Humber Zero

Sulphate monitoring and analysis – Phillips 66 Refinery Carbon Capture Development

Phillips 66 Ltd

Project number: 60712174

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Quality information

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Abbreviations

Abbreviation	Definition
CO_2	Carbon dioxide
deSOx	Desulphurisation additive
DO	Dissolved oxygen
EQS	Environmental Quality Standard
FCC	Fluid Catalytic Cracker
HRA	Habitats Regulation Assessment
H_2S	Hydrogen sulphide
IDB	Internal Drainage Board
LWS	Local Wildlife Site
m^3/s	Meters cubed per second (i.e. discharge)
mg/l	Milligrams per litre
Mtpa	Million tonnes (also known as megatonnes) per annum
PAHs	Polycyclic aromatic hydrocarbons
PCC	Post-Combustion Capture
PFOS	Perfluorooctane sulfonate
NGR	National Grid Reference
RRP	Rosper Road Pools
SAC	Special area of conservation
SO_4^{-2}	Sulphate ion
SPA	Special protection area
SKD	South Killingholme Drain
SSSI	Site of special scientific interest
TDS	Total dissolved solids
WFD	Water Framework Directive
µS/cm	Microsiemens Per Centimeter (units of meaaurement for electrical conductivity)
µg/l	Micrograms per litre
°C	Degrees celcius (temperature)

1. Introduction

This report has been written by AECOM to support the Humber Zero Environmental Statement (ES) on behalf of Phillips 66 Limited (Phillips 66). It summarises the results of water quality and hydrological monitoring to investigate the existing water environment downstream of the Phillips 66 Refinery discharge, including the interaction between the South Killingholme Drain (SKD), Rosper Road Pool (RRP) Local Wildlife Site (LWS) and the Humber Estuary, which is designated as a Ramsar, Special Protection Area (SPA), Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). The monitoring data has been used to develop a conceptual site model of the hydrological connectivity between the SKD and RRP, and to allow a simple mass balance and dilution analysis to be undertaken. Combined these allow a better understanding of the potential impacts that may occur from an increased sulphate discharge associated with the Humber Zero carbon capture project.

1.1 Project background

Humber Zero is a proposed project which will deliver up to 3.8 million tonnes (also known as megatonnes) per annum (Mtpa) of abated carbon dioxide (CO_2) emissions via:

- Post-Combustion Carbon Capture (PCC) retrofit to two gas turbines (GT1 and GT2) and two auxiliary gas boilers at the VPI Immingham CHP Plant ('the Proposed VPI Development'); and
- PCC retrofit to the Fluid Catalytic Cracker (FCC) stack at the Humber Refinery ('the Proposed Phillips 66 Development').

This report is related to the PCC retrofit on the FCC unit at the Phillips 66 Humber Refinery. The Proposed Phillips 66 Development will result in an elevated discharge of sulphate via the existing process discharge outfall from the Humber Refinery into South Killingholme Drain. The removal of oxides of sulphur (Sox) from the flue gas from the FCC unit (using the Wet Gas Scrubber) is required as part of the flue gas pre-treatment process to enable the CO_2 removal process for the FCC to be effective. If SOx was not removed from the flue gas, the amine within the PCC plant would react preferentially with the SOx, thereby significantly reducing the efficiency of CO_2 removal. The presence of SOx in the PCC plant also could lead to the formation of aerosols within the process that would increase emissions of amines to the atmosphere. As such the removal of SOx in the Wet Gas Scrubber (WGS) is critical to the effective operation of the PCC plant.

However, the operation of the Wet Gas Scrubber will result in a wastewater stream with an elevated concentration of sulphates, and therefore there will be an increased discharge of sulphate from the Phillips 66 Humber Refinery above the existing baseline levels.

Initial calculations that were reported in Chapter 9 - Water and Flood Risk of the Humber Zero Environmental Statement (ES)[1] and also in the original Environmental Permit application, indicate that the concentration of sulphates to be discharged, following the dilution with the existing Phillips 66 Humber Refinery site discharge, may be up to around 1,800 mg/l.

Treatment options to reduce the concentration of sulphate in the discharge have been investigated to reduce (mitigate) water quality impacts. The refinery currently add a desulphurisation additive (deSOx) to the flue gases from the FCC unit to reduce the SOx emissions, and it was originally envisaged that following the installation of the Wet Gas Scrubber, this would no longer be applied. However, the continued use of DeSOx following the installation of the Wet Gas Scrubber would reduce the concentration of sulphates in the resulting waste water by around 50%, thereby reducing any potential impacts.

The ES chapter recommended that water quality and flow monitoring along South Killingholme Drain (SKD) and Rosper Road Pools (RRP) should be undertaken to inform water quality calculations that confirm the potential range of residual discharge concentrations. This would then inform the Environmental Permit Application and the Habitats Regulations Assessment. This report has been undertaken to fulfil this recommendation.

[1] Humber Zero Environmental Statement VPI Immingham and Phillips 66 Ltd (AECOM, 2023)

1.2 Sulphate in water environments

Sulphate is not assessed as a contaminant under the Water Framework Directive (WFD) for either freshwater or marine water, as implemented in the Water Environment (WFD) (England and Wales) Regulations 2017. Sulphate is also not included in the indicative list of polluting substances in Annex II to the Industrial Emissions Directive (2010/75/EU) which continues to apply in England via the EU Withdrawal Act 2018. However, for the purpose of assessment Environmental Permit applications, the Environment Agency have an Environmental Quality Standard (EQS) of 400 mg/l for freshwaters (there is no EQS in place for estuaries and coastal waters, where sulphate levels will typically be much higher).

The Report to Inform HRA[2] includes a review of the literature available on ecotoxicity of sulphate to aquatic organisms and potential effects on aquatic ecosystems, the review demonstrated that there is no certainty regarding the effect levels of sulphate will have to aquatic organisms, including fish and macroinvertebrates. The review concluded that a level of approximately 1,000 mg/l of sulphate would be an appropriate maximum allowable concentration to protect aquatic life. A copy of this report has been provided in Appendix A, although please note it is a draft and will be updated to reflect scheme updates.

[2] Humber Zero (Proposed Phillips 66 Development) Report to Inform Habitats Regulations Assessment Rev 1 (AECOM, 2023)

2. Study area

The Proposed Development is located close to the mouth of the Humber Estuary on its southern bank between South Killingholme and the ABP Immingham Port. The local area is drained by a number of short watercourses, which form part of a coastal ditch system. These watercourses have been heavily modified by past and current land uses. The three principal water features of concern include the SKD, RRP, and the Humber Estuary. The hydrological function and interaction of these water features is one of the objectives of this monitoring programme, and this is described in more detail in Section 5 Conceptual Site Model. The following is a brief overview of each water feature.

2.1 South Killingholme Drain

SKD is an Ordinary Watercourse that is managed by the North-East Lindsey Internal Drainage Board (IDB). Upstream of RRP the watercourse is comprised of three drains:

- One from the Phillips 66 Refinery (which includes any flows from intercepted headwater catchment areas to the east of South Killingholme, which are small, ephemeral and poorly connected) (Photo 1);
- A drain to the west of Rosper Road into which VPI Immingham currently discharges process water (Photo 2); and
- A drain to the east of Rosper Road, the source of which is not certain but is likely to be industrial discharges.

These three channels coalesce just upstream of RRP, after which a single trapezoidal channel flows from north to south parallel to Rosper Road (Photo 3).

Photo 1 View upstream along SKD towards the Phillips 66 Refinery (TA1713317010) at approx. 15:00 29/09/2023 (approaching high tide)

Photo 2 View upstream along VPI Branch towards VPI Immingham (TA1713317010) at approx. 15:00 29/09/2023 (approaching high tide)

Photo 3 View upstream along SKD to the east of Rosper Road just upstream of RRP (TA1719816939) at approx. 15:00 29/09/203 (approaching high tide)

Photo 4 View downstream towards the Port of Immingham (TA1738316736) at 14:21 on 26/07/2023 (on the ebb tide)

From RRP the watercourse continues to flow south towards Humber Road where it turns generally east flowing to the north of the Port of Immingham (Photo 4). The watercourse discharges to the Humber Estuary at South Killingholme Haven within the port area. Access into the port has been restricted but it is thought that this discharge is via sluice gates. Either way, when the tide is high the flow in the watercourse is prevented from discharging and the watercourse is effectively 'tide-locked'. This has a significant effect on the flow regime causing a twice daily rise and fall in water level. The other major control on the flow regime is the dominance of surface water runoff and treated effluent from industrial sites, which it is estimated may make up around 97% of the flow. SKD has an open hydrological connection to the RRP via a shallow weir.

All the channels are heavily modified with a trapezoidal cross section and little variation in flow, substrate and habitat. The banks are well vegetated, but are steep and over deep, and so it is not expected that there would be any significant lateral connectivity between the channel and its floodplain. The bed material was observed to be 50 mm to 75 mm of brown/black organic sludge, beneath which is considered to be a brown clay with some sand[3]. This becomes firm between 25 mm and 50 mm and is assumed to be puddle clay[3]. The base of the initial section of the drain within the VPI Site was found to be hard and may be concrete lined[3].

Ecological surveys were carried out as part of the ES (Volume I, Chapter 13 Ecology and Nature Conservation) and confirmed that SKD had limited aquatic and marginal vegetation, which was limited to fennel-leaved pondweed and fool's watercress. Bankside vegetation comprises tall herbs to both banks and mixed scrub on the north bank. SKD was surveyed from within the channel all the way through to the VPI Immingham CHP Power Station downstream, beneath Rosper Road, to its discharge point into RRP in 2022 and there was no evidence protected species including water voles or otter.

Annual macroinvertebrate sampling is carried out on multiple locations along SKD by the refinery each year dating back to 1995. Philips 66 Ltd have provided copies of the last five survey reports dated November 2018-21 and July 2022. The ecological status is assessed using macroinvertebrate indices such as the BMWP (Biological Monitoring Working Party) score and ASPT. Although BMWP has been superseded by WHPT (Whalley, Hawkes, Paisley and Trigg method), it is retained so that the long-term record of trends can be maintained. It should be noted that these metrics were designed primarily to assess the impact of organic pollution, although several factors may influence the biotic scores, for example dredging and channel clearance, toxic chemicals, flow conditions, the presence or absence of macrophytes (aquatic plants) and type/diversity of habitat types can all affect the macroinvertebrate community[3]. The following is a summary of the latest results[3]. Sampling took place at four locations in South Killingholme:

- One situated directly upstream of the oil refinery;
- Two sites at approximately 450 m (upstream of Rosper Road) and 1.1 km downstream of the refinery (off Humber Road); and
- A second control site located on an arm of the South Killingholme Drain (near Marsh Lane) that does not receive any effluent from the refinery.

The results for the 2022 survey state that:

- Macroinvertebrate communities downstream of the refinery are considerably less diverse than at either upstream of the refinery or at the control site and consist almost entirely of the most pollution-tolerant taxa. BMWP scores were 14 and 37, and ASPT scores 3.5 and 3.7, respectively.
- Low abundances of macroinvertebrates were evident downstream of the refinery, with the macroinvertebrate communities at these sites being dominated by pollution-tolerant fly larvae (Chironomidae and Culicidae).
- In particular, the low abundance of organic pollution tolerant organisms such as Oligochaeta combined with the absence of Sphaeriidae may indicate inorganic contamination of the sediment.
- Oil was observed at the two sites downstream of the refinery during sampling and the invertebrate sample collected at the site just upstream of Rosper Road also had a noticeable odour of oil.
- Both of the sites downstream of the refinery exhibited very low dissolved oxygens levels (10-12% saturation) which is possibly an effect the oil film on the water surface (and not the increase of around 10 ºC downstream of the refinery as the control site was also warmer but had higher dissolved oxygen levels).
- Settlement of oil in the sediment at the two downstream sites may account for the lower abundance of detritus and sediment feeders/dwellers found during this survey and also in the recent historical data (2017 – 2021).

[3] APEM MI Report.

- It is possible that intermittent events such as oil discharge into the watercourse is restricting the macroinvertebrate community development at downstream sites.
- The very slow-flowing nature of the South Killingholme Drain is also likely to reduce the flushing of effluent downstream, allowing heavy particulates to enter the sediment and lighter oils to persist on the water surface.

Overall, SKD is heavily modified with very limited geomorphic features/diversity, has poor water quality, and low habitat quality and biodiversity. The flow regime is controlled by surface water runoff and discharges of final treated effluent, with poor connectivity with the historic catchment and generally little inputs of any other catchment flows. Daily tide-locking events at high tide also influence flow conditions creating regular and long periods of 'slack water'. It is therefore considered that SKD has negligible ecological value.

2.2 Rosper Road Pools

RRP was originally constructed as an Artificial Flood Relief Reservoir and is located to the south-east of the Proposed Development Sites, east of Rosper Road (see the Conceptual Site Model in Appendix B and Photo 5). Although artificial, the pools are designated as a LWS and indirectly support birds that are associated with the designated nature conservation sites of the Humber Estuary. RRP is managed by the North East Lindsey IDB, as is South Killingholme Drain.

This surface water feature has an indirect hydrological connection with the Proposed Developments via SKD and a backwater channel to a shallow crested weir. The function of this weir and flow connection with the SKD has been investigated as part of this monitoring study and is described in more detail later. A return outfall back into the SKD is present a short distance downstream along SKD, although its function appears to be impeded by siltation in the pools.

Photo 5 View of RRP (TA 17280 16970) on 23/08/2023 at 14:06 (ebb tide)

RRP lies outside the boundary of the Humber Estuary SPA/ Ramsar but is classed as functionally linked to the SPA/ Ramsar due to its supporting function to the qualifying species of birds, and specific surveys of RRP for wintering and breeding birds have been undertaken to confirm this. Surveys have recorded to good numbers of black-tailed godwit in RRP with several of the monthly counts recording numbers >1% Humber Estuary threshold. RRP also supports good numbers of lapwing, redshank and shelduck (although all counts were <1% Humber Estuary thresholds for these species), as well as wigeon (regular counts >1% Humber Estuary threshold). It is evaluated that this habitat is of importance in supporting the adjacent mudflats as a feeding, loafing and roosting resource for black-tailed godwit and wigeon and is therefore, functionally linked land to the SPA/ Ramsar site.

2.3 Humber Estuary

The Humber Estuary (see Photo 6) is split into three WFD waterbodies by the Environment Agency. These are the Upper Humber (Trent Falls to the Faxfleet Ness), the Middle Humber (Faxfleet Ness to Goxhill Haven), and the Lower Humber (Goxhill Haven to Spurn Point). The study area and surrounding watercourses naturally drain and outfall to the Lower

Humber water body, which thus has an indirect hydrological connection with the Proposed Development and is the ultimate downstream receptor.

The Humber Estuary has a large tidal range due to its position within the North Sea Basin, producing a mean spring tidal range of 5.7 m at Spurn. The tidal range is amplified as it propagates up the Estuary; being 7.4 m at Salt End, and 6.9 m at Hessle (being 45 km inland). It is because of these large tidal ranges that the Humber is classified as a macro-tidal Estuary. The size and scale of the estuary and its tidal range create large areas of salt marsh and mud flats exposed at low tide, as well as subtidal sandflats, which are important for a range of fauna and flora. It is for these reasons that the Humber Estuary is designated as a Ramsar, SPA, SAC and SSSI sites.

Photo 6 View looking east towards the mouth of the Humber Estuary (TA1478122960) on 27/01/2023 at 13:30 (low tide)

3. Background Water Quality Data

3.1 Environment Agency routine monitoring

There is a routine Environment Agency water quality monitoring on SKD, just upstream of its crossing at Rosper Road (TA 17125 17002) (site reference AN-SKDR4). Table 3-1 shows results from this monitoring station for key indicators of water quality, from January 2015 – October 2023 (note that the majority of water quality data is from 2015-2017).

Table 3-1. Environment Agency monitoring data (2015-2023) for SKD (TA 17125 17002)

Determinand	Units	Average	Minimum	Maximum
pH		8.21	7.96	8.50
Temperature of Water	°C	19.5	9.0	27.8
Conductivity at 25 °C	µs/cm	2621	1816	3263
Biochemical Oxygen Demand (BOD)	mg/l	3.04	1.03	8.30
Chemical Oxygen Demand (COD)	mg/l	69	44	138
Ammoniacal Nitrogen as N	mg/l	0.966	0.034	7.330
Nitrogen, Total Oxidised as N	mg/l	15.6	5.0	31.4
Nitrate as N	mg/l	15.4	4.8	31.1
Solids, Suspended at 105 °C	mg/l	14	3	179
Hardness, Total as $CaCO_3$	mg/l	472	183	889
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	657	476	848
Sulphide as S	mg/l	0.011	0.010	0.016
Orthophosphate, reactive as P	mg/l	0.404	0.138	1.060
Oxygen, Dissolved, % Saturation	mg/l	84.2	31.3	132.3
Oxygen, Dissolved as O2	mg/l	7.67	2.92	11.40

Notes:
The Environment Agency sampling point on Rosper Road includes inputs of surface water from and process effluent/surface water from VPI Immingham CHP Power Station. It is considered that similar flows from the Lindsey Refinery do not enter this watercourse (anecdotal information from site staff).
Results reported as less than the limit of detection have been entered as the limit of detection in calculating the average.

The data indicates that the water quality of South Killingholme Drain a relatively high pH, high alkalinity and high conductivity, likely due to the existing discharges to the watercourse (see Water Resources section below).

3.2 Other background data

An Environmental Risk Assessment for SKD has been carried out for the permit for Phillips 66 Humber Refinery[4]. This was supported by monitoring undertaken in SKD towards the outfall to Humber Estuary within the ABP Immingham Port area (i.e. NGR TA 1860 1702). The results suggested that there may be some saline intrusion into the lower reaches of SKD, due to high chloride levels, despite it being assumed that there is a tidal valve on the outfall (access has not been possible into the port). The water quality results also indicated that the current water quality exceeds EQS for some metals, polycyclic aromatic hydrocarbons (PAHs), Perfluorooctane sulfonate (PFOS) and other determinands. This implies that the SKD is acting largely as an ‘effluent channel’ conveying industrial discharges and surface water runoff from a range of industrial activities and land uses from South Killingholme to the Humber Estuary. Significant dilution of the existing effluent discharges does not take place until the flow meets the waters of the Humber at South Killingholme Haven.

[4] Humber Refinery - Environmental permit improvement conditions IC28 and IC29 - Environmental risk assessment (Wood Group UK Ltd, 2021)

4. Monitoring

4.1 Approach and methodology overview

To improve our understanding of the function and interaction of the principal water features downstream of the process water discharges from the Phillips 66 Refinery and VPI Immingham and obtain baseline data for the assessment of water quality impacts and ecological risk assessment, a water quality and hydrological monitoring programme has been undertaken. This monitoring programme has involved the collection of water samples from various locations along SKD, RRP and from the Humber Estuary, as well as flow gauging and water level monitoring of the SKD close the backwater connection to the pools to obtain data on how frequently spills into the pools occurs over the shallow weir.

4.2 Water quality, flow and level monitoring

Water quality sampling, flow gauging and reading of the water level logger was carried out fortnightly for 12 weeks (i.e. six visits) between July 2023 and October 2023, with an additional visit in Novemeber 2023 to further consider tidal ingress up the SKD. SKD experiences regular tide-locking conditions, therefore, the initial water quality was sampled, and spot flow gauging completed, on the ebb tide when water is flowing out of SKD (i.e. slack water was avoided). The additional sampling in November 2023, including an additional Site 9 (further downstream on approach to the port), on both low tide and high tide to investigate the potential of tidal ingress. The monitoring locations are as described in Table 3-2 and Figure 1.

Figure 1 Water quality, flow and level monitoring locations (basemap using OS OpenData)

A Water Quality Monitoring Plan was prepared and issued to the Environment Agency for comment in July 2023. The Environment Agency responded requesting a minimum of 12 monitoring visits and the inclusion of some additional metal parameters, following additional effluent characterisation work. The scope of any further monitoring is to be discussed with the Environment Agency following the issuing of this report.

Table 3-2. Proposed monitoring locations and monitoring type at each site

Location	Description	NGR	WQ	Flow	Level	Justification and other comments	Photograph
Site 1	SKD upstream VPI discharge at Marsh Lane	TA 17059 17160	✓			Provided as a control site to represent ambient conditions upstream of Proposed Development Sites. Location is just downstream of Marsh Lane culvert, opposite the VPI discharge. May have some connectivity to VPI through a small culvert beneath the road which was not visible during summer months (therefore may not provide a suitable control). The drain flows south on the other side of Rosper Road before flowing into the main SKD channel from the Phillips 66 Refinery at Site 4.	
Site 2	VPI effluent discharge	TA 17018 17182	✓	✓*		Water quality sampling carried out from Rosper Road at the point where the effluent from the VPI Immingham CHP Plant is discharged into a drain to the west of Rosper Road. Continuous flow monitoring already in place on the discharge with no or very limited additional flow from upstream.	
Site 3	Refinery effluent discharge	TA 16584 16689	✓	✓*		Location is the discharge of the refinery within the Refinery area. Sample collected from just upstream of the walkway and flume leaving the Refinery site into the SKD upstream of Rosper Road. Continuous flow monitoring already in place.	

Location	Description	NGR	WQ	Flow	Level	Justification and other comments	Photograph
Site 4	SKD between refinery and Rosper Road	TA 17104 17001	✓			Although no significant flows from South Killingholme are expected, by sampling water quality at this location any variation with the effluent discharge from the refinery can be determined.	
Site 5	Rosper Road Pools LWS	TA 17308 16970	✓			Baselined monitoring of water quality in the RRP LWS. Samples collected from the bank close to the weir or from the weir when water levels are low. Access elsewhere was not possible for the majority of monitoring due to wide and dense vegetated hydrosere around the pool. Elevation of weir surveyed and related to water level logger.	
Site 6	SKD downstream of the gabion wall access culvert	Water quality sampling: TA 17390 16733 Flow gauging and level logging: TA 17260 16830	✓	✓	✓	Water quality monitored downstream of gabion wall access culvert, to understand the likely water quality flowing into RRP LWS. A water level logger was installed at this location, and flow gauging was carried out between the water quality sampling location and the backwater channel to RRP.	
Site 7	Caverns Jetty Estuary	TA 18701 18035	✓			Sampling of estuarine water to provide baseline data for the estuary. Monitoring undertaken at Caverns Jetty off Marsh Lane as Immingham Port is not accessible, and the jetty provides good access to estuary waters.	

Location	Description	NGR	WQ	Flow	Level	Justification and other comments	Photograph
Site 8	Rosper Road Pools LWS 2	TA 17320 16815	✓			Single location within RRP LWS, which is located further southeast from the weir location. This location was only able to be accessed towards the end of the monitoring period due to vegetation clearance by NEL IDB. Monitoring undertaken to indicate whether water quality is well mixed across entire RRP LWS.	
Site 9	SKD at ABP Immingham Dock West Gate	TA 17709 16628	✓			Monitoring was undertaken on one day (high tide and low tide) in November 2023 to check for evidence of saline intrusion within SKD. Further downstream location possible prior to Immingham Dock, where access was not granted.	

Notes:

*Continuous flow monitoring already in place on effluent stream from Refinery and VPI Immingham CHP Plant.

4.2.1 Water quality sampling and analysis

In situ water testing for temperature, dissolved oxygen, electrical conductivity, total dissolved solids, pH, salinity, and turbidity (FNU) was carried out on site using a calibrated YSI EXO1 Multiparameter Sonde.

Water samples were collected by suitably trained AECOM Water Scientists using a 2.5 m extendable sampling pole and pre-rinsed container that was then decanted on site into clean glass bottles provided by the Phillips 66 laboratory. Care was taken to sample free-flowing water away from the channel or lake edges, from a mid-depth and without disturbing any fine sediment or organic matter on the bed. Samples were collected across as short a period of time as was practical (i.e. two to three hours) and on the same day to allow direct comparison.

Water quality determinands were identified to provide baseline data on concentrations of sulphate and data on physico-chemical properties of the water that may influence sulphate toxicity or indicate tidal ingress. These determinands are not listed here but can be viewed in Table 3-4.

Sample analysis was carried out by the Phillips 66 Laboratory. The Phillips 66 Laboratory is not a commercial or accredited laboratory but regularly carries out water quality analysis to conform compliance with their existing Environmental Permit from the Environment Agency. This analysis is undertaken in accordance with the Operator Monitoring Assessment (OMA) scheme. More detail is available here: *Operator monitoring assessment: environmental permits - GOV.UK (www.gov.uk)*.

4.2.2 Flow gauging

Velocity measurements were recorded using a Valeport Model 801 (Flat) Electromagnetic Flow Meter. Due to the steep banks and the depth of very soft sediments velocity readings were limited to those possible from the left bank (as looking downstream) as far as the approximate centreline of the channel. As the SKD is regularly tide-locked, to get readings of flow, the measurements were collected on the ebb tide. During tide-locking it is assumed that velocities fall to zero as flows cannot leave the channel and begin to back up filling channels further upstream.

A velocity-area method has been applied with the channel divided into segments and the velocity recorded within each segment. A tape measure was used to record the horizontal distance from a fixed point on the bank, and a wading rod to approximate the depth of water at the time of the velocity measurements, from which an estimate of the cross-section was determined.

During flow monitoring, it was not possible to enter SKD due to health and safety constraints (the banks were too steep to safely enter and exit and there are thick deposits of very soft sediment in the channel. Therefore, flow monitoring was undertaken from the left bank (looking downstream) to the approximate centreline of the watercourse. Velocity measurements were thus only directly measured for half of the channel, with the other half estimated from the first. Given this, the flow results are estimates. However, given the uniformity of the channel (i.e. straight, has a smooth bed, and a uniform trapezoidal cross section (thus laminar flow)) these should be representative of the flows within the channel.

The channel from left bank to the approximate centre line was divided into five segments (three on the first visit). As the channel is c. 3.5 m to 4 m wide this is considered an appropriate number of segments for half the channel. Velocity readings were then taken at each vertical by setting the current meter at a mid-depth below the surface. Using this ‘one point method’, the observed value is considered as the mean velocity in the vertical. This method is generally used in shallow streams and when water depth in vertical is less than 1 m (maximum depth recorded during all velocity measurements was 0.86 m).

4.2.3 Water level monitoring

A Solinst Levelogger 5 Model 3001 and a Solinst Barrologger 5 Model 3001 were installed within a custom made stilling well on site on the 23rd August 2023. Due to the steep trapezoidal banks and lack of suitable locations close to the backwater where the stilling well could be fixed in a vertical position, the stilling well was located at a diagonal laid on the bank and fixed securely in place with metal pegs.

The stilling well plastic PVC pipe had been pre-drilled with 1 cm diameter holes at regular spaces around the pipe no more than 5 cm apart. The two loggers were hung from a metal bolt and chain to rest just above bed level, in a positioned that the logger could be returned to each time following data downloads.

The relative elevation to a local benchmark (i.e. the surface of the concrete culvert across the backwater channel) of the RRP weir crest and the position of the water level logger was determined by levelling using a basic tripod mounted theodolite and levelling staff.

4.2.4 Assumptions and limitation

The following assumptions and limitations apply:

- This report is based on available background data and data collected on site.
- To the best of our knowledge there are no significant upstream flows along the branches of the SKD either side of Rosper Road north of VPI Immingham.
- No rainfall data is currently available, which would be useful to support and corroborate interpretation of how the RRP weir functions. This could be requested from the Environment Agency at a later date.
- No groundwater data is currently available; It is assumed that the SKD is not in hydrologic connectivity to groundwater and is likely to be lined by concrete or puddle clay.
- Certain limitations apply to the collection of some field data and details of these have already been described in the method above.

4.2.5 Consideration of error

Although every care has been taken to collect accurate and reproduceable results on site, there is always a degree of error associated with the use of field equipment or difficulties associated with the limitations described in the previous section. The results presented in this report (excluding laboratory chemical analysis) are therefore subject to the following error margins as presented in Table 3-3:

Table 3-3. Sources of error

Error source	Units	Potential error margin (+/-)
Levelling – vertical elevations	m	0.05
Levelling – horizontal distances	m	0.10
Water level – instrument accuracy	n/a	0.05% full scale
Water level - stilling well position/logger replacement/perforation	m	0.05
Velocity measurements – instrument accuracy	mm/s	0.5% of reading plus 5mm/s
Velocity measurements – horizontal distance error	m	0.10
Velocity measurements – vertical distance error	m	0.025
Flow estimation – channel access limitations	m^3/s	A reasonable assumption is 20% variance
Water quality meter – Dissolved Oxygen (DO)	mg/l	±1% of reading (0 to 200%)
Water quality meter - Temperature	°C	±0.01 °C (-5 to 35 °C)
Water quality meter - Salinity	ppm	n/a*
Water quality meter - Conductivity	µS/cm	±1.0% of reading or 2 µS/cm, whichever is greater
Water quality meter - pH	pH units	±0.1 within ±10 °C of calibration temperature ±0.2 for all other temperatures
Water quality meter – turbidity	FNU	0 to 999 FNU: 0.3 FNU or ±2% of reading, whichever is greater
Water quality meter – total dissolved solids (TDS)	mg/l	n/a*

**Salinity and TDS do not have an accuracy specification. Both are calculated based on conductivity and temperature data.*

4.3 Monitoring results

The results of the water quality, flow and level monitoring are summarised in this section and are provided in detail in Appendix B.

4.3.1 Water quality results

The summary water quality results for the monitoring are contained in Table 3-4. This presents the average concentrations across the monitoring period. The full water quality results are contained in Appendix B.

Table 3-4. Summary of water quality monitoring

Parameter	Units	Average concentration (26/07/2023 – 05/10/2023)								
		Site 1 (SKD)	Site 2 (SKD)	Site 3 (SKD)[1]	Site 4 (SKD)	Site 5 (RRP)	Site 6 (SKD)	Site 7 (Humber)	Site 8 (RRP)	Site 9 (SKD)
In-situ data										
Temperature	°C	19.24	20.38	-	23.5	20.68	21.99	16.29	14.28	16.783
Conductivity	µS/cm	2511.2	2778.7	-	2389.0	1888.6	2570.1	14862.1	2979	2233.5
TDS	mg/l	1827	1978	-	1589.3	1362	1771	10874	2435	1722.5
Salinity	psu	1.47	1.59	-	1.3	1.09	1.42	10.15	1.99	1.38
DO	% sat	101.3	97.0	-	87.6	66.9	91.4	92.4	110.1	86.5
DO	mg/l	9.22	8.68	-	7.4	6.00	7.89	8.58	11.14	8.33
pH	pH units	8.01	7.89	-	8.2	8.50	8.20	7.57	9.67	8.205
Turbidity	FNU	98.4	3.2	-	4.2	8.6[2]	3.6	217.8	7.13	5.46
Laboratory data										
Calcium Hardness	mg CaCO3/L	691.00	806.75	287.33	301	375	492.0	1187.7	326	476.0
COD	mg/L	41.63	50	63	52	61.2	53.4	87.1	163	49.0
Sodium (Na)	mg/L	284.43	184.2	320.1	339	279.3	298.1	6087.0	387.2	290.4
Ammonia-N	mg/L	1.23	30.4	0.9	2.2	2.1	1.5	23.0	1.5	3.9
Monoethanolamine	mg/L	0.78	1.2	<0.1	<0.1	<0.1	1.6	<1	<0.1	<0.1
Methylamine	mg/L	0.19	0.6	<0.1	<0.1	<0.1	0.2	6.1	<0.1	<0.1
Diethanolamine	mg/L	0.36	0.6	<0.1	0.51	<0.1	<0.1	<1	<0.1	<0.1
Potassium (K)	mg/L	19.50	23.0	26.8	19.9	25.8	21.8	189.0	22.0	10.8
Methyl diethanolamine	mg/L	10.18	0.6	0.5	<0.1	<0.1	<0.1	4.0	<0.1	<0.1
2-dimethylamino-ethanol	mg/L	<0.1	<0.1	3.9	2.0	<0.1	<0.1	<1	<0.1	<0.1
Calcium (Ca)	mg/L	181.91	184.2	92.9	104.9	112.9	126.1	280.1	183.3	<0.1
Basic Nitrogen	mg/L	13.70	42.0	1.4	5.3	2.7	3.7	36.2	2	5.0
Total Kjeldahl Nitrogen	mg/L	3.99	33.2	1.3	2.5	2.3	2.2	26.0	1.6	4.1
Fluoride (F-)	mg/L	0.58	0.43	2.69	1.64	0.9	1.4	0.9	0.6	0.5
Chloride (Cl-)	mg/L	165	172	173	178	171.7	176.3	11328.6	160	165.0
Acetate	mg/L	0.49	0.5	<0.1	1.0	0.4	<0.10	0.9	<0.1	0.6
Bromide (Br-)	mg/L	0.77	0.9	0.3	0.4	0.2	0.7	32.9	<0.1	<0.1
Nitrate	mg/L	57	77.38	41.67	42	15.5	50	8.8	14	63.5
Nitrate-N	mg/L	13.0	17.3	9.1	9.4	3.5	11	2.0	3.2	14.0
Phosphate	mg/L	1.9	2.4	7.9	5.8	6.0	5.1	1.0	2.2	<0.1
Phosphate-P	mg/L	0.6	0.8	2.6	1.84	1.9	1.7	0.8	0.71	<0.1
Sulphate	mg/L	603	700	245.0	251	328	410	1542.9	330	410.0
Nitrite[3]	mg/L	0.01	0.00	4.2	2.15	1.4	1.3	0.0	-	-
Total Inorganic Nitrogen[3]	mg/L	32.71	44.30	37.1	35.15	-	33.8	31.4	-	-

Note 1 In situ data was not recorded at Site 3 which is the effluent discharge from the Phillips 66 Refinery.

Note 2 Spurious result from 16th August 2023 not included in average.
Note 3 Determinand only analysed during the first monitoring visit.

The results of water quality monitoring from November 2023 to investigate any tidal ingress into SKD from the Humber Estuary are presented in Table 3-5.

Table 3-5. Results of monitoring undertaken on 23/11/2023 at High and Low tide

	Site	Site 6 (TA 17377 16738)		Site 9 (TA 17709 16628)	
Sample scenario and time	Scenario	Low tide	High tide	Low tide	High tide
	Sample time	09:56:00	14:05:00	09:35	14:16
Relevant parameters	Salinity (psu)	1.38	1.38	1.44	1.32
	Electrical Conductivity (uS/cm)	2051	2120	2046	2034
	Sulphate as S04 (mg/l)	380	470	450	370
	Chloride (mg/l)	170	150	170	160

The following points can be made:

- The water quality data from the Phillips 66 refinery and just downstream along SKD before Rosper Road (Sites 3 and 4) supports the site discharge data contained in the ES chapter, with sulphate levels ranging from 210-280 mg/l, with an average of 243 mg/l.
- There is a source(s) of elevated sulphate on Rosper Road, upstream of the confluence with the P66 discharge. There are two monitoring points (Site 1 and Site 2) on Rosper Road, and both indicate sulphate concentrations of between 430-920 mg/l, with average concentrations of 653 mg/l. Site 2 is immediately downstream of the VPI discharge point, while Site 1 is located on a drain on the opposite side of Rosper Road to the VPI discharge point. Site 1 is connected to Site 2 via a suspected pipe culvert under Rosper Road which may convey flows under tide locking conditions and when surface water runoff is or has been high. Anecdotal evidence regarding these elevated sulphate concentrations suggests that the source of this sulphate could be due to the presence of blast furnace slag beneath the VPI site (present prior to VPI construction). This historic contamination (which is known to the Environment Agency and was investigated in 2004 - 2007) has been known to leach sulphates into SKD via preferential pathways following the VPI drainage network, causing elevated sulphate levels in surface water. This anecdotal evidence on the elevated sulphate source and resulting elevated concentrations was not known at time the ES chapter was produced. Therefore, in the existing baseline case, it is considered that discharges from the Phillips 66 Refinery are diluting these higher historic background sulphate levels.
- The recorded concentrations of sulphate within the Lower SKD (Site 6) are higher than anticipated (due to the historic sulphate source further upstream along Rosper Road) with concentration of between 360-470 mg/l, and an average concentration of 405 mg/l. There is no evidence that the sulphate concentrations are influenced by the tide locking of the drain, in either the regular monitoring or during the monitoring visits undertaken on 23/11/2023 at high and low tide.
- The recorded concentrations of sulphate within the RRP (Site 5) (as sampled close to the weir due to access restrictions to littoral margins elsewhere) are slightly lower but broadly similar to the concentration in SKD, ranging between 160 – 390 mg/l, with an average of 328 mg/l.
- A single sample was possible from a more distant location on RRP (Site 8) during the final monitoring visit (06/10/2023) and this recorded a consistent value of 330 mg/l (the Site 5 concentration was 340 mg/l). This suggests that the water column is well mixed and the sulphate concentration within RRP is consistent across the pools. However, this is a single result and further data would be needed to confirm this.
- Monitored estuary sulphate levels ranged from 900 mg/l to 1900 mg/l, with sulphate concentrations being higher at or close to high tide. This is due to sea water typically having a high sulphate level (up to 2,700 mg/l)[5], and the various stages of mixing between freshwater and sea water through the estuarine system. The data recorded indicates that the estuary experiences high sulphate concentrations on a daily basis and thus the emissions from the Proposed Development are unlikely to be a concern. This also suggests that

[5] Meays, C., Nordin, R. (2013). Ambient Water Quality Guidelines for Sulphate. Ministry of Environment, Province of British Columbia. Available at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/sulphate/bc_moe_wqg_sulphate.pdf

there is no saline ingress up SKD to Site 6 at the times sampled, given sulphate concentrations are much lower at that location, however additional monitoring at high tides would be required to investigate further.

4.3.2 Flow results

Flow monitoring results for Site 6 (SKD downstream of RRP) are provided in Appendix B and summarised Table 3-6.

Table 3-6. Estimated flow at Site 6 on SKD based on spot flow measurements

Monitoring date	High tide at Immingham (time)	Time of measurements	Flow estimate (m^3/s)
16/08/23	06:47	12:30	0.123
23/08/23	10:26	15:30	0.152
06/09/23	10:59	15:40	0.179
19/09/23	08:59	12:50	0.274
05/10/23	10:29	13:00	0.283

Flow estimates have been obtained on five occasions during the ebb tide when flows are vacating SKD to avoid 'slack' water when the drain is tide-locked. They range from 0.123 m^3/s to 0.283 m^3/s, and indicate the typical flows experienced in the channel when not tide-locked.

As mentioned in Section 4.2.2, it was not possible to enter SKD due to health and safety constraints, therefore, flow monitoring water undertaken from the left bank to the approximate centreline of the watercourse. Velocity measurements were thus only directly measured for half of the channel, with the other half estimated from the first. Given this, the flow results are estimates. However, given the uniformity of the channel (i.e. straight, has a smooth bed, and a uniform trapezoidal cross section) these should be representative of the flows.

4.3.3 Water level monitoring and observations

Table 3-7 describes observations of the RRP weir between 26/07/2023 and 05/10/2023 and Figure 2 water level logger data from just upstream of Site 6 on SKD.

Table 3-7. RRP weir water level observations between 263/07/2023 and 05/10/2023

Monitoring date and time	High tide (time)[1]	Water level recorded at Site 6	Weather conditions	Description of observation
26/07/23 14:00	11:50	Not known as water level monitoring not in place	Weather on the day was warm, dry with some cloud following a couple of days of dry weather prior to heavy rain.	Active flow across weir into the RRP (depth of flow a few cm's). Recent in channel vegetation clearance and organic debris partially blocking downstream culverts may have encouraged flows to back-up more than usual. These observations were confirmed anecdotally by the IDB.
16/08/23 13:30	06:47	Not known as water level monitoring not in place	Weather on the day was warm (up to 25°C) with very little cloud cover. Week prior consisted of mostly warm temperatures and dry conditions, except for some scattered rain showers on the 12-14/08/2023.	Low water level in the backwater channel and no active flow over the weir into RRP.
23/08/23 14:00	10:26	0.299 m	Weather on the day was warm (temperatures up to 22°C), with fair weather clouds and light winds.	Low water level in the backwater channel and no active flow over the weir into RRP.
06/09/23 11:59	10:59	0.411 m	Weather on the day was dry and warm, temperatures up to 25°C and little to no cloud cover. The week prior was hot and dry with little rainfall.	Higher water level compared to previous two visits but no flow over the weir into the RRP.
19/09/23 12:19	08:59	0.573 m	Weather on the day was warm (temperatures up to 20°C), with fair weather clouds and light winds. There was light rain in the morning but it did not continue past 10:00am.	Active flow across the weir into RRP (depth of flow a few cm's).
26/09/23 14:59	16:40	0.494 m	Very heavy rainfall was experienced in the morning for two to three hours, after which it turned warm and sunny.	Water level in the backwater channel was at weir crest height. Possible that further water level rise before high tide would result in a small overtopping event.
05/10/23 11:49	10:29	0.517 m	Weather was overcast, with scattered showers (mainly after 12pm), temperatures ranged from 14 - 17°C. The week before experienced variable weather, with some warm sunny days and some warm wet days.	No flow over the weir into the RRP at the time of the observation but water levels in both the backwater channel and the pools were high (backwater level just below weir crest) and organic debris on the weir suggests a spill had recently occurred.

