were identified within the samples. Consequently, the biotope within all four zones was identified as barren littoral shingle. This biotope has a relatively low ecological value and is not considered to be representative of the intertidal sand and muddy sand habitat described and protected within the Holderness Inshore MCZ. The temporary ramp to allow vehicular access to the foreshore will not be constructed within the intertidal zone and will therefore have no impact on the MCZ. The construction vehicles required for undertaking works on the foreshore will access the beach using the ramp and will use the same access route across the beach to minimise any superficial impact to the intertidal area. This ramp will be removed once the works are complete. In the lower intertidal zone, a connection will need to be made from the HDD/microtunnelled section to the subtidal LSO section. A temporary cofferdam may be required to allow recovery of the Tunnel Boring Machine from the HDD/micro-tunnelling 'reception shaft. The temporary cofferdam could also be required to accommodate the deeper trench around the connection point and to provide protection against sedimentation of this trench section during construction. The temporary cofferdam could be approximately 30 m long and approximately 6m wide and constructed using sheet piles. The temporary cofferdam would be fully removed once the works were complete. To link the pipe at the end of the HDD/micro-tunnelling section to the subtidal pipe section, a trench of approximately 100m located between the cofferdam and the low water limit of the subtidal dredging equipment will be excavated by land-based hydraulic excavators. The trench will be approximately 100m long and 3.5m wide. The material excavated will be sidecast and then reinstated once the pipe is installed. The area of intertidal that will be temporarily smothered by the sidecast material is expected to be the same as the trenched area. Therefore, the total area of intertidal habitat that could be affected during these works will be 350m^2 within the trench and 180m^2 within the cofferdam, with the same again affected by the sidecast material, which equates to 1,060m^2, and represents 0.0204% of the area of intertidal habitat within the MCZ (5.2km^2). Within their SACOs Natural England quantify the area of this feature to be 1.08km^2. As such the potential total area of this feature temporarily impacted by these works equates to 0.098%.	No adverse impact on conservation objective predicted

Feature name	Conservation Objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
		While there will be a direct, but short term and temporary impact on the intertidal habitat as a result of trenching works, sidecasting and use of the cofferdam associated with the installation of the new LSO these will not have an adverse impact on this feature or its conservation objectives as it is not considered to be present within the works area. The reinstatement of the material will enable the recovery of the intertidal zone following completion of the works.	
Moderate energy circalittoral rock	Maintain	The subtidal biotopes within the LSO works area were determined to be circalittoral or sublittoral mixed sediments, or circalittoral coarse sediment which are characterised by impoverished infauna and dominated by fast-growing epifauna. While there will be a direct but temporary impact on the subtidal habitats within the MCZ it will not have an adverse impact on this feature as it is not considered to be present and no far-field impacts are predicted.	No adverse impact on conservation objective predicted
High energy circalittoral rock	Maintain	The subtidal biotopes within the LSO works area were determined to be circalittoral or sublittoral mixed sediments, or circalittoral coarse sediment which are characterised by impoverished infauna, dominated by fast-growing epifauna. The Holderness Coast is naturally a very turbid region and any sediment suspended as a result of these works is not expected to be significant above background levels. While these works will cause a direct but temporary impact on the subtidal habitat within the MCZ it will not have an adverse impact on this feature as it is not considered to be present within the works area and no far-field impacts are predicted.	No adverse impact on conservation objective predicted
Subtidal coarse sediment	Maintain	The subtidal biotopes within the LSO works area were determined to be circalittoral or sublittoral mixed sediments, or circalittoral coarse sediment which are characterised by impoverished fauna, dominated by fast-growing epifauna. These species will be subject to seasonal and sporadic cycles of scour through tide and storm action and so will be primarily opportunistic, resilient and ephemeral. The biotope present in the works area is considered to have a high recovery potential (Tillin and Tyler-Walters 2016). Following disturbance opportunistic species and communities are expected to re-colonise this biotope in less than a year where the underlying substratum remains the same (Tillin and Tyler-Walters 2016).	No adverse impact on conservation objective predicted