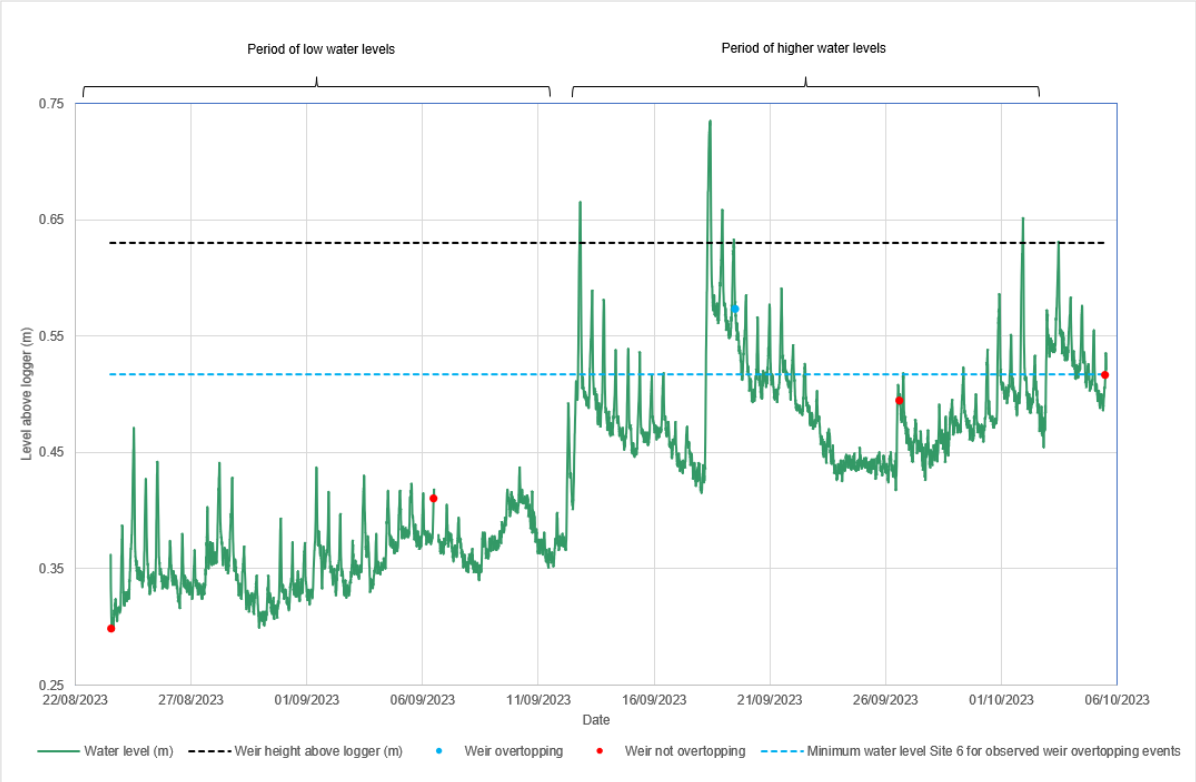

Figure 2 Water level near Site 6 (downstream RRP) between 23/08/2023 and 05/10/2023

The following points can be made:

- The RRP weir is approximately 0.2 m high and 18 m long. However, reeds have grown along the face leaving a shorter section of 2.2 m open. The progressive growth of reeds reflects the weir's quiescent function and the infrequency of overtopping events. When overtopping events do occur, they are low energy flows.
- SKD water levels are tidally influenced with levels rising during periods of high tide when the SKD becomes tide-locked, generally at a slight delay. The constant discharges of process effluent from the Phillips 66 Refinery and VPI Immingham, as well as surface water runoff following rainfall, also influence water levels. The growth of vegetation in the channel, especially around culverts, is also a factor to consider.
- The elevation of the water level logger to the RRP weir was determined by a simple levelling exercise relative to a local bench-mark. This determined that the level logger was approximately 0.63 m lower than the weir crest at RRP. Thus, any water level above 0.63 m at the logger site would likely coincide with a weir overtopping event. This elevation is shown by a black dashed line on Figure 2.
- The weir at RRP was observed to be overtopping on two occasions, during the first monitoring visit (26/07/2023) and on the fifth monitoring visit (19/09/2023). The water level within the backwater was also observed to be at the weir crest height on 26/09/2023 and there was site evidence to suggest the weir had recently overtopped on the 05/10/2023 (See Table 6 and Figure 2).
- The overtopping event observed on 26/07/2023 is considered to have been a consequence of recent vegetation clearance by the IDB, which had resulted in debris partially and temporarily blocking downstream culverts. Debris had cleared by the second visit on the 16/08/2023. The IDB has confirmed that overtopping events into the RRP increase when the channel is choked by vegetation. Please note that the logger was not installed at this time, so the event was not recorded.
- When water was overtopping the weir into RRP on 19/09/2023 the recorded water level at the logger was 0.573 m. When water levels in the backwater were at or close to the weir crest water level recorded by the logger was 0.494 m (26/09/2023) and 0.517 m (05/10/2023), respectively. These observations suggests that when the water level at the logger site is approximately 0.517 m or higher, water will begin to spill into RRP from the backwater. This is around 10 cm less than the 0.63 m suggested by the levelling exercise alone and may reflect other factors that funnel water towards the RRPs (e.g. vegetation in the channel reducing downstream flows through a small arch culvert.). Monitoring data error margins may also explain this discrepancy (see Table 3-3).

- The water level pattern in Figure 2 reflects the twice daily rise and fall in response to tide locking conditions, superimposed on a longer-term storm hydrograph, noting that process flows into the SKD are continuous. A review of rainfall records available from the Environment Agency would support further interpretation of this data.
- Up to mid-September the monitoring period was fairly warm and dry and thus water levels where relatively low and rarely exceeded 0.5 m. There were no observations of the weir overtopping during this period. Since mid-September there has been more frequent periods of rainfall and thus water levels have stayed generally above 0.5 m. The weir was observed overtopping on 19/09/2023.
- The weir does not overtop during every tide locking period. The weir was observed on 06/09/2023 at 12:21 which coincided with a tidal locking event within the SKD and subsequently a higher water level, but the weir was not overtopping.
- Weir overtopping is thought to occur when there are greater volumes of surface water runoff during periods of heavy or prolonged rainfall, or smaller rainfall events in combination with tide locking. On the 26/09/2023 water level in backwater was at the weir crest height following heavy rain in the morning, and although not overtopping, tide locking conditions were to continue for a period after the observations were made so it is possible that water levels would continue to rise.
- Overall, based on the available data there may have been around 20 overtopping events during the six-week monitoring period, all of which are likely to have occurred since mid-September. This may have included three sustained periods of flow from SKD into RRP:
  - 12-15th September 2023 during which tidal influence appears to be large due to the amplitude of the daily fluctuations and coinciding with increased surface water runoff.
  - 18-22nd September 2023 during which there may have been a sustained period of weir overtopping, followed by intermittent flows into the RRP during tide locking and as elevated water levels following surface water runoff recedes.
  - 30th September to 6th October 2023 during which tidal influence appears to be large due to the amplitude of the daily fluctuations and coinciding with increased surface water runoff, particularly during early October where there may have been a second sustained period of flows into the RRP.

5. Conceptual Site Model

5.1 Purpose of the Conceptual Site Model

A Conceptual Site Model (CSM) is a representation of the biological, physical and chemical processes that determine the ways that contaminants move from sources through the environment to receptors or vary over time in response to hydrological conditions or other processes. The focus of this CSM is to better understand the hydrological function and interaction of the SKD and the RRP so that it may support further assessment of potential water quality impacts from the Proposed Development and the determination of ecological risks. It is based on a synthesis of all available and relevant information about the Site, with interpretation as necessary and recognition of uncertainties or assumptions. This includes background information, desk study from readily available online sources, visual and olfactory observations during site visits, and monitoring data from existing effluent emissions and that which has been purposely collected for the project. The CSM has been presented in Appendix C and is described below.

5.2 Conceptual Site Model Components

The key components of the CSM are as follows:

- The key inflows into SKD and channels are:
  - The Phillips 66 refinery stormwater and effluent discharge (see channel (3) 'South Killingholme Drain' on the CSM);
  - The VPI stormwater and effluent discharge (see channel (1) 'VPI Branch' on the CSM);
  - Other effluent discharges and overland flow from the catchment, including roads and land further south around the Port of Immingham;
  - A third main branch of the SKD lies to the east of Rosper Road and extends north of Marsh Lane (see channel (2) 'Marsh Lane Branch' on the CSM).
  - Note that the main South Killingholme Drain channel from the refinery will be diverted further south with the construction of the Proposed Development, although the fundamental arrangement of channels will not change.
- The recorded data from monitoring indicates that stormwater and effluent flows from the Phillips 66 Refinery site comprise around 70-90% of the flows within SKD during dry periods (August 2023), and the majority of the remaining flow is other effluent discharges from other industrial sites (including VPI). During wet periods (September and October 2023), stormwater and effluent flows from Phillips 66 Refinery comprise around 50% of the flows within SKD, with the majority of the remaining flow being other effluent discharges and likely road runoff.
- The original course of SKD has also been significantly altered by the construction of the Phillips 66 Refinery and other industrial land uses, and it now has poor hydrological connectivity to head waters between the refinery and in and around South Killingholme. Although these areas may still provide storm runoff, they must flow via the refinery and will become mixed with refinery effluent.
- It is assumed that the drain is lined with puddle clay and thus is not thought to the connected with groundwater.
- The VPI Branch currently discharges at a reduced rate into the main SKD from the refinery via two tidal flap gates when water levels in the main drain are sufficiently low (i.e. when the SKD is not tide locked). Further upstream the VPI Branch is culverted underneath access to the VPI Site, after which it is considered to dry out with no significant upstream catchment. No upstream flows have been observed and the water in this branch is considered to be almost 100% from the VPI effluent discharge.
- The Marsh Lane Branch lies to the east of Rosper Road and continues north from the main branch from the refinery north of Marsh Lane, where it is considered to discontinue a short distance further. As with the VPI Branch, no significant upstream catchment is considered to exist. The current understanding is that the water in the channel is essential water that has 'backed-up' under tide locking conditions plus any road runoff or overland flow and infiltration from the agricultural land to the east. However, given the water quality results, there may be a direct connection between the VPI site and this drain (or potentially leaching through groundwater), however there is no evidence of this in discharge permits or observed on site.

- Downstream of the confluence of the SKD main channel from the refinery (3), the VPI Branch (1) and the Marsh Lane Branch (2), there is a shallow backwater channel that extends eastwards towards Rosper Road Pools (see channel (4) 'Rosper Road Pools Backwater Connection' on CSM). This terminates at a concrete weir into the pools that is c. 0.2 m high and when constructed was 18 m wide. However, progressive reed growth along the face of the weir has reduced the functional weir width to c. 2.2 m only.
- RRP was originally constructed as an Artificial Flood Relief Reservoir and is managed by the East Lindsey IDB. Although artificial, the pools are designated as a LWS and indirectly support birds that are associated with the designated nature conservation sites of the Humber Estuary. Based on observations alone, at no time has any change in water level exposed areas of mudflats, that may be locations where waders feed. The pool is surrounded by a wide hydrosere of reeds and this may mask any littoral mud exposure as water levels fluctuate. In any case, birds using the pools that are designated features of the Humber Estuary Ramsar/SPA will likely also feed on the mudflats of the estuary, which are regularly exposed to water sulphate levels as high 1900 mg/l.
- An outfall along SKD further downstream of the backwater is considered to be the original overflow from the pools, although no flow has been observed from this during the monitoring period and it is likely that its function is prohibited by being blocked by silt and/or dense reeds present as a hydrosere around the littoral margins of the pools. Thus, water level in the pool is likely controlled by the weir to the backwater.

5.3 Hydrological interactions

The CSM is based on the following hydrological observations:

- The flow regime within SKD is controlled by surface water runoff following rainfall events and twice daily tide-locking events when high tide in the Humber Estuary prevents free flow from the SKD outfall within the Port of Immingham.
- As effluent discharges from the refinery and VPI Immingham are continuous, during periods of rainfall (especially when the drain is tide-locked) water levels will rise and begin to back-up further upstream.
- The extent of this rise and backing up is controlled by the rate and volume of process discharges and surface water runoff, and the duration of the tide locking event (which may vary slightly depending on the height of the tide, although there has been no access to the SKD outfall in the Port of Immingham).
- The growth of reeds in the channel (especially at the connection of the backwater and the main channel) may also influence water levels in the backwater. Annual vegetation clearance that typically occurs in late July may also maintain water levels for a short time post works as organic debris left in the channel may reduce conveyance through two small concrete box culverts downstream before the Port of Immingham.

Based on the level monitoring and observations, flows into the RRP from SKD are intermittent but fairly frequent. It is considered that it only occurs in two scenarios:

- High surface water runoff or lower surface runoff but coinciding with a tide-locking event; and
- Vegetation blocking culvert – it was observed that at some times throughout the year, SKD becomes overgrown, and the capacity of culverts downstream of the backwater to RRP is reduced. When this occurs, water is encouraged to flow towards RRP, with overtopping of the weir occurring at lower rainfall and shorter tide-locking events.

5.4 Water quality

The CSM is based on the following water quality considerations:

- On the ebb tide water flows freely from SKD into the Humber Estuary. Under these falling water level conditions, the water quality in the SKD (as it passes RRP) will be a product of the effluent and surface water runoff from both the existing Phillips 66 and Immingham VPI Sites (including the anecdotal historic leaching of sulphates from beneath the VPI site), the Proposed Development, and any surface water runoff from any other local roads, land uses and fields.
- Under tide-locked conditions flows are prevented from discharging from SKD into the Humber Estuary. As water begins to back-up through the channel network the water quality will be largely controlled by the continuous effluent discharge from the Phillips 66 Refinery, diluted by any residual surface water runoff remaining in the system from previous rainfall or from active surface water runoff at the time. Process effluent, leaching of sulphates and any surface water runoff from the VPI Immingham Site will likely be

retained within the VPI Branch as the higher water levels in the main drain will have closed the tidal flap gates.

- As the RRP weir is most likely to be overtopped when heavy rainfall coincides with tide locked flow conditions, spills into the pools are expected to be diluted by the addition of surface water runoff.
- There was no evidence of tidal ingress into SKD or RRP with water quality across all monitoring sites (except Site 7 on the Humber Estuary) being broadly consistent at high and low tides within the lower SKD.
- Sulphate levels in SKD and RRP are generally comparable, being slightly lower in the pools. This suggests that there is an equilibrium between the pools and the drain. The likely mechanism is that the intermittent overtopping of the weir adds sulphate into the pools, which overtime increases the concentration within the pools. The levels are slightly lower in the pools due to dilution through direct rainfall, the fact that overtopping likely only occurs when there is a higher flow within SKD (therefore lower concentration of sulphate), and also potentially due to a gradual breakdown of sulphate to hydrogen sulphide (H_2S) gas by vegetation within the pools or precipitation to alkali sulphate salts[6]. Monitoring limitations have necessitated water quality sampling of the pools from very close to the weir on the majority of occasions. However, one sample collected from a more distant location on the pools suggests sulphate levels were broadly consistent across the pools which supports the equilibrium hypothesis. However, additional data is needed to corroborate this conclusion..

[6] P. A. Moreno-Casas, H. Aral, A, Vecchio-Sadus (2009). *Environmental Impact and toxicology of sulphate*. Conference paper, Environmine 2009.

6. Sulphate mass balance and dilution estimates

One purpose of the monitoring was to confirm existing sulphate concentrations, flows and levels within SKD, RRP and the Humber Estuary to improve the estimate of sulphate levels within the receptors during the operation of the Humber Zero project. Therefore, this section provides an estimate of the likely range of sulphate concentrations within the receptors based on various flow scenarios.

6.1 Data inputs

The data that has been utilised in this assessment is as follows:

Water quality data:

- Water quality data from this investigation;
- Environment Agency routine water quality data for SKD;
- Phillips 66 water quality data of existing effluent discharge; and
- Phillips 66 quality estimates of the new effluent discharge (with and without treatment).

Flow data:

- Recorded spot flow data from this investigation (however, please note that it was only possible to survey half of the channel safely, with the remaining flow estimated);
- Phillips 66 recorded discharge data (2021-2023); and
- Phillips 66 estimates of the new effluent discharge.

The new effluent stream has a flow rate of 0.00154 m3/s and an estimated sulphate concentration of 19,147 mg/l when 50% deSOx additive is used (or 38,295 mg/l without DeSOx additive). This therefore equates to a release rate of 29g/s of sulphate (or 59g/s without DeSOx).

6.2 Method

The sulphate concentrations have been estimated for a number of scenarios:

- Estimated sulphate concentrations for monitored data (i.e. estimating the concentrations that would have taken place with the new effluent stream on monitoring days); and
- Estimating flows based on long-term records for low, median and high flow rates.

The SO_4^{-2} concentration with the new effluent downstream of the refinery outfall was estimated using the following equations:

(1) $$P66\ Conc_{new} = \frac{P66\ Conc_{\ Existing} \times P66\ Flow_{Existing} + Eff\ Conc_{\ new} \times Eff\ flow_{new}}{P66\ Flow_{Existing} + Eff\ flow_{new}}$$

Where:

P66 Conc $_{new}$ is the calculated SO_4^{-2} concentration with the new effluent discharge;

P66 Conc $_{existing}$ is the recorded or calculated SO_4^{-2} concentration downstream of the refinery in the existing case (Site 3);

P66 Flow $_{existing}$ is the recorded flow from the refinery, provided by Phillips 66;

Eff Conc $_{new}$ is the concentration of the new effluent discharge, calculated by Phillips 66;

Eff Flow $_{new}$ is the average flow of the new effluent discharge (0.00154 m^3/s).

The SO_4^{-2} concentration within the Lower SKD (Site 6) was estimated using the following equation:

(2) $$SKD\ Conc_{new} = \frac{P66\ Conc_{\ new} \times P66\ Flow_{new} + RR\ Conc_{\ existing} \times RR\ flow_{existing}}{P66\ Flow_{new} + RR\ flow_{existing}}$$

Where:

SKD Conc $_{new}$ is the calculated SO_4^{-2} concentration in the lower SKD (Site 6);

P66 Conc $_{new}$ is the calculated SO_4^{-2} concentration with the new effluent discharge downstream of the refinery (Site 3);

P66 Flow $_{new}$ is the calculated flow downstream of the refinery (P66 Flow $_{existing}$ + Eff Flow $_{new}$);

RR Conc $_{existing}$ is the recorded or calculated SO_4^{-2} concentration along the northern SKD (Site 1) in the existing case;

RR Flow $_{existing}$ is the estimated flow along the northern SKD, this is estimated based either on the recorded flows at Site 6, minus the P66 discharge, modified to ensure that the recorded concentrations at Site 6 were achieved, or using VPI discharge data (where available).

6.3 Sulphate concentrations with new effluent discharge

6.3.1 Estimated sulphate concentrations for monitored data

The sulphate (SO_4^{-2}) concentrations recorded and estimated for the new effluent discharge, for monitored days, are presented below in Table 3-8.

Table 3-8. Recorded and estimated sulphate concentrations for recorded dates

Location	Date	SO_4^{-2} Recorded (mg/l)	SO_4^{-2} estimate with new effluent (no deSOx)		SO_4^{-2} estimate with new effluent (50% reduction with deSOx)	
			(mg/l)	% increase	(mg/l)	% increase
P66 Refinery Outfall (Site 3)	*26/07/2023*	220	802	265%	509	132%
	16/08/2023	230	763	232%	495	115%
	23/08/2023	250	783	213%	515	106%
	09/09/2023	240	593	147%	597	149%
	19/09/2023	280	693	148%	485	73%
	05/10/2023	250	790	216%	518	107%
Lower SKD (Site 6)	*26/07/2023*	360	791	120%	573	59%
	16/08/2023	370	741	100%	553	50%
	23/08/2023	380	789	108%	587	55%
	*09/09/2023**	440*	550*	25%	497	13%*
	19/09/2023	410	624	52%	517	26%
	05/10/2023	470	837	78%	645	37%

Note: Recorded concentrations on 09/09/2023 appear to be high in the lower South Killingholme Drain (Site 6) compared to the upstream concentrations (Site 1), therefore the increase estimated is likely lower than would occur.*

Based upon the data, during the recorded flow conditions, the new sulphate discharge would increase concentrations within the lower South Killingholme Drain by around 50-120% without the application of any deSOx (ignoring the event on the 9/9/2023 as flow data may be unreliable), and by around 25-60% with the continued application of deSOx treatment (assumed 50% sulphate reduction). With the deSOx treatment, concentrations would remain lower than 1000 mg/l within South Killingholme Drain at all locations.

The increase in concentration is less during rainfall wet periods (September/October monitoring dates), with only around a 30% increase in sulphate concentration predicted at Site 6. This is likely due to the stormwater runoff within Phillips 66 refinery, other industrial areas and road runoff resulting in a dilution within SKD. During dry periods (August 2023) the increase is higher, as the majority of the discharge within SKD is likely to be effluent flows and leaching from the industrial sites.

6.3.2 Estimated sulphate concentrations for low, median and high flow rates

Long-term estimates of likely sulphate concentrations for a variety of flow conditions have been estimated. This is to provide an understanding of potential concentrations that may be encountered within SKD and RRP. The effluent characteristics (flow and concentration) used in this assessment is the same as the permit application effluent data. However, the estimate considers different scenarios to estimate how flows could change at different flow return periods, and thus there may be some variance between the results.

The sulphate concentrations at low (Q_{95}), median (Q_{50}) and moderately high flows (Q_5) have been estimated using long term discharge data supplied by Phillips 66, VPI and the recorded water quality data. Phillips 66 have supplied discharge rates for the refinery from January 2021 – October 2023, which range between 0.052 to 0.196 m^3/s across this time period. Existing sulphate discharge concentrations have also been provided for 2022. Using this data, the return periods of discharges have been calculated, this is using the assumption that the discharge rate is related to rainfall onto the Phillips 66 Refinery site. The sulphate concentrations have been estimated at each discharge rate considered, and the results indicate that generally concentrations are similar across all flows, however, they are slightly lower at higher discharge rates. The data supplied by VPI is discharge rates in 2022, and therefore the amount of data is limited. Sulphate concentrations are not routinely monitored for this discharge, therefore the average recorded sulphate concentration at Site 2 was used.

Using this data, the long-term estimates of sulphate concentrations has been estimated. A conservative approach has been adopted with overland flow from roads excluded. The results of the assessment are contained in Table 3-9.

Table 3-9. Estimates of long-term sulphate concentrations

Location	Return period	SO_4^{-2} Baseline (mg/l)	SO_4^{-2} Estimated with new effluent (no deSOx and peak discharge rate)		SO_4^{-2} Estimated with new effluent (50% reduction with deSOx and average discharge rate)		SO_4^{-2} Estimated with new effluent (80% reduction with deSOx and minimum discharge rate)	
			(mg/l)	% increase	(mg/l)	% increase	(mg/l)	% increase
P66 Outfall (Site 3)	*Q95*	269	1527	468%	600	123%	320	19%
	Q80	254	1339	427%	539	112%	298	17%
	Q50	251	1191	374%	498	98%	289	15%
	Q30	247	1114	351%	474	92%	282	14%
	Q5	238	980	312%	432	82%	268	13%
Lower SKD (Site 6)	*Q95*	391	1264	211%	630	55%	431	7%
	Q80	388	1124	179%	591	47%	426	6%
	Q50	387	1024	155%	564	40%	427	15%
	Q30	389	966	138%	551	36%	423	5%
	Q5	388	876	117%	527	30%	320	19%

The results of the long-term average result in similar increases to the assessment using monitored data and show that concentrations are lower at higher rainfall events when discharges are higher from Phillips 66.

It is at the higher events (over Q50) that spills may occur into RRP, and therefore concentrations within SKD are anticipated to be around 564 mg/l or less, with an approximately 40% increase in concentration above the existing case (taking into account 50% deSOx treatment and an average effluent discharge rate). At minimum effluent flow rates and 80% deSOx treatment, the concentration of sulphate in SKD at the estimated Q50 flow would be 427 mg/l, which is just a 15% increase.

7. Summary and Conclusions

The following key points can be made:

- The majority of flows within South Killingholme Drain are derived from process effluent and stormwater discharge from Phillips 66 Refinery, VPI and other industrial sites. This is reflected in the water quality of SKD.
- The water quality data from the Phillips 66 refinery and just downstream along SKD before Rosper Road (Sites 3 and 4) supports the Phillips 66 discharge monitoring data, with sulphate levels ranging from 210-280 mg/l, with an average of 245 mg/l.
- There is a source(s) of elevated sulphate on Rosper Road, upstream of the confluence with the Phillips 66 discharge. There are two monitoring points (Site 1 and Site 2) on Rosper Road, and both indicate sulphate concentrations of between 430-920 mg/l, with average concentrations of 652 mg/l. This is considered to be due to historic contamination (blast furnace slag) beneath the VPI site leaching sulphate into SKD. Therefore, in the existing baseline case, discharges from the Phillips 66 Refinery are diluting these higher sulphate levels.
- The recorded concentrations of sulphate within the Lower SKD (Site 6) are higher than anticipated (due to the historic sulphate leaching further upstream along Rosper Road) with concentration of between 360-470 mg/l, and an average concentration of 405 mg/l. There is no evidence of tide locking influencing the concentrations in the drain.
- The recorded concentrations of sulphate within the RRP (Site 5) (as sampled close to the weir due to access restrictions to littoral margins elsewhere) are slightly lower but broadly similar to the concentration in SKD, ranging between 160 – 390 mg/l, with an average of 328 mg/l.
- A single sample was possible from a more distant location on RRP during the final monitoring visit (06/10/2023) and this recorded a consistent value of 330 mg/l (the Site 5 concentration was 340 mg/l). This suggests that the water column is well mixed and the sulphate concentration within RRP is consistent across the pools. However, this is a single result and further data would be needed to confirm this.
- The recorded sulphate concentrations within the Humber Estuary (Site 7) range between 900 mg/l and 1900 mg/l, being higher at high tide. Sulphate concentrations in the Humber Estuary are therefore significantly higher than those predicted in SKD with the proposed development.
- Monitoring data from SKD undertaken on the same day at high and low tide provides no evidence of saline ingress up SKD to the Immingham Post West Gate site.
- Based on the level monitoring and observations, flows into the RRP from SKD are intermittent but fairly frequent. It is considered that the only occur in two scenarios:
  - High surface water runoff or lower surface runoff but coinciding with a tide-locking event; and
  - Vegetation blocking culvert – it was observed that at some times throughout the year, SKD becomes overgrown, and the capacity of culverts downstream of the backwater to RRP is reduced. When this occurs, water is encouraged to flow towards RRP, with overtopping of the weir occurring at lower rainfall and shorter tide-locking events.
- Without the continued use of deSOx on the FCC flue gases at the Phillips 66 Refinery, the concentration in SKD, and likely RRP, could exceed 1,000 mg/l. Therefore, the continued application of deSOx is required to reduce sulphate concentrations in the new discharged effluent.
- With deSOx removing 50% of the sulphate, and at an average effluent discharge rate, the concentrations of sulphate in SKD adjacent to RRP would likely increase from an average of 328mg/l (monitored baseline of RRP) to between approximately 530-630 mg/l, which would be an increase of around 62% to 92% over the existing case (based on the estimated flows; see Table 3-9). Note however, that the predicted value of 630mg/l in SKD would be during low flows (Q95) when the weir is less likely to spill into RRP. Thus, there will be an increase in sulphate concentrations within SKD, but less than 1,000 mg/l concentration identified by the literature review provided in the HRA as being the appropriate maximum allowable concentration to protect aquatic life, and a lower increase than previously anticipated (due to the baseline concentration being higher).
- With the continued use of deSOx, the concentration in SKD at the outflow will be lower than the sulphate concentration in the estuary (including at low tide). Without treatment the concentration may slightly exceed baseline conditions as the SKD will discharge on the ebb tide. However, this would only be temporary as higher sulphate levels are expected to return as the tide comes back in. The fauna and flora will be adapted to these higher sulphate concentrations and thus it is not expected to have any impact.

Therefore, the data and analysis to date supports the following conclusion:

1. Based on the available data (noting sampling of RRP is from a bankside location close to the weir) the RRP has similar water chemistry to SKD. This is supported by the single water sample taken from location within RRP that is more distant from SKD. It is likely that over time, following the introduction of the new sulphate containing waste water, an equilibrium will be reached between the RRP and SKD, although the concentration is likely to remain slightly lower in RRP because:
    a. sulphate will only be added to RRP when the weir is overtopped, which typically occurs at higher discharge return periods when the sulphate concentration in SKD will be more diluted from surface water runoff; and
    b. due to direct rainfall and run-off into RRP, which will provide additional dilution.

    This conclusion is also based on the assumptions that sulphate does not degrade or precipitate overtime.
2. Continued use of deSOx would reduce the concentrations of sulphate in the waste water discharge from the new development at Phillips 66 Refinery to levels that would minimise the increase in sulphate concentrations within RRP to below 1000 mg/l for all flow scenarios.
3. The baseline concentrations of sulphate in SKD and RRP are higher than anticipated, potentially due to historic contamination leaching sulphate into the SKD, and therefore RRP are likely more adapted to an elevated sulphate concentration than initially thought, given that anecdotally the water quality has had elevated sulphate levels for a number of years.
4. With the application of DeSOx in the FCC removing 50% of the sulphate in the wastewater, and an average effluent discharge rate, the concentration of sulphate in SKD adjacent to RRP would likely increase from an average of 328mg/l (monitored baseline for RRP) to between approximately 530 - 630mg/l, which would be an increase of around 62% - 92% over the existing case (based on the estimated flows; see Table 3-9). Note however, that the predicted value of 630mg/l in SKD would be during low flows (Q95) when the weir is less likely to spill into RRP. Thus there will be an increase in sulphate concentrations within SKD, but less than the 1,000 mg/l concentration identified in the literature review provided in the HRA as being the appropriate maximum allowable concentration to protect aquatic life, and a lower level of increase than previously anticipated, due to the baseline concentration being higher.
5. Discharges to the estuary will be within the baseline range and thus no impacts are likely, including at low tide.

Appendix A Report to Inform HRA (AECOM, 2023)

AECOM

Humber Zero (Proposed Phillips 66 Development)

Report to Inform Habitats Regulations Assessment

Phillips 66

Project number: 60668866
REVISION 2

December 2023

Delivering a better world

Quality information

Prepared by	Checked by	Verified by	Approved by
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Revision History

Revision	Revision date	Details	Authorized	Name	Position
00	Feb 2023	FINAL	For Issue	K Cobb	Project Manager
01	Oct 2023	Revised following stakeholder consultation	For Issue		
02	Dec 2023	Revised following further stakeholder consultation	For Issue		

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Figures

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1. Introduction

Overview

1.1 This report to inform a Habitats Regulations Assessment (HRA) has been prepared on behalf of Phillips 66 Limited (the Applicant) for the Proposed Development. The terms of reference used in this report are consistent with those defined within the main chapters of the ES (Volume 1). References are included, under relevant subject headings, to those chapters, technical appendices and/ or paragraphs within the ES that contain the information required by the competent authority to undertake an "appropriate assessment" under the terms of Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (commonly referred to as the 'Habitats Regulations'). It is designed to serve two key functions:

- to assist the competent authority by making it easier to undertake and consult on a Habitats Regulations Assessment; and
- to ensure that all the relevant information needed for a Habitats Regulations Assessment, which is included within the various Chapters of the ES, is summarised (and cross referenced to as appropriate) within one document.

Summary of Updates in Revision 01

1.2 This report to inform HRA represents Revision 1 having been updated since the original report was issued in February 2023 with the application to North Lincolnshire Council. The updates include additional clarifications and assessment work undertaken in respect of noise, air quality and water quality impact pathways, following consultation with Natural England and North Lincolnshire Council.

1.3 The following sections of this report have been updated:

- Section 4 (Baseline Evidence Gathering): further information added into designated features section for Humber Estuary SSSI unit condition assessments relevant to the air quality assessment, in terms of evidencing the saltmarsh habitat types present as receptors.
- Section 5 (Stage 1: Screening for Likely Significant Effects): Construction Noise/ Visual Disturbance to Functionally Linked Land (Rosper Road Pools) – this pathway has been separated into sections for construction visual impacts and construction noise impacts, with the latter pathway now screened as LSE and taken forward to Stage 2: Appropriate Assessment.
- Section 5 (Stage 1: Screening for Likely Significant Effects): Construction Noise/ Visual Disturbance to Functionally Linked Land (Terrestrial Fields) – this pathway has been separated into sections for construction visual impacts and construction noise impacts, with the latter pathway now screened as LSE and taken forward to Stage 2: Appropriate Assessment.
- Section 5 (Stage 1: Screening for Likely Significant Effects): Operational Noise/ Visual Disturbance to Functionally Linked Land (Rosper Road Pools) – this pathway has been separated into sections for operational visual impacts and operational noise impacts. Further clarification has been provided with a comparison of operational noise against the baseline noise monitoring results to inform the no LSE screening conclusion (Section G.3 of Appendix G: Additional Noise Assessment).
- Section 5 (Stage 1: Screening for Likely Significant Effects): Operational Noise/ Visual Disturbance to Functionally Linked Land (Terrestrial Fields) - this pathway has been separated into sections for operational visual impacts and operational noise impacts. Further clarification has been provided with a comparison of operational noise against

the baseline noise monitoring results to inform the no LSE screening conclusion (Section G.3 of Appendix G: Additional Noise Assessment).

- Section 5 (Stage 1: Screening for Likely Significant Effects): Operational Air Quality – further clarification of habitat types screened into assessment and revision of habitat types based on information provided by Natural England. Further information to explain rationale for screening out this pathway added into text. Appendix H: Additional Air Quality Information added.
- Section 6 (Stage 2: Appropriate Assessment): Construction Noise Disturbance to Functionally Linked Land (Rosper Road Pools) - further assessment to take into account a 3dBA threshold change in noise levels from ambient levels for indicating potential disturbance to birds. Additional assessment and noise contour plots provided in Section G.1 of Appendix G: Additional Noise Assessment.
- Section 6 (Stage 2: Appropriate Assessment): Construction Noise Disturbance to Functionally Linked Land (Terrestrial Fields) - further assessment to take into account a 3dBA threshold change in noise levels from ambient levels for indicating potential disturbance to birds. Additional assessment and noise contour plots provided in Section G.2 of Appendix G: Additional Noise Assessment.
- Section 6 (Stage 2: Appropriate Assessment): Changes in Surface Water Quality During Operation – additional reference added to the AECOM Baseline Water Quality Monitoring Report following completion for additional baseline water quality monitoring at Rosper Road Pools and South Killingholme Drain.
- Section 7 (Task 3: Assessment of Alternatives): this section has now been removed as the baseline water quality monitoring has now been undertaken and this element of uncertainty from the original appropriate assessment has been addressed (AECOM Baseline Water Quality Monitoring report).
- Appendix I (Technical Note on DeSOx Process) – this technical note was prepared for Natural England (and submitted to Natural England on 23rd November 2023) to clarify the SOx reduction process and to explain the assumptions in the technical assessment that around a 50% reduction in sulphates in the effluent discharge will be achieved through deSOx.

The Proposed Phillips 66 Development

Description

1.4 As described in ES Chapter 1 (Introduction), the ES relates to two Proposed Developments – the Proposed VPI Development and the Proposed Phillips 66 Development – which together comprise the first phase of the Humber Zero project.

1.5 Although a combined ES has been prepared for the two Proposed Developments, it is acknowledged that it is necessary to undertake a separate HRA for each Proposed Development alone as well as in combination (and also in combination with any other relevant plans or projects). This HRA therefore considers the Proposed Phillips 66 Development only. A separate HRA document has been prepared for the Proposed VPI Development, although clearly there is much duplication between the two documents as they are on adjoining plots.

1.6 The Proposed Developments are necessarily located adjacent to the existing activities that are to be decarbonised (namely the Humber Refinery Fluid Catalytic Cracker (FCC) and the VPI Immingham Combined Heat and Power (CHP) Plant), but they are also well situated to connect into either the Viking carbon dioxide (CO_2) gathering network and/or the Humber Low Carbon Pipelines CO2 gathering network for transport to storage sites under the North Sea. Development Consent Order applications for both of these CO2 gathering networks are being

progressed by Harbour Energy and National Grid respectively, and are due to be submitted in mid 2023.

1.7 The Proposed VPI Development will comprise a Post-combustion Carbon Capture (PCC) plant and associated facilities for capturing CO2 from two of the gas turbines (GT1 and GT2)[1] and two auxiliary boilers at the VPI Immingham CHP Plant.

1.8 The Proposed Phillips 66 Development will comprise a PCC plant and associated facilities for the Fluid Humber Refinery FCC.

1.9 The Proposed Phillips 66 Development will include the following components:

- FCC flue gas waste heat exchanger for energy recovery;
- ducting over an existing internal access road to connect the FCC unit to the PCC plant;
- flue gas pre-treatment using Selective Catalytic Reduction (SCR), a wet gas scrubber and wet electrostatic precipitator with associated air-cooled heat exchangers;
- one PCC unit with associated absorber, stack, stripper/ regenerator, thermal reclaimer unit and air-cooled heat exchangers/ fin fans;
- high pressure and low pressure CO_2 vent stacks for use during start up, shut down and emergencies only;
- a CO_2 compression facility with associated air-cooled heat exchangers/ fin fans;
- oxygen removal and dehydration facilities;
- CO_2 metering and a pipeline connecting the PCC plant and compression facilities to the CO_2 gathering network interface, including a pipeline crossing of the Phillips 66 railway sidings and Network Rail railway line;
- on-site electrical substation;
- caustic, solvent and other chemical offloading and storage facilities;
- utilities (including chillers, steam generator and air compressors);
- internal access roads;
- surface water and foul water drainage systems;
- construction and maintenance laydown areas; and
- a new site access from Eastfield Road.

Need Case

1.10 The need case for the Proposed Phillips 66 Development is set out in Chapter 3 (Proposed Developments Description, Need and Alternatives Considered), a summary of which is provided below.

1.11 The need for the Proposed Phillips 66 Development is defined by the UK Government's legally binding target to reach net zero by 2050. This is set out in ES Chapter 5 (Policy Context).

1.12 The Humber is the largest industrial cluster in the UK in terms of existing CO_2 emissions, emitting approximately 20 million tonnes of CO_2 per year. The industrial cluster is important for the UK energy security. If built, the Proposed Developments will remove 95% of CO_2 emissions (3.8 million tonnes of CO_2 per year) from two of the large industrial processes in the Humber cluster – the Humber Refinery's FCC and the VPI Immingham CHP Plant, representing a 26% reduction in the overall emissions from the Humber industrial cluster.

[1] The third gas turbine is proposed to be converted to hydrogen firing in future as part of the wider Humber Zero project.

Alternatives

1.13 The alternatives are described in Section 3.9 of ES Chapter 3 (Proposed Developments, Need and Alternatives Considered) including the reasons for the Applicants to proceed with the Proposed Phillips 66 Developments, a summary of which is provided below.

1.14 The consideration of alternatives and design evolution has been undertaken with the aim of developing a PCC plant for the FCC to meet the identified national need for industrial decarbonisation, while avoiding and/ or reducing adverse environmental effects (following the mitigation hierarchy of avoid, reduce and, if possible, remedy), as well as maintaining operational efficiency and cost-effectiveness, and considering other relevant matters such as available land and planning policy.

1.15 The alternative of ceasing operation of the FCC is not considered to be an option given the economic significance of the Humber Refinery.

1.16 Alternative sites within the Applicant's control were considered, however the nature of the Proposed Phillips 66 Development involves retrofitting existing infrastructure with carbon capture technologies, therefore proximity to the existing FCC is a key consideration.

1.17 The FCC stack is the largest CO_2 emitting unit (stack) at the Humber Refinery so has been selected for the first PCC project at the Humber Refinery, and the selected location for the Proposed Phillips 66 Development has been chosen for its availability and proximity to the FCC and its stack. Other emission points at the Refinery may be retrofitted with PCC in future (and the currently proposed Phillips 66 Development may in fact enable other such developments by providing a CO_2 compression network within the Humber Refinery and establishing a tie-in to the CO_2 gathering network).

1.18 No alternative technologies to post combustion carbon capture have been identified for the decarbonisation of the Humber Refinery FCC, since this is a refinery process that inherently generates CO_2 emissions (as opposed to resulting from an energy input requirement). Therefore the only option is to capture the CO_2 emissions generated.

1.19 Alternative design options have been explored for the Proposed Phillips 66 Development. Decisions taken regarding the concept design have, where relevant and possible, been informed by environmental appraisal and assessment work and by consultation with stakeholders. These include:

- cooling technology selected to reduce water demand because water resources are already constrained in the region;
- flue gas pre-treatment technologies selected to remove SO_x, NOx and particulates from the flue gas whilst recovering energy to ensure reliable operation of the CO_2 capture plant;
- carbon capture technology provider (Shell) selected to deliver the highest carbon capture rate (95%); and
- options to connect to either Humber Low Carbon Pipelines and/ or Viking CCS CO_2 transmission network kept open to maintain operational and commercial flexibility.

2. Legislative Framework

2.1 This is a technical report to inform and support the competent authority (North Lincolnshire Council) in its decision making. As part of the decision-making process it is legally necessary to consider whether the Proposed Phillips 66 Development is likely to have a significant impact on areas that have been internationally designated for nature conservation purposes (i.e. 'European sites'). This requirement is set out in the Conservation of Habitats and Species Regulations 2017 (as amended) (the 2017 Regulations). The 2017 Regulations apply the precautionary principle[2] to European Sites.

2.2 Over the years, the phrase 'Habitats Regulations Assessment' (HRA) has come into wide currency to describe the overall process set out in the 2017 Regulations, from the screening for Likely Significant Effects (LSEs) through to identification of Imperative Reasons of Overriding Public Interest (IROPI). This has arisen in order to distinguish the overall process from the individual stage of "Appropriate Assessment". Throughout this Report the term HRA is used for the overall process and restricts the use of Appropriate Assessment to the specific stage of that name. Box 1 sets out the legislative basis for HRA.

Conservation of Habitats and Species Regulations 2017 (as amended)

Regulation 63 of the 2017 Regulations states that:

"*A competent authority, before deciding to … give any consent for a plan or project which is likely to have a significant effect on a European site … must make an appropriate assessment of the implications for the plan or project in view of that site's conservation objectives… The competent authority may agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the European site*."

Box 1. The Legislative basis for Appropriate Assessment

2.3 If adverse effects on integrity are identified, mitigation should be considered to avoid those effects or reduce them to an insignificant level. However, where no alternative solution exists, and so an adverse effect on integrity remains, a further assessment should be made of whether the scheme is required for IROPI and whether there are any viable alternatives to delivering the objectives of the scheme without causing harm. If the scheme meets those IROPI and No Alternatives tests, compensatory measures will be required in order to maintain the integrity of the overall network of internationally important sites in the UK, known as the National Site Network (NSN). The HRA methodology is set out in Section 3.

[2] The Precautionary Principle, which is referenced in Article 191 of the Treaty on the Functioning of the European Union, has been defined by the United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2005) as:
"When human activities may lead to morally unacceptable harm [to the environment] that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm. The judgement of plausibility should be grounded in scientific analysis".

3. Assessment Method

Introduction

3.1 The HRA has been carried out with reference to the general EC guidance on HRA[3], general guidance on HRA published by the UK government in July 2019[4] and February 2021[5], and Planning Inspectorate (PINS) Advice Note 10[6] (even though the Proposed Phillips 66 Development is not a nationally significant infrastructure project (NSIP)).

3.2 The UK left the EU on 31 January 2020 under the terms set out in the European Union (Withdrawal Agreement) Act 2020 ("the Withdrawal Act"). The Withdrawal Act retains the body of existing EU-derived law within our domestic law, meaning that legislation relating to nature conservation continues to apply within the UK. As such this HRA takes account of relevant EU case law (for instance, the Holohan and People over Wind cases, discussed below).

3.3 Box 2 below sets out the stages of HRA according to PINS Advice Note 10 as that document clearly sets out the HRA process applicable to all plans and projects (not just NSIPs).

3.4 Whilst the HRA decisions must be taken by the competent authority (North Lincolnshire Council), the information needed to undertake the necessary assessments must be provided by the Applicant. This HRA provides the information needed for the competent authority to establish whether there are any LSEs or, where those are found to be present, adverse effects on site integrity from the proposed development.

HRA Stage 1: Screening for Likely Significant Effects (LSEs)

3.5 The objective of HRA Stage 1 LSEs screening stage is to 'screen out' those aspects of the Proposed Phillips 66 Development that can, without any detailed appraisal, be concluded not to result in significant adverse effects upon European sites, usually because there is no mechanism for an adverse interaction (i.e. a pathway) with European sites. The remaining aspects (if there are remaining aspects) are then taken forward to Appropriate Assessment. The assessment must consider the potential for effects in-combination with other plans and projects.

3.6 This report has been prepared having regard to all relevant case law relating to the 2017 Regulations, the Habitats Directive and Birds Directive. This includes the ruling by the Court of Justice of the European Union (CJEU) in the case of People Over Wind, Peter Sweetman v Coillte Teoranta (C-323/17).

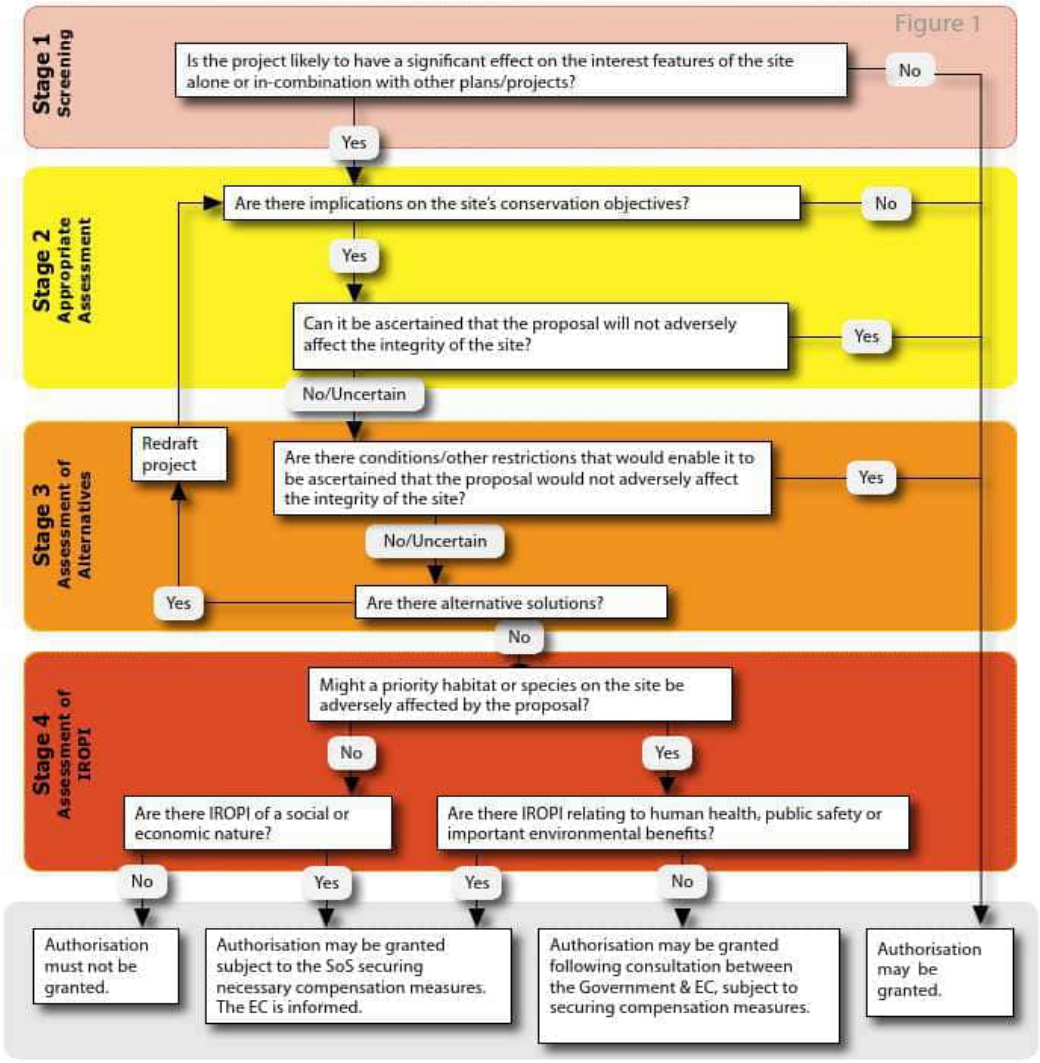
3.7 This case held that "*it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site*" (paragraph 40). This establishes that mitigation measures cannot be taken into account at the HRA Stage 1 LSEs screening stage, but they can be taken into account when undertaking an Appropriate Assessment at HRA Stage 2. However, it is important to note that not all mitigation measures are excluded from consideration – only those "*intended to avoid or reduce the harmful effects of the… project on that site*". Mitigation measures which are, for example, intended to avoid effects on a local watercourse outside the European site designated boundary but which outfalls into the European designated site, can be taken into account as the

[3] European Commission. (2001). *Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC*. Luxembourg: Office of Official Publications of the European Communities.
[4] Ministry of Housing, Communities & Local Government. (July 2019). *Guidance on the use Habitats Regulations Assessment*. Available at: https://www.gov.uk/guidance/appropriate-assessment [Accessed on the 25/04/2022]
[5] Department for Environment, Food & Rural Affairs. (2021, February 24). *How a competent authority must decide if a plan or project proposal that affects a European site can go ahead*. Available at: https://www.gov.uk/guidance/habitats-regulations-assessments-protecting-a-european-site [Accessed on the 25/04/2022]
[6] The Planning Inspectorate. (November 2017). *Advice Note Ten: Habitats Regulations Assessment relevant to nationally significant infrastructure projects*, Version 8. Available at: https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/advice-note-ten/ [Accessed on the 25/04/2022]

benefit conveyed to the European site is coincidental and the measures would be delivered as part of good practice even if no European sites were present.

3.8 This represents a deviation from the approach usually adopted in the ecological impact assessment (EcIA), which considers embedded mitigation (even those measures that are included to directly avoid or reduce harmful effects on a European designated site) to form a part of the proposed development, and takes these measures into account when assessing the potential impacts on qualifying habitats and species.

3.9 Where mitigation measures are mentioned in this report and taken into account at the screening stage, they are therefore ones which may reduce or avoid harmful effects on certain (local) habitats or species but are not relied on to directly avoid or reduce harmful effects on the European. This includes standard best practice mitigation measures incorporated into the Construction Environmental Management Plan (CEMP) such as management of surface water runoff.



Box 2. Four Stage approach to Habitats Regulations Assessments of Projects.

HRA Stage 2 – Appropriate Assessment

3.10 Where it is determined that a conclusion of 'no LSE' cannot be drawn, the HRA assessment proceeds to the next stage of HRA known as HRA Stage 2 - Appropriate Assessment. Case law has clarified that 'Appropriate Assessment' is not a technical term. In other words, there are no specific technical analyses, or level of detail, that are classified by law as belonging to

Appropriate Assessment rather than the screening for LSEs. The Appropriate Assessment constitutes whatever level of further assessment is required to determine whether an adverse effect on the integrity of a European site would arise as a result of the Proposed Development.

3.11 By virtue of the fact that HRA Stage 2 – Appropriate Assessment follows the screening process, there is an understanding that the analysis will be more detailed than that undertaken at the previous stage. One of the key considerations during HRA Stage 2 - Appropriate Assessment is whether there is available mitigation that would address the potential effect, allowing for a conclusion of no adverse effect on integrity. In practice, HRA Stage 2 – Appropriate Assessment takes any element of the proposed development that could not be excluded as having LSEs following HRA Stage 1 and assesses the potential for an effect in more detail, with a view to concluding whether that element would cause an adverse effect on site integrity for a European site. Adverse effects on a European site's integrity include disruption of the coherent structure and function of the European site(s) and the ability of the site to achieve its Conservation Objectives.

3.12 In 2018 the Holohan ruling was handed down by the European Court of Justice. Among other provisions paragraph 39 of the ruling states that *"As regards other habitat types or species, which are present on the site, but for which that site has not been listed, and with respect to habitat types and species located outside that site, … typical habitats or species must be included in the appropriate assessment, if they are necessary to the conservation of the habitat types and species listed for the protected area"* [emphasis added]. This ruling has been considered in relation to the Proposed Phillips 66 Development, particularly with regard to mobile qualifying species in the Humber Estuary SPA / Ramsar.

In Combination Scope

3.13 It is a requirement of Regulation 63(a) of the 2017 Regulations to not only assess the impacts of a development project alone, but also to investigate whether there is a potential for in-combination effects with other projects or plans. In practice, such in-combination assessment is of greatest relevance when an impact pathway relating to a project would otherwise be screened out – not because it is not present – but because its individual contribution is considered not to result in LSEs.

3.14 For the purposes of this HRA, several plans, projects and strategies proposing/ aiming for development have been identified, which may act in-combination with the Proposed Phillips 66 Development. These are set out in ES Chapter 18 (Cumulative and Combined Effects) and summarised below:

- PINS (Able Humber Ports Ltd) - Able Marine Energy Park (AMEP);_
- PA/SCO/2022/7 - Enabling works on and adjacent to the Able Marine Energy Park site;
- PA/2021/1525 - Monopile Manufacturing Facility. Land at Able Marine Energy park ;
- PINS (VPI Immingham B Ltd) – VPI Immingham Open Cycle Gas Turbine (OCGT);
- PA/2022/1223 - Land Adjacent to the Westgate Entrance, Port of Immingham;
- Humber Zero - Proposed Phillips 66 Development (sister project to Humber Zero Proposed VPI Development;
- PINS (Chrysaor Production (UK) Limited) – Viking CCS Pipeline;
- PINS (National Grid) - Humber Low Carbon Pipelines
- PINS (C.GEN Killingholme Ltd) - North Killingholme Power Project
- PINS (Associated British Ports) - Immingham Eastern Ro-Ro Terminal
- PINS (Associated British Ports) – Immingham Green Energy Terminal; and
- Gigastack – 100 MW hydrogen electrolyser and associated cable connections.

3.15 These projects were examined for the potential for interactions on the designated features of the Humber Estuary SPA/ SAC/ Ramsar with impacts arising from the Proposed Phillips 66 Development, and where necessary were screened into the assessment.

The Rochdale Envelope

3.16 In July 2018, the Planning Inspectorate published Advice Note Nine: Rochdale Envelope (The Planning Inspectorate, 2018), explaining how the principles of the Rochdale Envelope should be used by planning applications for the Environmental Impact Assessment (EIA) process.

3.17 The Rochdale Envelope[7] is applicable where some of the details of a scheme cannot be confirmed when an application is submitted, and flexibility is needed to address uncertainty. Notwithstanding, all significant potential effects of schemes must be properly addressed.

3.18 The Rochdale Envelope encompasses three key principles:

- The assessment should adopt a cautious worst-case approach;
- The level of information assessed should be sufficient to enable the LSEs and/ or adverse effects of a proposed development to be assessed; and
- The allowance for flexibility should not be abused to provide inadequate descriptions of projects.

3.19 This HRA has given due consideration to the Rochdale Envelope. The worst-case (i.e. the potentially most impactful) construction/decommissioning and operational scenarios have been assessed in relation to impact pathways.

3.20 Throughout this HRA construction impacts and decommissioning impacts on European sites are likely to be very similar in type, magnitude and effect. As such they are treated together.

[7] The Rochdale Envelope arises from two cases: R. v Rochdale MBC ex parte Milne (No.1) and R. v Rochdale MBC ex parte Tew [1999], which are cases that dealt with outline planning applications for a proposed business park in Rochdale.

4. Baseline Evidence Gathering

Scoping

4.1 There is no guidance that dictates the general physical scope of an HRA document as the potential Zone of Impact (ZoI) is dependent on specific impact pathways. Therefore, in considering the physical scope of the assessment, the assessment has been guided primarily by the identified impact pathways (called the source-pathway-receptor model).

4.2 Briefly defined, impact pathways are routes by which the implementation of a project can lead to an effect upon a European designated site. An example of this would be visual and noise disturbance arising from the construction/decommissioning work or operational phase associated with a project. If there are sensitive ecological receptors within a nearby European site (e.g. non-breeding overwintering birds), this could alter their foraging and roosting behaviour and potentially affect the site's integrity. For some impact pathways (notably air pollution) there is guidance that sets out distance-based zones required for assessment.

4.3 For statutory designated nature conservation sites subject to the provisions of the Habitats Regulations, it is usual to consider a search radius of 10 km when examining the potential pathways for air quality impacts on the sites.

4.4 One European designated site has been identified within this radius; this is the Humber Estuary Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar site, which is approximately 1.7 km east from the nearest component of the Proposed Phillips 66 Development. The SAC supports qualifying Annex I habitats that are potentially susceptible to the effects of emissions to air from the Proposed Phillips 66 Development. The SPA/ Ramsar supports internationally important assemblages of wintering and passage waterbirds that may be displaced either directly due to noise from construction/ operation reaching intertidal feeding habitats, or indirectly from functionally linked habitats outside the designation boundary.

4.5 Surface water pathways to the designated habitats (and thus the qualifying species they support) have also been considered because the surrounding surface water drainage network, into which surface water from the construction and operation of the Proposed Phillips 66 Development will outfall, drains into the Humber Estuary.

Summary of Designated Features

4.6 The Proposed Phillips 66 Development will not directly impact any European designated site.

4.7 As summarised above, there are a number of European designations within the potential Zone of Influence (ZoI) of the Proposed Phillips 66 Development associated with the Humber Estuary:

- Humber Estuary SAC;
- Humber Estuary SPA; and
- Humber Estuary Ramsar.

4.8 A summary of the qualifying features/ habitats of the Humber Estuary SAC/ SPA/ Ramsar is provided in Table 1 below, along with the threats/ pressures on them and potential impact pathways associated with the Proposed Phillips 66 Development.

Table 1. Summary of the European sites within a Zone of Influence (ZoI) of 10 km of the Proposed Phillips 66 Development[8].

European site	Approx. distance from Proposed Phillips 66 Development	Qualifying species/habitats	Threats and pressure to site integrity	Potential impact pathways linking to the Proposed Phillips 66 Development
Humber Estuary SAC	1.7 km east	**Habitats that are a primary reason for selection of this site**: – Estuaries – Mudflats and sandflats not covered by seawater at low tide **Habitats and species present as a qualifying feature, but not a primary reason for selection of this site**: – Sandbanks which are slightly covered by sea water all the time – Coastal lagoons – Salicornia and other annuals colonizing mud and sand – Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) – Embryonic shifting dunes – Shifting dunes along the shoreline with *Ammophila arenaria* – Fixed coastal dunes with herbaceous vegetation – Dunes with *Hippopha rhamnoides* – Sea lamprey *Petromyzon marinus* – River lamprey *Lampetra fluviatilis* – Grey seal *Halichoerus grypus*	– Water pollution – Coastal squeeze – Changes in species distributions – Invasive species – Natural changes to site conditions – Public pressure access/ disturbance – Fisheries: fish stocking – Fisheries: commercial Pressure marine and estuarine – Direct land take from development	**Construction:** Water pollution (dust and synthetic / non-synthetic pollutants mobilized in surface runoff) Atmospheric pollution (emissions from construction vehicles, such as Heavy Goods Vehicles (HGVs)) **Operation:** Atmospheric pollution (from plant emissions)
Humber Estuary SPA	1.7 km east	**Article 4.1 qualification - bird species regularly occurring in numbers of 1% or more of the Great Britain populations** Wintering: – Avocet *Recurvirostra avosetta* – Bittern *Botaurus stellaris* – Hen harrier *Circus cyaneus* – Golden plover *Pluvialis apricaria* – Bar-tailed godwit *Limosa lapponica* Passage: – Ruff *Philomachus pugnax* Breeding: – Bittern *Botaurus stellaris*	– Problematic native species – Changes in abiotic conditions – Changes in biotic conditions – Abiotic (slow) natural processes – Outdoor sports and leisure activities, recreational activities	**Construction period:** Loss of functionally linked land. Visual and noise disturbance to intertidal feeding habitat within boundary of SPA. Visual and noise disturbance to terrestrial feeding habitat outside boundary of SPA (functionally linked land)

[8] For a full summary of European sites, including an introduction to sites, Ramsar qualifying features and Conservation Objectives, please refer to Appendix B.

European site	Approx. distance from Proposed Phillips 66 Development	Qualifying species/habitats	Threats and pressure to site integrity	Potential impact pathways linking to the Proposed Phillips 66 Development
		– Marsh harrier *Circus aeruginosus* – Avocet *Recurvirostra avosetta* – Little tern *Sternula albifrons* **Article 4.2 qualification - bird species regularly occurring in numbers of 1% or more of the biogeographical populations of migratory species** Wintering: – Shelduck *Tadorna tadorna* – Knot *Calidris canutus* – Dunlin *Calidris alpina* – Black-tailed godwit *Limosa limosa* – Redshank *Tringa totanus* Passage: – Knot – Dunlin – Black-tailed godwit – Redshank **Article 4.2 qualification – used regularly by over 20,000 waterbirds in any season** Area regularly supports 153,934 individual waterbirds[9] (five-year peak mean 1996/97 – 2000/01) in the non-breeding season.		Water pollution (dust and synthetic/ non-synthetic pollutants mobilized in surface runoff) Atmospheric pollution (emissions from construction vehicles, such as HGVs) **Operation:** Atmospheric pollution (from plant emissions) Visual and noise disturbance to intertidal feeding habitat within boundary of SPA. Visual and noise disturbance to terrestrial feeding habitat outside boundary of SPA (functionally linked land) Presence of tall structures in close proximity to terrestrial feeding habitat outside boundary of SPA (functionally linked land)
Humber Estuary Ramsar	1.7 km east	**Criterion 1:** Site is a representative example of a near-natural estuary with the following component habitats:	Same as for Humber Estuary SPA	Same as for Humber Estuary SPA

[9] Waterbirds as defined by the Ramsar Convention

European site	Approx. distance from Proposed Phillips 66 Development	Qualifying species/habitats	Threats and pressure to site integrity	Potential impact pathways linking to the Proposed Phillips 66 Development
		dune systems and humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes, and coastal brackish/ saline lagoons. **Criterion 3:** Breeding colony of grey seals (at Donna Nook) Breeding natterjack toad *Bufo calamita* (at Saltfleetby-Theddlethorpe) **Criterion 5:** Supports a waterfowl assemblage of international importance. **Criterion 6:** Supports the following species/ populations occurring at levels of international importance: Wintering: – Shelduck – Golden plover – Red knot – Dunlin – Black-tailed godwit – Bar-tailed godwit – Common redshank **Criterion 8:** Migratory river and sea lamprey		

Habitats

4.10 The air quality assessment has scoped in sensitive Humber Estuary SAC/ Ramsar habitat receptors within the zone of influence of potential changes in air quality resulting from the construction and operation of the Proposed Development. To assist with defining the habitat types present and assigning the relevant Critical Levels/ Loads for pollutants as part of the air quality impact assessment, all relevant publicly available habitats data has been reviewed. This has included previous air quality assessments that are in the public domain for nearby developments including the VPI CCGT, which is in close proximity to the Proposed Development and therefore utilises the same nearest coastal habitat receptors as identified in this assessment.

Pioneer/ low-mid saltmarsh (Air Quality Ecology Receptor OE1e)

4.11 The nearest coastal unit of the Humber Estuary SSSI to the Proposed Development, which overlaps with the Humber Estuary SAC/ SPA/ Ramsar, is Unit 94 (Jetty to North Killingholme Haven). The Natural England condition assessment summary on the MAGIC database defines the main habitat as 'littoral sediment'. This is a large unit covering the stretch of coastline from the oil jetty north to the Able UK terminal at North Killingholme Haven. The unit was evaluated as 'unfavourable-recovering' condition in the most recent condition assessment in 2011, with the saltmarsh habitat within the unit evaluated as 'favourable condition' following a site survey in 2018 (Humber Estuary SSSI - NEFU Saltmarsh Surveys 2018[10]).

4.12 A review of the 'Saltmarsh Extent & Zonation' mapping layer (which has been mapped from aerial photography collected predominantly between 2016 and 2019) identifies that there is a small area of saltmarsh within the southernmost section of the unit (from 'The Lookout' south to the HIT jetty), which is mapped as a mix of 'unclassified' and *Spartina sp*. It is therefore reasonable to conclude that this area of coastal saltmarsh sits somewhere between the pioneer and low-mid saltmarsh habitat communities and is fairly regularly inundated by saltwater. The slightly higher 20 – 30 kg/ N/ ha/ yr Critical Load is therefore applied to this habitat type at receptor OE1e, as it is clearly less vulnerable to the effects of N deposition due to regular tidal inundation.

Upper saltmarsh (Air Quality Ecology Receptor OE2)

4.13 The next nearest coastal unit of the Humber Estuary SSSI to the Proposed Development, which overlaps with the Humber Estuary SAC/ SPA/ Ramsar, is Unit 95 (North Killingholme Haven Saltmarsh). The Natural England condition assessment summary on the MAGIC database defines the main habitat as 'fen, marsh and swamp - lowland'. The unit was evaluated as 'unfavourable-recovering' condition in the most recent condition assessment in 2011, with the saltmarsh evaluated as 'unfavourable' in the 2018 survey due to the loss of Atlantic salt meadow SAC community resulting from erosion.

4.14 A review of the 'Saltmarsh Extent & Zonation' mapping layer indicates that this area is a mix of upper marsh, reedbeds and mid-low saltmarsh habitats, and therefore the lower 10 – 20 kg/ N/ ha/ yr Critical Load for upper saltmarshes is therefore applied to this habitat type at receptor OE2 as it is not subject to 'regular' tidal inundation (typically 100-200 days per year).

Wetland and reedbed (Air Quality Ecology Receptor OE1d)

4.15 This habitat type aligns with receptor OE1d, and is located in North Killingholme Haven Pits SSSI Unit 1. The main habitat type is listed as 'inshore sublittoral sediment' and the condition assessment was favourable at the most recent survey in 2018. The condition assessment for this unit indicates that it is meeting its targets for all features, which included the extent of open water (which provides feeding and roosting habitat for SPA/ Ramsar waterbirds, water depth (which is controlled via a water level management plan) and salinity (which is within the target range). The open water areas are managed through regular control of reed/ clubrush, and

[10] Unpublished Natural England report on coastal saltmarsh surveys undertaken in 2018, which have informed the 2022 site check information published on the MAGIC database for the Humber Estuary SSSI unit condition assessments.

therefore these habitats are identified as those that could be susceptible to airborne N deposition resulting from the operation of the Proposed Development.

4.16 Within the APIS database, this habitat aligns with the 'fen, marsh, swamp' habitat type, but does not fit particularly well into either the 'valley mires, poor fens and transition mires' habitat type (which specifically excludes reedbed) or ''rich fens' which are a rare and threatened Annex I habitat for which critical loads have been published. However, for the purposes of the impact assessment, the lowest critical load in the 10 – 30 kgN/ha/yr range has been adopted in the screening task as a precaution. This is consistent with the approach in the original assessment, which assigned this habitat type to receptor OE7 (at Rosper Road Pools). Reedbeds are used for pollution mitigation to reduce the impact of nitrogen in aquatic ecosystems, and can therefore be reasonably assumed to be more tolerant to the effects of nitrogen uptake (from either aquatic or airborne sources) than the more species-rich fen habitats for which increased nitrogen can result in reduced species-richness.

Ornithology Data

4.17 Ornithological baseline data to support the HRA have been obtained from a range of sources. This has included both ornithology surveys undertaken specifically for the Proposed Phillips 66 Development (land adjacent to the Proposed Phillips 66 Development site ('the Phillips 66 Site')), as well as a desk-based review of publicly available ornithological data e.g. reports submitted as part of the nearby Able Marine Energy Park (AMEP) scheme and any other relevant planning applications.

4.18 The Humber Estuary 5-year peak mean counts for each of the key species has been summarised in Table 2 below, as this enables the 1% threshold (at which a site/ area may be considered important to that species within the context of the Humber Estuary) to be calculated. These data are presented in the annual Wetland Birds Survey (WeBS) reports published online.

Species	GB Population	Humber Estuary 5-year Peak Mean Population at SPA Designation 1996/ 97 – 2000/ 01[11]	Humber Estuary 5-year Peak Mean Population[12] 2015/16 – 2019/ 20	1% Threshold Humber Estuary Population	Peak Month in Humber Estuary
Bar-tailed godwit	29,575	2,752	1,561	16	February
Black-tailed godwit	40,798	1,113	4,545	45	September
Curlew	63,067	(assemblage)	2,787	28	January
Dunlin	246,985	22,222	15,954	160	August
Golden plover	145,083	30,709	31,237	312	December
Lapwing	272,630	(assemblage)	16,453	165	December
Oystercatcher	216,625	(assemblage)	5,816	58	October
Pink footed goose[13]	493,416	N/A	14,345	143	October
Redshank	74,939	4,632	2,881	29	September

[11] Humber Estuary SPA citation (August 2007)
[12] Frost, T.M., Calbrade, N.A., Birtles, G.A., Hall, C., Robinson, A.E., Wotton, S.R., Balmer, D.E. and Austin, G.E. 2021. *Waterbirds in the UK 2019/20: The Wetland Bird Survey*. BTO/RSPB/JNCC. Thetford.
[13] Although not a qualifying species for the Humber Estuary SPA/ Ramsar, this species has been included on the basis that Natural England now consider pink-footed goose to be part of the SPA/ Ramsar designated assemblage due to the increases in numbers in this area

Species	GB Population	Humber Estuary 5-year Peak Mean Population at SPA Designation 1996/ 97 – 2000/ 01[11]	Humber Estuary 5-year Peak Mean Population[12] 2015/16 – 2019/ 20	1% Threshold Humber Estuary Population	Peak Month in Humber Estuary
Shelduck	44,844	4,464	4,515	45	October
Teal	157,059	(assemblage)	3,757	38	October
Wigeon	376,708	(assemblage)	2,672	27	February

Table 2. Qualifying Species Relevant to North Killingholme Marshes – Humber Estuary 5-year Peak Mean Populations (Wintering)

AMEP Ornithology Data

4.19 Given the large land take associated with the consented AMEP scheme in the North Killingholme Marshes area (some of which was considered functionally linked to the SPA/ Ramsar), and its proximity to other functionally linked land to the south of AMEP, there have been many surveys of the terrestrial fields and North Killingholme Marshes foreshore area over several years associated with this Development Consent Order (DCO) application and associated planning applications. A desk study review of these data was undertaken to provide further insight into the longer-term history of waterbird usage of the North Killingholme Marshes area to support conclusions drawn from surveys undertaken for the Proposed Developments in 2021/ 22.

4.20 A summary of the AMEP reports/ data reviewed is as follows, and the data is presented in Tables 3 and 4 below:

- Able Marine Energy Park: Area K Monopile Factory Habitats Regulations Assessment Report (August 2021) prepared by Ecology Consulting on behalf of Able UK Ltd, which contained the following data:
  - survey data from the Killingholme Fields collected during winter 2020/ 21;
  - breeding bird surveys undertaken at the site during May-August 2021, and specific surveys to determine the current status of marsh harriers and their use of the site;
  - data from previous surveys of the Killingholme Fields undertaken between 2006 and 2011 included in Chapter 11 of the AMEP DCO ES, and during autumn 2016 (Cutts and Hemingway 2017).
- British Trust for Ornithology (BTO) Wetland Bird Survey (WeBS) high tide (core) counts for Killingholme Marshes Foreshore (2014-15 to 2019-20)
- BTO WeBS low tide counts doe Killingholme Marshes Foreshore (November 2011 through to February 2012) - the most recently available low tide counts.
- site-specific surveys of the Killingholme Marshes Foreshore undertaken by JBA (2019) during the 2017-18 autumn and winter. This included:
  - Autumn Passage – autumn migration. Weekly visits between late September and November.
  - Winter - two surveys per month between October to March inclusive.
  - Spring Passage – spring migration. Weekly visits between March to Mid-May inclusive.
- Associated British Ports (ABP) data 2018-19 and 2019-20 - through the tide counts of the Killingholme Marshes Foreshore, twice-monthly from October through to March.
- survey data from the Killingholme Marshes Foreshore collected by Cutts and Hemingway (2021) during winter 2020-21.

Table 3. Summary of AMEP Ornithology Data for North Killingholme Marshes Fields from Desk Study Review

Survey	Survey Period	Species Recorded	Comments
Wintering surveys of North Killingholme Marshes Fields for AMEP DCO	Winter 2006 – 2011	Curlew	Peak of 106 equivalent to 2.4% of the Humber Estuary population at the time.
		Redshank, black-tailed godwit, lapwing, whimbrel, shelduck	Recorded at numbers <1% of the Humber Estuary population
Wintering surveys of North Killingholme Marshes Fields for AMEP DCO	Autumn 2016	Curlew	Peak of 15 in AMEP site indicating reduced numbers when compared to previous surveys, thought likely to be due to longer sward (arable/ improved grassland had reverted to more rank neutral grassland in the absence of agricultural management). Surveys recorded peak of 110 curlew in fields at the Tank Farm to the north of AMEP site, indicating curlew still present in area but preferring other fields.
Wintering surveys of North Killingholme Marshes Fields for AMEP Monopile Facility	December 2020 – May 2021	Curlew	Peak of 45 in site boundary equivalent to 1.6% of Humber Estuary population, indicating land is still functionally linked to the estuary.
		Lapwing, snipe	Recorded in numbers <1% Humber Estuary population
		Teal, mallard, marsh harrier, oystercatcher, redshank	Single or low numbers (<10 birds) recorded

Table 4. Summary of Ornithology Data for North Killingholme Marshes Foreshore from Desk Study Review

Survey	Survey Period	Species Recorded	Comments
North Killingholme Marshes Foreshore WeBS Sector (high tide)	Five year mean peak count 2015/ 16 – 2019/ 20	Black-tailed godwit	Key feeding habitat in the estuary for this species, numbers occurring at 33.5% of Humber Estuary population.
		Shoveler, little ringed plover, moorhen, coot	Species occurring in numbers >10% of the Humber Estuary population
		Mute swan, shelduck, gadwall, mallard, teal, little grebe, grey heron, avocet, lapwing, ringed plover, curlew, bar-tailed godwit, turnstone, dunlin, snipe, redshank	Species occurring in numbers >1% of Humber Estuary population
North Killingholme Marshes Foreshore WeBS Sector (low tide)[14]	2011 – 2012	Black-tailed godwit	Peak counts of 2000 birds in August and September 2012
		Greylag goose, shelduck, mallard, teal, grey heron, little	Low numbers of these species recorded

[14] Surveys did not cover main wintering period which may explain lower numbers of some species when compared to other WeBS count datasets.

Survey	Survey Period	Species Recorded	Comments
		egret, cormorant, moorhen, oystercatcher, avocet, little ringed plover, curlew, redshank, black-headed gull, common tern	
JBA Surveys of North Killingholme Marshes Foreshore	September 2017 – May 2018	Black-tailed godwit, lapwing, dunlin	Most numerous species recorded, in numbers >500 birds.
		Redshank, teal, shelduck, wigeon, curlew	Recorded in numbers >100 birds
ABP Monitoring Surveys North Kilingholme Marshes Foreshore	October 2018 – March 2019	Black-tailed godwit, lapwing, teal	Most numerous species recorded, in numbers >1000 birds
		Avocet, dunlin, redshank	Recorded in numbers >100 birds
	October 2019 – March 2020	Black-tailed godwit, lapwing	Most numerous species recorded, in numbers >1000 birds
		Teal, avocet, dunlin, redshank	Recorded in numbers >100 birds
Able UK Surveys North Killingholme Marshes Foreshore (Cutts and Hemingway)	December 2020 – March 2021	Teal, lapwing, avocet	Higher peak counts of these species than in previous surveys: teal (1466), lapwing (980), avocet (205)
		Black-tailed godwit	Peak of 170 birds is lower than previous surveys (where numbers are usually into the 1000s). However, survey period did not include August and September which are typically when numbers of this species peak at North Killingholme Marshes Foreshore.

Summary of AMEP Ornithology Data

4.21 The North Killingholme Marshes Foreshore is a key location in the estuary for overwintering black-tailed godwit, with huge increases in the peak counts for this species in the Humber Estuary since the site was designated in the early 2000s. The bird count data indicate peak counts for this species at North Killingholme Marshes Foreshore regularly exceed 2000 birds (in August/ September), with large aggregations roosting at high tide in the nearby North Killingholme Haven Pits lagoons (close to Humber Sea Terminal).

4.22 The arable/ pasture fields inland between the estuary and Rosper Road (referred to as North Killingholme Marshes Fields) also provide feeding, roosting and loafing habitat for some SPA/ Ramsar species primarily curlew, with occasional usage by redshank, lapwing and other small wading birds. This area is considered functionally linked land to the SPA/ Ramsar due to the curlew peak counts being >1% of the Humber Estuary population (the threshold at which habitats are considered to be of importance to that species within the estuary context), although many of the fields are small and therefore less favoured by waterbirds.

4.23 The arable/ pasture fields at North Killingholme Marshes Fields have generally seen a decline in bird numbers since the counts originally undertaken for the AMEP scheme in the mid-2000s as they have been progressively taken out of agricultural management (and thus the sward height has increased) and become less suitable for waterbirds. The fields north of Station Road have all been permanently lost to development of the AMEP scheme, which commenced around 6 years ago, for which compensatory wet grassland habitat has been delivered at East Halton Skitter (north of Humber Sea Terminal).

Surveys for the Proposed Developments

4.24 Specific ecological surveys were undertaken by Ecological Services Limited (ESL) for the Proposed Phillips 66 and VPI Developments, and which have informed the baseline for ecological impact assessment and this HRA, and which are presented in ES Chapter 13 (Ecology and Nature Conservation).

4.25 A summary of the ecological surveys relevant to this HRA that were undertaken by ESL is presented below:

- Phase 1 Habitat survey and Preliminary Ecological Appraisal (PEA) of the Proposed Development Sites ('the Sites') in June 2021;
- monthly bird surveys (terrestrial) – two visits per month between October 2021 and March 2022 inclusive covering the period two hours either side of high tide. Survey scope included the Rosper Road Pools and terrestrial fields to the east of Rosper Road that had the potential to be functionally linked to the Humber Estuary SPA/ Ramsar;
- monthly bird surveys (coastal) - two visits per month between October 2021 and March 2022 inclusive covering the period two hours either side of high tide of the section of North Killingholme Marshes (NKM) mudflats closest to the Proposed Developments; and
- breeding bird surveys – six visits of all habitats adjacent to the Sites between April and June 2021.

4.26 The Phase 1 Habitat survey undertaken in June 2021 confirmed that the Phillips 66 Site comprises mainly hardstanding and bare ground with buildings/ infrastructure, as it is largely within the footprint of the existing Phillips 66 Humber Refinery, and this provides no suitable habitat for feeding, roosting or loafing wintering/ passage SPA/ Ramsar bird species. The area of the Phillips 66 Site that overlaps with the VPI Site was also surveyed and was found to contain no suitable habitat for feeding, roosting or loafing wintering/ passage SPA/ Ramsar bird species.

4.27 The majority of the Phillips 66 Site was therefore not subject to specific wintering or breeding bird surveys; the only areas surveyed were those that overlap with the VPI Site.

4.28 A summary of the survey results is presented below. Further details on the methods, result and detailed data analysis is provided in ES Chapter 13 (Ecology and Nature Conservation) and is presented as Appendix C (Breeding Birds) and Appendix D (Wintering Birds) to this HRA for completeness.