Feature name	Conservation Objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
		The dredging of the trench for the new LSO, and back-filling using the side-cast material, is expected to take approximately 2 months to complete. The total area of subtidal habitat that will be temporarily impacted during this phase of construction is considered to be 0.0239km^2 and a similar area will be used for the placement of the side-cast material, resulting in a conservative total area of impact to subtidal habitats of 0.0478km^2. This represents approximately 0.015% of the area of subtidal habitat (303.7km^2) within the MCZ. Although this will be a direct impact it will be short-term and temporary. As the substrate will be reinstated this will allow recolonisation of associated fauna and recovery of the habitat in less than a year. Natural infilling by surrounding surface sediments is also predicted to augment the reinstatement and recovery of the seabed affected by the excavation of the trench. A small sediment plume will occur during dredging, however due to the coarse, mixed nature of the sediment it is expected that the sediment will rapidly resettle in close proximity to the dredge area. The dredged sediment will not be brought to the surface of the water column, but will be side cast at depth which will minimise the potential for resuspension. The Holderness Coast is naturally a very turbid region and any sediment suspended as a result of these works is not expected to be significant above background levels. The placement of scour protection around the diffuser will lead to the loss of subtidal habitat directly beneath it. This blanket will extend to a minimum of 9m in all directions from the centre of the diffuser riser, leading to an area of impact of approximately 255m^2. This is not considered to represent a significant area of impact as it represents approximately 0.000825% of the MCZ area and 0.000839% of the subtidal area of the MCZ. In the absence of data on the area of subtidal coarse sediment present within the MCZ, this percentage loss of habitat should be attributed to all mixed or coarse sediments within the MCZ. The nature of the scour protection – a rock blanket - will provide substrate for the settlement of opportunistic epifauna in the same manner as that of the surrounding natural habitat and will support the natural biodiversity of this region. While there will be a direct impact on this feature as a result of dredging works this will be short-term and temporary. This feature is expected to make a full recovery from this impact to give no net loss of habitat. The installation of scour protection around the new diffuser will lead to a loss of natural habitat within its footprint, approximately 0.000825% of the MCZ area, which is not considered to be significant. The rock scour protection is	

Feature name	Conservation Objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
		expected to be colonised by opportunistic species which specialise in this highly dynamic environment, supporting the natural biodiversity of the MCZ.	
Subtidal mixed sediments	Maintain	The biotopes within the LSO works area were determined to be circalittoral or sublittoral mixed sediments, or circalittoral coarse sediment which are characterised by impoverished fauna, dominated by fast-growing epifauna. These species will be subject to seasonal and sporadic cycles of scour through tide and storm action and so will be primarily opportunistic and ephemeral. This biotope is considered to have a high recovery potential (Tillin and Tyler-Walters 2016). Following disturbance opportunistic species and communities would re-colonise this biotope in less than a year where the underlying substratum remains the same (Tillin and Tyler-Walters 2016). The dredging of the trench, and back-filling using the side-cast material, is expected to take 2 months to complete. The total area of subtidal habitat that will be temporarily impacted during this phase of construction is considered to be 0.0239km^2 and a similar area will be used for the placement of the side-cast material, resulting in a conservative total area of impact to subtidal habitats of 0.0478km^2. This represents approximately 0.015% of the area of subtidal habitats (303.7km^2) within the MCZ. Although this will be a direct impact it will be short-term and temporary. In addition, natural infilling by surrounding surface sediments is also predicted to augment the reinstatement and recovery of the seabed affected by the excavation of the trench. As the substrate will be reinstated this will allow recolonisation by associated fauna and recovery of the habitat within a matter of months. A small sediment plume will occur during dredging, however due to the coarse, mixed nature of the sediment it is expected that the sediment will rapidly resettle in close proximity to the dredge area. The dredged sediment will not be brought to the surface of the water column, but will be side cast at depth which will minimise the potential for resuspension. The Holderness Coast is naturally a very turbid region and any sediment suspended as a result of these works is not expected to be significant above background levels. The placement of scour protection around the diffuser will lead to the loss of subtidal habitat directly beneath it. This blanket will extend to a minimum of 9m in all directions from the centre of the diffuser riser, leading to an area of impact of approximately 255m^2. This is not considered to represent a significant area of impact as it represents 0.000825% of the MCZ area and 0.000839% of the subtidal area of the MCZ. In the absence of data on the area of subtidal coarse sediment present within the MCZ, this percentage loss of habitat should be attributed to all mixed or coarse sediments within the MCZ. The nature of the scour protection – a rock blanket - will provide	No adverse impact on conservation objective predicted