4.29 The survey area (including field numbers for reference throughout this HRA) is shown in Plate 1 below.

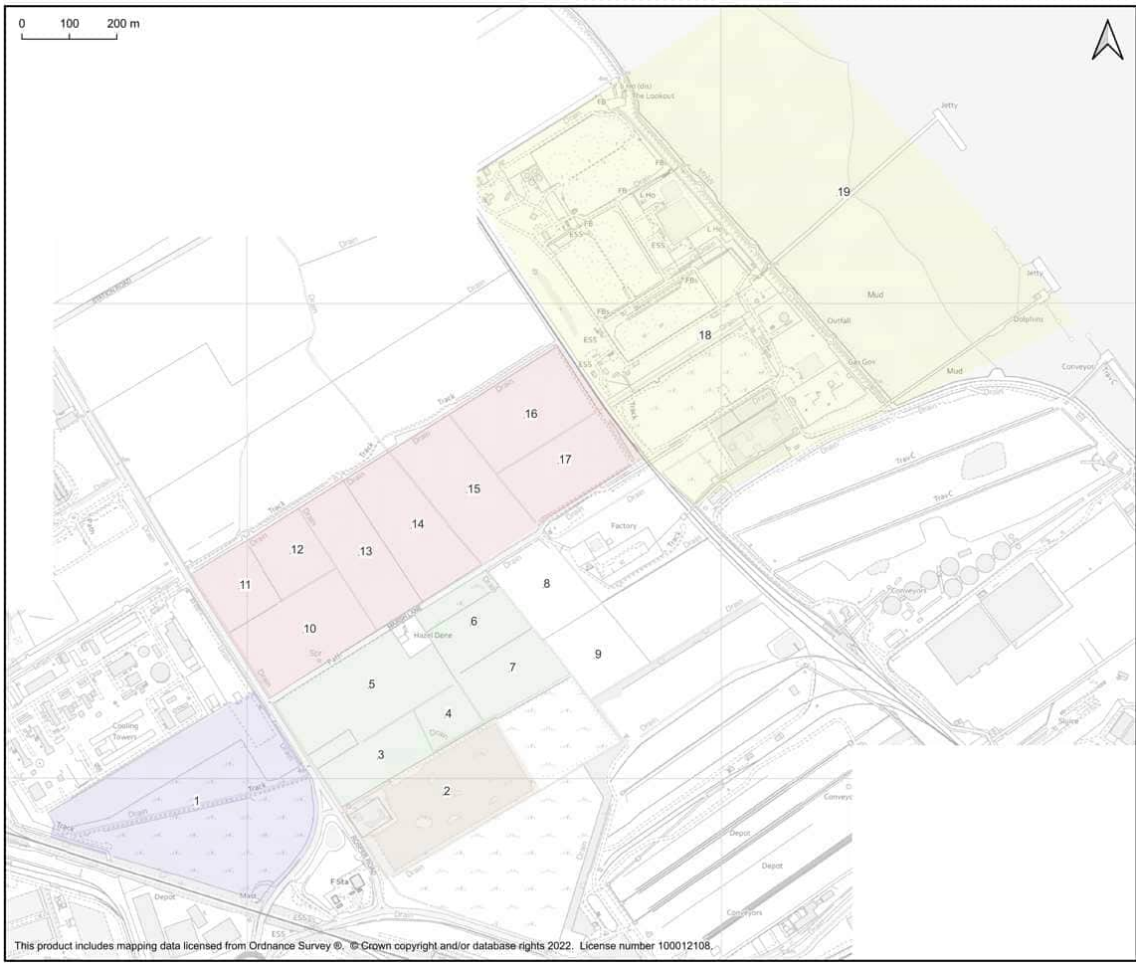


Plate 1: ESL Bird Survey Area 2021 – 2022

SPA/ Ramsar Breeding Birds

4.30 A summary of the survey results is presented in Table C1 in Appendix C. Further details on the method, result and detailed data analysis are provided in ES Chapter 13 (Ecology and Nature Conservation) and presented as Appendix C to this HRA for completeness.

4.31 The Phase 1 Habitat survey undertaken in June 2021 confirmed that the Phillips 66 Site comprises mainly hardstanding, bare ground and buildings; there is therefore no suitable habitat within the Phillips 66 Site for breeding bittern, marsh harrier, avocet or little tern. With the exception of avocet (see below), these species are not considered further in this HRA.

4.32 Rosper Road Pools Local Wildlife Site (LWS), which is approximately 500 m east of the Proposed Phillips 66 Development and which is not within the boundary of the Humber Estuary SPA/ Ramsar, was found to support breeding avocet (Area 2). This is a large drainage lagoon with a marginal reed fringe, which is linked to the surrounding network of ditches that outfall into the estuary at the northern end of Immingham Docks. The LWS has had some relatively recent habitat enhancement works (c. 2016) to create small islands specifically for nesting avocet.

4.33 Breeding avocet is a qualifying feature of the Humber Estuary SPA/ Ramsar with 64 breeding pairs in the five-year peak mean 1998 – 2002 that is listed in the 2007 citation (see Appendix A). Although the avocets at Rosper Road Pools are nesting in habitats outside the boundary of the designated site and therefore not part of the SPA/ Ramsar qualifying breeding avocet population, given the proximity and that birds will likely feed on the nearby North Killingholme Marshes mudflats, it is assumed for the purposes of this HRA that the Pools are functionally linked to the Humber Estuary SPA/ Ramsar for breeding avocet.

SPA/ Ramsar Wintering Birds (Land East of Rosper Road)

4.34 A summary of the survey results is presented in Table 5 below. Further details on the method, result and detailed data analysis is provided in ES Chapter 13 (Ecology and Nature Conservation), and is presented as Appendix C to this HRA for completeness.

4.35 A plan showing the field numbers included within the survey scope is provided as Plate 1 above.

4.36 Peak counts exceeding the 1% threshold for that species are highlighted in **bold text**.

Table 5. Summary of Wintering Bird Survey Peak Counts and Analysis against Humber Estuary 1% Threshold

Species	Peak Counts																Humber Estuary 1% Threshold
	Proposed Phillips 66 Development Site (Field 1)	Area 2 (Rosper Road Pools)	Field 3	Field 5	Field 6	Field 7	Field 8	Field 9	Field 10	Field 13	Field 14	Field 15	Field 16	Field 17	Area 18	Area 19 (NKM Mudflats)	
Bar-tailed godwit		**6**															16
Black-tailed godwit		**480**						2	8						1	35	45
Curlew			1	9	**50**	24		**35**	**74**	15	**38**	**35**	3	2	**79**	**108**	28
Dunlin																**205**	160
Lapwing	4	66						2				1			18	**665**	165
Oystercatcher																2	58
Pink-footed goose[15]							1										143
Redshank		8													**40**	**69**	29
Shelduck		12														28	45
Wigeon		**126**				4										2	27

[15] Although not a qualifying species for the Humber Estuary SPA/ Ramsar, this species has been included on the basis that Natural England now consider pink-footed goose to be part of the SPA/ Ramsar designated assemblage due to the increases in numbers in this area

4.37 No Humber Estuary SPA/ Ramsar bird species were recorded in Fields 4, 11 and 12 and therefore these fields are excluded from Table 5.

4.38 Curlew was recorded in some of the terrestrial fields surveyed in numbers regularly exceeding 1% of the Humber Estuary threshold (Fields 6, 9, 10, 14 and 15); this reaffirms the findings of many other surveys conducted in these fields in recent years. In all cases, use of the fields by curlew was sporadic, although the surveys are only a snapshot of the usage across the high tide period and there are likely to be many factors influencing the use of the fields by this species across the passage and wintering period (e.g. localised disturbance, sward height etc.). It is evaluated that the fields are functionally linked land to the Humber Estuary SPA/ Ramsar due to their supporting role in providing feeding, roosting and loafing habitat for curlew across the high tide period. Curlew were recorded in most of the fields surveyed on the east side of Rosper Road, although the smaller fields (3, 4, 11 and 12) were either used by only small numbers or avoided altogether by curlew.

4.39 Redshank was recorded on one visit within the terrestrial fields surveyed with that visit recording a peak count of 40 redshank, which is >1% Humber Estuary threshold for this species, in Area 18 (group of fields/ land within the tank farms adjacent to the estuary). The species was regularly recorded on the North Killingholme Marshes mudflats across the survey period, although does not appear to favour the adjacent terrestrial fields for feeding, roosting and loafing.

4.40 Very small numbers of other SPA/ Ramsar species were recorded in the surveyed fields across the survey period; there were occasional records of single figure numbers of black-tailed godwit, oystercatcher and wigeon. The fields are therefore providing a supporting habitat to the estuary for these species, but as they are present in such low numbers, which are well below the 1% thresholds for each species, it is concluded that the fields are not providing functionally linked land for these species.

4.41 Rosper Road Pools (Area 2) was recorded to support good numbers of black-tailed godwit with several of the monthly counts recording numbers >1% Humber Estuary threshold. Rosper Road Pools also supported good numbers of lapwing, redshank and shelduck (although all counts were <1% Humber Estuary thresholds for these species), as well as wigeon (regular counts >1% Humber Estuary threshold). It is evaluated that this habitat is of importance in supporting the adjacent mudflats as a feeding, loafing and roosting resource for black-tailed godwit and wigeon, and is therefore functionally linked land to the SPA/ Ramsar.

4.42 Surveys of the nearest section of the mudflats at North Killingholme Marshes was undertaken; this survey area coincides with the lower end of WeBS Core Count Killingholme Marshes Sector J. Very few black-tailed godwits were recorded, and this is perhaps surprising given that this area is known to be a key foraging resource for this species in the Humber Estuary. However, as the surveys were undertaken over the high tide period, this would be expected to coincide with the period when black-tailed godwit are roosting elsewhere. Other species recorded at North Killingholme Marshes mudflats also reaffirmed the results of previous survey work, with curlew, lapwing and dunlin present in numbers >1% threshold.

Summary of Surveys for the Proposed Development

4.43 The Phillips 66 Site is unsuitable for feeding, roosting and loafing SPA/ Ramsar waterbirds and is not functionally linked to SPA/ Ramsar.

4.44 The surveys undertaken for the Proposed Phillips 66 and VPI Developments in the fields east of Rosper Road reaffirmed the findings of previous surveys in this part of the estuary, with the terrestrial fields supporting numbers of curlew regularly exceeding 1% of the Humber Estuary threshold indicating their importance within the estuary, and thus confirming that they are functionally linked to SPA/ Ramsar. Although some of the fields are small (e.g. Fields 4, 11 and 12) and therefore not favoured by curlew (due to their enclosed nature they do not provide sufficient scanning distances for predators), the overall complex of fields within this part of North Killingholme is clearly providing high tide roosting, loafing and feeding habitat for curlew and can be considered functionally linked land to the SPA/ Ramsar.

4.45 Redshank was the only other species recorded in terrestrial habitats in numbers above the 1% Humber Estuary threshold for the species; this was in Area 18 which incorporated all the

habitats around the tank farm immediately adjacent to the mudflats. The Rosper Road fields are clearly not regularly used by redshank, or any other SPA/ Ramsar species in numbers that would be considered important within the Humber Estuary context.

4.46 Most of the terrestrial fields east of Rosper Road supported only small numbers of wintering and passage SPA/ Ramsar birds, likely due to the relatively small and enclosed nature of the fields, which are not favoured by feeding, roosting or loafing birds because they do not offer sufficient visual scanning distances for birds to observe approaching ground-based predators.

4.47 Of the fields closest to the Proposed Phillips 66 Development:

- Field 3 – supported curlew on 1 survey visit (peak count of 1 bird);
- Field 5 – supported curlew on 2 survey visits with peak counts <10 birds on both occasions, and no other SPA/ Ramsar birds were recorded;
- Field 10 - supported numbers of curlew >1% threshold on 2 of 3 surveys this species was present, lapwing was recorded on 1 survey visit (peak count of 2 birds) and black-tailed godwit recorded on 1 visit (peak count of 2 birds); and
- Fields 11 and 12 – no SPA/ Ramsar birds were recorded during the surveys.

4.48 Surveys confirmed that Rosper Road Pools provides high tide roosting and loafing habitat for black-tailed godwit, supporting the conclusion that this part of the estuary is a stronghold for this species with the habitats provided by the intertidal mudflats at North Killingholme Marshes, supported by terrestrial habitats close by including Rosper Road Pools and Killingholme Pits Site of Special Scientific Interest (SSSI), which is known to be favoured roost site for black-tailed godwit. The SSSI is approximately 2.7 km north of Rosper Road Pools.

Baseline Water Quality Monitoring

4.49 Baseline water quality monitoring for South Killingholme Drain undertaken by the Environment Agency indicates that it has a relatively high pH, high alkalinity and high conductivity, likely due to the existing discharges to the watercourse. An Environmental Risk Assessment for South Killingholme Drain has been carried out for the permit for the adjacent Phillips 66 Humber Refinery site. This was supported by monitoring undertaken in South Killingholme Drain towards the outfall to Humber Estuary. The high chloride levels indicate that there may be some saline intrusion into the lower reaches of South Killingholme Drain, despite the tidal valve on the outfall. The water quality results indicate that the current water quality exceeds Environmental Quality Standards (EQS) for some metals, PAHs, PFOS and other determinands. This indicates that the South Killingholme Drain is acting largely as an effluent channel, taking industrial discharges and surface water runoff from a range of industrial activities and land uses between South Killingholme and the Humber Estuary, and significant dilution of the existing effluent discharges does not take place until the flow meets the waters of the Humber at South Killingholme Haven.

4.50 There is no baseline water quality data for Rosper Road Pools, and it is assumed that this is not monitored by the Environment Agency.

Baseline Aquatic Invertebrate Monitoring

4.51 Terrestrial invertebrate monitoring of South Killingholme Drain is undertaken regularly on behalf of Phillips 66 (most recently by APEM in July 2022). The results indicate that the section of South Killingholme Drain within the Site boundary has a low diversity and abundance of macroinvertebrates, which is dominated by pollution-tolerant fly larvae (Chironomidae and Culicidae). The report highlights that the low abundance of organic pollution-tolerant organisms such as Oligochaeta combined with the absence of Sphaeriidae may indicate inorganic contamination of the sediment (APEM Ltd, 2022). The section of ditch to the west of Rosper Road was also noted to have an oily film on its surface, and had very low dissolved oxygen levels (10 – 12% saturation), as well as being very slow flowing, which is likely to reduce the flushing of existing effluent discharges downstream.

4.52 There are no baseline aquatic invertebrate data for available for Rosper Road Pools.

5. Stage 1: Screening for Likely Significant Effects (LSEs)

Identification of Potential Construction Impacts

Potential Construction Impact Pathways Scoped In

5.1 The potential impact pathways by which the Proposed Phillips 66 Development could impact the qualifying features of each designated site during construction, and which were scoped into the EcIA, are summarised below:

- visual disturbance to SPA/ Ramsar birds using functionally linked land – disturbance to breeding avocet at Rosper Road Pools, and wintering/ passage waterbirds feeding, roosting and loafing in terrestrial fields east of Rosper Road, and Rosper Road Pools.
- noise disturbance to SPA/ Ramsar birds using functionally linked land – disturbance to breeding avocet at Rosper Road Pools, and wintering/ passage waterbirds feeding, roosting and loafing in terrestrial fields east of Rosper Road, and Rosper Road Pools.
- noise and visual disturbance to SPA/ Ramsar birds within the SPA/ Ramsar – disturbance to wintering/ passage waterbirds feeding, roosting and loafing on intertidal mudflats within the boundary of the designated site; and
- surface water quality – potential pathways for the surface water pollution to the adjacent drainage network, and ultimately to the Humber Estuary SAC/ SPA/ Ramsar into which the surface water drainage flows during the construction phase of the Proposed Phillips 66 Development e.g. sedimentation, vehicle fuel spill (although it is noted that the existing Refinery Effluent Treatment Plant (ETP) is in place to prevent this).

Construction Impact Pathways Scoped Out

5.2 The following impact pathways have been scoped out of the HRA screening based on the conclusions of the EcIA:

- noise/ visual disturbance to breeding bittern, marsh harrier and little tern - there is no suitable habitat for these qualifying species of SPA/ Ramsar breeding birds within the potential zone of influence of noise and visual disturbance arising from the construction of the Proposed Phillips 66 Development;
- underwater noise disturbance to SAC/ Ramsar marine mammals and fish – all works are > 1km from the estuary and over this distance it is reasonable to conclude that there would be no propagation of underwater noise such that the qualifying features could be significantly affected;
- direct loss or physical damage to qualifying habitats or habitats used by qualifying species – as established in the ecological impact assessment accompanying the application, the Phillips 66 Site itself is unsuitable as functionally linked land for SPA/ Ramsar birds as it is a mosaic of tall grassland, bare ground and dense/ scattered scrub. Moreover, given the distance between the designations and the Proposed Phillips 66 Development there is no pathway that could result in direct habitat loss or direct physical damage to any of the designated habitats. Similarly, there are no groundwater pathways over this distance through which the Proposed Phillips 66 Development could give rise to any effects on the groundwater dependent terrestrial ecosystems (GWTEs) of the sites;
- air quality (dust emissions) – given the distance of the designated habitats from the Proposed Phillips 66 Development (approximately 1.7 km), they are well outside the zone of influence of fugitive dust emissions from construction, which is approximately 50 m; and

- air quality (emissions from road traffic movements) – the affected roads are >200 m from the Humber Estuary SAC/ Ramsar boundary and therefore this pathway is scoped out of the Air Quality assessment for road traffic movements in Chapter 6 (Air Quality), in accordance with IAQM guidance (IAQM, 2020).

5.3 The Proposed Phillips 66 Development is approximately 800 m south-west of the consented AMEP 'Mitigation Area A' land, which is on the eastern side of Rosper Road directly opposite the existing VPI Immingham CHP Plant. This habitat was included within the AMEP DCO to mitigate extensive losses of functionally linked land supporting overwintering/ passage waterbirds in numbers >1% of the Humber Estuary populations within the footprint of the AMEP development. However, this mitigation area has subsequently been permitted to be relocated to the Halton Marshes Wet Grassland Mitigation Area in a non-material change to the DCO. The former Mitigation Area A land will now be subject to further development associated with the AMEP scheme as part of a material amendment to the DCO[16]. The Halton Marshes Wet Grassland Mitigation Area, which is north of Able UK's Humber Sea Terminal, has already been created. This habitat is approximately 5 km north of the Proposed Phillips 66 Development and therefore well outside the zone of influence of any noise/ visual disturbance associated with the Proposed Phillips 66 Development. This potential impact pathway is therefore scoped out.

Construction Visual Disturbance to Functionally Linked Land (Rosper Road Pools)

5.4 The Proposed Phillips 66 Development is approximately 500 m west of Rosper Road Pools on the western side of Rosper Road and the link road off the A160. The existing infrastructure within the operational Phillips 66 Humber Refinery and the adjacent VPI Immingham CHP Plant, as well as Rosper Road also lies between the Proposed Development and Rosper Road Pools, and it is therefore reasonable to conclude that there is no potential for visual disturbance to bird using Rosper Road Pools during construction.

5.5 The nature and scale of the temporary construction activities associated with the Proposed Phillips 66 Development are not significantly different from on-going industrial activities within the area surrounding the Rosper Road Pools. This includes temporary construction activities in the AMEP DCO site to the north-east, and the structures associated with the existing VPI Immingham CHP Plant to the east of the Proposed Phillips 66 Development. It is envisaged that the plant, machinery, vehicles and structures used during construction will not result in any material change in the conditions currently surrounding the Rosper Road Pools.

5.6 No likely significant visual disturbance effects on breeding avocet or wintering/ passage waterbirds using Rosper Road Pools are predicted as a result of visual impacts during construction. This pathway is therefore screened out of Task 2: Appropriate Assessment.

Construction Noise Disturbance to Functionally Linked Land (Rosper Road Pools)

5.7 Given the proximity of the Proposed Phillips 66 Development to Rosper Road Pools and therefore the potential for noise disturbance to qualifying species of waterbirds, Likely Significant Effects cannot be screened out and therefore this pathway is taken forward to Stage 2: Appropriate Assessment.

Construction Visual Disturbance to Functionally Linked Land (Terrestrial Fields)

5.8 The Proposed Phillips 66 Development is approximately 500 m from the nearest fields used occasionally by numbers of curlew >1% Humber Estuary population threshold and which are considered functionally linked land. The Proposed Phillips 66 Development is physically separated from these fields by the existing Phillips 66 complex (and associated operations), as

[16] Application for AMEP Area K Monopile Facility submitted to North Lincolnshire Council in August 2021 (not yet determined) will partly impact upon the former Mitigation Area A land (Planning Ref: PA/2021/1525)

well as the existing VPI Immingham CHP plant, which is on the opposite side of Rosper Road to the fields.

5.9 As discussed above in respect of potential disturbance to Rosper Road Pools, the nature and scale of the temporary construction activities associated with the Proposed Phillips 66 Development are not significantly different from on-going industrial activities within the area surrounding the Rosper Road Pools. This includes temporary construction activities in the AMEP DCO site to the north-east, and the structures associated with the existing VPI Immingham CHP Plant to the east of the Proposed Phillips 66 Development. It is envisaged that the plant, machinery, vehicles and structures used during construction will not result in any material change in the conditions currently surrounding Rosper Road Pools.

The hedgerows/ scattered trees along the eastern side of Rosper Road also provide some visual screening of traffic/ plant movement along Rosper Road and within the construction site.

5.10 No likely significant effects on SPA/ Ramsar birds in habitats that are functionally linked to the SPA/ Ramsar are predicted as a result of visual impacts during construction. This pathway is therefore screened out of Task 2: Appropriate Assessment.

Construction Noise Disturbance to Functionally Linked Land (Terrestrial Fields)

5.11 Given the proximity of the Proposed Phillips 66 Development to Terrestrial Fields east of Rosper Road that are functionally linked to the Humber Estuary, and therefore the potential for noise disturbance to qualifying species of waterbirds, Likely Significant Effects cannot be screened out and therefore this pathway is taken forward to Stage 2: Appropriate Assessment.

5.12 Construction Noise/ Visual Disturbance to Habitats within SPA/ Ramsar Boundary

5.13 The Proposed Phillips 66 Development is approximately 1.7 km inland from the nearest intertidal mudflats at North Killingholme Marshes Foreshore. At this distance it is reasonable to conclude there is no potential for direct noise or visual disturbance to waterbirds feeding, roosting and loafing on the mudflats as a result of construction activities.

5.14 No likely significant effects on SPA/ Ramsar birds within the SPA/ Ramsar are predicted as a result of noise and visual impacts during construction. This pathway is therefore screened out of Task 2: Appropriate Assessment.

Construction Surface Water Quality

5.15 There is the potential for pollution/ siltation of Humber Estuary via the surface water drainage network, into which surface water run-off from the Proposed Phillips 66 Development will outfall during construction. However, standard environmental measures to control pollution to the drains during construction phase will adequately minimise risk. As this is required for compliance with environmental legislation, and not specifically to mitigate for impacts on the SAC/ SPA/ Ramsar, this can be taken into account at the screening stage. It is therefore concluded that with the embedded measures to control pollution/ siltation during construction, there will be no likely significant effects on Humber Estuary SAC/ SPA/ Ramsar habitats or the species they support. This pathway is therefore screened out of Task 2: Appropriate Assessment.

Identification of Potential Operational Impacts

Potential Operational Impact Pathways Scoped In

5.16 The potential impact pathways by which the Proposed Phillips 66 Development could impact the qualifying features of each designated site during operation, and which were scoped into the EcIA are as follows:

- visual disturbance to SPA/ Ramsar birds using functionally linked land – disturbance to breeding avocet at Rosper Road Pools, and wintering/ passage waterbirds feeding, roosting and loafing in terrestrial fields east of Rosper Road, and Rosper Road Pools;
- noise disturbance to SPA/ Ramsar birds using functionally linked land – disturbance to breeding avocet at Rosper Road Pools, and wintering/ passage waterbirds feeding, roosting and loafing in terrestrial fields east of Rosper Road, and Rosper Road Pools;
- noise and visual disturbance to SPA/ Ramsar birds within the SPA/ Ramsar – disturbance to wintering/ passage waterbirds feeding, roosting and loafing on intertidal mudflats within the boundary of the designated site;
- surface water quality – potential pathways for the surface water pollution to the adjacent drainage network, and ultimately to the Humber Estuary SAC/ SPA/ Ramsar into which the surface water drainage flows during the operational phase of the Proposed Phillips 66 Development (although it is noted that the existing Refinery Effluent Treatment Plant (ETP) is in place to prevent this); and
- air quality - potential pathways identified through stack emissions to air (acid, ammonia and nitrogen) during the operational phase of Proposed Phillips 66 Development resulting in effects on susceptible habitats within the Humber Estuary SAC/ SPA/ Ramsar.

Operational Impact Pathways Scoped Out

5.17 The following impact pathways have been scoped out of the HRA screening based on the conclusions of the EcIA:

- noise/ visual disturbance to breeding bittern, marsh harrier and little tern - there is no suitable habitat for these qualifying species of SPA/ Ramsar breeding birds within the potential zone of influence of noise and visual disturbance arising from the construction of the Proposed Phillips 66 Development; and
- air quality impacts on intertidal and subtidal habitats in the SAC/ Ramsar - intertidal habitats are not susceptible to the effects of changes in air quality arising from stack emissions during operation (increased nitrogen, ammonia and acid deposition) because of their regular tidal inundation. Subtidal habitats have similarly been scoped out. air quality impacts due to road traffic movements – the affected roads are >200 m from the Humber Estuary SAC/ Ramsar boundary. This pathway is therefore scoped out in accordance with IAQM guidance.

Operational Visual Disturbance to Functionally Linked Land (Rosper Road Pools)

5.18 The Proposed Phillips 66 Development is approximately 500 m west of Rosper Road Pools to the west of Rosper Road, the link road off the A160 and a railway line, which lie between the Pools and the Proposed Phillips 66 Development. The existing infrastructure within the operational Phillips 66 Humber Refinery complex also lies between the Proposed Phillips 66 Development and Rosper Road Pools, and it is therefore reasonable to conclude that there is no potential for visual disturbance to birds using Rosper Road Pools during operation.

5.19 The nature and scale of the operational activities associated with the Proposed Phillips 66 Development are not significantly different from on-going industrial activities within the area surrounding the Rosper Road Pools. This includes the operation of the existing VPI Immingham CHP Plant to the east of the Proposed Phillips 66 Development, the Lindsey Oil Refinery to the north and ongoing construction activities within the consented AMEP development area to the north-east. It is envisaged that the plant, machinery, vehicles and structures used during operation will not result in any material change in the conditions currently surrounding the Rosper Road Pools.

5.20 No likely significant effects on breeding avocet or wintering/ passage waterbirds are predicted as a result of visual impacts during operation. This pathway is therefore screened out of Task 2: Appropriate Assessment.

Operational Noise Disturbance to Functionally Linked Land (Rosper Road Pools)

5.21 Noise modelling has been undertaken and is presented in ES Chapter 7 (Noise and Vibration). Noise contour maps for operation are provided in Appendix D. The modelled noise levels at the nearest part of Rosper Road Pools are <60 dB $L_{Aeq,T}$ across the open lagoon habitat. As discussed in respect of operational noise, studies indicate that noise levels >84 dBA typically elicit a flight response in birds and the same research recommends that construction noise levels are kept below 70 dB to avoid excessive disturbance of birds. Given that the modelled operational noise levels are well below 70 dB $L_{Aeq,T}$/ L_{Amax}, it is therefore concluded that nesting avocet at Rosper Road Pools would not be disturbed.

5.22 A noise contour plan has been prepared for the operational phase to show the predicted LAeq at the ecology receptors in Rosper Road Pools (Eco 3 and Eco 4) and is presented as Figure G3.1 in Appendix G. A summary of the predicted changes in LAeq as a result of operation is presented in Table G3.1 in Section G.3 of Appendix G. The modelling demonstrates that there are no predicted exceedances of Natural England's suggested 3 dBA 'rule-of-thumb' change in noise level threshold at Eco 3 and Eco 4 in Rosper Road Pools. Operational noise levels are actually lower than ambient noise levels at all modelled receptors for both the daytime and nighttime scenarios.

5.23 No likely significant effects on breeding avocet or wintering/ passage waterbirds are predicted as a result of noise impacts during operation. This pathway is therefore screened out of Task 2: Appropriate Assessment.

Operational Visual Disturbance to Functionally Linked Land (Terrestrial Fields)

5.24 The nature and scale of the temporary construction activities associated with the Proposed Phillips 66 Development are not significantly different from on-going industrial activities within the area surrounding the Rosper Road fields. This includes temporary construction activities in the AMEP DCO site to the north-east, and the structures associated with the existing VPI Immingham CHP Plant to the east of the Proposed Phillips 66 Development, and the Lindsey Oil Refinery to the north-west. It is envisaged that the plant, machinery, vehicles and structures present during operation will not result in any material change in the conditions currently surrounding the Rosper Road fields. The hedgerows/ scattered trees along the eastern side of Rosper Road also provide some visual screening of traffic/ plant movement along Rosper Road and within the operational site.

5.25 It is reasonable to assume that any SPA/ Ramsar waterbirds roosting, loafing and/or foraging in fields on the west side of Rosper Road are habituated to the general industrial nature (and its associated noise and visual impact from vehicle traffic, sirens, railway operations, chimney stacks, pipe racks, buildings etc.) of the surrounding area.

5.26 No likely significant effects on SPA/ Ramsar birds in habitats that are functionally linked to the SPA/ Ramsar are predicted as a result of visual impacts during operation. This pathway is therefore screened out of Task 2: Appropriate Assessment.

Operational Noise Disturbance to Functionally Linked Land (Terrestrial Fields)

5.27 Noise modelling has been undertaken and is presented in ES Chapter 7 (Noise and Vibration). Noise contour maps for operation are provided in Appendix D. The modelled noise levels at the nearest functionally linked land associated with Rosper Road Fields (Field 5) are <60 dB $L_{Aeq,T}$ across the open lagoon habitat. As discussed in respect of construction noise, studies indicate that noise levels >84 dBA typically elicit a flight response in birds and the same research recommends that construction noise levels are kept below 70 dB to avoid excessive disturbance of birds. Given that the modelled operational noise levels are well below 70 dB $L_{Aeq,T}$/ L_{Amax}, it is therefore concluded that nesting avocet at Rosper Road Pools would not be disturbed.

5.28 Noise contours have been prepared for the operational phase to show the predicted LAeq at the ecology receptors in the functionally linked land (Eco 1 and Eco 2) and are presented as Figure G3.1 in Section G.3 of Appendix G. A summary of the predicted changes in LAeq as a result of operation are presented in Table G3.1 in Section G.3 of Appendix G. The modelling demonstrates that there are no predicted exceedances of Natural England's suggested 3 dBA 'rule-of-thumb' change in noise level threshold at Eco 1 and Eco 2 in the functionally linked land to the east of Rosper Road. . A 'with mitigation' scenario has been modelled for the operational phase as this includes noise mitigation measures required for environmental compliance and is not related to ecological mitigation (as no ecological mitigation is required). Operational noise levels are actually lower than ambient noise levels at all modelled receptors for both the daytime and nighttime scenarios.

5.29 No likely significant effects on breeding avocet or wintering/ passage waterbirds are predicted as a result of noise impacts during operation. This pathway is therefore screened out of Task 2: Appropriate Assessment.

Operational Noise/ Visual Disturbance to Habitats within SPA/ Ramsar Boundary

5.30 The Proposed Phillips 66 Development is approximately 1.7 km inland from the nearest intertidal mudflats at North Killingholme Marshes Foreshore. At this distance it is reasonable to conclude there is no potential for direct noise or visual disturbance to waterbirds feeding, roosting and loafing on the mudflats as a result of operational activities.

5.31 No likely significant effects on SPA/ Ramsar birds within the SPA/ Ramsar are predicted as a result of noise and visual impacts during operation. This pathway is therefore screened out of Task 2: Appropriate Assessment.

Operational Surface Water Quality

5.32 There is the potential for pollution of Humber Estuary via the surface water drainage network, into which surface water run-off from the Proposed Phillips 66 Development will outfall during operation. Standard environmental measures to control most pollutants to the drains during operation will adequately minimise risk; the majority of wastewater will be routed through the existing refinery Effluent Treatment Plant (ETP) before being routed to a holding pond prior to discharge into South Killingholme Drain. However, the Wet Gas Scrubber unit (which is required to remove sulphur oxides from the flue gas prior to carbon capture) generates an effluent stream that has elevated sulphate levels that cannot be reduced by the ETP.. Options for the treatment of sulphate in the effluent stream are being examined; however, in the absence of sulphate treatment the effluent stream will need to be discharged into the South Killingholme Drain.

5.33 South Killingholme Drain runs west to east across the land to the east of the Refinery before passing beneath Rosper Road in a small culvert, and continuing south and then east where it eventually discharges to the Humber Estuary approximately 1 km east of Rosper Road. The drain is hydrologically connected to Rosper Road Pools, which is functionally linked to the Humber Estuary SPA/ Ramsar due as it provides feeding, loafing and roosting habitat for birds at high tide, as well as nesting habitat for avocet. Given the connectivity of South Killingholme Drain to Rosper Road Pools and the Humber Estuary, and the potential for surface water quality to be altered by elevated sulphate concentrations, which may change the water chemistry and thus affect aquatic organisms on which designated features of the Humber Estuary feed, **LSEs cannot be excluded** at the screening stage and **this pathway is taken forward for Task 2: Appropriate Assessment**.

5.34 Other potential contaminants will be controlled through standard operational mitigation measures and controlled by the Environmental Permit and this will adequately minimise risk. As this is required for compliance with environmental legislation, and not specifically to mitigate for impacts on the SAC/ SPA/ Ramsar, this can be taken into account at the screening stage. It is therefore concluded that with the embedded measures to control pollution (except sulphate) during operation of the Proposed Phillips 66 Development, there will be no likely significant effects on Humber Estuary SAC/ SPA/ Ramsar habitats or the species they support.

Operational Air Quality

5.35 Air quality modelling has been undertaken for operational emissions from the Proposed Phillips 66 Development and is presented in ES Chapter 6 (Air Quality). The impact of emissions on sensitive ecological receptors are quantified in two ways:

- direct impacts – due to increases in atmospheric pollutant concentrations, which are assessed against defined 'critical levels'; and
- indirect impacts – deposition of acids and nutrient nitrogen to the ground surface, which are assessed against defined 'critical loads'.

5.36 The critical levels for the protection of vegetation and ecosystems are defined as "*concentrations of pollutants in the atmosphere above which direct adverse effects on...plants [and] ecosystems...may occur according to present knowledge," and critical loads are defined as "a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge*" (Centre for Ecology and Hydrology (CEH) and Air Pollution Information System (APIS) website (2022). Critical levels and loads are set out in detail in Section 6.2 of ES Chapter 6 (Air Quality).

5.37 The air quality assessment has considered the modelled effects of nitrogen dioxide NO_2 (annual mean/ daily mean), sulphur dioxide SO_2 (annual mean) and ammonia NH_3 (annual mean) emissions from the Proposed Phillips 66 Development on the worst impacted designated site receptor. All impacts are considered to be insignificant at the ecological receptors as they do not exceed the 1% screening threshold for Process Contributions (PC). For NO_2 (annual mean and daily mean) and SO_2 (annual mean), the PC is negative i.e. represents a reduction in emissions for these two pollutants. It is therefore concluded that the Proposed Phillips 66 Development will result no likely significant effects on the Humber Estuary SAC/ SPA/ Ramsar habitats as a result of changes in air quality due to operational stack emissions. This pathway is therefore screened out of Task 2: Appropriate Assessment.

5.38 Depositional impacts of nutrient nitrogen and acid deposition are shown in Table 6B.21 and Table 6B.22 respectively in Chapter 6 (Air Quality). The Phillips 66 Baseline nitrogen deposition results show that, on the whole, the existing impacts are less than the 1% screening threshold to demonstrate insignificance. Nitrogen deposition impacts at OE1d (1.4%), OE2 (1.4%), OE7 (1.2%) and OE8 (1.4%) are only slightly over the 1% screening threshold. Guidance from the IAQM (2020) clarifies that the 1% threshold is not intended to be precise to a set number of decimal places but to the nearest whole number, and therefore where an increase is shown to be 1.4%, as in the case of nitrogen deposition at Receptor OE1d, for example, this can be rounded down to 1% for the purpose of assessment and therefore the impacts can be considered to still be insignificant. This has been the accepted approach for other air quality impact assessments undertaken to inform HRAs for consented developments in this part of Humber Estuary, including the VPI CCGT power station and the South Humber Bank Power Station, both of which were granted permission by the relevant planning authority.

5.39 Following further consultation with Natural England, additional screening has been undertaken of this pathway as Natural England is not comfortable with adopting the IAQM guidance of rounding down the 1% screening threshold numbers. The habitat types and rationale for selection of critical loads/ levels has also been updated (see Appendix H), as well as an updated version of Table 6B.38 taking these revisions into account (see below).

Revised Table 6B.38 – Phillips 66 Future – Nitrogen Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load	Change in PC over Phillips 66 Baseline Assessment
Original values presented in ES Chapter 6 (Air Quality)								
OE1d	*Northern wet heath*	*20.44*	*10*	*0.14*	*1.4%*	*20.6*	*206%*	*+0.1%*

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load	Change in PC over Phillips 66 Baseline Assessment
OE1e	*Pioneer, low, mid upper saltmarshes*	*20.44*	*20*	*0.13*	*0.6%*	*20.6*	*103%*	*0%*
OE2	*Pioneer, low, mid upper saltmarshes*	*20.44*	*20*	*0.14*	*0.7%*	*20.6*	*103%*	*0%*
Revised Values								
OE1d	**Wetland and reedbed**	**17.0**	**10**	*0.14*	**1.4%**	**17.1**	**171%**	*+0.1%*
OE1e	**Pioneer, low, low- mid saltmarshes**	**16.8**	**20**	*0.13*	**0.6%**	**16.9**	**85%**	*+0.1%*
OE2	**Upper saltmarshes**	**17.0**	**10**	*0.14*	**1.4%**	**17.1**	**171%**	*0.1%*

5.40 Receptor OE8 (broadleaved woodland) is not a qualifying SAC habitat, is not within the boundary of the SAC, and is not functionally linked to the SAC; this receptor is therefore screened out. Receptors OE1d (wetland and reedbed) at North Killingholme Haven Pits SSSI and OE7 (wetland and reedbed) at Rosper Road Pools are outside the boundary of the Humber Estuary SAC/ SPA/ Ramsar but are functionally linked habitats to the SPA/ Ramsar because they support SPA/ Ramsar waterbirds for feeding, roosting and loafing. However, it is reasonable to conclude that the small process contribution from the Proposed Phillips 66 Development would not result in any significant damage to reedbed habitats, or any changes to the suitability of this habitat for SPA/ Ramsar waterbirds. The reed/ clubrush habitat at North Killingholme Haven Pits SSSI is being already regularly managed through periodic cutting back/ removal to control its spread into open water habitats. The Natural England condition assessment for North Killingholme Haven Pits SSSI Unit 1 (which is the location of receptor OE1d) states that the habitat is in favourable condition as it is meeting its targets for open water habitats (including the proportion of open water and other factors such as salinity) supporting qualifying species of waterbirds. This pathway is therefore screened out of Task 2: Appropriate Assessment.

5.41 There are no exceedances of the 1% screening threshold resulting from operational N deposition at any of the nearest sensitive saltmarsh receptors in the Humber Estuary SAC/ Ramsar (OE1e and OE2) when the numbers are rounded down in accordance with IAQM guidance. At receptor OE2 (upper saltmarsh) with the application of the more conservative critical load for upper saltmarsh of 10 kgN/ha/yr, the process contribution has been revised to 1.4%, which is not exceeding the 1% screening threshold. However, as discussed above receptor OE1d, the process contribution from the operational N deposition is very small and affects only a tiny proportion of the overall saltmarsh resource within the Humber Estuary; the area of upper saltmarsh affected at receptor OE2 is less than the total area of the SSSI unit, which is 1.88 ha in total; as a worst case if all of this habitat was upper saltmarsh, it represents approximately 0.3% of all of the estuary saltmarsh (which is approximately 630 ha[17]). There is already high background N deposition at this location, which exceeds the lower critical load of 10 kgN/ha/yr for upper saltmarsh; however, the saltmarsh habitat at this location (within Humber Estuary SSSI Unit 95) is only in unfavourable condition due to coastal erosion. The changes in N deposition predicted by the assessment would therefore not reasonably result in any likely significant effects on this small section of upper saltmarsh in the Humber Estuary SAC/ Ramsar. This pathway is therefore screened out of Task 2: Appropriate Assessment.The acid depositional impacts at receptors OE1a, OE1d and OE4 are all over the 1% screening threshold for insignificance. The background acid deposition at all these sites is already far exceeding the relevant critical loads, and will already include the baseline contribution from the existing Phillips 66 Site sources. The process contribution from the operational emissions at all receptors is insignificant when considered in this context. This is therefore concluded to result

[17] Total area of SAC is 36,657.15, of which approximately 630 ha is saltmarsh: saltmarsh-fact-sheet.pdf (humbernature.co.uk)

in no likely significant effects on designated habitats. This pathway is therefore screened out of Task 2: Appropriate Assessment.

6. Stage 2: Appropriate Assessment

Introduction

6.1 Appropriate Assessment is not a technical term, it literally means an assessment that is appropriate to support a conclusion of no adverse effects on the integrity of a European site. In the Stage 1: Likely Significant Effects Screening, reported in Section 5 of this document, the following pathways could not be dismissed as posing no likely significant effect:

- construction noise disturbance to SPA/ Ramsar birds using functionally linked land – disturbance to breeding avocet at Rosper Road Pools, and wintering/ passage waterbirds feeding, roosting and loafing in terrestrial fields east of Rosper Road, and Rosper Road Pools; and
- changes in surface water quality during operation – the effluent discharge from the Wet Gas Scrubber will result in an increase in sulphates entering the South Killingholme Drain, and may affect habitats within Rosper Road Pools (which is functionally linked land to the Humber Estuary SPA/ Ramsar) and/ or the Humber Estuary SAC/ SPA/ Ramsar into which the drain ultimately discharges.