Feature name	Conservation Objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
		substrate for the settlement of opportunistic epifauna in the same manner as that of the surrounding natural habitat and will support the natural biodiversity of this region. While there will be a direct impact on this feature as a result of dredging works this will be short-term and temporary. This feature is expected to make a full recovery to give no net loss of habitat. The installation of scour protection around the new diffuser will lead to a loss of natural habitat within its footprint, approximately 0.000825% of the MCZ area, which is not considered to be significant. The rock scour protection is expected to be colonised by opportunistic species which specialise in this highly dynamic environment, supporting the natural biodiversity of the MCZ.	
Subtidal sand	Maintain	The biotopes within the LSO works area were determined to be circalittoral or sublittoral mixed sediments, or circalittoral coarse sediment which are characterised by impoverished fauna, dominated by fast-growing epifauna. A side-scan sonar survey at the site identified sandy habitat in the near-shore subtidal region. The dredging of the trench, and back-filling using the side-cast material, is expected to take approximately 2 months to complete. The total area of subtidal habitat that will be temporarily impacted during this phase of construction is considered to be 0.0239km^2 and a similar area will be used for the placement of the side-cast material, resulting in a conservative total area of impact to subtidal habitats of 0.0478km^2. This represents approximately 0.015% of the area of subtidal habitats (303.7km^2) within the MCZ. Although this will be a direct impact it will be short-term and temporary. Natural infilling by surrounding surface sediments is also predicted to augment the reinstatement and recovery of the seabed affected by the excavation of the trench within months. A small sediment plume will occur during dredging, however due to the coarse, mixed nature of the sediment it is expected that the sediment will rapidly resettle in close proximity to the dredge area. The dredged sediment will not be brought to the surface of the water column, but will be side cast at depth which will minimise the potential for resuspension. The Holderness Coast is naturally a very turbid region and any sediment suspended as a result of these works are not expected to be significant above background levels.	No adverse impact on conservation objective predicted

Feature name	Conservation Objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
		The placement of scour protection around the diffuser will lead to the loss of subtidal habitat directly beneath it. This blanket will extend to a minimum of 9m in all directions from the centre of the diffuser riser, leading to an area of impact of approximately 255m^2. This is not considered to represent a significant area of impact as it represents approximately 0.000825% of the MCZ area and 0.000839% of the subtidal area of the MCZ. In the absence of data on the area of subtidal coarse sediment present within the MCZ, this percentage loss of habitat should be attributed to all mixed or coarse sediments within the MCZ. The nature of the scour protection – a rock blanket - will provide substrate for the settlement of opportunistic epifauna in the same manner as that of the surrounding natural habitat and will support the natural biodiversity of this region. While there will be a direct impact on this feature as a result of dredging works this will be short-term and temporary. This feature is expected to make a full recovery to give no net loss of habitat. The installation of scour protection around the new diffuser will lead to a loss of natural habitat within its footprint, approximately 0.000839% of the subtidal area within the MCZ, which is not considered to be significant. The rock scour protection is expected to be colonised by opportunistic species which specialise in this highly dynamic environment, supporting the natural biodiversity of the MCZ.	
Subtidal mud	Maintain	The subtidal biotopes within the LSO works area were determined to be circalittoral or sublittoral mixed sediments, or circalittoral coarse sediment which are characterised by impoverished infauna and dominated by fast-growing epifauna. Mud sediments were not identified within the Particle Size Analysis carried out on the samples. The Holderness Coast is naturally a very turbid region and any sediment suspended as a result of these works are not expected to be significant above background levels. While there will be a direct impact on subtidal habitats within the MCZ as a result of dredging works these will not have an adverse impact on this feature as it is not considered to be present within the works area and no far-field impacts are predicted.	No adverse impact on conservation objective predicted
Spurn Head (subtidal geological feature)	Maintain	Spurn Head is approximately 14km to the south of the proposed LSO, along the coast. A small sediment plume will occur during dredging, however due to the coarse, mixed nature of the sediment it is expected that the sediment will rapidly resettle in close proximity to the dredge area. The dredged sediment will	No adverse impact on conservation objective predicted

Feature name	Conservation Objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
		not be brought to the surface of the water column, but will be side cast at depth which will minimise the potential for resuspension. Any impacts upon physical processes as a result of the proposed dredging works are considered to be short-term and temporary in nature given they will occur over a two-month period and over the length of the subtidal trench (approximately 1km in length), with the trench being infilled with previously dredged material and seabed levels reinstated within a tolerance of +/-0.5m of existing levels on completion of the works. Due to the distance of the proposed LSO to Spurn Head, and the localised nature of the predicted impacts there will be no adverse impact on Spurn Head.	

Table 16.6 Stage 1 MCZ Assessment - Decommissioning of the existing LSO

Feature name	Conservation objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
Intertidal sand and muddy sand	Maintain	After the new LSO is commissioned, the existing LSO will be decommissioned. This will involve the removal of the pipe from the foreshore area. This will require a trench to be dug by long reach excavators, and the resulting material will be side-cast and used to infill the trench once the pipe has been removed. The trench will be approximately 100m long by 3.5m wide and a similar area is expected to be needed for the side-cast material. This will result in the disturbance of approximately 700m^2 of intertidal habitat. This equates to 0.013% of the area of intertidal habitat within the MCZ (5.2km^2) and 0.06% of the area of this feature (1.08km^2). The decommissioning of the existing LSO is programmed to take one week to complete. An intertidal ecology survey was carried out in order to describe the habitats and assign biotopes present within the proposed works area. The survey identified a relatively uniform and homogenous habitat with four distinct zones; upper, mid, lower-mid and lower. In all these zones the sediment was coarse and mixed with shingle and gravel. No flora or fauna were identified within the samples. Consequently, the biotope within all four zones was identified as barren littoral shingle. This biotope has a relatively low ecological value and is not considered to be representative of the intertidal sand and muddy sand habitat described and protected within the Holderness Inshore MCZ.	No adverse impact on conservation objective predicted

Feature name	Conservation objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
		The removal of the existing LSO will be a short-term, reversible impact to the intertidal habitat within the MCZ. The reinstatement of the material will be augmented by the natural infilling of sediment through sediment transport pathways in this highly dynamic environment, enabling the recovery of the intertidal following this activity.	
Moderate energy circalittoral rock	Maintain	The biotopes within the LSO works area were determined to be circalittoral or sublittoral mixed sediments, or circalittoral coarse sediment which are characterised by impoverished fauna, dominated by fast-growing epifauna and as such it is considered that this habitat is not present within the works area. The Holderness Coast is naturally a very turbid region and any sediment suspended as a result of these works is not expected to be significant above background levels. While the decommissioning works will cause a direct but temporary impact on the subtidal habitat within the MCZ it will not have an adverse impact on this feature as it is not considered to be present within the works area and no far-field impacts are predicted.	No adverse impact on conservation objective predicted
High energy circalittoral rock	Maintain	The biotopes within the LSO works area were determined to be circalittoral or sublittoral mixed sediments, or circalittoral coarse sediment which are characterised by impoverished fauna, dominated by fast-growing epifauna and as such it is considered that this habitat is not present within the works area. The Holderness Coast is naturally a very turbid region and any sediment suspended as a result of these works is not expected to be significant above background levels. While the decommissioning works will cause a direct but temporary impact on the subtidal habitat within the MCZ it will not have an adverse impact on this feature as it is not considered to be present within the works area and no far-field impacts are predicted.	No adverse impact on conservation objective predicted
Subtidal coarse sediment	Maintain	The decommissioning of the existing LSO will involve the removal of the diffuser and the associated scour protection. The removal of these elements will take approximately one week to complete and as such will cause a temporary impact to the benthic environment as any colonisation of the diffuser or the scour will be lost with its removal. However, as discussed earlier the Holderness Coast is a naturally highly dynamic environment which is dominated by habitats and species which are resilient to disturbance. Considering this the re-establishment and recolonisation of habitats and species within this area is expected to occur relatively rapidly. Recovery of this	No adverse impact on conservation objective predicted