Construction Noise Disturbance to Functionally Linked Land (Rosper Road Pools)

6.2 A noise impact assessment has been undertaken and is presented in ES Chapter 7: Noise and Vibration (ES Volume I). A potential source-receptor pathway has been identified in the LSE screening task as a result of changes in noise levels during construction that may disturb waterbirds using Rosper Road Pools.

6.3 Noise modelling has been undertaken and is presented in ES Chapter 7 (Noise and Vibration). Noise contour maps are provided in Appendix D. The noisiest activities during construction are associated with the site clearance works (vehicle movements etc.) as there will be no driven impact piling of foundations for the buildings on site; all piling will be done using Continuous Flight Auger (CFA) rigs, which do not produce the 'peaky' noise output that can be disruptive to birds. The modelled noise levels at the nearest part of Rosper Road Pools are in the 60 – 65 dB $L_{Aeq,T}$ range and <60 dB $L_{Aeq,T}$ across the open lagoon habitat. The predicted maximum noise level arising from construction activities on the nearest part of the Proposed Phillips 66 Development site to Rosper Road Pools is <60 dB L_{Amax} across the whole of Rosper Road Pools. Studies indicate that noise levels >84 dBA typically elicit a flight response in birds and the same research recommends that construction noise levels are kept below 70 dB to avoid excessive disturbance of birds. Given that the modelled levels are well below 70 dB $L_{Aeq,T}$/ L_{Amax}, it is therefore concluded that nesting avocet and wintering/ passage waterbirds at Rosper Road Pools would not be disturbed.

6.4 Natural England requested that additional assessment work was undertaken to review the predicted changes in construction noise against ambient noise and suggested that a 3 dBA 'rule of thumb' change in noise level compared to ambient noise represented a suitable threshold above which any changes could disturb birds. A 3 dBA increase is a concept used in acoustics and sound engineering to describe a doubling or of sound energy using a logarithmic scale. It is therefore not an absolute threshold above which disturbance to birds would occur, but has been applied in this report to inform HRA as a screening threshold above which disturbance to birds may occur, and therefore requires further assessment.

6.5 Baseline noise modelling was undertaken at two locations within Rosper Road Pools (Eco 3 and Eco 4); these locations were chosen to be representative of habitats that supported important numbers of SPA/ Ramsar waterbirds that were considered functionally linked to the Humber Estuary. Further information on the methodology for the baseline noise monitoring and the locations is provided in Section G.1 in Appendix G.

6.6 Noise contours have been prepared for the construction phase to show the predicted LAeq and LAmax at the ecology receptors in Rosper Road Pools. A summary of the predicted changes in LAeq and LAmax as a result of construction are presented in Table G2.1 in Section G.2 of Appendix G. The modelling demonstrates that there are no predicted exceedances of Natural England's suggested 3 dBA 'rule-of-thumb' change in noise level threshold at Eco 3 and Eco 4 in Rosper Road Pools. Noise contours showing the predicted construction LAmax and LAeq are presented as Figure G2.1 and G2.2.

6.7 It is therefore concluded that the change in noise levels during construction is not at a magnitude that would be expected to cause any disturbance to waterbirds using Rosper Road Pools for breeding, feeding or roosting at any time of year, and therefore there will be no adverse effects on the integrity of the Humber Estuary SPA/ Ramsar.

Construction Noise Disturbance to Functionally Linked Land (Terrestrial Fields)

6.8 A noise impact assessment has been undertaken and is presented in ES Chapter 7: Noise and Vibration (ES Volume I). A potential source-receptor pathway has been identified in the LSE screening task as a result of changes in noise levels during construction that may disturb waterbirds using Rosper Road Pools.

6.9 Noise modelling has been undertaken and is presented in ES Chapter 7 (Noise and Vibration). The noisiest activities during construction are associated with the site clearance works (vehicle movements etc.) as there will be no driven impact piling of foundations for the buildings on site; all piling will be done using Continuous Flight Auger (CFA) rigs, which do not produce the 'peaky' noise output that can be disruptive to birds. The modelled noise levels at the nearest functionally linked field (Field 5) to the Proposed Phillips 66 Development are in the 60 – 65 dB $L_{Aeq,T}$ range and <60 dB $L_{Aeq,T}$ across the majority of the field. Studies indicate that noise levels >84 dBA typically elicit a flight response in birds and the same research recommends that construction noise levels are kept below 70 dB to avoid excessive disturbance of birds. Given that the modelled levels are well below 70 dB $L_{Aeq,T}$/ L_{Amax}, it is therefore concluded that wintering/ passage waterbirds using terrestrial fields east of Rosper Road would not be disturbed during the construction phase of the Proposed Phillips 66 Development.

6.10 As described above for noise impacts at Rosper Road Pools, additional assessment work was undertaken to review the predicted changes in construction noise against ambient noise using the 3 dBA 'rule of thumb' change in noise level threshold suggested by Natural England as a suitable threshold above which any changes could disturb birds. It is not an absolute threshold above which disturbance to birds would occur, but has been applied in this report to inform HRA as a screening threshold above which disturbance to birds may occur, and therefore requires further assessment.

6.11 Baseline noise modelling was undertaken at two locations within functionally linked land to the east of Rosper Road (Eco 1 and Eco 2); these locations were chosen to be representative of habitats that supported important numbers of SPA/ Ramsar waterbirds that were considered functionally linked to the Humber Estuary. Further information on the methodology for the baseline noise monitoring and the locations is provided in Section G.1 in Appendix G.

6.12 Noise contours have been prepared for the construction phase to show the predicted LAeq and LAmax at the ecology receptors in the functionally linked land and are presented as Figure G2.1 and G2.2 in Section G.2 of Appendix G. A summary of the predicted changes in LAeq and LAmax as a result of construction are presented in Table G2.1 in Section G.2 of Appendix G. The modelling demonstrates that there are no predicted exceedances of Natural England's suggested 3 dBA 'rule-of-thumb' change in noise level threshold at Eco 1 and Eco 2 in the functionally linked land to the east of Rosper Road.

6.13 It is therefore concluded that the change in noise levels during construction is not at a magnitude that would be expected to cause any disturbance to waterbirds using Rosper Road Pools for breeding, feeding or roosting at any time of year, and therefore there will be no adverse effects on the integrity of the Humber Estuary SPA/ Ramsar.

Changes in Surface Water Quality during Operation

6.14 A water quality impact assessment has been undertaken and is presented in ES Chapter 9: Water Quality and Flood Risk (ES Volume I). A potential source-receptor pathway has been identified in the LSE screening task as a result of effluent discharge from the Wet Gas Scrubber containing elevated sulphate levels to South Killingholme Drain, which has hydrological connectivity to Rosper Road Pools and which ultimately discharges into the Humber Estuary via a sluice gate.

6.15 The concentrations of sulphate to be discharged to South Killingholme Drain following dilution with the existing Phillips 66 Humber Refinery discharge are anticipated to be up to approximately 810 mg/l. This would be diluted in the Drain by around 40% before reaching Rosper Road Pools. Treatment to reduce the concentration of the effluent leaving the Refinery by around 50% have been identified (using deSOx additive) but beyond this no viable options for sulphate treatment have been identified (see Appendix I). A review of the literature available on ecotoxicity of sulphate to aquatic organisms and potential effects on aquatic ecosystems demonstrated that there is no certainty regarding the effect levels of sulphate to aquatic organisms, including fish and macroinvertebrates. Government bodies such as the Environment Agency in the UK state that "*reducing [Sulphate] concentrations is not, in itself, an objective of mine water treatment in the UK, […], partly because its impact on surface watercourses is usually limited, and partly because of the great difficulty of removing sulphate using conventional treatment technologies*" (Environment Agency, 2009).

6.16 Again, in the UK, the UKTAG advisory group describe sulphate as "*a chemical that had no effect on the ecology*" (UKTAG, 2008). Consequently, they have derived standards "*only for chemicals where there is general confidence that they cause biological impacts*" (UKTAG, 2008).

6.17 These statements are to be taken with caution, but they highlight the fact that sulphate it is not considered to be a priority in setting out quality standards for the protection of aquatic life.

6.18 Sulphate is not included in the indicative list of polluting substances in Annex II to the Industrial Emissions Directive (2010/75/EU) to be taken into account for setting emission limit values. However, freshwater organisms can be harmed by excessive sulphate concentrations, and this is reflected in the Environment Agency having an annual average Environmental Quality Standard (EQS) of 400 mg/l for freshwaters. There is no maximum allowable concentration EQS for sulphate (which relates to evaluating the short-term impacts of discharges). There is no sulphate EQS in place for estuaries and coastal waters.

6.19 Rosper Road Pools functions as a water storage area for the South Killingholme Drain catchment; its purpose is to store water when the system is tide locked to prevent flooding in the catchment. When the tide is in and there is no flow from South Killingholme Drain out into the Estuary, the water level in the drain rises and spills over a weir structure on the northern side of Rosper Road Pools, and then discharges back into the catchment as the tide falls. The frequency at which this system is in use depends on the weather i.e. if there is a period of heavy rainfall then water can be flowing into Rosper Road Pools on every high tide during that period.

6.20 A literature review has been undertaken to assist with the assessment of the effects of elevated sulphate discharge, given the lack of published UK guidance on discharge levels from industrial processes. The results of the review are presented in Appendix F. There are differing levels of recommended sulphate discharge to freshwaters that are considered acceptable from an environmental perspective, and only two states in the US (Illinois and Iowa) and Canadian British Columbia have published standards for water quality for this pollutant. The level of toxicity is affected by baseline conditions including the pH, conductivity and hardness ($CaCO_3$) of the receiving water. The review concluded that a level of ~1,000 mg/l of sulphate would be an appropriate maximum allowable concentration to protect aquatic life.

6.21 Baseline water quality monitoring has been undertaken at South Killingholme Drain and Rosper Road Pools in 2023 to assist with the interpretation of the changes in sulphate levels within the

effluent discharge that will occur during operation of the Proposed Phillips 66 Development. This is presented in the AECOM Baseline Water Quality Monitoring Report.

6.22 Despite the predicted high sulphate level at the point of discharge, it is unlikely that water entering Rosper Road Pools when the system is tide locked would be at the same level as that discharged, as when water flows into the Pools over the weir there are higher levels of water in the ditches and thus there would be some dilution. It is predicted that the discharge would be diluted in South Killingholme Drain by around 40% before reaching Rosper Road Pools, reducing the sulphate concentration to less than 650 mg/l. There would also not be regular routine operational discharge into the Pools, as the weir is not overtopped at high tide unless there are high levels of rainfall (although the regularity of weir overtopping is not monitored by the Internal Drainage Board). This assumption was confirmed during the visual observations made during the baseline monitoring work undertaken in 2023. However, there remains a risk that on occasion, water containing an elevated sulphate level would enter the Pools. This may change the water chemistry over time and could result in adverse effects on the aquatic faunal assemblage on which SPA/ Ramsar waterbirds feed. It is difficult to establish what the effects of elevated sulphate would be in the aquatic environment, as the literature has identified a number of factors that affect sulphate toxicity to aquatic fauna, and thus what level would adversely affect the aquatic fauna of Rosper Road Pools and consequently the waterbirds that feed on them. Although only a small site, Rosper Road Pools plays an important role in providing alternative feeding, roosting and loafing habitat for waterbirds pushed off the nearby North Killingholme mudflats across the high tide, and is considered functionally linked to the SPA/ Ramsar. Any damage to this functionally linked habitat due to a depletion in the availability of aquatic feeding resources may result in the displacement of waterbirds, and therefore has the potential to adversely affect the integrity of the SPA/ Ramsar.

6.23 Baseline data have now been collected for Rosper Road Pools and South Killingholme Drain, , however, there are uncertainties surrounding the acceptable level of sulphate discharge for the protection of the aquatic environment and routine monitoring of effluent discharges for sulphates is neither undertaken nor required in the UK as part of the environmental permitting regime. The Pools are very shallow (approximately 1 m in depth), and already subject to some (albeit limited) saline intrusion, with the baseline water quality monitoring confirming that the water chemistry of the Pools is comparable with that of South Killingholme Drain, due to their hydrological connectivity via the weir, into which water from South Killingholme Drain flows intermittently, mostly during periods of high rainfall when the drainage system is tidally locked. Overtopping of the weir is also influenced by high vegetation levels in South Killingholme Drain in the summer months, which reduces the capacity of the drain and therefore water flows over the weir into the Pools during lower rainfall and shorter tide locking events. The drain is cleared annually of vegetation by the Internal Drainage Board as part of ongoing maintenance.

6.24 The recorded baseline concentrations of sulphate within Rosper Road Pools (as sampled close to the weir due to access restrictions to littoral margins elsewhere) were, as expected, broadly similar to the concentration in South Killingholme Drain, ranging between 160 – 390 mg/l, with an average of 328 mg/l. A single sample was possible from a more distant location on Rosper Road Pools during the final monitoring visit (06/10/2023) and this recorded a consistent value of 330 mg/l, and although just a single sample, suggests that the water column is well mixed and the sulphate concentration within Rosper Road Pools is consistent across the Pools.

6.25 The key waterbird species (i.e., species recorded in numbers >1% of the Humber Estuary populations) using Rosper Road Pools in the winter months were black-tailed godwit and wigeon. The results of the bird surveys at Rosper Road Pools are presented in Table 11 in Appendix 13A of ES Chapter 13: Ecology. Black-tailed godwit is a qualifying species for the SPA/ Ramsar and wigeon, although not a qualifying species of the SPA/ Ramsar, is part of the assemblage (Article 4.2) qualification. These species are therefore potentially vulnerable to any changes in water chemistry that would adversely affect their food source, as it could result in them being displaced from the affected habitat. Black-tailed godwit was recorded relatively frequently at Rosper Road Pools, with groups of feeding/ loafing/ roosting birds observed on 8 out of 12 survey visits in 2021/22, although numbers >1% Humber Estuary threshold were only present on 3 out of the 8 occasions they were recorded. Wigeon was recorded on 7 out of 12 survey visits in 2021/22. For both species, it was typically not possible for the surveyor to determine their behaviour on all survey visits to differentiate between feeding, roosting and

loafing. However, for the purposes of the assessment it is assumed that both these species are using Rosper Road Pools regularly for feeding, roosting and loafing.

6.26 Breeding avocet are also present on the specially created nesting islands. However, it is reasonable to assume that the availability of the Pools for nesting avocet would not be impacted by any changes in the water chemistry, since the nesting habitats would not be affected. The SPA/ Ramsar conservation objectives relating to breeding avocet would therefore not be affected, and it can be concluded with confidence that there would be no adverse effects on the integrity of the designated site for this qualifying species.

6.27 With no treatment of operational effluent, the sulphate concentration in South Kililngholme Drain, and likely Rosper Road Pools, could exceed 1,000 mg/l, which is the threshold at which the literature review indicated may result in damage to aquatic organisms. Therefore, mitigation through deSOx treatment is required to reduce sulphate concentrations in the effluent such that no adverse effects on the integrity of the designated site would be predicted.

6.28 On-site desulphurisation (deSOx) treatment of the FCC flue gas will be used to reduce the effluent sulphate concentration at the point of discharge from the Humber Refinery to South Killingholme Drain by around 50%, but beyond this no viable option for sulphate treatment have been identified. The assumptions made in respect of the 50% reduction through deSOx treatment are presented in Appendix I. There are no WFD Environmental Quality Standards (EQS) for sulphate under the WFD (Classifications and Standards) Directions (England and Wales) 2015. The Environment Agency has a freshwater standard for sulphate of 400 mg/l; however this is unlikely to be applicable to South Killingholme Drain as it is referring to drinking water standards. A literature review, presented in Appendix F, has identified a potential maximum allowable concentration of 1,000 mg/l of sulphate for the protection of the freshwater environment. To inform the applicability of any mitigation for impacts on Rosper Road Pools, baseline data for its water chemistry was collected to inform further assessment. Water chemistry baseline data were also collected for South Killingholme Drain.

6.29 With 50% sulphate removal through deSOx, the concentrations of sulphate in South Killingholme Drain adjacent to Rosper Road Pools would likely increase from around 360 - 470 mg/l to between 530-630 mg/l, which would be an increase of around 30% to 55% above baseline. Thus, there will be an increase over the existing baseline, but less than 1,000 mg/l concentration (suggested EQS) and a lower increase than previously anticipated (due to the baseline concentration being higher than previously anticipated). Therefore, on the balance of available evidence that because the sulphate levels within the effluent would be reduced to an environmentally acceptable level (i.e. <1,000 mg/l), it is reasonable to conclude that there would be no damage to the aquatic flora and fauna of the functionally linked land at Rosper Road Pools that supports qualifying waterbird species, and therefore that there will be no adverse effects on the integrity of the Humber Estuary SPA/ Ramsar .

6.30 As there is no EQS in place for estuaries and coastal waters, it is very difficult to determine a magnitude at which elevated sulphate levels may affect aquatic organisms in the Estuary. However, given that the discharge point to the Estuary is over 1 km downstream of the effluent discharge point, it is reasonable to assume that there will be some dilution by the time the effluent reaches the Humber Estuary. There will also be significant dilution once it reaches the Estuary. Seawater typically contains about 2,700 mg/L of sulphate (Hitchcock, 1975), although the baseline water quality monitoring at the South Killingholme Drain discharge point into the Humber Estuary recorded a lower level of 1,600 mg/L (presumably due to the significant freshwater content of the drain discharge at that point) and therefore the level of sulphate in the wet gas scrubber effluent is below the naturally occurring levels in seawater. The water quality monitoring has concluded that with deSOx treatment, the concentration in South Killingholme Drain at the outflow into the Estuary will be lower than the sulphate concentration in the estuary (including at low tide). Without treatment the concentration may slightly exceed baseline conditions as the South Killingholme Drain will discharge on the ebb tide. However, this would only be temporary as higher sulphate levels are expected to return as the tide comes back in. The fauna and flora of the Estuary will be adapted to these higher sulphate concentrations and thus we would not expect any impact on the habitats or species present. It is concluded that the elevated level of sulphate in the effluent discharge will not result in any discernible changes to the sulphate concentration of the Estuary, and therefore it can be concluded with certainty that

this pathway will not result in an adverse effect on the integrity of the Humber Estuary SAC/ SPA/ Ramsar.

7. In Combination Effects

Stage 1: Screening for LSEs In Combination with Other Plans or Projects

7.1 The HRA process requires potential effects to be discussed in-combination with other plans and projects. This is to account for cumulative impacts of development plans, where the individual effects of a proposal are screened out due to there being an insufficient magnitude of impact. Ultimately, this approach allows the identification of individually small, but cumulatively material effects with the potential to cause LSEs or adverse effects.

7.2 Although a combined ES has been prepared for the Proposed VPI Development and the Proposed Phillips 66 Development, it has been agreed with stakeholders that a separate HRA will be prepared for each of the Proposed Developments. The Proposed VPI Development is therefore screened for potential in-combination effects.

7.3 The projects in Table 6 below were considered for in combination effects. However, it was ultimately concluded that no in combination adverse effect on integrity would arise alongside the Proposed Phillips 66 Development because the projects, with the exception of the Proposed VPI Development, will affect different parts of the European sites or functionally linked land and therefore not overlap in impacts, or will not be constructed at the same time, or the Proposed Phillips 66 Development will not lead to impacts that would arise from the other projects (such as loss of functionally linked land due to the AMEP development).

Table 6: List of plans and projects that have been appraised as part of the in-combination assessment, including location in relation to the nearest European site and potential for interaction with the Proposed Phillips 66 Development

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
PINS (Able Humber Ports Ltd) - Able Marine Energy Park (AMEP) Consented, under construction	New quay, capital dredging and onshore facilities for manufacture, assembly and storage of marine energy installation components.	Partly within	<u>Potential In Combination Loss of Functionally Linked Land</u> Mitigation for the large-scale losses of functionally linked land associated with the AMEP scheme at North Killingholme Marshes has already been delivered north of Humber Sea Terminal, at Halton Marshes Wet Grassland Scheme (HMWGS). The HRA therefore concluded that there would be no adverse effect on integrity of the SPA/ Ramsar. The HMWGS mitigation area is several kilometres north of the Proposed Phillips 66 Development and will therefore not be affected by the Proposed Phillips 66 Development as it is well outside the zone of influence. There is also no potential for in-combination LSE on functionally linked land east of Rosper Road because the loss of fields within the AMEP site has already been compensated for through habitat creation at HMWGS for Habitats Regulations compliance.	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			Potential In Combination Noise/ Visual Disturbance During Construction and Operation Site clearance work within the AMEP development boundary has been ongoing for several years, and therefore is part of the baseline conditions that birds within the remaining Rosper Road fields (south of Station Road) will be experiencing. Any birds present in these fields are therefore present within this context, and therefore there is no potential for effects in combination with the Proposed Phillips 66 Development.	No
Enabling works on and adjacent to the AMEP site EIA Scoping Request (PA/ SCO/ 2022/7)	Enabling works for AMEP	0.2 km	The scoping opinion request letter states that as alternative mitigation land has already been delivered at HMWGS, significant effects on ecology receptors are considered unlikely. It is assumed that the Applicant's HRA will consider all potential pathways for likely significant effects, including noise and visual disturbance during construction and operation. However, as all the land within and surrounding the site has been either developed, or planned/ consented for future development there is a presumption that this area will be lost for SPA/ Ramsar birds (which has driven the creation of the HMWGS), and consequently all SPA/ Ramsar waterbirds will be permanently displaced.	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
AMEP Monopile Manufacturing Facility (PA/2021/1525) Approved August 2022	Monopile manufacturing facility approximately 26 ha in extent.	0.2 km	<u>Potential In Combination Noise/ Visual Disturbance During Construction</u> The HRA screening concluded LSEs as a result of construction noise, and subsequently an appropriate assessment was undertaken. The appropriate assessment concluded that there would be no adverse effect on integrity of the SPA/ Ramsar given that only a small area of functionally linked land would be affected, and that this land supported only very low numbers of curlew (peak count of 7 birds is well below the 1% Humber Estuary population threshold). No other SPA/ Ramsar waterbirds were present in numbers >1% threshold in the surrounding fields, and therefore they were screened out of the assessment.	No
			<u>Potential In Combination Loss of Functionally Linked Land</u> Mitigation for the large-scale losses of functionally linked land associated with the AMEP scheme at North Killingholme Marshes has already been delivered north of Humber Sea Terminal, at Halton Marshes Wet Grassland Scheme (HMWGS). A detailed conservation management plan and an updated site improvement plan (dated June 2022) has been prepared to ensure the site meets its objectives. The HRA therefore concluded that there would be no adverse effect on integrity of the SPA/ Ramsar.	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			As discussed above in respect of the AMEP development, the HMWGS mitigation area is several kilometres north of the Proposed Phillips 66 Development and will therefore not be affected by the Proposed Phillips 66 Development as it is well outside the zone of influence. There is also no potential for in-combination LSE on functionally linked land east of Rosper Road because the majority of the fields (including the monopile facility site) have already been consented for development for Able UK projects (mostly associated with AMEP), and adequate compensation delivered at HMWGS for Habitats Regulations compliance.	
			Potential In Combination Noise/ Visual Disturbance During Operation The HRA screening concluded no LSE on the SPA/ Ramsar or surrounding functionally linked land due to noise/ visual disturbance during operation because modelled noise levels outside the site <55dB and therefore too low to result in disturbance/ displacement of waterbirds.	No
			Potential In Combination Lighting Disturbance During Operation Given the proximity of the site to the SPA/ Ramsar, the HRA screening conclude that this pathway would result in LSE, and therefore an appropriate assessment was undertaken.	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			The appropriate assessment concluded that operational lighting disturbance would result in no adverse effect on integrity of the SPA/ Ramsar. Given the distance of the Proposed Phillips 66 Development from the Humber Estuary SPA/ Ramsar, and the physical separation of the site from the functionally linked land east of Rosper Road, it is concluded that there is no potential for in-combination LSE on the SPA/ Ramsar as a result of operational lighting.	
PINS (VPI Immingham B Ltd) - VPI Immingham Open Cycle Gas Turbine (OGCT) Consented	New 299 MW power station on land west of Rosper Road approximately 12 ha	1.4 km	<u>Potential In Combination Noise/ Visual Disturbance During Construction</u> Given the proximity of this development to the Proposed Phillips 66 Development, noise/ visual disturbance from each development should they be constructed together has been identified as a potential pathway for in-combination effects on waterbirds feeding, roosting and loafing in terrestrial fields on the eest side of Rosper Road. The No Significant Effects (NSE) report submitted as part of the DCO has been reviewed for relevant information to inform this in-combination effects assessment. Other than piling, discussed below, none of the other construction activities associated with the construction of the VPI Immingham OGCT will generate noise that would be discernible above the ambient noise environment of the industrial sites surrounding the Rosper Road fields. It is	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			reasonable to conclude that there is no potential for in-combination likely significant effects on waterbirds via this pathway. This pathway is therefore scoped out. Construction of the VPI Immingham OGCT may require the use of piling techniques. The NSE report states that any potential noise or vibration impacts arising from the use of these techniques would be controlled through measures to be included in the detailed Construction Environmental Management Plan (CEMP), a draft of which was included as part of the DCO application.	
			<u>Potential In Combination Loss of Functionally Linked Land</u> Habitat within the boundary of the VPI Immingham OCGT scheme and the Proposed Phillips 66 Development is not functionally linked to the SPA/ Ramsar.	No
			<u>Potential In Combination Noise/ Visual Disturbance During Operation</u> Noise modelling was carried out for the operational phase of the VPI Immingham OCGT, which predicted that that operational noise levels will have attenuated to below 50 dB L_{Aeq} across the majority of the fields west of Rosper Road, with only the most western edge (along the boundary to Rosper Road) experiencing worst case operational noise levels of 57 dB L_{Aeq}. The sound levels along the eastern	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			edge of the Rosper Road fields was predicted to be below 40 dB L_{Aeq}. These levels are well within the ambient range of noise levels across these fields, which was between 61 dB L_{Aeq} and 51 dB L_{AF90} along Rosper Road at the closest point of the field nearest to the Proposed Phillips 66 Development, to 48 dB L_{Aeq} and 43/46 dB L_{AF90} along the eastern edge. The NSE report therefore concluded that operational noise would not result in any increase in the baseline levels experienced by waterbirds that may be using the fields east of Rosper Road.	
			<u>Potential In Combination Air Quality Impacts During Operation</u> Negligible impacts from construction traffic. Cumulative operational emissions for the OCGT with the operation of the existing VPI Immingham CHP Power Plant were considered at the time of the OCGT DCO application. Given that the OCGT Development only results in negligible increases in pollutant concentrations that will be released from the OCGT, no cumulative impacts are anticipated.	No
Land Adjacent to the Westgate	Port-related storage (including full application for open storage and outline application for	0.7 km	<u>Potential In Combination Loss of Functionally Linked Land</u> Habitat within the boundary of the Land Adjacent to Westgate Entrance scheme comprised a mosaic of tall grassland and scrub habitat originating from abandoned	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
Entrance, Port of Immingham (PA/2022/1223) Awaiting determination	buildings) occupying approximately 9 ha		agricultural land, and was assessed as unsuitable to support loafing, feeding and roosting waterbirds. The land was therefore concluded to be not functionally linked to the SPA/ Ramsar.	
			<u>Potential In Combination Noise/ Visual Disturbance During Construction (Open Storage)</u> Given the proximity of this development to the Proposed Phillips 66 Development, noise/ visual disturbance from each development should they be constructed together has been identified as a potential pathway for in-combination effects on waterbirds feeding, roosting and loafing in terrestrial fields on the west side of Rosper Road, and breeding in Rosper Road Pools. The Report to Inform a Habitats Regulations Assessment submitted with the planning application (dated June 2022) has been reviewed for relevant information to inform this in-combination effects assessment. Construction activities associated with this proposed development will generate noise that would be <45 dB in the fields adjacent to the site/ Rosper Road Pools and would therefore not be discernible above the ambient noise environment of the industrial sites surrounding the Rosper Road fields and pool. It is reasonable to conclude that there is no potential for in-combination likely significant effects on	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			waterbirds via this pathway. This pathway is therefore screened out. In terms of visual impacts, the screening assessment concluded that the nature and scale of construction activities would not be significantly different form on-going construction activities in the area. It is reasonable to conclude that there is no potential for in-combination likely significant effects on waterbirds via this pathway. This pathway is therefore screened out.	
			<u>Potential In Combination Noise/ Visual Disturbance During Construction (With Buildings)</u> Construction piling activities associated with the buildings will generate noise that would be >70 dB L_{Amax} across the entire Rosper Road Pools and >80 dB L_{Amax} over much of the pools. As this exceeds the general accepted limit of 70 dB above which waterbirds would be expected to be disturbed to such an extent that they took flight, this pathway was concluded to result in **LSE.** In terms of visual impacts, as for the open storage scenario, the screening assessment concluded that the nature and scale of construction activities would not be significantly different from on-going construction activities in the area. It is reasonable to conclude that there is no potential for in-	Yes

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			combination likely significant effects on waterbirds via this pathway. This pathway is therefore screened out.	
			Potential In Combination Noise/ Visual Disturbance During Operation (Open Storage) Noise modelling was carried out for the operational phase of this proposed development, which predicted that that operational noise levels will have attenuated to below 55 dB L_{Amax} across Rosper Road Pools, and therefore it was concluded that there would be no likely significant effects. However, the modelled L_{Amax} noise levels (the peaks of noise caused every time a shipping container makes contact) will exceed 70 dB L_{Amax} over the whole of Rosper Road Pools and exceed 80 dB L_{Amax} over some of the Pools. As this exceeds the general accepted limit of 70 dB above which waterbirds would be expected to be disturbed to such an extent that they took flight, this pathway was concluded to result in **LSE.** In terms of visual impacts, the screening assessment concluded that the nature and scale of operational activities would not be significantly different form on-going construction activities in the area. This pathway is therefore screened out. This option included luminaires on masts up to approximately 40 m high across the centre of the site, and	Yes

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			up to 30 m high at the northern boundary, and this pathway was therefore concluded to result in **LSE.**	
			Potential In Combination Noise/ Visual Disturbance During Operation (With Buildings) Noise modelling was carried out for the operational phase of this proposed development, which predicted that that operational noise levels will have attenuated to below 55 dB L_{Aeq} and 55 dB L_{Amax} across Rosper Road Pools, and therefore it was concluded that there would be no likely significant effects. It is reasonable to conclude that there is no potential for in-combination likely significant effects on waterbirds via this pathway. This pathway is therefore screened out. In terms of visual impacts, the screening assessment concluded that the nature and scale of operational activities would not be significantly different form on-going construction activities in the area. Operational lighting impacts were also considered and not predicted to be higher than existing light levels to Rosper Road Pools. It is reasonable to conclude that there is no potential for in-combination likely significant effects on waterbirds via this pathway. This pathway is therefore screened out.	No
		1.7 km	Potential In Combination Loss of Functionally Linked Land	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
Humber Zero: Proposed VPI Development Sister project to Humber Zero: Phillips 66 Development Submission due at the same time as the Proposed Phillips 66 Development	Carbon capture and storage plant with associated infrastructure		Habitat within the boundary of the VPI Site does not support loafing, feeding and roosting waterbirds. The land was therefore concluded to be not functionally linked to the SPA/ Ramsar. There is therefore no potential for in-combination losses of functionally linked land.	
			<u>Potential In Combination Noise/ Visual Disturbance during Construction</u> Noise modelling was carried out for the construction phase of the Proposed VPI Development, which predicted that that operational noise levels will have attenuated to below 55 dB L_{Aeq} and 55 dB L_{Amax} across Rosper Road Pools and the surrounding terrestrial fields east of Rosper Road. Noise contour plots for the Proposed Phillips 66 Development in combination with the Proposed VPI Development are provided in Appendix E. Further assessment has been undertaken to review the changes in predicted noise levels against the baseline noise levels (see Appendix G), and a 3 dBA 'rule of thumb' in levels change suggested by Natural England to be used as a screening threshold for identifying potential bird disturbance. At one of the locations modelled (Eco 1, in the functionally linked land east of Rosper Road), the increase is predicted to be 5 dBA above ambient (see Table G4.1 in Section G.4 of Appendix G). This pathway is therefore	**Yes**

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			screened into the Stage 2 assessment. No other changes above the 3 dBA threshold are identified at any of the other ecological receptors, and therefore noise impacts at these locations are concluded to result in no likely significant effects on waterbirds. The nature and scale of the temporary construction activities associated with the Proposed VPI Development are not significantly different from on-going industrial activities within the area surrounding the Rosper Road Pools. This pathway is therefore screened out.	
			<u>Potential In Combination Noise/ Visual Disturbance during Operation</u> Noise modelling was carried out for the operational phase of the Proposed VPI Development, which predicted that that operational noise levels will have attenuated to below 55 dB L_{Aeq} and 55 dB L_{Amax} across Rosper Road Pools and the surrounding terrestrial fields east of Rosper Road. Further assessment has been undertaken to review the changes in predicted noise levels against the baseline noise levels (see Appendix G), and a 3 dBA 'rule of thumb' in levels change suggested by Natural England to be used as a screening threshold for identifying potential bird disturbance. A noise contour map has been prepared to show the predicted LAeq at the ecology receptors for the operation of the Proposed	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			Phillips 66 Development in combination with the operation of the Proposed VPI Development (see Figure G4.3 in Section G.4 of Appendix G). For both the daytime and nighttime scenarios at all receptors there are no changes exceeding 3 dBA (see Table G4.2). It is therefore reasonable to conclude that the cumulative effects of operational noise would not result in disturbance to waterbirds, and therefore there would be no likely significant effects on SPA/ Ramsar waterbirds using Rosper Road Pools or functionally linked land resulting from the operation of the Proposed Phillips 66 Development in combination with the operation of the Proposed VPI Development. This pathway is therefore screened out. The nature and scale of the operational activities associated with the Proposed Development are not significantly different from on-going industrial activities within the area surrounding the Rosper Road Pools. This pathway is therefore screened out.	
			<u>Potential In-Combination Air Quality Impacts during Operation</u> An air quality impact assessment has been undertaken and has modelled the cumulative effects of the two Proposed Developments. Further information on the cumulative assessment work undertaken is presented below.	**Yes**

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
PINS (Chrysaor Production (UK) Limited - Viking CCS Pipeline Scoping Report Submitted	New 55 km underground CO_2 pipeline from Immingham to Theddlethorpe	0.2 km	<u>Potential In-Combination Air quality Impacts during Construction and Operation</u> There is the potential for construction activities to overlap, but no significant air quality effects have been identified in the scoping report. No operational emissions are envisaged.	No
			<u>Potential In Combination Loss of Functionally Linked Land</u> The Scoping Report highlights the first 5 km of pipeline at the northern end of the EIA Scoping Boundary (1 km wide corridor adjacent to the Phillips 66 Site) as being functionally linked land to the Humber Estuary SPA/ Ramsar, although surveys are still ongoing. The Applicant will need to undertake a cumulative impact assessment for losses of functionally linked land once surveys are complete. However, given that the Proposed Development will not result in any losses of functionally linked land, there is no potential for in-combination effects.	No
PINS (National Grid) - Humber Low	CO_2 and hydrogen transport pipelines across the Humber region	Crosses Humber Estuary	<u>Potential In-Combination Air quality Impacts during Construction and Operation</u> There is the potential for construction activities to overlap, but no significant air quality effects have been identified.	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
Carbon Pipelines Scoping Report Submitted			No operational emissions are envisaged.	
			Potential In Combination Loss of Functionally Linked Land The Scoping Report identifies a number of route corridor options that would impact functionally linked land to the Humber Estuary SPA/ Ramsar, although surveys are still ongoing. The Applicant will need to undertake a cumulative impact assessment for losses of functionally linked land once surveys are complete. However, given that the Proposed Phillips 66 Development will not result in any losses of functionally linked land, there is no potential for in-combination effects.	No
			Potential In-Combination Noise/ Visual Disturbance during Construction and Operation Due to the distance of the project from the Proposed Phillips 66 Development (2.4 km), it is not considered that there is potential for cumulative effects on SPA/ Ramsar birds due to noise/ visual disturbance.	No
PINS (C.GEN Killinghol me Ltd) -	New 470 MW gas-fired power station	Adjacent	Potential In-Combination Air quality Impacts during Construction Potential for construction activities to overlap, but due to distance from the Proposed Phillips 66 Development (3.1	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
North Killingholme Power Project Consented			km), and the Study Area for construction type activities being 350 m, there is limited potential for cumulative effects.	
			Potential In-Combination Air quality Impacts during Operation Operational emissions from the North Killingholme Power Project and the Proposed Phillips 66 Development will be subject to regulation via Environmental Permits and the use of Best Available Techniques for the control of emissions. The North Killingholme Power Project is 3.1 km north of the Proposed Phillips 66 Development, and the prevailing wind direction (from the south-west) will mean that the location of peak impacts from both developments will not occur in the same location. Significant cumulative impacts are therefore not foreseen. Further assessment work will be undertaken by the Applicant, and will consider potential in-combination effects with the Proposed Phillips 66 Development.	No
PINS (Associated British Ports) - Immingham Eastern	Roll-on roll-off terminal including new jetty	Partly within	Potential In-Combination Noise/ Visual Impacts during Construction and Operation There is the potential for construction activities to overlap, but due to distance from the Proposed Phillips 66 Development (3.6 km), and the Study Area for construction type activities being 350 m, there is limited potential for cumulative effects.	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
Ro-Ro Terminal Scoping Report submitted			<u>Potential In-Combination Air quality Impacts during Operation</u> Emissions from vessels associated with the Ro-Ro Terminal could have the potential to result in cumulative impacts of combustion emissions with the Proposed Phillips 66 Development, although no assessment has been carried out to date, as the project is at scoping stage. Further assessment work will be undertaken by the Applicant, and will consider potential in-combination effects with the Proposed Development.	No
PINS (Associated British Ports) - Immingham Green Energy Terminal (IGET) Scoping Report submitted	Green energy terminal including new jetty	Partly within	<u>Potential In-Combination Air quality Impacts during Construction</u> There is the potential for construction activities to overlap, but due to distance from the Proposed Phillips 66 Development (3.6 km), and the Study Area for construction type activities being 350 m, there is limited potential for cumulative effects.	No
			<u>Potential In-Combination Air Quality Impacts during Operation</u> Emissions from docked vessels associated with the new jetty could have the potential to result in cumulative impacts of combustion emissions with the Proposed Phillips 66 Development. Further assessment work will be undertaken	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			by the Applicant, and will consider potential in-combination effects with the Proposed Phillips 66 Development.	
Gigastack (PA/SCO/ 2022/13) Scoping Report submitted	100 MW hydrogen electrolyser and underground electrical cable connection to Hornsea Two onshore substation, water discharge and a hydrogen export pipeline to the Humber Estuary	1 km	<u>Potential In Combination Noise/ Visual Disturbance during Construction and Operation</u> The Gigastack project is immediately to the north of Rosper Road Pools, which forms the southern boundary of the site. There is therefore the potential for noise/ visual disturbance to Humber Estuary SPA/ Ramsar waterbirds using Rosper Road Pools, which is identified as functionally linked land to the SPA/ Ramsar. Further assessment work will be undertaken by the Applicant to assess this potential pathway. At this stage a precautionary approach has been taken, and this pathway is scoped in.	**Yes**
			<u>Potential In Combination Loss of Functionally Linked Land</u> The Scoping Report states that analysis of wintering bird survey data for the site is ongoing and will be presented in the ES. However, it is assumed based on the baseline data collected for the Proposed Developments, that the field in which the Gigastack development will be located is functionally linked to the Humber Estuary SPA/ Ramsar. The Applicant will need to undertake a cumulative impact assessment for losses of functionally linked land once the data analysis and impact assessment has been completed.	No

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
			However, given that the Proposed Phillips 66 Development will not result in any losses of functionally linked land, there is no potential for in-combination effects.	
			Potential In Combination Air Quality Effects during Operation The scoping report states that the only continuous process emissions expected from the development are an oxygen vent and small hydrogen vent, with periodic hydrogen venting during maintenance, start up and energy situations. No combustion will take place on the site during hydrogen production. However, further assessment work will be undertaken by the Applicant as necessary, including procession emission modelling (if needed). However, at this stage, the information provided indicates that there would be no operational emissions to air that could adversely affect sensitive habitats. It is therefore unlikely that there will be any potential for operational air quality impacts in combination with the Proposed Phillips 66 Development.	No
Humber Zero: Proposed VPI Development			Potential In Combination Noise/ Visual Disturbance during Construction Further assessment has been undertaken to review the changes in predicted noise levels against the baseline noise levels (see Appendix G) arising from simultaneous construction of the Proposed Phillips 66 Development with	**Yes**

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
Sister project to Humber Zero: Phillips 66 Development Submission due at the same time as the Proposed Phillips 66 Development			the Proposed VPI Development, Land adjacent to Westgate Immingham and Viking CCS. The 3 dBA 'rule of thumb' in levels change suggested by Natural England to be used as a screening threshold for identifying potential bird disturbance has been used. At receptors Eco 1, Eco 3 and Eco 4, the increases are predicted to exceed the 3 dBA above ambient screening threshold (see Table G4.3 in Section G.4 of Appendix G). This pathway is therefore screened into the Stage 2 assessment. <u>Potential In Combination Noise/ Visual Disturbance during Operation</u> Further assessment has been undertaken to review the changes in predicted noise levels against the baseline noise levels (see Appendix G) arising from simultaneous operation of the Proposed Phillips 66 Development with the Proposed VPI Development, Land adjacent to Westgate Immingham and Viking CCS. The 3 dBA 'rule of thumb' in levels change suggested by Natural England to be used as a screening threshold for identifying potential bird disturbance has been used. For both the daytime and nighttime scenarios at all receptors there are no changes exceeding 3 dBA (see Table G4.5 in Section G4 of Appendix G). It is therefore reasonable to conclude that the cumulative effects of	No
Land Adjacent to the Westgate Entrance, Port of Immingham				

Project Name (Planning Reference)	Proposal	Proximity to Humber Estuary SAC/ SPA/ Ramsar	Potential In Combination Impact Pathways	Likely Significant Effects in combination with Proposed Phillips 66 Development?
(PA/2022/1223) Awaiting determination			operational noise would not result in disturbance to waterbirds, and therefore there would be no likely significant effects on SPA/ Ramsar waterbirds using Rosper Road Pools or functionally linked land resulting from the operation of the Proposed Phillips 66 Development in combination with the operation of the Proposed VPI Development, Land off Westgate Immingham (Open Storage Option and With Buildings Option) and Viking CCS. This pathway is therefore screened out.	
PINS (Chrysaor Production (UK) Limited - Viking CCS Pipeline Scoping Report Submitted				

Stage 2: Appropriate Assessment In Combination with Other Plans or Projects

7.4 The in-combination screening assessment identified the following pathways by which other plans or projects could result in LSE on Humber Estuary SPA/ Ramsar bird populations, and thus which pathways should be screened into appropriate assessment in-combination with the Proposed Phillips 66 Development:

- noise/ visual disturbance during construction – Proposed Phillips 66 Development in combination with Proposed VPI Development;
- noise/ visual disturbance during construction – Proposed Phillips 66 Development in combination with Land Adjacent to Westgate Entrance, Port of Immingham (With Buildings Option) and Gigastack;
- noise/ visual disturbance during construction – Proposed Phillips 66 Development in combination with Proposed VPI Development, Land Adjacent to Westgate Entrance, Port of Immingham (Open Storage Option and With Buildings Option) and Viking CCS;
- changes in air quality during operation – Proposed Phillips 66 Development in combination with Proposed VPI Development; and
- noise/ visual disturbance during operation - Proposed Phillips 66 Development in combination Land Adjacent to the Westgate Entrance, Port of Immingham (Open Storage Option).

Construction

Construction Noise/ Visual Disturbance

Proposed Phillips 66 Development in Combination with Proposed VPI Development

7.5 The potential for the construction of the Proposed Phillips 66 Development to result in in-combination disturbance effects with the Proposed VPI Development at receptor Eco 1, which is within functionally linked land to the Humber Estuary SPA/ Ramsar, was identified at the screening stage. This was as a result of the predicted change in noise levels at Eco 1 exceeding the 3 dBA 'rule of thumb' threshold for change suggested by Natural England as a threshold above which disturbance to birds may occur.

7.6 At receptor Eco 1 there is a predicted 5 dBA increase in LAeq assuming construction activities proceed at the same time (see Table G4.1 in Section G.4 of Appendix G). Although this is higher than the 3 dBA 'rule of thumb' indicated by Natural England as a change in magnitude potentially resulting in disturbance, both the ambient noise levels and cumulative construction noise levels at this receptor are below 50 dB LAeq, which is equivalent to the sound of moderate rainfall and below even noise levels arising from normal conversation (60 dBA). A noise contour plan illustrating the predicted cumulative construction noise LAmax and LAeq are provided as Figures G4.1 and G4.2 in Section G4 of Appendix G. It is therefore reasonable to conclude that the cumulative effects of construction noise at this location would not result in disturbance to waterbirds, and there would be no significant adverse effects on the integrity of the Humber Estuary SPA/ Ramsar resulting from construction noise from the Proposed Phillips 66 Development in combination with construction noise from the Proposed VPI Development.

Proposed Phillips 66 Development in Combination Land Adjacent to the Westgate Entrance, Port of Immingham (With Buildings Option)

7.7 The potential for the construction of Land Adjacent to the Westgate Entrance, Port of Immingham (With Buildings Option) to result in in-combination disturbance effects with the Proposed Phillips 66 Development on Rosper Road Pools (functionally linked to the Humber Estuary SPA/ Ramsar) was identified at the screening stage. Construction piling activities associated with the 'With Buildings' option for this scheme were modelled to generate noise that would be >70 dB L_{Amax} across the entire Rosper Road Pools and >80 dB L_{Amax} over much

of the pools. As this exceeds the general accepted limit of 70 dB above which waterbirds would be expected to be disturbed to such an extent that they took flight, this pathway was concluded to result in likely significant effects for this scheme alone.

7.8 In order to reduce noise levels (L_{Amax}) to below 70 dB across Rosper Road Pools during construction of Phase 2, the HRA identified that it was necessary to introduce mitigation if driven piling is confirmed to be necessary at the detailed design stage. Various mitigation options were proposed to reduce noise levels to acceptable levels across Rosper Road Pools including the use of acoustic barriers, acoustic shrouding around the driving system, resilient material (non-metallic dolly) between the hammer and the pile head/driving helmet and/ or pile driving equipment that partially or fully encloses the hammer and pile. With mitigation in place mitigation in place to reduce construction noise levels to below 70 dB L_{Amax} no adverse effect on integrity will arise through noise disturbance during building construction in combination with the Proposed Phillips 66 Development.

7.9 In terms of visual impacts, the HRA screening assessment for Land Adjacent to Westgate Entrance (With Buildings Option) concluded that the nature and scale of construction activities would not be significantly different from on-going construction activities in the area. It is reasonable to conclude that there is no potential for in-combination likely significant effects on waterbirds via this pathway and this pathway was therefore screened out.

Proposed Phillips 66 Development with Gigastack

7.10 Given the proximity of Gigastack to Rosper Road Pools and the potential for simultaneous construction with the Proposed Phillips 66 Development, there is potential for in-combination noise/ visual disturbance to Rosper Road Pools (functionally linked to the Humber Estuary SPA/ Ramsar). No detailed assessment of the potential impacts of construction of the Gigastack development has been undertaken at this stage, however, the Gigastack development is much closer to Rosper Road Pools than the Proposed Phillips 66 Development and it is therefore reasonable to conclude that there is no potential for additional disturbance to arise from the simultaneous construction of Gigatstack with the Proposed Phillips 66 Development However, further assessment will need to be undertaken by the Applicant as part of its HRA and ES.

7.11 In respect of potential noise/ visual disturbance to functionally linked land to the north of Gigastack, as all the remaining land has been either developed, or planned/ consented for future development there is a presumption that this land will be lost for SPA/ Ramsar birds (which has driven the creation of the HMWGS for the various Able UK developments, including AMEP and Enabling Works), and consequently all SPA/ Ramsar waterbirds will be permanently displaced.

Proposed Phillips 66 Development with Proposed VPI Development, Land off Westgate Immingham (Open Storage Option and With Buildings Option) and Viking CCS

7.12 The potential for the construction of the Proposed Phillips 66 Development to result in in-combination disturbance effects with the Proposed VPI Development (Open Storage Option and With Buildings Option), Land off Westgate Immingham and Viking CCS at receptors Eco 1, Eco 3 and Eco 4, which are within functionally linked land to the Humber Estuary SPA/ Ramsar, was identified at the screening stage. This was as a result of the predicted change in noise levels at these receptors exceeding the 3 dBA 'rule of thumb' threshold for change suggested by Natural England as a threshold above which disturbance to birds may occur.

7.13 For both the daytime and nighttime scenarios at receptors Eco 1, Eco 3 and Eco 4 there are predicted in-combination construction noise level changes exceeding Natural England's suggested 3 dBA 'rule of thumb' (see Table G4.3 in Section G.4 of Appendix G). This is due to the proximity of construction at the Land off Westgate, Immingham site to Rosper Road Pools. This increase would only arise in a situation where all four projects are under construction simultaneously and all projects undertake their noisiest construction activities at the closest point to Rosper Road Pools and the fields to the north simultaneously. Although representing the worst-case scenario, this is unrealistic given that there are as yet no confirmed/ committed construction timescales for the other projects, given that they are yet to be even consented by the relevant planning authorities (North Lincolnshire Council and the Planning Inspectorate). Furthermore, given the inter-dependencies associated with the construction of the Proposed

VPI Development and the Viking CCS (which is the pipeline route required to transport the captured carbon from the Proposed VPI Development to a storage facility) the applicants for those developments, once consented, will need to time their construction activities so they are not overlapping by virtue of their partially shared site boundaries.

7.14 However, even assuming the worst-case theoretical scenario described above where all four projects are constructed simultaneously, the cumulative construction noise level increases at Eco 1, Eco 3 and Eco 4 of up to 8 dBA does not result in construction noise levels exceeding 58 dB LAeq at any of these receptors, which to put into context is below noise levels arising from normal conversation (60 dBA). It is therefore reasonable to conclude that the cumulative effects of construction noise on functionally linked land would not result in disturbance to waterbirds, and there would be no significant adverse effects on the integrity of the Humber Estuary SPA/ Ramsar resulting from construction noise from the Proposed Phillips 66 Development in combination with construction noise from the Proposed VPI Development, Land off Westgate Immingham (Open Storage Option and With Building Option) and Viking CCS.

Operation

Operational Changes in Air Quality

Proposed Phillips 66 Development with Proposed VPI Development

7.15 There are no in-combination exceedances of the 1% Critical Load screening threshold for SO_2. There is no existing emission of ammonia (NH_3) from the VPI Site, and therefore the in-combination assessment remains below the 1% threshold for ammonia. There is therefore no potential for in-combination effects on designated habitats as a result of these emissions from the two Proposed Developments operating together.

7.16 The in-combination Nox impacts are largely comparable with those presented for the VPI Site, as the VPI Site has the larger mass emission of Nox from the existing operations, with the SO_2 impacts being largely comparable with those presented for the Phillips 66 Site, as the Phillips 66 Site has the larger SO_2 mass emission.

7.17 As the acid deposition impacts are largely influenced by the Phillips 66 Site emissions of SO_2 and NH_3, the depositional impacts of the in-combination assessment are comparable with those presented for the Phillips 66 Baseline Assessment.

7.18 The air quality modelling indicates three places within the Humber Estuary where in-combination contribution from the two Proposed Developments operating together will exceed 1% of the Critical Load for nitrogen deposition (receptors OE1d,OE1e and OE2) (ES Appendix 6B, Table 6B.44). In the previous version of this assessment OE1d was assigned as heathland, which was not a designated feature of the Humber Estuary SAC, and was therefore not considered further. However, as set out in Appendix H, this receptor has been revised to wetland and reedbed habitat, which although also not a designated feature of the Humber Estuary SAC, has been included in the assessment on the basis that it provides functionally linked habitat for qualifying species of SPA/ Ramsar in waterbirds. A revised version of ES Chapter 6 Table 6B.44 has been prepared as part of the updated assessment (see below).

Revised Table 6B.44 – In-Combination Future – Nitrogen Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load	Change in PC over VPI Baseline Assessment
Original values presented in ES Chapter 6 (Air Quality)								
OE1d	*Northern wet heath*	*20.44*	*10*	*0.48*	*4.8%*	*20.9*	*209%*	*+2.9%*
OE1e	*Pioneer, low, mid upper saltmarshes*	*20.44*	*20*	*0.97*	*4.8%*	*20.9*	*107%*	*+3.6%*

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load	Change in PC over VPI Baseline Assessment
OE2	*Pioneer, low, mid upper saltmarshes*	*20.44*	*20*	*0.48*	*2.4%*	*20.9*	*105%*	*+1.4%*
Revised Values								
OE1d	**Wetland and reedbed**	**17.0**	**10**	*0.48*	**4.8%**	**17.5**	**175%**	**+2.9%**
OE1e	**Pioneer, low, low- mid saltmarshes**	**16.8**	**20**	*0.97*	**4.8%**	**17.8**	**89%**	**+3.6%**
OE2	**Upper saltmarshes**	**17.0**	**10**	*0.48*	**4.8%**	**17.5**	**175%**	**+2.8%**

7.19 At receptors OE1e and OE2 (saltmarsh) where the in-combination Critical Load for this habitat is exceeded and the contribution of the two Proposed Developments (driven by the contribution of the Proposed VPI Development) is 4.8% of the critical load. However, paragraph 4.25 of Natural England guidance[18] indicates that the simple fact that '1% of the Critical Load threshold' is exceeded doesn't necessarily mean an adverse effect on integrity will occur.

7.20 For saltmarsh, the UK Air Pollution Information System (APIS) provides several Critical Load ranges, the appropriateness of which depends on position in the tidal profile. For lower and middle saltmarsh a critical load of 20-30 kg/ha/yr is provided, while for infrequently inundated upper saltmarsh (defined as EUNIS classes MA223 and MA224) a critical load range of 10-20 kgN/ha/yr is provided. Nitrogen inputs have been experimentally demonstrated to have an effect on overall species composition of saltmarsh. However, the Critical Loads on APIS are relatively generic for each habitat type and cover a wide range of deposition rates. They do not (and are not intended to) take other influences (to which the habitat on a given site may be exposed) into consideration.

7.21 Moreover, it is important to note from APIS that the experimental studies which underlie conclusions regarding the sensitivity of saltmarsh have '… *neither used very realistic N doses nor input methods i.e. they have relied on a single large application more representative of agricultural discharge'*, which is far in excess of anything that would be deposited from atmosphere. Therefore, APIS indicates that determining which part of the critical load range to use for saltmarsh requires expert judgment. Overall, there is good reason to believe the upper part of the critical load range (30 kgN/ha/yr) may be more appropriate than the lower part (20 kgN/ha/yr) for some saltmarsh communities. However, the more conservative Critical Load of 20 kgN/ha/yr has been applied to receptor OE1e in the assessment as a precaution. This is an appropriately precautionary critical load for lower to middle saltmarsh.

7.22 Generally, nitrogen inputs from the air to saltmarsh are not as important as nitrogen from other sources. Effects of nitrogen deposition from atmosphere are likely to be dominated by much greater impacts from marine or agricultural sources. This is reflected on APIS itself, which states regarding saltmarsh that '*Overall, N deposition [from atmosphere] is likely to be of low importance for these systems as the inputs are probably significantly below the large nutrient loadings from river and tidal inputs'*. Another mitigating factor is that the nature of intertidal saltmarsh in the Humber estuary means that there is daily flushing from tidal incursion. This is likely to further reduce the role of nitrogen from atmosphere in controlling botanical composition.

7.23 It is therefore assessed that even with the in-combination elevation of nitrogen deposition above the 1% screening threshold, the Process Contribution (PC) from the two Proposed Developments is insignificant at 0.97 kg N/ ha/ yr (OE1e) and 0.48 kg/N/ha/yr (OE2) compared to a Predicted Environmental Concentration (PEC) of 17.8 kg N/ ha/ yr (OE1e) and 17.5 kg/N/ha/yr (OE2). At receptor OE1e, the PEC is towards the lower end of the critical load range for pioneer, low, and low-mid saltmarsh. At receptor OE2 the high background N deposition is already exceeding the lower critical load for upper saltmarsh habitat; however, based on the

[18] http://publications.naturalengland.org.uk/publication/4720542048845824

condition assessment for Unit 95 of the Humber Estuary SSSI (in which OE2 is located) the saltmarsh habitat is in unfavourable condition only due to coastal erosion. The in-combination process contribution from operational N deposition affects only a tiny proportion of the overall saltmarsh resource within the Humber Estuary; the area of upper saltmarsh affected at receptor OE2 is less than the total area of the SSSI unit, which is 1.88 ha in total; as a worst case if all of this habitat was upper saltmarsh, it represents approximately 0.3% of all of the estuary saltmarsh (which is approximately 630 ha[19]). The very small N deposition contribution resulting from the operational emissions to air of the Proposed Phillips 66 Development in combination with the Proposed VPI development would therefore not reasonably be expected to result in any changes to the extent or distribution of this habitat within the Humber Estuary such that the conservation objectives would be compromised.

7.24 Receptor OE1d (wetland and reedbed) at North Killingholme Haven Pits SSSI is outside the boundary of the Humber Estuary SAC/ SPA/ Ramsar but is functionally linked habitat to the SPA/ Ramsar because it supports SPA/ Ramsar waterbirds for feeding, roosting and loafing. However, as discussed above for receptor OE2, the process contribution to N deposition at this location is very small in context with the high background N deposition. The Natural England condition assessment for North Killingholme Haven Pits SSSI Unit 1 (which is the location of receptor OE1d) states that the habitat is in favourable condition as it is meeting its targets for habitats supporting qualifying species of waterbirds, and this is set within the context of the existing high background N deposition. Reedbed habitats are also reasonably assumed to be not particularly susceptible to damage from the small increases in nitrogen uptake predicted during operation of the Proposed Phillips 66 Development in combination with the operation of the Proposed VPI Development (either from airborne or aquatic sources). It is therefore concluded that there will be no changes in the extent or distribution of reedbed habitats supporting qualifying species of waterbirds that are functionally linked to the Humber Estuary SPA/ Ramsar, such that the conservation objectives for the SPA/ Ramsar would be compromised.

7.25 It is therefore concluded that the in-combination effects of changes in air quality (arising from nitrogen deposition) from operation of the Proposed Phillips 66 Development with the Proposed VPI Development will not result in an adverse effect on the integrity of the Humber Estuary SAC/ SPA/ Ramsar.

Operational Noise/ Visual Disturbance

Proposed Phillips 66 with Land Adjacent to the Westgate Entrance, Port of Immingham (Open Storage Option)

7.26 The potential for the operation of Land Adjacent to the Westgate Entrance, Port of Immingham (Open Storage option) to result in in-combination effects with the Proposed Phillips 66 Development on Rosper Road Pools (functionally linked to the Humber Estuary SPA/ Ramsar) was identified at the screening stage. Operational activities associated with the 'Open Storage' option for this scheme were modelled to be >80 dB L_{Amax} at Rosper Road Pools.

7.27 In order to reduce noise levels (L_{Amax}) to below 70 dB across Rosper Road Pools, the HRA identified that it was necessary to introduce a row of unused containers stacked lengthways along the northern boundary (i.e. the boundary with Rosper Road Pools) to create a barrier c. 9 m high, slightly above his being the maximum height to which containers would be stacked during storage. This will also serve an additional purpose of visually screening Rosper Road Pools from the operational works at the Land Adjacent to Westgate Entrance but would not be high enough or close enough to cast significant shade on the Pools.

7.28 With this mitigation in place operational noise levels in an open site would be below 45 dB L_{Aeq} and below 70 dB L_{Amax} (with noise levels over most of the pools being below 60 dB). With this mitigation in place, it is considered that no adverse effect on integrity will arise through noise disturbance during operation in combination with the Proposed Phillips 66 Development.

[19] Total area of SAC is 36,657.15, of which approximately 630 ha is saltmarsh: saltmarsh-fact-sheet.pdf (humbernature.co.uk)

Proposed Phillips 66 Development with Gigastack

7.29 Given the proximity of Gigastack to Rosper Road Pools and the potential for simultaneous operation with the Proposed Phillips 66 Development, there is potential for in-combination noise/ visual disturbance to Rosper Road Pools (functionally linked to the Humber Estuary SPA/ Ramsar). No detailed assessment of the potential impacts of the operational phase of the Gigastack development has been undertaken at this stage, however, the Gigastack development is much closer to Rosper Road Pools than the Proposed Phillips 66 Development and it is therefore reasonable to conclude that there is no potential for additional disturbance to arise from the simultaneous operation of the Proposed Phillips 66 Development with Gigastack. However, further assessment will need to be undertaken by the Applicant as part of its HRA and ES.

In respect of potential noise/ visual disturbance to functionally linked land to the north of Gigastack, as all the remaining land has been either developed, or planned/ consented for future development there is a presumption that this land will be lost for SPA/ Ramsar birds (which has driven the creation of the HMWGS for the various Able UK developments, including AMEP and Enabling Works), and consequently all SPA/ Ramsar waterbirds will be permanently displaced.

8. Conclusion

8.1 Appropriate Assessment is an assessment that is appropriate to support a conclusion of no adverse effects on the integrity of a European site. In the test of Likely Significant Effects reported in Section 5 (project alone) and Section 8 (in combination with other plans or projects) of this document, the following impacts could not be dismissed as posing no LSE either alone or in combination with other plans or projects:

- changes in surface water quality during operation – the effluent discharge from the Wet Gas Scrubber will result in an increase in sulphates entering the South Killingholme Drain, and may affect habitats within Rosper Road Pools (which is functionally linked land to the Humber Estuary SPA/ Ramsar) and/ or the Humber Estuary SAC/ SPA/ Ramsar into which the drain ultimately discharges.
- In combination noise/ visual disturbance during construction – Proposed Phillips 66 Development in combination with Proposed VPI Development;
- in combination noise/ visual disturbance during construction – Proposed Phillips 66 Development in combination with Land Adjacent to Westgate Entrance, Port of Immingham (With Buildings Option) and Gigastack;
- in combination noise/ visual disturbance during construction – Proposed Phillips 66 Development in combination with Proposed VPI Development, Land Adjacent to Westgate Entrance, Port of Immingham (Open Storage Option and With Buildings Option) and Viking CCS;
- in combination changes in air quality during operation – Proposed Phillips 66 Development in combination with Proposed VPI Development; and
- in combination noise/ visual disturbance during operation - Proposed Phillips 66 Development in combination with, Land Adjacent to the Westgate Entrance, Port of Immingham (Open Storage Option) and Gigastack.

8.2 Operation of the Proposed Phillips 66 Development will result in effluent discharges to South Killingholme Drain that contain elevated sulphate, and a potential pathway for effects on the Humber Estuary SPA/ Ramsar has been identified due to the hydrological connectivity of the drain to Rosper Road Pools. There are uncertainties around the maximum allowable concentration of sulphate in process discharges to freshwater as there is no EQS for this pollutant in the WFD, although the literature search indicates ~1,000 mg/L would be appropriate. to reduce the sulphate levels in the effluent, which in the absence of mitigation is anticipated to be ~810 mg/l at the point of discharge when mixed with existing refinery discharge. There is currently technology available to reduce the effluent sulphate levels by approximately 50% through desulphurisation (deSOx) of flue gas, which is a technique currently used for the reduction of SOx emissions. This mitigation will therefore be implemented to reduce sulphate levels in the effluent to an environmentally acceptable level. Based on a review of available literature in respect of the effects of sulphate on the aquatic environment, it is concluded that with mitigation, the successful reduction in effluent sulphate levels at the point of discharge to below 1,000 mg/L will result in no adverse effects on Rosper Road Pools. Consequently this HRA has concluded that there would be no adverse effects on the integrity of the Humber Estuary SAC/ SPA/ Ramsar.

8.3 The appropriate assessment has taken into account the various mitigation measures proposed for addressing impacts from the Proposed Phillips 66 Development, mitigation proposed to address noise/ visual disturbance to Rosper Road Pools for the construction (With Buildings Option) and operation (Open Storage Option) of the Land Adjacent to the Westgate Entrance, Port of Immingham proposed development. No information on proposed mitigation (or compensation, if needed) for the Gigastack development is currently available, and therefore a precautionary approach to the screening and appropriate assessment of Gigastack in combination with the Proposed VPI Development has been undertaken.

8.4 With mitigation, the appropriate assessment has concluded that there would be no adverse effects on the integrity of the Humber Estuary SPA/ SAC/ Ramsar, either alone or in combination with other plans or projects, as a result of these pathways.

9. References

APEM Ltd (2022) South Killingholme Drain Macroinvertebrate Survey 2022. Report prepared on behalf of Phillips 66 Ltd by APEM Ltd, Stockport.

Davies T.D. (1996) Sulphate toxicity to freshwater organisms and molybdenum toxicity to rainbow trout (O. mykiss). The University of British Columbia.

Davies T.M, Pickard J.S. and Hall K.J. (undated) Sulphate toxicity to freshwater organisms and molybdenum toxicity to rainbow trout embryos/alevins

Environment Agency (2009) Ecological indicators for abandoned mines, Phase 1: Review of the literature

Hitchcock, D.R. (1975) Biogenic contributions to atmospheric sulphate levels. In: Proceedings of the 2nd National Conference on Complete Water Re-use. Chicago, IL, American Institute of Chemical Engineers.

Institute of Air Quality and Management (IAQM) (2020) A guide to the assessment of air quality impacts on designated nature conservation sites. Version 1.1 May 2020. IAQM, London.

Soucek D.J. & Kennedy A.J. (2005) Effects of Hardness, chloride and acclimation on the acute toxicity of sulfate to freshwater invertebrates. Environmental Toxicology and Chemistry, Vol 24, No. 5, pp 1204-1210

UK Technical Advisory Group (UKTAG) on the Water Framework Directive (2008) UK Environmental Standards and Conditions (Phase 1). Final report

Appendix A Designated Site Citations

STANDARD DATA FORM for sites within the ‘UK national site network of European sites’

Special Protection Areas (SPAs) are classified and Special Areas of Conservation (SACs) are designated under:

- the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales (including the adjacent territorial sea) and to a limited extent in Scotland (reserved matters) and Northern Ireland (excepted matters);
- the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) in Scotland;
- the Conservation (Natural Habitats, &c) Regulations (Northern Ireland) 1995 (as amended) in Northern Ireland; and
- the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) in the UK offshore area.

Each SAC or SPA (forming part of the UK national site network of European sites) has its own Standard Data Form containing site-specific information. The information provided here generally follows the same documenting format for SACs and SPAs, as set out in the Official Journal of the European Union recording the Commission Implementing Decision of 11 July 2011 (2011/484/EU).

Please note that these forms contain a number of codes, all of which are explained either within the data forms themselves or in the end notes.

More general information on SPAs and SACs in the UK is available from the SPA homepage and SAC homepage on the JNCC website. These webpages also provide links to Standard Data Forms for all SAC and SPA sites in the UK.

https://jncc.gov.uk/

NATURA 2000 - STANDARD DATA FORM

For Special Protection Areas (SPA),
Proposed Sites for Community Importance (pSCI),
Sites of Community Importance (SCI) and
for Special Areas of Conservation (SAC)

SITE **UK0030170**

SITENAME **Humber Estuary**

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1. SITE IDENTIFICATION

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1.1 Type	1.2 Site code
B	UK0030170

1.3 Site name

Humber Estuary

1.4 First Compilation date	1.5 Update date
2007-08	2015-12

1.6 Respondent:

Name/Organisation: Joint Nature Conservation Committee

Address: Joint Nature Conservation Committee Monkstone House City Road Peterborough PE1 1JY

Email:

Date site proposed as SCI:	2007-08
Date site confirmed as SCI:	2008-12
Date site designated as SAC:	2009-12
National legal reference of SAC designation:	Regulations 11 and 13-15 of the Conservation of Habitats and Species Regulations 2010 (http://www.legislation.gov.uk/uksi/2010/490/contents/made).

2. SITE LOCATION

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2.1 Site-centre location [decimal degrees]:

Longitude	Latitude
-0.734722222	53.58916667

2.2 Area [ha]:

36657.15

2.3 Marine area [%]

91.6

2.4 Sitelength [km]:

0.0

2.5 Administrative region code and name

NUTS level 2 code	Region Name
UKE1	East Yorkshire and Northern Lincolnshire
UKF3	Lincolnshire
UKZZ	Extra-Regio

2.6 Biogeographical Region(s)

Atlantic (100.0 %)

3. ECOLOGICAL INFORMATION

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3.1 Habitat types present on the site and assessment for them

Annex I Habitat types						Site assessment			
Code	PF	NP	Cover [ha]	Cave [number]	Data quality	A|B|C|D	A|B|C		
						Representativity	Relative Surface	Conservation	Global
1110			1656.9	0	P	C	A	C	C
1130			36657.15	0	G	B	B	B	B
1140			9384.23	0	G	B	B	B	B
1150	X		7.33	0	G	C	C	B	C
1210				0		D			
1310			47.65	0	P	C	C	B	C
1320			135.63	0	G	D			
1330									

			784.46	0	G	C	B	C	C
2110			18.33	0	G	C	A	C	C
2120			14.66	0	G	C	B	C	C
2130	X		14.66	0	G	C	C	C	C
2160			65.98	0	G	C	B	C	C

- **PF:** for the habitat types that can have a non-priority as well as a priority form (6210, 7130, 9430) enter "X" in the column PF to indicate the priority form.
- **NP:** in case that a habitat type no longer exists in the site enter: x (optional)
- **Cover:** decimal values can be entered
- **Caves:** for habitat types 8310, 8330 (caves) enter the number of caves if estimated surface is not available.
- **Data quality:** G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation)

3.2 Species referred to in Article 4 of Directive 2009/147/EC and listed in Annex II of Directive 92/43/EEC and site evaluation for them

Species					Population in the site						Site assessment			
G	Code	Scientific Name	S	NP	T	Size		Unit	Cat.	D.qual.	A|B|C|D	A|B|C		
						Min	Max				Pop.	Con.	Iso.	Glo.
F	1102	Alosa alosa			p				P	DD	D			
F	1103	Alosa fallax			p				P	DD	D			
M	1364	Halichoerus grypus			p	1800	1800	i		G	C	B	B	C
F	1099	Lampetra fluviatilis			p				P	DD	A	B	C	C
F	1095	Petromyzon marinus			p	251	500	i		M	B	C	C	C
M	1365	Phoca vitulina			p				P	DD	D			

- **Group:** A = Amphibians, B = Birds, F = Fish, I = Invertebrates, M = Mammals, P = Plants, R = Reptiles
- **S:** in case that the data on species are sensitive and therefore have to be blocked for any public access enter: yes
- **NP:** in case that a species is no longer present in the site enter: x (optional)
- **Type:** p = permanent, r = reproducing, c = concentration, w = wintering (for plant and non-migratory species use permanent)
- **Unit:** i = individuals, p = pairs or other units according to the Standard list of population units and codes in accordance with Article 12 and 17 reporting (see reference portal)
- **Abundance categories (Cat.):** C = common, R = rare, V = very rare, P = present - to fill if data are deficient (DD) or in addition to population size information
- **Data quality:** G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation); VP = 'Very poor' (use this category only, if not even a rough estimation of the population size can be made, in this case the fields for population size can remain empty, but the field "Abundance categories" has to be filled in)

4. SITE DESCRIPTION

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4.1 General site character

Habitat class	% Cover
N03	4.4
N07	0.4
N04	0.4
N02	94.9
Total Habitat Cover	100.10000000000002

Other Site Characteristics

1 Terrestrial: Soil & Geology: shingle,sedimentary,sandstone,neutral,mud,sand,alluvium,clay 2 Terrestrial: Geomorphology and landscape: coastal,floodplain,lowland 3 Marine: Geology: gravel,mud,sedimentary,sand,sandstone/mudstone,clay,shingle,limestone/chalk 4 Marine: Geomorphology: shingle bar,lagoon,islands,estuary,subtidal sediments (including sandbank/mudbank),intertidal sediments (including sandflat/mudflat),cliffs

4.2 Quality and importance

Sandbanks which are slightly covered by sea water all the time for which the area is considered to support a significant presence. Estuaries for which this is considered to be one of the best areas in the United Kingdom. Mudflats and sandflats not covered by seawater at low tide for which this is considered to be one of the best areas in the United Kingdom. Coastal lagoons for which the area is considered to support a significant presence. Salicornia and other annuals colonising mud and sand for which the area is considered to support a significant presence. Atlantic salt meadows (Glauco-Puccinellietalia maritimae) for which the area is considered to support a significant presence. Embryonic shifting dunes for which the area is considered to support a significant presence. which is considered to be rare as its total extent in the United Kingdom is estimated to be less than 1000 hectares. Shifting dunes along the shoreline with Ammophila arenaria (?white dunes?) for which the area is considered to support a significant presence. Dunes with Hippophae rhamnoides for which the area is considered to support a significant presence. which is considered to be rare as its total extent in the United Kingdom is estimated to be less than 1000 hectares. Fixed dunes with herbaceous vegetation (?grey dunes?) for which the area is considered to support a significant presence. Petromyzon marinus for which the area is considered to support a significant presence. Lampetra fluviatilis for which the area is considered to support a significant presence. Halichoerus grypus for which the area is considered to support a significant presence.

4.3 Threats, pressures and activities with impacts on the site

The most important impacts and activities with high effect on the site

Negative Impacts			
Rank	Threats and pressures [code]	Pollution (optional) [code]	inside/outside [i|o|b]
H	M01		B
H	E02		O
H	J02		B
H	H02		B
H	K01		I

Positive Impacts			
Rank	Activities, management [code]	Pollution (optional) [code]	inside/outside [i|o|b]
H	D05		I
H	A02		I
H	B02		I
H	A04		I

Rank: H = high, M = medium, L = low

Pollution: N = Nitrogen input, P = Phosphor/Phosphate input, A = Acid input/acidification, T = toxic inorganic chemicals, O = toxic organic chemicals, X = Mixed pollutions

i = inside, o = outside, b = both

4.5 Documentation

Conservation Objectives - the Natural England links below provide access to the Conservation Objectives (and other site-related information) for its terrestrial and inshore Natura 2000 sites, including conservation

advice packages and supporting documents for European Marine Sites within English waters and for cross-border sites. See also the 'UK Approach' document for more information (link via the JNCC website).

Link(s): http://publications.naturalengland.org.uk/category/6490068894089216

http://publications.naturalengland.org.uk/category/3212324
http://jncc.defra.gov.uk/pdf/Natura2000_StandardDataForm_UKApproach_Dec2015.pdf

5. SITE PROTECTION STATUS (optional)

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5.1 Designation types at national and regional level:

Code	Cover [%]	Code	Cover [%]	Code	Cover [%]
UK01	1.8	UK04	100.0		

6. SITE MANAGEMENT

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6.1 Body(ies) responsible for the site management:

Organisation:	Natural England
Address:	
Email:	

6.2 Management Plan(s):

An actual management plan does exist:

☐	Yes
☐	No, but in preparation
☒	No

6.3 Conservation measures (optional)

For available information, including on Conservation Objectives, see Section 4.5.

EXPLANATION OF CODES USED IN THE SPECIAL AREA OF CONSERVATION (SAC) AND SPECIAL PROTECTION AREA (SPA) STANDARD DATA FORMS

The codes in the table below generally follow those explained in the official European Union guidelines for the Standard Data Form (also referencing the relevant page number).

1.1 Site type

CODE	DESCRIPTION	PAGE NO
A	SPA (classified Special Protection Area)	53
B	cSAC, SCI or SAC (candidate Special Area of Conservation, Site of Community Importance, designated Special Area of Conservation)	53
C	SPA area/boundary is the same as the cSAC/SCI/SAC i.e. a co-classified/designated site (Note: this situation only occurs in Gibraltar)	53

3.1 Habitat code

CODE	DESCRIPTION	PAGE NO
1110	Sandbanks which are slightly covered by sea water all the time	57
1130	Estuaries	57
1140	Mudflats and sandflats not covered by seawater at low tide	57
1150	Coastal lagoons	57
1160	Large shallow inlets and bays	57
1170	Reefs	57
1180	Submarine structures made by leaking gases	57
1210	Annual vegetation of drift lines	57
1220	Perennial vegetation of stony banks	57
1230	Vegetated sea cliffs of the Atlantic and Baltic Coasts	57
1310	Salicornia and other annuals colonizing mud and sand	57
1320	Spartina swards (Spartinion maritimae)	57
1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	57
1340	Inland salt meadows	57
1420	Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	57
2110	Embryonic shifting dunes	57
2120	Shifting dunes along the shoreline with Ammophila arenaria ("white dunes")	57
2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	57
2140	Decalcified fixed dunes with Empetrum nigrum	57
2150	Atlantic decalcified fixed dunes (Calluno-Ulicetea)	57
2160	Dunes with Hippopha• rhamnoides	57
2170	Dunes with Salix repens ssp. argentea (Salicion arenariae)	57
2190	Humid dune slacks	57
21A0	Machairs (* in Ireland)	57
2250	Coastal dunes with Juniperus spp.	57
2330	Inland dunes with open Corynephorus and Agrostis grasslands	57
3110	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	57
3130	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	57
3140	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	57
3150	Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation	57

CODE	DESCRIPTION	PAGE NO
3160	Natural dystrophic lakes and ponds	57
3170	Mediterranean temporary ponds	57
3180	Turloughs	57
3260	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	57
4010	Northern Atlantic wet heaths with Erica tetralix	57
4020	Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	57
4030	European dry heaths	57
4040	Dry Atlantic coastal heaths with Erica vagans	57
4060	Alpine and Boreal heaths	57
4080	Sub-Arctic Salix spp. scrub	57
5110	Stable xerothermophilous formations with Buxus sempervirens on rock slopes (Berberidion p.p.)	57
5130	Juniperus communis formations on heaths or calcareous grasslands	57
6130	Calaminarian grasslands of the Violetalia calaminariae	57
6150	Siliceous alpine and boreal grasslands	57
6170	Alpine and subalpine calcareous grasslands	57
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	57
6230	Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	57
6410	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	57
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	57
6510	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	57
6520	Mountain hay meadows	57
7110	Active raised bogs	57
7120	Degraded raised bogs still capable of natural regeneration	57
7130	Blanket bogs (* if active bog)	57
7140	Transition mires and quaking bogs	57
7150	Depressions on peat substrates of the Rhynchosporion	57
7210	Calcareous fens with Cladium mariscus and species of the Caricion davallianae	57
7220	Petrifying springs with tufa formation (Cratoneurion)	57
7230	Alkaline fens	57
7240	Alpine pioneer formations of the Caricion bicoloris-atrofuscae	57
8110	Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	57
8120	Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)	57
8210	Calcareous rocky slopes with chasmophytic vegetation	57
8220	Siliceous rocky slopes with chasmophytic vegetation	57
8240	Limestone pavements	57
8310	Caves not open to the public	57
8330	Submerged or partially submerged sea caves	57
9120	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)	57
9130	Asperulo-Fagetum beech forests	57
9160	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	57
9180	Tilio-Acerion forests of slopes, screes and ravines	57
9190	Old acidophilous oak woods with Quercus robur on sandy plains	57
91A0	Old sessile oak woods with Ilex and Blechnum in the British Isles	57
91C0	Caledonian forest	57
91D0	Bog woodland	57
91E0	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	57
91J0	Taxus baccata woods of the British Isles	57

3.1 Habitat representativity (abbreviated to 'Representativity' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent representatively	57
B	Good representatively	57
C	Significant representatively	57
D	Non-significant presence representatively	57

3.1 Relative surface

CODE	DESCRIPTION	PAGE NO
A	> 15%-100%	58
B	> 2%-15%	58
C	≤ 2%	58

3.1 Degree of conservation (abbreviated to 'Conservation' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	59
B	Good conservation	59
C	Average or reduced conservation	59

3.1 Global assessment (abbreviated to 'Global' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	59
B	Good value	59
C	Significant value	59

3.2 Population (abbreviated to 'Pop.' in data form)

CODE	DESCRIPTION	PAGE NO
A	> 15%-100%	62
B	> 2%-15%	62
C	≤ 2%	62
D	Non-significant population	62

3.2 Degree of conservation (abbreviated to 'Con.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	63
B	Good conservation	63
C	Average or reduced conservation	63

3.2 Isolation (abbreviated to 'Iso.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Population (almost) Isolated	63
B	Population not-isolated, but on margins of area of distribution	63
C	Population not-isolated within extended distribution range	63

3.2 Global Grade (abbreviated to 'Glo.' or 'G.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	63
B	Good value	63
C	Significant value	63

3.3 Other species – essentially covers bird assemblage types

CODE	DESCRIPTION	PAGE NO
WATR	Non-breeding waterbird assemblage	UK specific code
SBA	Breeding seabird assemblage	UK specific code

BBA	Breeding bird assemblage (applies only to sites classified pre 2000)	UK specific code

4.1 Habitat class code

CODE	DESCRIPTION	PAGE NO
N01	Marine areas, Sea inlets	65
N02	Tidal rivers, Estuaries, Mud flats, Sand flats, Lagoons (including saltwork basins)	65
N03	Salt marshes, Salt pastures, Salt steppes	65
N04	Coastal sand dunes, Sand beaches, Machair	65
N05	Shingle, Sea cliffs, Islets	65
N06	Inland water bodies (Standing water, Running water)	65
N07	Bogs, Marshes, Water fringed vegetation, Fens	65
N08	Heath, Scrub, Maquis and Garrigue, Phygrana	65
N09	Dry grassland, Steppes	65
N10	Humid grassland, Mesophile grassland	65
N11	Alpine and sub-Alpine grassland	65
N14	Improved grassland	65
N15	Other arable land	65
N16	Broad-leaved deciduous woodland	65
N17	Coniferous woodland	65
N19	Mixed woodland	65
N21	Non-forest areas cultivated with woody plants (including Orchards, groves, Vineyards, Dehesas)	65
N22	Inland rocks, Screes, Sands, Permanent Snow and ice	65
N23	Other land (including Towns, Villages, Roads, Waste places, Mines, Industrial sites)	65
N25	Grassland and scrub habitats (general)	65
N26	Woodland habitats (general)	65

4.3 Threats code

CODE	DESCRIPTION	PAGE NO
A01	Cultivation	65
A02	Modification of cultivation practices	65
A03	Mowing / cutting of grassland	65
A04	Grazing	65
A05	Livestock farming and animal breeding (without grazing)	65
A06	Annual and perennial non-timber crops	65
A07	Use of biocides, hormones and chemicals	65
A08	Fertilisation	65
A10	Restructuring agricultural land holding	65
A11	Agriculture activities not referred to above	65
B01	Forest planting on open ground	65
B02	Forest and Plantation management & use	65
B03	Forest exploitation without replanting or natural regrowth	65
B04	Use of biocides, hormones and chemicals (forestry)	65
B06	Grazing in forests/ woodland	65
B07	Forestry activities not referred to above	65
C01	Mining and quarrying	65
C02	Exploration and extraction of oil or gas	65
C03	Renewable abiotic energy use	65
D01	Roads, paths and railroads	65
D02	Utility and service lines	65
D03	Shipping lanes, ports, marine constructions	65
D04	Airports, flightpaths	65
D05	Improved access to site	65
E01	Urbanised areas, human habitation	65
E02	Industrial or commercial areas	65

CODE	DESCRIPTION	PAGE NO
E03	Discharges	65
E04	Structures, buildings in the landscape	65
E06	Other urbanisation, industrial and similar activities	65
F01	Marine and Freshwater Aquaculture	65
F02	Fishing and harvesting aquatic ressources	65
F03	Hunting and collection of wild animals (terrestrial), including damage caused by game (excessive density), and taking/removal of terrestrial animals (including collection of insects, reptiles, amphibians, birds of prey, etc., trapping, poisoning, poaching, predator control, accidental capture (e.g. due to fishing gear), etc.)	65
F04	Taking / Removal of terrestrial plants, general	65
F05	Illegal taking/ removal of marine fauna	65
F06	Hunting, fishing or collecting activities not referred to above	65
G01	Outdoor sports and leisure activities, recreational activities	65
G02	Sport and leisure structures	65
G03	Interpretative centres	65
G04	Military use and civil unrest	65
G05	Other human intrusions and disturbances	65
H01	Pollution to surface waters (limnic & terrestrial, marine & brackish)	65
H02	Pollution to groundwater (point sources and diffuse sources)	65
H03	Marine water pollution	65
H04	Air pollution, air-borne pollutants	65
H05	Soil pollution and solid waste (excluding discharges)	65
H06	Excess energy	65
H07	Other forms of pollution	65
I01	Invasive non-native species	65
I02	Problematic native species	65
I03	Introduced genetic material, GMO	65
J01	Fire and fire suppression	65
J02	Human induced changes in hydraulic conditions	65
J03	Other ecosystem modifications	65
K01	Abiotic (slow) natural processes	65
K02	Biocenotic evolution, succession	65
K03	Interspecific faunal relations	65
K04	Interspecific floral relations	65
K05	Reduced fecundity/ genetic depression	65
L05	Collapse of terrain, landslide	65
L07	Storm, cyclone	65
L08	Inundation (natural processes)	65
L10	Other natural catastrophes	65
M01	Changes in abiotic conditions	65
M02	Changes in biotic conditions	65
U	Unknown threat or pressure	65
XO	Threats and pressures from outside the Member State	65

5.1 Designation type codes

CODE	DESCRIPTION	PAGE NO
UK00	No Protection Status	67
UK01	National Nature Reserve	67
UK04	Site of Special Scientific Interest (GB)	67
UK05	Marine Conservation Zone	67
UK06	Nature Conservation Marine Protected Area	67
UK86	Special Area (Channel Islands)	67
UK98	Area of Special Scientific Interest (NI)	67
IN00	Ramsar Convention site	67
IN08	Special Protection Area	67
IN09	Special Area of Conservation	67

STANDARD DATA FORM for sites within the ‘UK national site network of European sites’

Special Protection Areas (SPAs) are classified and Special Areas of Conservation (SACs) are designated under:

- the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales (including the adjacent territorial sea) and to a limited extent in Scotland (reserved matters) and Northern Ireland (excepted matters);
- the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) in Scotland;
- the Conservation (Natural Habitats, &c) Regulations (Northern Ireland) 1995 (as amended) in Northern Ireland; and
- the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) in the UK offshore area.