Feature name	Conservation objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
		habitat is expected to occur in the medium term resulting in no net loss of habitat, but the re-establishment of natural habitat where the diffuser and scour protection once was. Works to decommission the existing LSO will have a short term and temporary impact but on a very small, localised area and due to the highly dynamic nature of the surrounding habitat a full recovery is expected to re-establish the natural habitat.	
Subtidal mixed sediments	Maintain	The decommissioning of the existing LSO will involve the removal of the diffuser and the associated scour protection. The removal of these elements will take approximately one week to complete and as such will cause a temporary impact to the benthic environment as any colonisation of the diffuser or the scour will be lost with its removal. However, as discussed earlier the Holderness Coast is a naturally highly dynamic environment which is dominated by habitats and species which are resilient to disturbance. Considering this the re-establishment and recolonisation of habitats and species within this area is expected to occur relatively rapidly. Recovery of this habitat is expected to occur in the medium term resulting in no net loss of habitat, but the re-establishment of natural habitat where the diffuser and scour protection once was. Works to decommission the existing LSO will have a short term and temporary impact but on a very small, localised area and due to the highly dynamic nature of the surrounding habitat a full recovery is expected to re-establish the natural habitat.	No adverse impact on conservation objective predicted
Subtidal sand	Maintain	The decommissioning of the existing LSO will involve the removal of the diffuser and the associated scour protection. The removal of these elements will take one week to complete and as such will cause a temporary impact to the benthic environment as any colonisation of the diffuser or the scour will be lost with its removal. However, as discussed earlier the Holderness Coast is a naturally highly dynamic environment which is dominated by habitats and species which are resilient to disturbance. Considering this the re-establishment and recolonisation of habitats and species within this area is expected to occur relatively rapidly. Recovery of this habitat is expected to occur in the medium term resulting in no net loss of habitat, but the re-establishment of natural habitat where the diffuser and scour protection once was. This feature is expected to make a full recovery to give no net loss of habitat. Works to decommission the existing LSO will have a short term and temporary impact but on a very small, localised area and due to the highly dynamic nature of the surrounding habitat a full recovery is expected to re-establish the natural habitat.	No adverse impact on conservation objective predicted

Feature name	Conservation objective	Description of the proposed scheme impacts on conservation objectives	Adverse impact as a result of the proposed plan or project?
Subtidal mud	Maintain	The biotopes within the LSO works area were determined to be circalittoral or sublittoral mixed sediments, or circalittoral coarse sediment which are characterised by impoverished fauna, dominated by fast-growing epifauna. Mud sediments were not identified within the Particle Size Analysis carried out on the samples. The Holderness Coast is naturally a very turbid region and any sediment suspended as a result of the decommissioning works are not expected to be significant above background levels. While there will be a direct impact on subtidal habitats within the MCZ as a result of decommissioning works these will not have an adverse impact on this feature as it is not considered to be present within the works area and no far-field impacts are predicted.	No adverse impact on conservation objective predicted
Spurn Head (subtidal geological feature)	Maintain	Spurn Head is approximately 14km to the south of the proposed LSO, along the coast. A small sediment plume may occur during the removal of the diffuser and associated scour protection, however due to the coarse, mixed nature of the sediment it is expected that the sediment will rapidly resettle in close proximity to the LSO and no far-field effects are predicted. Any impacts upon physical processes as a result of the proposed decommissioning works are considered to be short-term and temporary in nature given they will occur over the course of one week. Due to the distance of the LSO to Spurn Head, and the localised nature of the predicted impacts there will be no adverse impact on Spurn Head.	No adverse impact on conservation objective predicted

16.8. Conclusions of MCZ Assessment

Based on the outcome of the above Stage 1 MCZ assessment, it has been concluded that the proposed replacement LSO at Withernsea, and the decommissioning of the existing LSO (including partial removal), will not result in a significant risk to the conservation objectives for the Holderness Inshore MCZ. It is also concluded that the MMO will therefore be able to exercise its functions to 'further' the conservation objectives stated for the MCZ in accordance with Section 125(2)(a) of the MCAA 2009. A Stage 2 assessment is therefore not considered necessary in support of this project.

17. Conclusions

17.1. Site specific (within scheme impacts)

Table 17.1 presents each of the construction, operation and decommissioning impacts of the proposed scheme on the receptors presented within this ES, any mitigation measures and the residual effect.

In conclusion, where an impact from the proposed scheme is predicted, the residual impacts range from minor adverse significance to negligible, with mitigation measures implemented where necessary.

Table 17.1 Summary of the construction, operation and decommissioning impacts of the proposed scheme

Description of Effect	Significance	Mitigation	Residual Effect
Hydrodynamic and Sedimentary Regime			
Construction Phase			
Increased suspended sediment concentrations and sediment deposition	Negligible	Use of trenchless techniques in the intertidal zone	Negligible
Interruptions to longshore sediment transport	Negligible	Monitoring of effects and re-instatement of profile	Negligible
Operational Phase			
Diffuser dome and its protection measures will present an obstacle to sediment transport on the seabed	Negligible	Limit size to 450 mm in diameter (i.e. the same order of size as a large boulder on the seabed). The rock blanket around the diffuser will be installed flush with the seabed	Negligible
Decommissioning Phase			
Increased suspended sediment concentrations and sediment deposition during removal	Negligible	Capping and abandonment of sub-tidal section (rather than trenching and removal).	Negligible
Marine Sediment and Water Quality			
Construction Phase			
Reduction in marine water quality – increase in suspended sediments	Negligible	None required	Negligible
Reduction in marine water quality – *E. coli*	Negligible	None required	Negligible
Reduction in marine water quality – Bentonite	Negligible	None required	Negligible
Operation Phase			
Reduction in marine water quality (discharges from the LSO)	Negligible	None required	Negligible
Decommissioning Phase			

Description of Effect	Significance	Mitigation	Residual Effect
Reduction in marine water quality (increase in SSC or *E. coli* contamination)	Negligible	Capping and abandonment of sub-tidal section (rather than trenching and removal).	Negligible
Marine and Coastal Ecology			
Construction Phase – Benthic Ecology			
Temporary disturbance	Minor adverse	None required	Minor adverse
Increases in SSC	Negligible	None required	Negligible
Construction Phase – Intertidal Ecology			
Temporary disturbance	Minor adverse	None required	Minor adverse
Construction Phase – Marine Mammals			
Underwater noise	Minor adverse	None required	Minor adverse
Operational Phase			
Impacts from water quality changes	Negligible	None required	Negligible
Decommissioning Phase – Benthic Ecology			
Temporary disturbance	Negligible	None required	Negligible
Increases in SSC	Negligible	None required	Negligible
Decommissioning Phase – Intertidal Ecology			
Temporary disturbance	Minor adverse	None required	Minor adverse
Decommissioning Phase – Marine Mammals			
Underwater noise	Minor adverse	None required	Minor adverse
Fish and Fisheries			
Construction Phase			
Increased suspended sediment concentration	Negligible	None required	Negligible
Suspended sediment effects on herring spawning grounds	Negligible	None required	Negligible
Smothering due to suspended sediment	Minor adverse	None required	Minor adverse
Reduced dissolved oxygen concentration	Negligible – adults Minor adverse – larvae and juveniles	None required	Negligible – adults Minor adverse – larvae and juveniles
Changes to subtidal food availability	Minor adverse	None required	Minor adverse
Noise emissions	Negligible	None required	Negligible
Displacement of commercial fishing activities	Negligible – vessels over 12m Minor adverse – vessels under 10m	Employment of FLO and issue of local Notice to Mariners	Negligible