Each SAC or SPA (forming part of the UK national site network of European sites) has its own Standard Data Form containing site-specific information. The information provided here generally follows the same documenting format for SACs and SPAs, as set out in the Official Journal of the European Union recording the Commission Implementing Decision of 11 July 2011 (2011/484/EU).

Please note that these forms contain a number of codes, all of which are explained either within the data forms themselves or in the end notes.

More general information on SPAs and SACs in the UK is available from the SPA homepage and SAC homepage on the JNCC website. These webpages also provide links to Standard Data Forms for all SAC and SPA sites in the UK.

https://jncc.gov.uk/

NATURA 2000 - STANDARD DATA FORM

For Special Protection Areas (SPA),
Proposed Sites for Community Importance (pSCI),
Sites of Community Importance (SCI) and
for Special Areas of Conservation (SAC)

SITE	**UK9006111**
SITENAME	**Humber Estuary**

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1. SITE IDENTIFICATION

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1.1 Type	1.2 Site code
A	UK9006111

1.3 Site name

Humber Estuary

1.4 First Compilation date	1.5 Update date
2007-08	2015-12

1.6 Respondent:

Name/Organisation:	Joint Nature Conservation Committee
Address:	Joint Nature Conservation Committee Monkstone House City Road Peterborough PE1 1JY
Email:	

1.7 Site indication and designation / classification dates

Date site classified as SPA:	2007-08
National legal reference of SPA designation	Regulations 12A and 13-15 of the Conservation Habitats and Species Regulations 2010, (http://www.legislation.gov.uk/uksi/2010/490/contents/made) as amended by The Conservation of Habitats and Species (Amendment) Regulations 2011 (http://www.legislation.gov.uk/uksi/2011/625/contents/made).

2. SITE LOCATION

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2.1 Site-centre location [decimal degrees]:

Longitude	Latitude
0.0569	53.5497

2.2 Area [ha]:

37630.24

2.3 Marine area [%]

89.5

2.4 Sitelength [km]:

0.0

2.5 Administrative region code and name

NUTS level 2 code	Region Name
UKZZ	Extra-Regio
UKF3	Lincolnshire
UKE1	East Yorkshire and Northern Lincolnshire

2.6 Biogeographical Region(s)

Atlantic (100.0 %)

3. ECOLOGICAL INFORMATION

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3.2 Species referred to in Article 4 of Directive 2009/147/EC and listed in Annex II of Directive 92/43/EEC and site evaluation for them

Species					Population in the site						Site assessment		
G	Code	Scientific Name	S	NP	T	Size		Unit	Cat.	D.qual.	A|B|C|D	A|B|C	
						Min	Max				Pop.	Con.	Iso.
B	A052	Anas crecca			w	2322	2322	i		G	C		C
B	A050	Anas penelope			w	5044	5044	i		G	C		C
B	A053	Anas platyrhynchos			w	2456	2456	i		G	C		C
B	A169	Arenaria interpres			w	629	629	i		G	C		C
B	A059	Aythya ferina			w	719	719	i		G	C		C
B	A062	Aythya marila			w	127	127	i		G	C		C
B	A021	Botaurus stellaris			r	2	2	cmales	P	G	B		C
B	A021	Botaurus stellaris			w	4	4	i		G	B		C
		Branta											

B	A675	bernicla bernicla			w	2098	2098	i		G	C		C
B	A067	Bucephala clangula			w	467	467	i		G	B		C
B	A144	Calidris alba			c	818	818	i		G	B		C
B	A144	Calidris alba			w	486	486	i		G	B		C
B	A672	Calidris alpina alpina			c	20269	20269	i		G	B		C
B	A672	Calidris alpina alpina			w	22222	22222	i		G	B		C
B	A143	Calidris canutus			w	28165	28165	i		G	B		C
B	A143	Calidris canutus			c	18500	18500	i		G	B		C
B	A137	Charadrius hiaticula			c	1766	1766	i		G	C		C
B	A137	Charadrius hiaticula			w	403	403	i		G	C		C
B	A081	Circus aeruginosus			r	10	10	bfemales	P	G	B		B
B	A082	Circus cyaneus			w	8	8	i		G	C		C
B	A130	Haematopus ostralegus			w	3503	3503	i		G	C		C
B	A157	Limosa lapponica			w	2752	2752	i		G	B		C
B	A616	Limosa limosa islandica			w	1113	1113	i		G	B		C
B	A616	Limosa limosa islandica			c	915	915	i		G	B		C
B	A160	Numenius arquata			w	3253	3253	i		G	C		C
B	A158	Numenius phaeopus			c	113	113	i		G	C		C
B	A151	Philomachus pugnax			c	128	128	i		G	C		C
B	A140	Pluvialis apricaria			w	30709	30709	i		G	B		C
B	A141	Pluvialis squatarola			w	1704	1704	i		G	B		C
B	A141	Pluvialis squatarola			c	1590	1590	i		G	B		C
B	A132	Recurvirostra avosetta			w	59	59	i		G	C		B
B	A132	Recurvirostra avosetta			r	64	64	p		G	C		B
B	A195	Sterna albifrons			r	51	51	p		G	B		C
		Tadorna											

B	A048	tadorna			w	4464	4464	i		G	B		C
B	A164	Tringa nebularia			c	77	77	i		G	C		C
B	A162	Tringa totanus			w	4632	4632	i		G	B		C
B	A162	Tringa totanus			c	7462	7462	i		G	B		C
B	A142	Vanellus vanellus			w	22765	22765	i		G	C		C

- **Group:** A = Amphibians, B = Birds, F = Fish, I = Invertebrates, M = Mammals, P = Plants, R = Reptiles
- **S:** in case that the data on species are sensitive and therefore have to be blocked for any public access enter: yes
- **NP:** in case that a species is no longer present in the site enter: x (optional)
- **Type:** p = permanent, r = reproducing, c = concentration, w = wintering (for plant and non-migratory species use permanent)
- **Unit:** i = individuals, p = pairs or other units according to the Standard list of population units and codes in accordance with Article 12 and 17 reporting (see reference portal)
- **Abundance categories (Cat.):** C = common, R = rare, V = very rare, P = present - to fill if data are deficient (DD) or in addition to population size information
- **Data quality:** G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation); VP = 'Very poor' (use this category only, if not even a rough estimation of the population size can be made, in this case the fields for population size can remain empty, but the field "Abundance categories" has to be filled in)

3.3 Other important species of flora and fauna (optional)

Species					Population in the site				Motivation					
Group	CODE	Scientific Name	S	NP	Size		Unit	Cat.	Species Annex		Other categories			
					Min	Max		C|R|V|P	IV	V	A	B	C	D
B	WATR	Waterbird assemblage			153934	153934	i						X	

- **Group:** A = Amphibians, B = Birds, F = Fish, Fu = Fungi, I = Invertebrates, L = Lichens, M = Mammals, P = Plants, R = Reptiles
- **CODE:** for Birds, Annex IV and V species the code as provided in the reference portal should be used in addition to the scientific name
- **S:** in case that the data on species are sensitive and therefore have to be blocked for any public access enter: yes
- **NP:** in case that a species is no longer present in the site enter: x (optional)
- **Unit:** i = individuals, p = pairs or other units according to the standard list of population units and codes in accordance with Article 12 and 17 reporting, (see reference portal)
- **Cat.:** Abundance categories: C = common, R = rare, V = very rare, P = present
- **Motivation categories: IV, V:** Annex Species (Habitats Directive), **A:** National Red List data; **B:** Endemics; **C:** International Conventions; **D:** other reasons

4. SITE DESCRIPTION

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4.1 General site character

Habitat class	% Cover
N06	0.6
N03	4.6

N04	0.8
N02	93.6
N07	0.3
Total Habitat Cover	99.89999999999998

Other Site Characteristics

1 Terrestrial: Soil &
Geology: mud,shingle,alluvium,sandstone,sand,neutral,clay,limestone,sedimentary,sandstone,shingle,sand,neut
Terrestrial: Geomorphology and landscape: lowland,floodplain,coastal,lowland,floodplain,coastal 3 Marine:
Geology: sand,gravel,mud,sedimentary,clay,sandstone/mudstone,shingle,limestone/chalk,clay,sedimentary,sanc
Marine: Geomorphology: shingle bar,islands,intertidal sediments (including
sandflat/mudflat),cliffs,estuary,intertidal sediments (including sandflat/mudflat),islands,lagoon,estuary,subtidal
sediments (including sandbank/mudbank),shingle bar,cliffs

4.2 Quality and importance

ARTICLE 4.1 QUALIFICATION (79/409/EEC) During the breeding season the area regularly supports: Botaurus stellaris (Europe - breeding) 10.5% of the population in Great Britain 2000-2002 Circus aeruginosus 6.3% of the population in Great Britain 1998-2002 Recurvirostra avosetta (Western Europe/Western Mediterranean - breeding) 8.6% of the population in Great Britain 1998-2002 Sterna albifrons (Eastern Atlantic - breeding) 2.1% of the population in Great Britain 1998-2002 Over winter the area regularly supports: Botaurus stellaris (Europe - breeding) 4% of the population in Great Britain 1998/9 to 2002/3 Circus cyaneus 1.1% of the population in Great Britain 1997/8 to 2001/2 Limosa lapponica (Western Palearctic - wintering) 4.4% of the population in Great Britain 1996/7 to 2000/1 Pluvialis apricaria [North-western Europe - breeding] 12.3% of the population in Great Britain 1996/7 to 2000/1 Recurvirostra avosetta (Western Europe/Western Mediterranean - breeding) 1.7% of the population in Great Britain 1996/7 to 2000/1 On passage the area regularly supports: Philomachus pugnax (Western Africa - wintering) 1.4% of the population in Great Britain 1996-2000 ARTICLE 4.2 QUALIFICATION (79/409/EEC) Over winter the area regularly supports: Calidris alpina alpina (Northern Siberia/Europe/Western Africa) 1.7% of the population 1996/7 to 2000/1 Calidris canutus (North-eastern Canada/Greenland/Iceland/North-western Europe) 6.3% of the population 1996/7 to 2000/1 Limosa limosa islandica (Iceland - breeding) 3.2% of the population 1996/7 to 2000/1 Tadorna tadorna (North-western Europe) 1.5% of the population 1996/7 to 2000/1 Tringa totanus (Eastern Atlantic - wintering) 3.6% of the population 1996/7 to 2000/1 On passage the area regularly supports: Calidris alpina alpina (Northern Siberia/Europe/Western Africa) 1.5% of the population 1996-2000 Calidris canutus (North-eastern Canada/Greenland/Iceland/North-western Europe) 4.1% of the population 1996-2000 Limosa limosa islandica (Iceland - breeding) 2.6% of the population 1996-2000 Tringa totanus (Eastern Atlantic - wintering) 5.7% of the population 1996-2000 ARTICLE 4.2 QUALIFICATION (79/409/EEC): AN INTERNATIONALLY IMPORTANT ASSEMBLAGE OF BIRDS Over winter the area regularly supports: 153934 waterfowl (5 year peak mean 1991/92-1995/96) Including: Botaurus stellaris , Branta bernicla bernicla , Tadorna tadorna , Anas penelope , Anas crecca , Anas platyrhynchos , Aythya ferina , Aythya marila , Bucephala clangula , Haematopus ostralegus , Recurvirostra avosetta , Charadrius hiaticula , Pluvialis apricaria [North-western Europe - breeding], Pluvialis squatarola , Vanellus vanellus , Calidris canutus , Calidris alba , Calidris alpina alpina , Philomachus pugnax , Limosa limosa islandica , Limosa lapponica , Numenius phaeopus , Numenius arquata , Tringa totanus , Tringa nebularia , Arenaria interpres

4.3 Threats, pressures and activities with impacts on the site

The most important impacts and activities with high effect on the site

Negative Impacts			
Rank	Threats and pressures [code]	Pollution (optional) [code]	inside/outside [i|o|b]
H	K01		I
H	I01		B
H	G01		I
H	M02		B
H	M01		B

Positive Impacts			
Rank	Activities, management [code]	Pollution (optional) [code]	inside/outside [i|o|b]
H	A02		I
H	D05		I
H	B02		I
H	D05		I
H	A04		I
H	A03		I

Rank: H = high, M = medium, L = low

Pollution: N = Nitrogen input, P = Phosphor/Phosphate input, A = Acid input/acidification,

T = toxic inorganic chemicals, O = toxic organic chemicals, X = Mixed pollutions
i = inside, o = outside, b = both

4.5 Documentation

Conservation Objectives - the Natural England links below provide access to the Conservation Objectives (and other site-related information) for its terrestrial and inshore Natura 2000 sites, including conservation advice packages and supporting documents for European Marine Sites within English waters and for cross-border sites. See also the 'UK Approach' document for more information (link via the JNCC website).

Link(s): http://publications.naturalengland.org.uk/category/6490068894089216

http://publications.naturalengland.org.uk/category/3212324
http://jncc.defra.gov.uk/pdf/Natura2000_StandardDataForm_UKApproach_Dec2015.pdf

5. SITE PROTECTION STATUS (optional)

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5.1 Designation types at national and regional level:

Code	Cover [%]	Code	Cover [%]	Code	Cover [%]
UK04	100.0				

6. SITE MANAGEMENT

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6.1 Body(ies) responsible for the site management:

Organisation:	Natural England
Address:	
Email:	

6.2 Management Plan(s):

An actual management plan does exist:

- [ ] Yes
- [ ] No, but in preparation
- [X] No

6.3 Conservation measures (optional)

For available information, including on Conservation Objectives, see Section 4.5.

7. MAP OF THE SITES

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INSPIRE ID:

Map delivered as PDF in electronic format (optional)

- [ ] Yes
- [X] No

Reference(s) to the original map used for the digitalisation of the electronic boundaries (optional).

EXPLANATION OF CODES USED IN THE SPECIAL AREA OF CONSERVATION (SAC) AND SPECIAL PROTECTION AREA (SPA) STANDARD DATA FORMS

The codes in the table below generally follow those explained in the official European Union guidelines for the Standard Data Form (also referencing the relevant page number).

1.1 Site type

CODE	DESCRIPTION	PAGE NO
A	SPA (classified Special Protection Area)	53
B	cSAC, SCI or SAC (candidate Special Area of Conservation, Site of Community Importance, designated Special Area of Conservation)	53
C	SPA area/boundary is the same as the cSAC/SCI/SAC i.e. a co-classified/designated site (Note: this situation only occurs in Gibraltar)	53

3.1 Habitat code

CODE	DESCRIPTION	PAGE NO
1110	Sandbanks which are slightly covered by sea water all the time	57
1130	Estuaries	57
1140	Mudflats and sandflats not covered by seawater at low tide	57
1150	Coastal lagoons	57
1160	Large shallow inlets and bays	57
1170	Reefs	57
1180	Submarine structures made by leaking gases	57
1210	Annual vegetation of drift lines	57
1220	Perennial vegetation of stony banks	57
1230	Vegetated sea cliffs of the Atlantic and Baltic Coasts	57
1310	Salicornia and other annuals colonizing mud and sand	57
1320	Spartina swards (Spartinion maritimae)	57
1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	57
1340	Inland salt meadows	57
1420	Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	57
2110	Embryonic shifting dunes	57
2120	Shifting dunes along the shoreline with Ammophila arenaria ("white dunes")	57
2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	57
2140	Decalcified fixed dunes with Empetrum nigrum	57
2150	Atlantic decalcified fixed dunes (Calluno-Ulicetea)	57
2160	Dunes with Hippopha• rhamnoides	57
2170	Dunes with Salix repens ssp. argentea (Salicion arenariae)	57
2190	Humid dune slacks	57
21A0	Machairs (* in Ireland)	57
2250	Coastal dunes with Juniperus spp.	57
2330	Inland dunes with open Corynephorus and Agrostis grasslands	57
3110	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	57
3130	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	57
3140	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	57
3150	Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation	57

CODE	DESCRIPTION	PAGE NO
3160	Natural dystrophic lakes and ponds	57
3170	Mediterranean temporary ponds	57
3180	Turloughs	57
3260	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	57
4010	Northern Atlantic wet heaths with Erica tetralix	57
4020	Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	57
4030	European dry heaths	57
4040	Dry Atlantic coastal heaths with Erica vagans	57
4060	Alpine and Boreal heaths	57
4080	Sub-Arctic Salix spp. scrub	57
5110	Stable xerothermophilous formations with Buxus sempervirens on rock slopes (Berberidion p.p.)	57
5130	Juniperus communis formations on heaths or calcareous grasslands	57
6130	Calaminarian grasslands of the Violetalia calaminariae	57
6150	Siliceous alpine and boreal grasslands	57
6170	Alpine and subalpine calcareous grasslands	57
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	57
6230	Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	57
6410	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	57
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	57
6510	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	57
6520	Mountain hay meadows	57
7110	Active raised bogs	57
7120	Degraded raised bogs still capable of natural regeneration	57
7130	Blanket bogs (* if active bog)	57
7140	Transition mires and quaking bogs	57
7150	Depressions on peat substrates of the Rhynchosporion	57
7210	Calcareous fens with Cladium mariscus and species of the Caricion davallianae	57
7220	Petrifying springs with tufa formation (Cratoneurion)	57
7230	Alkaline fens	57
7240	Alpine pioneer formations of the Caricion bicoloris-atrofuscae	57
8110	Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	57
8120	Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)	57
8210	Calcareous rocky slopes with chasmophytic vegetation	57
8220	Siliceous rocky slopes with chasmophytic vegetation	57
8240	Limestone pavements	57
8310	Caves not open to the public	57
8330	Submerged or partially submerged sea caves	57
9120	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)	57
9130	Asperulo-Fagetum beech forests	57
9160	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	57
9180	Tilio-Acerion forests of slopes, screes and ravines	57
9190	Old acidophilous oak woods with Quercus robur on sandy plains	57
91A0	Old sessile oak woods with Ilex and Blechnum in the British Isles	57
91C0	Caledonian forest	57
91D0	Bog woodland	57
91E0	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	57
91J0	Taxus baccata woods of the British Isles	57

3.1 Habitat representativity (abbreviated to 'Representativity' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent representatively	57
B	Good representatively	57
C	Significant representatively	57
D	Non-significant presence representatively	57

3.1 Relative surface

CODE	DESCRIPTION	PAGE NO
A	> 15%-100%	58
B	> 2%-15%	58
C	≤ 2%	58

3.1 Degree of conservation (abbreviated to 'Conservation' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	59
B	Good conservation	59
C	Average or reduced conservation	59

3.1 Global assessment (abbreviated to 'Global' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	59
B	Good value	59
C	Significant value	59

3.2 Population (abbreviated to 'Pop.' in data form)

CODE	DESCRIPTION	PAGE NO
A	> 15%-100%	62
B	> 2%-15%	62
C	≤ 2%	62
D	Non-significant population	62

3.2 Degree of conservation (abbreviated to 'Con.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	63
B	Good conservation	63
C	Average or reduced conservation	63

3.2 Isolation (abbreviated to 'Iso.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Population (almost) Isolated	63
B	Population not-isolated, but on margins of area of distribution	63
C	Population not-isolated within extended distribution range	63

3.2 Global Grade (abbreviated to 'Glo.' or 'G.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	63
B	Good value	63
C	Significant value	63

3.3 Other species – essentially covers bird assemblage types

CODE	DESCRIPTION	PAGE NO
WATR	Non-breeding waterbird assemblage	UK specific code
SBA	Breeding seabird assemblage	UK specific code

BBA	Breeding bird assemblage (applies only to sites classified pre 2000)	UK specific code

4.1 Habitat class code

CODE	DESCRIPTION	PAGE NO
N01	Marine areas, Sea inlets	65
N02	Tidal rivers, Estuaries, Mud flats, Sand flats, Lagoons (including saltwork basins)	65
N03	Salt marshes, Salt pastures, Salt steppes	65
N04	Coastal sand dunes, Sand beaches, Machair	65
N05	Shingle, Sea cliffs, Islets	65
N06	Inland water bodies (Standing water, Running water)	65
N07	Bogs, Marshes, Water fringed vegetation, Fens	65
N08	Heath, Scrub, Maquis and Garrigue, Phygrana	65
N09	Dry grassland, Steppes	65
N10	Humid grassland, Mesophile grassland	65
N11	Alpine and sub-Alpine grassland	65
N14	Improved grassland	65
N15	Other arable land	65
N16	Broad-leaved deciduous woodland	65
N17	Coniferous woodland	65
N19	Mixed woodland	65
N21	Non-forest areas cultivated with woody plants (including Orchards, groves, Vineyards, Dehesas)	65
N22	Inland rocks, Screes, Sands, Permanent Snow and ice	65
N23	Other land (including Towns, Villages, Roads, Waste places, Mines, Industrial sites)	65
N25	Grassland and scrub habitats (general)	65
N26	Woodland habitats (general)	65

4.3 Threats code

CODE	DESCRIPTION	PAGE NO
A01	Cultivation	65
A02	Modification of cultivation practices	65
A03	Mowing / cutting of grassland	65
A04	Grazing	65
A05	Livestock farming and animal breeding (without grazing)	65
A06	Annual and perennial non-timber crops	65
A07	Use of biocides, hormones and chemicals	65
A08	Fertilisation	65
A10	Restructuring agricultural land holding	65
A11	Agriculture activities not referred to above	65
B01	Forest planting on open ground	65
B02	Forest and Plantation management & use	65
B03	Forest exploitation without replanting or natural regrowth	65
B04	Use of biocides, hormones and chemicals (forestry)	65
B06	Grazing in forests/ woodland	65
B07	Forestry activities not referred to above	65
C01	Mining and quarrying	65
C02	Exploration and extraction of oil or gas	65
C03	Renewable abiotic energy use	65
D01	Roads, paths and railroads	65
D02	Utility and service lines	65
D03	Shipping lanes, ports, marine constructions	65
D04	Airports, flightpaths	65
D05	Improved access to site	65
E01	Urbanised areas, human habitation	65
E02	Industrial or commercial areas	65

CODE	DESCRIPTION	PAGE NO
E03	Discharges	65
E04	Structures, buildings in the landscape	65
E06	Other urbanisation, industrial and similar activities	65
F01	Marine and Freshwater Aquaculture	65
F02	Fishing and harvesting aquatic ressources	65
F03	Hunting and collection of wild animals (terrestrial), including damage caused by game (excessive density), and taking/removal of terrestrial animals (including collection of insects, reptiles, amphibians, birds of prey, etc., trapping, poisoning, poaching, predator control, accidental capture (e.g. due to fishing gear), etc.)	65
F04	Taking / Removal of terrestrial plants, general	65
F05	Illegal taking/ removal of marine fauna	65
F06	Hunting, fishing or collecting activities not referred to above	65
G01	Outdoor sports and leisure activities, recreational activities	65
G02	Sport and leisure structures	65
G03	Interpretative centres	65
G04	Military use and civil unrest	65
G05	Other human intrusions and disturbances	65
H01	Pollution to surface waters (limnic & terrestrial, marine & brackish)	65
H02	Pollution to groundwater (point sources and diffuse sources)	65
H03	Marine water pollution	65
H04	Air pollution, air-borne pollutants	65
H05	Soil pollution and solid waste (excluding discharges)	65
H06	Excess energy	65
H07	Other forms of pollution	65
I01	Invasive non-native species	65
I02	Problematic native species	65
I03	Introduced genetic material, GMO	65
J01	Fire and fire suppression	65
J02	Human induced changes in hydraulic conditions	65
J03	Other ecosystem modifications	65
K01	Abiotic (slow) natural processes	65
K02	Biocenotic evolution, succession	65
K03	Interspecific faunal relations	65
K04	Interspecific floral relations	65
K05	Reduced fecundity/ genetic depression	65
L05	Collapse of terrain, landslide	65
L07	Storm, cyclone	65
L08	Inundation (natural processes)	65
L10	Other natural catastrophes	65
M01	Changes in abiotic conditions	65
M02	Changes in biotic conditions	65
U	Unknown threat or pressure	65
XO	Threats and pressures from outside the Member State	65

5.1 Designation type codes

CODE	DESCRIPTION	PAGE NO
UK00	No Protection Status	67
UK01	National Nature Reserve	67
UK04	Site of Special Scientific Interest (GB)	67
UK05	Marine Conservation Zone	67
UK06	Nature Conservation Marine Protected Area	67
UK86	Special Area (Channel Islands)	67
UK98	Area of Special Scientific Interest (NI)	67
IN00	Ramsar Convention site	67
IN08	Special Protection Area	67
IN09	Special Area of Conservation	67

Information Sheet on Ramsar Wetlands (RIS)

Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).

Notes for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.

2. Further information and guidance in support of Ramsar site designations are provided in the *Strategic Framework for the future development of the List of Wetlands of International Importance* (Ramsar Wise Use Handbook 7, 2nd edition, as amended by COP9 Resolution IX.1 Annex B). A 3rd edition of the Handbook, incorporating these amendments, is in preparation and will be available in 2006.

3. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Secretariat. Compilers should provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of all maps.

1. Name and address of the compiler of this form:

FOR OFFICE USE ONLY.

DD MM YY

Designation date | Site Reference Number

Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough
Cambridgeshire PE1 1JY
UK
Telephone/Fax: +44 (0)1733 – 562 626 / +44 (0)1733 – 555 948
Email: RIS@JNCC.gov.uk

2. Date this sheet was completed/updated:

Designated: 31 August 2007

3. Country:

UK (England)

4. Name of the Ramsar site:

Humber Estuary

5. Designation of new Ramsar site or update of existing site:

This RIS is for: Updated information on an existing Ramsar site

6. For RIS updates only, changes to the site since its designation or earlier update:

a) Site boundary and area:

The boundary has been extended

** Important note: If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

7. Map of site included:

Refer to Annex III of the *Explanatory Notes and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

a) A map of the site, with clearly delineated boundaries, is included as:

i) **hard copy** (required for inclusion of site in the Ramsar List): *yes* ✓ -or- *no* □;
ii**) an electronic format** (e.g. a JPEG or ArcView image) Yes
iii) **a GIS file providing geo-referenced site boundary vectors and attribute tables** *yes* ✓ -or- *no* □;

b) Describe briefly the type of boundary delineation applied:

e.g. the boundary is the same as an existing protected area (nature reserve, national park etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

The site boundary is the same as, or falls within, an existing protected area.

For precise boundary details, please refer to paper map provided at designation

8. Geographical coordinates (latitude/longitude):

053 32 59 N 000 00 03 E

9. General location:

Include in which part of the country and which large administrative region(s), and the location of the nearest large town.

Nearest town/city: Kingston-upon-Hull

The Humber Estuary is located on the boundary between the East Midlands Region and the Yorkshire and the Humber Region, on the east coast of England bordering the North Sea.

Administrative region: City of Kingston upon Hull; East Riding of Yorkshire; Humberside; Lincolnshire; North East Lincolnshire; North Lincolnshire

10. Elevation (average and/or max. & min.) (metres): 11. Area (hectares): 37987.8

Min. -13
Max. 10
Mean No information available

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

The Humber Estuary is the largest macro-tidal estuary on the British North Sea coast. It drains a catchment of some 24,240 square kilometres and is the site of the largest single input of freshwater from Britain into the North Sea. It has the second-highest tidal range in Britain (max 7.4 m) and approximately one-third of the estuary is exposed as mud or sand flats at low tide. The inner estuary supports extensive areas of reedbed with areas of mature and developing saltmarsh backed in places by limited areas of grazing marsh in the middle and outer estuary. On the north Lincolnshire coast the saltmarsh is backed by low sand dunes with marshy slacks and brackish pools. The Estuary regularly supports internationally important numbers of waterfowl in winter and nationally important breeding populations in summer.

13. Ramsar Criteria:

Circle or underline each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11).

1, 3, 5, 6, 8

14. Justification for the application of each Criterion listed in 13 above:

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

Ramsar 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.

It 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. Examples of both strandline, foredune, mobile, semi-fixed dunes, fixed dunes and dune grassland occur on both banks of the estuary and along the coast. The estuary supports a full range of saline conditions from the open coast to the limit of saline intrusion on the tidal rivers of the Ouse and Trent. Wave exposed sandy shores are found in the outer/open coast areas of the estuary. These change to the more moderately exposed sandy shores and then to sheltered muddy shores within the main body of the estuary and up into the tidal rivers. The lower saltmarsh of the Humber is dominated by common cordgrass *Spartina anglica* and annual glasswort *Salicornia* communities. Low to mid marsh communities are mostly represented by sea aster *Aster tripolium*, common saltmarsh grass *Puccinellia maritima* and sea purslane *Atriplex portulacoides* communities. The upper portion of the saltmarsh community is atypical, dominated by sea couch *Elytrigia atherica* (*Elymus pycnanthus*) saltmarsh community. In the upper reaches of the estuary, the tidal marsh community is dominated by the common reed *Phragmites australis* fen and sea club rush *Bolboschoenus maritimus* swamp with the couch grass *Elytrigia repens (Elymus repens)* saltmarsh community. Within the Humber Estuary Ramsar site there are good examples of four of the five physiographic types of saline lagoon.

Ramsar 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*.

Ramsar criterion 5

Assemblages of international importance:

153,934 waterfowl, non-breeding season

(5 year peak mean 1996/97-2000/2001)

Ramsar criterion 6 – species/populations occurring at levels of international importance.

Eurasian golden plover, *Pluvialis apricaria*

altifrons subspecies – NW Europe, W Continental Europe, NW Africa population

17,996 individuals, passage, representing an average of 2.2% of the population

(5 year peak mean 1996-2000)

Red knot, *Calidris canutus*

islandica subspecies

18,500 individuals, passage, representing an average of 4.1% of the population

(5 year peak mean 1996-2000)

Dunlin, *Calidris alpina*
alpina subspecies – Western Europe (non-breeding) population
20,269 individuals, passage, representing an average of 1.5% of the population
(5 year peak mean 1996-2000)

Black-tailed godwit, *Limosa limosa*
islandica subspecies
915 individuals, passage, representing and average of 2.6% of the population
(5 year peak mean 1996-2000)

Common redshank, *Tringa totanus*
brittanica subspecies
7,462 individuals, passage, representing an average of 5.7% of the population
(5 year peak mean 1996-2000)

Common shelduck, *Tadorna tadorna*
Northwestern Europe (breeding) population
4,464 individuals, wintering, representing an average of 1.5% of the population
(5 year peak mean 1996/7-2000/1)

Eurasian golden plover, *Pluvialis apricaria*
altifrons subspecies – NW Europe, W Continental Europe, NW Africa population
30,709 individuals, wintering, representing an average of 3.8% of the population
(5 year peak mean 1996/7-2000/1)

Red knot, *Calidris canutus*
islandica subspecies
28,165 individuals, wintering, representing an average of 6.3% of the population
(5 year peak mean 1996/7-2000/1)

Dunlin, *Calidris alpina*
alpina subspecies – Western Europe (non-breeding) population
22,222 individuals, wintering, representing an average of 1.7% of the population
(5 year peak mean 1996/7-2000/1)

Black-tailed godwit, *Limosa limosa*
islandica subspecies
1,113 individuals, wintering, representing an average of 3.2% of the population
(5 year peak mean 1996/7-2000/1)

Bar-tailed godwit , *Limosa lapponica*
lapponica subspecies
2,752 individuals, wintering, representing an average of 2.3% of the population
(5 year peak mean 1996/7-2000/1)

Common redshank, *Tringa totanus*
brittanica subspecies
4,632 individuals, wintering, representing an average of 3.6% of the population
(5 year peak mean 1996/7-2000/1)

Ramsar 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.

Ramsar criterion 5

Assemblages of international importance:

Species with peak counts in winter:
153934 waterfowl (5 year peak mean 1998/99-2002/2003)

Ramsar criterion 6 – species/populations occurring at levels of international importance.

Qualifying Species/populations (as identified at designation):

Species with peak counts in spring/autumn:

European golden plover , *Pluvialis apricaria apricaria*, P. a. altifrons Iceland & Faroes/E Atlantic	17996 individuals, representing an average of 2.2% of the population (1996-2000)
Red knot , *Calidris canutus islandica*, W & Southern Africa	18500 individuals, representing an average of 4.1% of the population (1996-2000)
(wintering)	
Dunlin , *Calidris alpina alpina*, W Siberia/W Europe	20269 individuals, representing an average of 1.5% of the population (1996-2000)
Black-tailed godwit , *Limosa limosa islandica*, Iceland/W Europe	915 individuals, representing an average of 2.6% of the population (1996-2000)
Common redshank , *Tringa totanus totanus*,	7462 individuals, representing an average of 5.7% of the population (1996-2000)

Species with peak counts in winter:

Common shelduck , *Tadorna tadorna*, NW Europe	4464 individuals, representing an average of 1.5% of the population (1996/7 to 2000/1)
European golden plover , *Pluvialis apricaria apricaria*, P. a. altifrons Iceland & Faroes/E Atlantic	30709 individuals, representing an average of 3.8% of the population (1996/7 to 2000/1)
Red knot , *Calidris canutus islandica*, W & Southern Africa	28165 individuals, representing an average of 6.3% of the population (1996/7 to 2000/1)
(wintering)	
Dunlin , *Calidris alpina alpina*, W Siberia/W Europe	22222 individuals, representing an average of 1.7% of the population (1996/7 to 2000/1)

Black-tailed godwit , *Limosa limosa islandica*, Iceland/W Europe	1113 individuals, representing an average of 3.2% of the population (1996/7 to 2000/1)
Bar-tailed godwit , *Limosa lapponica lapponica*, W Palearctic	2752 individuals, representing an average of 2.3% of the population (1996/7 to 2000/1)

Contemporary data and information on waterbird trends at this site and their regional (sub-national) and national contexts can be found in the Wetland Bird Survey report, which is updated annually. See www.bto.org/survey/webs/webs-alerts-index.htm.
See Sections 21/22 for details of noteworthy species
Details of bird species occuring at levels of National importance are given in Section 22

15. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region:
Atlantic

b) biogeographic regionalisation scheme (include reference citation):
Council Directive 92/43/EEC

16. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

Soil & geology	neutral, shingle, sand, mud, clay, alluvium, sedimentary, sandstone, sandstone/mudstone, limestone/chalk, gravel, nutrient-rich
Geomorphology and landscape	lowland, coastal, floodplain, shingle bar, intertidal sediments (including sandflat/mudflat), estuary, islands, cliffs
Nutrient status	eutrophic
pH	circumneutral
Salinity	brackish / mixosaline, fresh, saline / euhaline
Soil	mainly mineral
Water permanence	usually permanent
Summary of main climatic features	Annual averages (Cleethorpes, 1971–2000) (www.metoffice.com/climate/uk/averages/19712000/sites/cleethorpes.html) Max. daily temperature: 13.1° C Min. daily temperature: 6.4° C Days of air frost: 29.0 Rainfall: 565.4 mm Hrs. of sunshine: 1521.9

General description of the Physical Features:

The Humber estuary is approximately 70 km long from the limit of saline intrusion on the River Ouse at Boothferry to the estuary mouth at Spurn Head, where it enters the North Sea. The area of the estuary is approx. 365 km2, and it has a width of 6.6 km at the mouth.

The Humber is a macro-tidal estuary with a tidal range of 7.4 m, the second-largest range in the UK and comparable to other macro-tidal estuaries worldwide. It is a shallow and well mixed estuary, with an average depth of 6.5m rising to 13.2 m at the mouth.

The Humber is the second-largest coastal plain estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. Suspended sediment concentrations are high, and are derived from a variety of sources, including marine sediments and eroding boulder clay along the Holderness coast. This is the northernmost of the English east coast estuaries whose structure and function is intimately linked with soft eroding shorelines.