Description of Effect	Significance	Mitigation	Residual Effect
Operational Phase			
Obstacle for fishing at new LSO	Negligible	None required	Negligible
Decommissioning Phase			
Increased suspended sediment concentration	Negligible	None required	Negligible
Suspended sediment effects on herring spawning grounds	Negligible	None required	Negligible
Smothering due to suspended sediment	Minor adverse	None required	Minor adverse
Reduced dissolved oxygen concentration	Negligible – adults Minor adverse – larvae and juveniles	None required	Negligible – adults Minor – larvae and juveniles
Changes to subtidal food availability	Minor adverse	None required	Minor adverse
Noise emissions	Negligible	None required	Negligible
Displacement of commercial fishing activities	Negligible – vessels over 12m Minor adverse – vessels under 10m	Employment of FLO and issue of local Notice to Mariners	Negligible
Marine and Coastal Ornithology			
Construction Phase			
Direct disturbance to waterbirds from airborne noise	Negligible	None	Negligible
Direct impact to waterbirds from visual disturbance	Negligible	None	Negligible
Reductions in water quality	Negligible	None	Negligible
Operational Phase			
Direct disturbance to waterbirds	Negligible	None	Negligible
Decommissioning Phase			
Direct disturbance to waterbirds from airborne noise	Negligible	None	Negligible
Direct impact to waterbirds from visual disturbance	Negligible	None	Negligible
Reductions in water quality	Negligible	None	Negligible
Marine Historic Environment			
Construction Phase			
Direct impacts to known heritage assets	No impact	None	No impact
Direct impacts to potential heritage assets (intertidal)	Negligible	Protocol for reporting archaeological discoveries	Negligible

Description of Effect	Significance	Mitigation	Residual Effect
Direct impacts to potential heritage assets (marine, anomalies of possible archaeological interest)	Negligible	Avoidance of anomalies of archaeological potential.	No impact
		Archaeological monitoring during seabed preparation/UXO clearance	Negligible
		Protocol for reporting archaeological discoveries	Negligible
Impacts to the setting of known heritage assets	No impact	None	No impact
Indirect impacts associated with changes to coastal processes and hydrodynamics	No impact	None	No impact
Operational Phase			
Direct impacts to known heritage assets	No impact	None	No impact
Direct impacts to potential heritage assets	No impact	None	No impact
Impacts to the setting of known heritage assets	No impact	None	No impact
Indirect impacts associated with changes to coastal processes and hydrodynamics	No impact	None	No impact
Decommissioning Phase			
Direct impacts to known heritage assets	No impact	None	No impact
Direct impacts to potential heritage assets	No impact	None	No impact
Impacts to the setting of known heritage assets	No impact	None	No impact
Indirect impacts associated with changes to coastal processes and hydrodynamics	No impact	None	No impact

17.2. Cumulative impacts

There no cumulative impacts predicted with the replacement WwTW and associated works, or with any nearby projects or plans, either during construction or operation.

17.3. WFD Compliance Assessment

The comparison of the activities against the WFD scoping criteria has not identified any risk to WFD compliance receptors. As a result, no further assessment is believed necessary.

17.4. Habitats Regulations Assessment

An assessment of the potential for the proposed scheme to affect sites designated for nature conservation has been undertaken. The proposed scheme, when assessed alone and in-combination with nearby projects and plans, would not result in a 'likely significant effect' (LSE) on the Humber Estuary SPA/Ramsar/SAC designation.

However, the assessment concluded that the proposed scheme would have the potential to result in a LSE on the Greater Wash SPA., during the decommissioning of the existing LSO, which could occur during the overwintering period. However, the effects and impacts of the proposed scheme are considered to be of sufficiently low magnitude that an adverse effect on the integrity of the site would not occur (either alone or in-combination with other projects).

17.5. Marine Conservation Zone Assessment

Based on the outcome of the Stage 1 MCZ assessment, it has been concluded that the proposed replacement LSO at Withernsea, and the decommissioning of the existing LSO (including partial removal), will not result in a significant risk to the conservation objectives for the Holderness Inshore MCZ. It is also concluded that the MMO will therefore be able to exercise its functions to 'further' the conservation objectives stated for the MCZ in accordance with Section 125(2)(a) of the MCAA 2009. A Stage 2 assessment is therefore not considered necessary in support of this project.

17.6. Summary

The EIA process relating to the proposed LSO replacement scheme has found that through the implementation and adherence to the identified mitigation measures, there will be:

- No significant (i.e. moderate or major) adverse residual impacts resulting from the proposed scheme; and
- No significant adverse cumulative impacts resulting from the proposed scheme in cumulation with other plans and projects.

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