Upstream from the Humber Bridge, the navigation channel undergoes major shifts from north to south banks. This section of the estuary is noteworthy for extensive mud and sand bars, which in places form semi-permanent islands.

The estuary covers the full salinity range from fully marine at the mouth of the estuary (Spurn Head) to the limit of saline intrusion on the Rivers Ouse and Trent)). A salinity gradient from north to south bank is observed in the outer estuary, due to the incoming tide flowing along the north bank, while the fresh water keeps to the south bank as it discharges to the sea. As salinity declines upstream, reedbeds and brackish saltmarsh communities fringe the estuary..

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17. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, general land use, and climate (including climate type).

The Humber catchment covers an area of ca. 24,240 km2, more than 20% of the land area of England. Average annual precipitation in the upland areas of the catchment is as much as 1000 mm. Average freshwater flow into the Humber estuary from the rivers is 250 m3s-1, ranging from 60 m3s-1 in drier periods to 450 m3s-1 in wet periods. Peak flows of up to 1500 m3s-1 have been recorded during floods. The rivers Trent and Ouse, which provide the main fresh water flow into the Humber, drain large industrial and urban areas to the south and west (River Trent), and less densely populated agricultural areas to the north and west (River Ouse). The Trent/Ouse confluence is known as Trent Falls.

On the north bank of the Humber estuary the principal river is the river Hull, which flows through the city of Kingston-upon-Hull, and has a tidal length of 32 km, up to the Hempholme Weir. The Hull provides only about 1% of the freshwater input to the estuary. On the south bank, the River Ancholme enters the Humber at South Ferriby, but the tide is excluded by a sluice and a tidal lock. Altogether, the total tidal length of rivers and estuary is 313 km.

There are several major urban centres within the river catchments. Nottingham, Leicester, and the West Midlands/Birmingham conurbation are drained by the Trent, the Leeds-Bradford area in West Yorkshire is drained by the Aire/Calder and the Sheffield/Rotherham/Doncaster area in South Yorkshire is drained by the Don. There are also large rural regions, whose populations are currently experiencing high population growth, while the urban areas are showing a small decline. The 1992 population for the Ouse catchment was 4.1 million, and for the Trent catchment was 7.1 million. The population of Humberside, which comprises North and North-east Lincolnshire, the East Riding of Yorkshire, and Kingston-upon-Hull (Hull), was just under 0.9 million. Land use around the estuary itself is 50-98% agricultural, within only two areas of high population/ industry – the major conurbation around Kingston-upon-Hull (Hull) on the north bank, and several large industrial areas around Grimsby/ Immingham/ Cleesthorpes on the south bank.

The area around the Humber estuary is low-lying, and much land-claim of wetlands and supratidal zones, as well as parts of the intertidal zone, was carried out in the past two centuries. The mid to

outer estuary (Humber Bridge to Spurn Point) changed from a region of low water erosion in the 19th century to one of accretion in the 20th century, nonetheless a net loss of intertidal zone of some 3000 ha has taken place since the mid-19th century. Around the estuary some 894 km2 of land are below the 5 m contour, protected by extensive coastal defences. Most of the sediment entering the estuary comes from the North Sea, and a large part of it is believed to come from the continuing erosion of the Holderness Cliffs, which form the coastline to the north of the estuary mouth at Spurn Head. The estuary currently has approximately 1,775 ha of saltmarsh

18. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

Sediment trapping

19. Wetland types:

Marine/coastal wetland

Code	Name	% Area
F	Estuarine waters	66.8
G	Tidal flats	26.4
H	Salt marshes	4.7
E	Sand / shingle shores (including dune systems)	0.8
7	Gravel / brick / clay pits	0.5
Q	Saline / brackish lakes: permanent	0.3
J	Coastal brackish / saline lagoons	0.3
Other	Other	0.1
9	Canals and drainage channels	0.01
Y	Freshwater springs	0.01

20. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

Description

Much of the intertidal area of the Humber Estuary consists of mudflats with fringing saltmarsh. There are smaller areas of intertidal sand flats, and sand dunes. The saltmarsh is both eroding and accreting; although coastal squeeze is resulting in net losses, and cord grass Spartina anglica is a major colonising species. In areas of reduced salinity such as the Upper Humber there are extensive areas of common reed Phragmites australis with some sea club-rush Bolboschoenus maritimus. Mid-level saltmarsh tends to be much more floristically diverse, and in the higher level marsh with its dendritic network of drainage channels, salt pans and borrow pits grasses dominate with thrift Armeria maritima where the marsh is grazed by cattle and sheep. Extensive areas of eel grass Zostera marina and Z. nolti have been known to occur at Spurn Bight, although in recent years records are limited. Behind the sandflats of the Cleethorpes coast the mature sand-dune vegetation contains some locally and nationally rare species including chestnut flat sedge Blysmus rufus, bulbous meadow grass Poa bulbosa and dense silky-bent Apera interrupta. The sand dunes, which cap the shingle spit that forms Spurn Peninsula are dominated by marram grass Ammophila arenaria and patches of dense sea buckthorn Hippophae rhamnoides.

Ecosystem services

Aesthetic

Education

Food

Recreation

Storm/wave protection

21. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in **12**. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

None reported

22. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in **12**. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Birds

Species Information

Species Information

Birds

Species currently occurring at levels of national importance:

Great bittern, *Botaurus stellaris*
stellaris subspecies – W Europe, NW Africa (breeding) population
2 booming males, breeding, representing an average of 10.5% of the GB population
(3 year mean 2000-2002)

Eurasian marsh harrier, *Circus aeruginosus*
Europe population
10 females, breeding, representing an average of 6.3% of the GB population
(5 year mean 1998-2002)

Pied avocet, *Recurvirostra avosetta*
Western Europe (breeding) population
64 pairs, breeding, representing an average of 8.6% of the GB population
(5 year mean 1998-2002)

Little tern, *Sterna albifrons*
albifrons subspecies, Western Europe (breeding) population
51 pairs, breeding, representing an average of 2.1% of the GB population
(5 year mean 1998-2002)

Dark-bellied brent goose, *Branta bernicla*
bernicla subspecies
2,098 individuals, wintering, representing an average of 2.1% of the GB population
(5 year peak mean 1996/7-2000/1)

Eurasian wigeon, *Anas penelope*
Northwestern Europe (non-breeding) population
5,044 individuals, wintering, representing an average of 1.2% of the GB population
(5 year peak mean 1996/7-2000/1)

Common teal, *Anas crecca*
crecca subspecies, Northwestern Europe (non-breeding population)
2,322 individuals, wintering, representing an average of 1.2% of the GB population

(5 year peak mean 1996/7-2000/1)

Common pochard, *Aythya ferina*
Northeastern & Northwestern Europe (non-breeding) population
719 individuals, wintering, representing an average of 1.2% of the GB population
(5 year peak mean 1996/7-2000/1)

Greater scaup, *Aythya marila*
marila subspecies, Western Europe (non-breeding) population
127 individuals, wintering, representing an average of 1.7% of the GB population
(5 year peak mean 1996/7-2000/1)

Common goldeneye, *Bucephala clangula*
clangula subspecies, Northwestern & Central Europe (non-breeding) population
467 individuals, wintering, representing an average of 1.9% of the GB population
(5 year peak mean 1996/7-2000/1)

Great bittern, *Botaurus stellaris*
stellaris subspecies – W Europe, NW Africa (breeding) population
4 individuals, wintering, representing an average of 4.0% of the GB population
(5 year peak mean 1998/9-2002/3)

Hen harrier, *Circus cyaneus*
Europe population
8 individuals, wintering, representing an average of 1.1% of the GB population
(5 year peak mean 1997/8-2001/2)

Eurasian oystercatcher, *Haematopus ostralegus*
ostralegus subspecies
3,503 individuals, wintering, representing an average of 1.1% of the GB population
(5 year peak mean 1996/7-2000/1)

Pied avocet, *Recurvirostra avosetta*
Western Europe (breeding) population
59 individuals, wintering, representing an average of 1.7% of the GB population
(5 year peak mean 1996/7-2000/1)

Great ringed plover, *Charadrius hiaticula*
hiaticula subspecies
403 individuals, wintering, representing an average of 1.2% of the GB population
(5 year peak mean 1996/7-2000/1)

Grey plover, *Pluvialis squatarola*
squatarola subspecies, Eastern Atlantic (non-breeding) population
1,704 individuals, wintering, representing an average of 3.2% of the GB population
(5 year peak mean 1996/7-2000/1)

Northern lapwing, *Vanellus vanellus*
Europe (breeding) population
22,765 individuals, wintering, representing an average of 1.1% of the GB population
(5 year peak mean 1996/7-2000/1)

Sanderling, *Calidris alba*
Eastern Atlantic (non-breeding) population

486 individuals, wintering, representing an average of 2.3% of the GB population
(5 year peak mean 1996/7-2000/1)

Curlew, *Numenius arquata*
arquata subspecies
3,253 individuals, wintering, representing an average of 2.2% of the GB population
(5 year peak mean 1996/7-2000/1)

Ruddy turnstone, *Arenaria interpres*
interpres subspecies, Northeastern Canada & Greenland (breeding) population
629 individuals, wintering, representing an average of 1.3% of the GB population
(5 year peak mean 1996/7-2000/1)

Great ringed plover, *Charadrius hiaticula*
psammodroma subspecies
1,766 individuals, passage, representing an average of 5.9% of the GB population
(5 year peak mean 1996-2000)

Grey plover, *Pluvialis squatarola*
squatarola subspecies, Eastern Atlantic (non-breeding) population
1,590 individuals, passage, representing an average of 2.3% of the GB population
(5 year peak mean 1996-2000)

Sanderling, *Calidris alba*
Eastern Atlantic (non-breeding) population
818 individuals, passage, representing an average of 2.7% of the GB population
(5 year peak mean 1996-2000)

Ruff, *Philomachus pugnax*
Western Africa (non-breeding) population
128 individuals, passage, representing an average of 1.4% of the GB population
(5 year peak mean 1996-2000)

Whimbrel, *Numenius phaeopus*
islandicus subspecies
113 individuals, passage, representing an average of 2.3% of the GB population
(5 year peak mean 1996-2000)

Common greenshank, *Tringa nebularia*
Northwestern Europe (breeding) population
77 individuals, passage, representing an average of 5.5% of the GB population
(5 year peak mean 1996-2000)

23. Social and cultural values:

Describe if the site has any general social and/or cultural values e.g. fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values.

Aesthetic
Aquatic vegetation (e.g. reeds, willows, seaweed)
Archaeological/historical site
Environmental education/ interpretation
Fisheries production
Livestock grazing
Non-consumptive recreation

Sport fishing
Sport hunting
Tourism
Transportation/navigation

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning? No

If Yes, describe this importance under one or more of the following categories:

i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:

ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:

iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:

iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

24. Land tenure/ownership:

Ownership category	On-site	Off-site
Non-governmental organisation (NGO)	+	+
Local authority, municipality etc.	+	+
National/Crown Estate	+	+
Private	+	+
Public/communal	+	+

25. Current land (including water) use:

Activity	On-site	Off-site
Nature conservation	+	+
Tourism	+	+
Recreation	+	+
Current scientific research	+	
Cutting of vegetation (small-scale/subsistence)	+	
Fishing: commercial	+	+
Fishing: recreational/sport	+	+
Gathering of shellfish	+	+
Bait collection	+	+
Permanent arable agriculture		+
Permanent pastoral agriculture	+	+
Hunting: recreational/sport	+	+
Industrial water supply	+	+
Industry	+	+
Sewage treatment/disposal	+	+
Harbour/port	+	+

Flood control	+	+
Irrigation (incl. agricultural water supply)		+
Mineral exploration (excl. hydrocarbons)		+
Oil/gas exploration	+	+
Transport route	+	+
Domestic water supply		+
Urban development		+
Non-urbanised settlements		+
Military activities	+	+
Horticulture (incl. market gardening)		+

26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

Explanation of reporting category:

1. *Those factors that are still operating, but it is unclear if they are under control, as there is a lag in showing the management or regulatory regime to be successful.*
2. *Those factors that are not currently being managed, or where the regulatory regime appears to have been ineffective so far.*

NA = Not Applicable because no factors have been reported.

Adverse Factor Category	Reporting Category	Description of the problem (Newly reported Factors only)	On-Site	Off-Site	Major Impact?
Disturbance to vegetation through cutting / clearing	1	Reedbeds being cut and cleared on margins of pits associated with angling. Management agreements and enforcement to address.	+		
Vegetation succession	1	Lack of reedbed management leading to scrub encroachment. Management agreement to address.	+		
Water diversion for irrigation/domestic/industrial use	1	Abstraction causes reduced freshwater input. Review of consents well advanced but not yet implemented.	+	+	
Overfishing	2	Substantial lamprey by-catch in eel nets in River Ouse.		+	
Pollution – domestic sewage	1	Reduced dissolved oxygen in River Ouse is a barrier to fish migration. Review of consents well advanced but not yet implemented.	+	+	+
Pollution – agricultural fertilisers	1	Reduced dissolved oxygen in River Ouse is a barrier to fish migration. To be addressed through Catchment Sensitive Farming Initiatives and implementation of Water Framework Directive.	+	+	+
Recreational/tourism disturbance (unspecified)	1	Particularly illegal access by motorised recreational vehicles and craft. Control through management scheme.	+		

Other factor	1	Coastal squeeze causing loss of intertidal habitats and saltmarsh due to sea level rise and fixed defences. The Humber Flood Risk Management Strategy has been developed and is being implemented.	+		+

For category 2 factors only.
What measures have been taken / are planned / regulatory processes invoked, to mitigate the effect of these factors?
Overfishing - Overfishing – to be considered through an 'in-combination' assessment of possible factors as part of the Review of Consents exercise.

Is the site subject to adverse ecological change? YES

27. Conservation measures taken:

List national category and legal status of protected areas, including boundary relationships with the Ramsar site; management practices; whether an officially approved management plan exists and whether it is being implemented.

Conservation measure	On-site	Off-site
Site/ Area of Special Scientific Interest (SSSI/ASSI)	+	+
National Nature Reserve (NNR)	+	
Special Protection Area (SPA)	+	
Land owned by a non-governmental organisation for nature conservation	+	+
Management agreement	+	+
Site management statement/plan implemented	+	
Area of Outstanding National Beauty (AONB)		+
Special Area of Conservation (SAC)	+	
IUCN (1994) category IV	+	

b) Describe any other current management practices:
The management of Ramsar sites in the UK is determined by either a formal management plan or through other management planning processes, and is overseen by the relevant statutory conservation agency. Details of the precise management practises are given in these documents.

28. Conservation measures proposed but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

No information available

29. Current scientific research and facilities:

e.g. details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Fauna.
Numbers of migratory and wintering wildfowl and waders are monitored annually as part of the national Wetland Birds Survey (WeBS) organised by the British Trust for Ornithology, Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the Joint Nature Conservation Committee.
Seal populations are monitored by the Sea Mammal Research Unit
Humber Wader Ringing Group
Spurn Bird Observatory
National Nature Reserve monitoring

Environment.
Institute of Estuarine & Coastal Studies, Hull: various
Industrial Concerns: monitoring on behalf of companies such as Associated British Ports and BP
Environment Agency monitoring: various
Geomorphological studies associated with shoreline management planning
National Nature Reserve monitoring

30. Current communications, education and public awareness (CEPA) activities related to or benefiting the site:

e.g. visitor centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

There are a four National Nature Reserves with associated facilities within the Ramsar site (Spurn, Far Ings, Donna Nook and Saltfleetby – Theddlethorpe Dunes) and a number of other visitor, information and/or education centres including the Spurn Bird Observatory, the Cleethorpes Discovery Centre, Water's Edge and Far Ings. A wide range of Humber wide and area-specific information is available through a range of media (eg leaflets, displays, internet etc) including 'Humber Estuary European Marine Site Codes of Conduct' developed with a range of stakeholders to cover a range of recreational and educational activities and 'Coastal Futures' – a partnership project working with local communities affected by flood risk and associated issues including managed realignment includes proactive education work within schools.

31. Current recreation and tourism:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

Activities, Facilities provided and Seasonality.
Sailing: marinas at Brough, Winteringham, Hull, Grimsby and South Ferriby.

Bathing etc: Cleethorpes (some 6m visitors/yr).

Walking/Horse riding: throughout

Beach fishing, match sea-fishing, non-commercial bait digging.

Non-commercial samphire collection

Wildfowling

Tourist amusements: Cleethorpes.

Bird watching: throughout but particularly at Blacktoft Sands RSPB reserve and the four National Nature Reserves.

32. Jurisdiction:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept. of Agriculture/Dept. of Environment, etc.

Head, Natura 2000 and Ramsar Team, Department for Environment, Food and Rural Affairs, European Wildlife Division, Zone 1/07, Temple Quay House, 2 The Square, Temple Quay, Bristol, BS1 6EB

33. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Site Designations Manager, English Nature, Sites and Surveillance Team, Northminster House, Northminster Road, Peterborough, PE1 1UA, UK

34. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see **15** above), list full reference citation for the scheme.

Site-relevant references

Site-relevant references

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Appendix B Conservation Objectives

Site	Conservation Objectives
Humber Estuary SAC	Ensure that the integrity of the qualifying natural habitat is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring: • the extent and distribution of qualifying natural habitats and habitats of qualifying species; • the structure and function (including typical species) of the qualifying natural habitats; • the structure and function of the habitats of qualifying species; • the supporting processes on which qualifying natural habitats and habitats of qualifying species rely; • the populations of qualifying species, and • the distribution of qualifying species within the site.
Humber Estuary SPA	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring: • the extent and distribution of the habitats of the qualifying features • the structure and function of the qualifying features • the supporting processes on which the habitats of the qualifying features rely • the populations of each of the qualifying features, and • the distribution of the qualifying features within the site.
Humber Estuary Ramsar	Not specifically listed. Assumed as for Humber Estuary SAC and SPA.

Appendix C Bird Survey Results

C.1 Breeding Birds

Method

A breeding bird survey was undertaken using an adapted Common Bird Census (CBC) methodology, which was scaled down to six visits during the 2022 breeding bird season for each of the survey areas. These bird surveys were undertaken between April and June 2022. This was considered adequate to provide a good indication of the breeding bird ornithological baseline for the purposes of an assessment of ornithological impacts.

The surveys involved recording all the birds observed, their locations and activity/ behaviour. Contacts with birds (by song, call or sighting) were marked on the survey map using BTO species codes and standard behaviour notation[20].

Surveys were carried out during the mornings in suitable weather conditions (unrestricted visibility, winds less than Beaufort 5 and not in continuous rain). Afternoons, when bird activity usually drops significantly, were avoided as much as possible; however, some flexibility was allowed to accommodate surveys around periods of bad weather at the surveyor's discretion.

The survey maps were analysed to determine breeding activity for species of conservation concern and/ or protected species according to the following categories:

- possible breeding (Po) – species present during the survey period in possible nesting habitat, but with no indication of breeding. Presumed passage migrants are not included.
- probable breeding (Pr) – observations of one or more of the following activities during the survey period:
  - singing male heard, or breeding calls heard.
  - pair observed in suitable nesting habitat during the survey period.
  - display or courtship.
  - birds visiting a probable nest site.
  - birds seen to be carrying nesting material.
- confirmed breeding (Co) – observations of any one or more of the following activities during the survey period:
  - agitated behaviour or anxiety calls from adults suggesting a nest or young close by.
  - distraction display or injury feigning from adults.
  - a nest has obviously been used or eggshells found.
  - adults seen carrying food for young.
  - adults seen carrying faecal sac away from nest site.
  - nest with eggs.
  - nest with young or downy young in the case of waders, game birds etc.
  - recently fledged young.
  - soliciting calls from young birds.
- non-breeding (Nb) – species present during the survey period however the habitat type within the survey area is unsuitable for the particular species (for example passage migrants).

[20] https://www.bto.org/sites/default/files/u10/downloads/taking-part/species_codes.pdf).

Results

No SPA/ Ramsar waterbirds were recorded breeding within the Phillips 66 Site boundary during surveys undertaken in 2022.

A summary of the species recorded as confirmed, probably or possibly breeding within the VPI Site (which the Phillips 66 Site partially overlaps with west of the railway line) is provided in Table C1 below.

Table C1: Numbers of confirmed, probable or possible breeding birds recorded on VPI Site during the 2022 breeding bird surveys

Species	Survey dates						Likely No. of pairs
	Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6	
	11/04/'22	22/04/'22	09/05/'22	25/05/'22	08/06/'22	20/06/'22	
Mallard**	0	4	1	0	0	0	1
Kestrel**	1	0	0	1	1	0	0
Little egret	0	0	0	0	1	0	0
Sparrow hawk**	0	0	0	1	0	0	0
Pheasant	1	1	0	2	2	3	1
LITTLE RINGED PLOVER	0	2	1	1	0	0	1
Lapwing*	3	4	4	3	2	3	2
Snipe**	5	2	0	0	0	0	0
Woodpigeon**	3	2	2	1	0	7	2-3
Stock dove**	2	0	0	0	0	0	0
Skylark*	0	0	2	0	1	2	1-2
Meadow pipit**	2	0	0	1	0	0	1?
Chaffinch	0	1	0	1	0	0	0
Pied wagtail	1	1	1	1	0	1	1
Grey wagtail**	1	0	0	0	0	0	0
Wren**	9	4	5	9	7	8	6-8
Dunnock**	4	1	3	3	2	1	1-2
Robin	1	0	0	1	1	0	1
Wheatear**	0	1	0	0	0	0	0
Blackbird	2	1	0	1	0	3	1-2
Song thrush*	0	1	0	1	0	0	1?
Blackcap	1	0	1	0	1	1	1
Lesser whitethroat	0	0	0	1	0	2	1

Species	Survey dates						Likely No. of pairs
	Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6	
	11/04/'22	22/04/'22	09/05/'22	25/05/'22	08/06/'22	20/06/'22	
Whitethroat**	0	1	5	3	2	5	2
Chiffchaff	4	1	1	1	0	0	1
Reed warbler	0	0	1	0	0	1	1
Sedge warbler**	0	3	5	6	3	5	2-3
Long-tailed tit	0	2	0	3	0	0	1?
Great tit	3	0	0	0	0	2	0
Blue tit	2	0	0	0	0	0	0
Carrion Crow	1	3	1	2	1	0	1?
Magpie	0	0	1	2	2	1	1
Goldfinch	1	6	0	0	0	3	1
Linnet*	4	5	4	5	3	7	2-3
Bullfinch*	0	0	0	0	2	0	0
Reed bunting**	2	5	4	3	1	2	2

KEY: Species names shown in bold are Section 41 Species of Principal Importance. Those in capitals are birds on Schedule-1 of the Wildlife and Countryside Act. Red List species shown with * and Amber List species with ** (Birds of Conservation Concern, 2015).

C.2 Wintering and Passage Birds

Methods

The following surveys were undertaken in the Survey Areas shown on Plate 1:

- monthly bird surveys (terrestrial) – two visits per month between October 2021 and March 2022 inclusive covering the period two hours either side of high tide. Survey scope included the VPI Site, Rosper Road Pools and terrestrial fields to the east of Rosper Road that had the potential to be functionally linked to the Humber Estuary SPA/ Ramsar. And
- monthly bird surveys (coastal) - two visits per month between October 2021 and March 2022 inclusive covering the period two hours either side of high tide of the section of North Killingholme Marshes (NKM) mudflats closest to the Proposed Phillips 66 Development.

Table C2: Wintering/ Passage Waterbird Survey Dates

Survey Number	Date	Weather (Temp, cloud cover, windspeed, wind direction)	Tide Times (height)
1	15.10.21	8-12°C 3/8 F1-2 NW	LT 08:38 (2.45m) HT 15:08 (5.85m)
2	29.10.21	13°C 6/8 F6 SE	LT 06:06 (2.8m) HT 12:39 (5.39m)
3	12.11.21	11°C 8/8 F4-5 SSW	HT 12:22 (5.85m) LT 18:09 (2.99m)
4	26.11.21	6°C 4/8 F2-3 WSW	HT 09:52 (5.84m) LT 15:50 (2.66m)
5	03.12.21	3°C 7/8 F2 SSE	LT 10:58 (1.07m) HT 17:02 (7.16m)
6	17.12.21	4°C F0-1 NNW	LT 10:48 (1.78m) HT 16:59 (6.65m)
7	07.01.22	2°C 3/8 F3-4 WSW	HT 09:22 (6.78m) LT 15:18 (1.73m)
8	27.01.22	11°C 1-7/8 F6-7 WNW	LT 06:41 (2.12m) HT 13:00 (5.86m)
9	11.02.22	1°C 1/8 F1 SW	LT 07:24 (2.87m) HT 14:04 (5.48m)
10	25.02.22	7°C 1/8 F3-4 WNW	LT 06:06 (2.39m) HT 12:20 (5.69m)
11	11.03.22	11°C 3/8 F6 SE	LT 05:15 (2.8m) HT 11:27 (5.38m)
12	30.03.22	4°C 8/8 F4-5 NE/E Light Rain	HT 05:59 (6.76m) LT 11:51 (1.62m)

Results

The raw data from the wintering and passage waterbird surveys is provided in Tables C3 to C18 below. Counts are provided per survey and per field for completeness, with records split into feeding, roosting and loafing behaviour by SPA/ Ramsar species where this was able to be determined by the surveyor. Non-SPA/ Ramsar species are excluded from the results tables, as these are not relevant to the assessment. Peak counts as presented in Table 5 in Section 4 of this HRA are derived from the highest number of each individual species recorded across the survey period on any survey visit, to provide an indication of the overall importance of each field/ area to SPA/ Ramsar waterbirds.

No SPA/ Ramsar waterbirds were recorded in Fields 4, 11 and 12 and therefore these fields are excluded from the results tables.

Table C3: Field 1 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (loafing)											
	1	2	3	4	5	6	7	8	9	10	11	12
Lapwing	0	0	0	0	0	0	0	0	0	0	1	4
Species	**Visit number (roosting)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Lapwing	0	0	0	0	0	0	0	0	0	1	0	0
Species	**Visit number (undetermined)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Lapwing	0	0	0	0	0	0	0	0	0	0	2	0

Table C4: Area 2 – Rosper Road Pools - Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Lapwing	0	0	0	0	0	0	0	0	17	47	11	21
Redshank	0	0	0	0	0	0	0	3	8	0	8	8
Black-tailed godwit	353	0	0	0	0	2	5	34	37	70	38	68
Shelduck	0	0	0	0	0	0	0	12	0	8	2	4
Wigeon	0	0	0	0	11	0	0	42	0	0	0	0
Gadwall	0	0	0	0	94	30	0	18	0	0	0	0
Pintail	0	0	0	0	0	7	0	0	0	0	0	0
Species	**Visit number (loafing)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Lapwing	0	0	0	0	0	0	1	16	0	66	55	0
Black-tailed godwit	0	0	0	0	0	0	0	0	0	80	133	123
Bar-tailed godwit	0	0	0	0	1	0	0	0	0	0	6	0
Black-headed gull	0	0	0	0	0	0	0	0	12	0	0	0
Shelduck	0	0	0	0	0	0	0	0	0	1	2	0
Wigeon	0	0	0	0	0	0	0	0	7	0	0	0
Gadwall	0	0	0	0	18	16	8	0	0	0	0	0
Pintail	0	0	0	0	0	0	0	6	0	4	0	0
Species	**Visit number (roosting)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Redshank	0	0	0	2	0	0	0	0	0	0	0	0
Lapwing	0	0	0	0	0	0	0	0	46	7	2	0
Species	**Visit number (undetermined)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Redshank	0	0	0	0	2	0	0	0	0	0	0	0
Lapwing	0	0	0	0	0	0	0	0	0	0	2	0
Black-tailed godwit	480	40	79	0	0	0	0	0	0	0	0	0
Gadwall	0	0	0	32	0	0	0	0	0	0	0	0
Pintail	4	2	2	1	0	0	0	0	0	0	0	0

Shelduck	2	0	0	0	0	0	0	0	0	0	0	0
Wigeon	92	126	0	26	11	42	0	42	7	0	0	0

Table C5: Field 3 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (loafing)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	1	0	0	0	0

Table C6: Field 5 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	0	0	9	0	0
Species	**Visit number (loafing)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	0	0	0	7	0

Table C7: Field 6 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	0	0	50	0	0
Species	**Visit number (loafing)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	0	0	0	9	1

Table C8: Field 7 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (loafing)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	6	0	0	24	4	0
Wigeon	0	0	0	0	0	0	0	4	0	0	0	0

Table C9: Field 8 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Pink-footed goose	0	0	0	0	1	0	0	0	0	0	0	0

Table C10: Field 9 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	18	0	0	0	0	0	0	0
Black-tailed godwit	0	0	0	0	2	0	0	0	0	0	0	0
Species	**Visit number (loafing)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	31	0	0	35	0	0
Lapwing	0	0	0	0	0	0	0	0	0	0	0	2

Table C11: Field 10 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	17	64	0	74	0
Black-tailed godwit	0	0	0	0	0	0	0	0	0	0	8	0

Table C12: Field 13 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	0	15	0	0	0

Table C13: Field 14 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	0	38	0	28	0

Table C14: Field 15 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	2	35	0	0	0	0	0	4
Lapwing	0	0	0	0	0	0	0	0	0	0	0	1

Table C15: Field 16 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	0	0	0	3	0

Table C16: Field 17 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	0	0	0	0	2	0

Table C17: Area 18 – Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	26	8	31	0	11	1	12	39	1	0	2	0
Redshank	0	0	0	0	0	0	0	0	1	0	0	0
Species	**Visit number (loafing)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	12	0	0	0	0	0	0	0	0	0	0
Species	**Visit number (roosting)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	0	0	0	0	79	34	0	0	0	0
Redshank	0	0	0	0	0	0	0	0	40	0	0	0
Lapwing	0	18	0	6	0	0	0	0	0	0	0	0
Black-tailed godwit	0	1	0	0	0	0	0	0	0	0	0	0
Species	**Visit number (undetermined)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	0	0	12	0	0	0	0	0	0	0	0	0

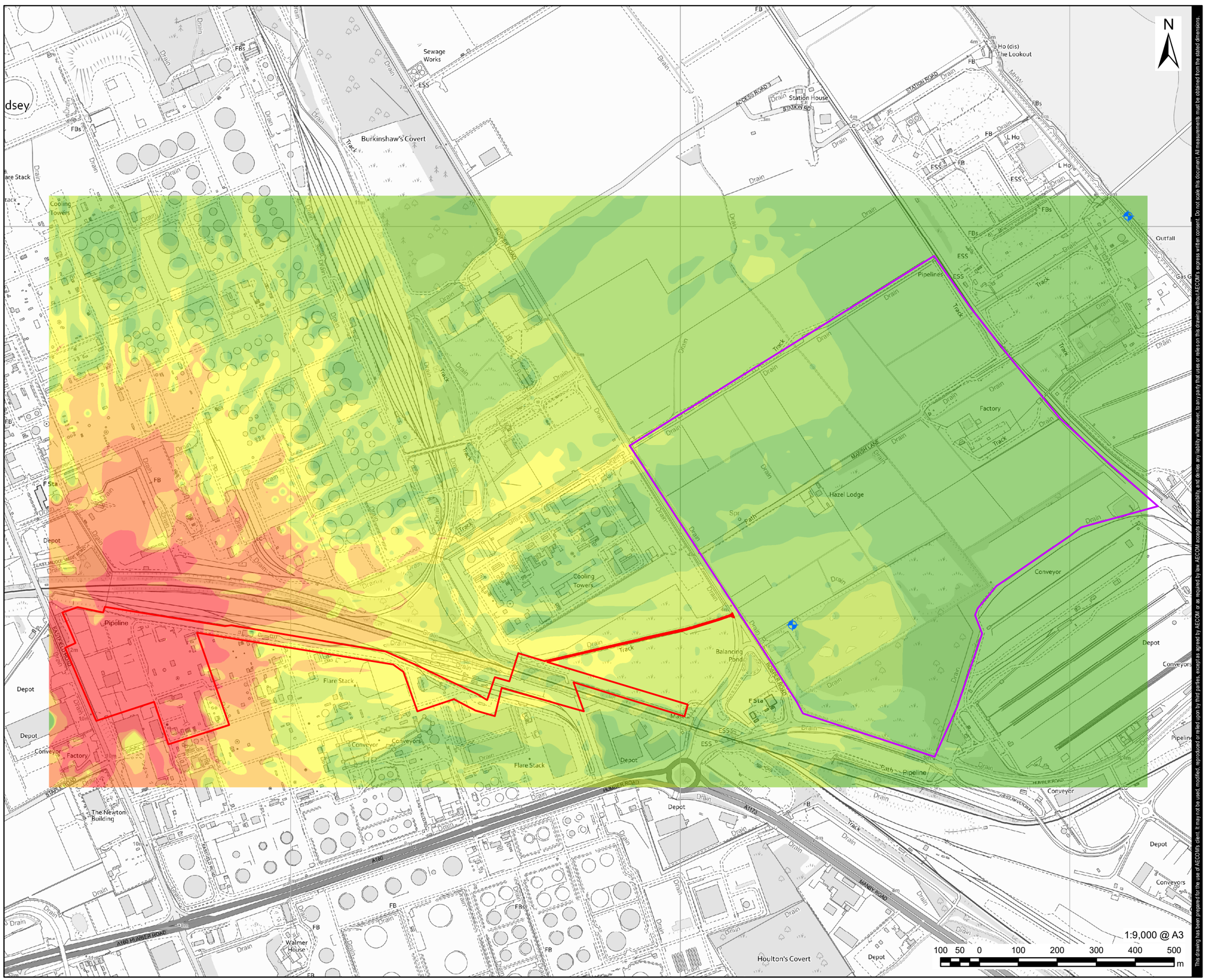
Table C18: Area 19 – North Killingholme Marshes Mudflats - Winter 2021/ 22 Survey Peak Counts

Species	Visit number (feeding)											
	1	2	3	4	5	6	7	8	9	10	11	12
Dunlin	0	0	0	0	0	105	12	125	136	6	0	0
Curlew	1	7	0	0	0	2	8	50	9	14	2	5
Redshank	0	0	0	3	8	6	67	52	69	69	8	0
Lapwing	0	0	0	0	176	0	0	0	1	0	0	0
Oystercatcher	0	0	0	1	0	0	0	0	0	0	2	0
Black-tailed godwit	0	0	0	0	0	0	35	18	1	0	0	0
Shelduck	0	2	0	8	0	0	0	0	7	28	0	13
Species	**Visit number (loafing)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Curlew	1	0	0	0	0	0	0	0	0	5	3	0
Shelduck	0	0	0	0	0	0	4	0	2	0	0	0
Wigeon	0	0	0	0	0	0	2	0	0	0	0	0
Species	**Visit number (roosting)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Dunlin	0	0	0	205	120	0	0	0	0	0	0	0
Curlew	0	0	0	32	18	8	0	68	48	108	76	3
Redshank	0	0	0	0	0	0	0	6	0	8	2	2
Lapwing	1	0	0	38	0	85	0	665	260	90	0	0
Black-tailed godwit	0	0	0	0	0	0	0	11	0	10	0	0
Shelduck	0	0	0	0	0	0	0	0	2	17	4	15
Species	**Visit number (undetermined)**											
	1	2	3	4	5	6	7	8	9	10	11	12
Dunlin	0	0	0	0	311	0	0	0	0	0	0	0
Curlew	0	0	38	7	3	0	7	0	0	0	0	0
Lapwing	0	0	2	2	5	0	0	0	0	0	0	0
Shelduck	0	0	0	0	3	0	0	0	0	0	0	0

Appendix D Noise Modelling Contour Plots (Proposed Phillips 66 Development Alone)

Revision: 1 Drawn: ER Checked: LC Approved: KC Date: 2023-02-10

Filename: \\na.aecomnet.com\fs\EMEA\Leeds-UKLDS2\Legacy\UKLDS2PFPSW0011WIP\LE_Projects\Newproj\60668866 - Humber Zero\900_CAD_GIS\02_Maps\HRA\P66\HZ_HRA_D1_Daytime_Noise_Levels_P66_20230206_ER_v1.mxd



PROJECT

Humber Zero

CLIENT

Phillips 66 Limited

CONSULTANT

AECOM Limited
One Trinity Gardens
Newcastle
NE1 2HF
www.aecom.com

LEGEND

- Phillips 66 Site
- Ecological Receptor (Point)
- Ecological Receptor (Area)

Noise Levels dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- >65

NOTES

Noise model source: SoundPLAN v8.2

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60668866

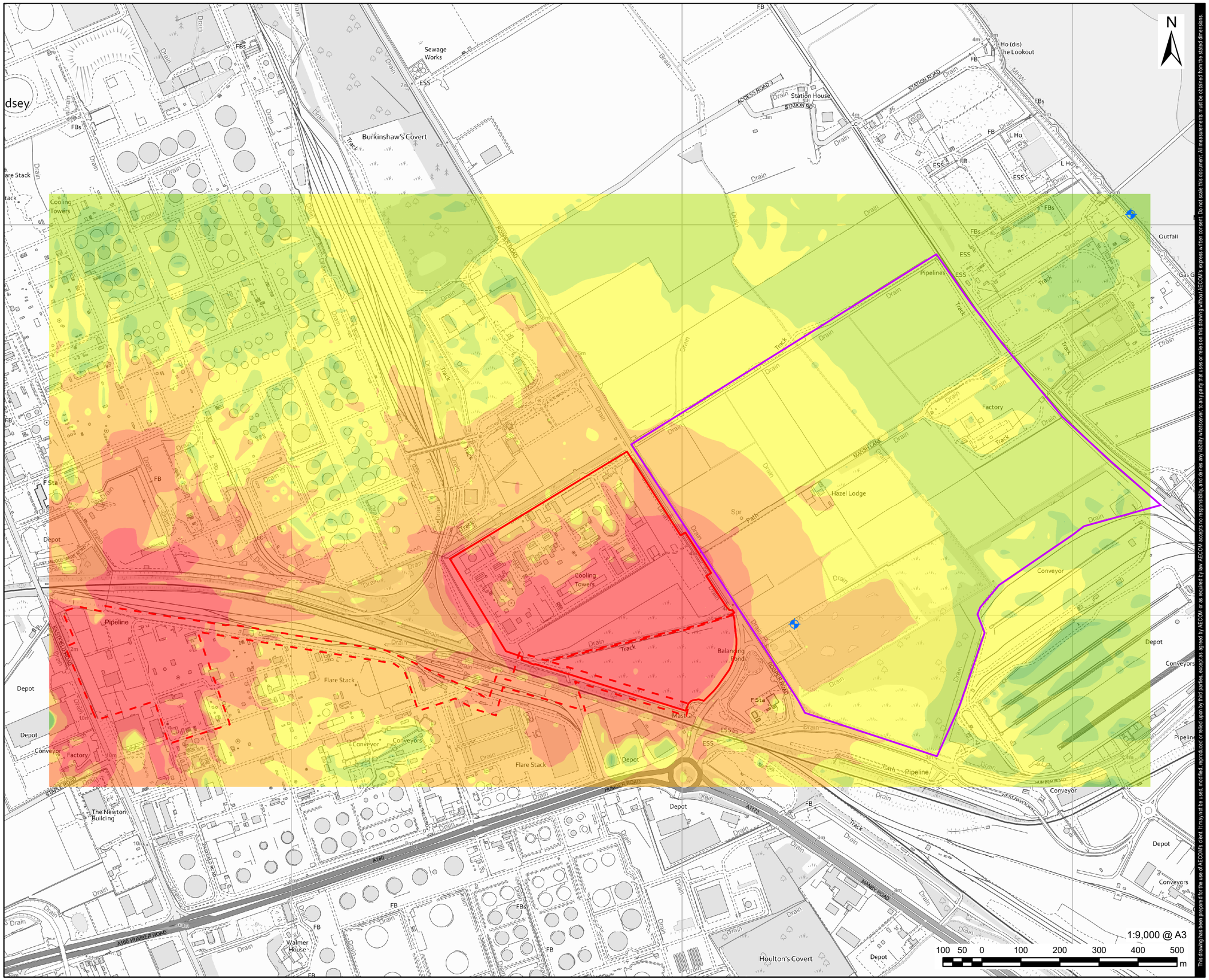
FIGURE TITLE

Predicted Construction Noise Levels (L_{Aeq}) from Phillips 66 Site at Noise Sensitive Receptors, Height Above

FIGURE NUMBER

Figure D1

Appendix E Noise Modelling Contour Plots (In Combination with Proposed VPI Development)



AECOM

PROJECT

Humber Zero

CLIENT

Phillips 66 Limited

CONSULTANT

AECOM Limited
5th Floor
2 City Walk
Leeds, LS11 9AR
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LEGEND

- Phillips 66 Site
- VPI Site
- Ecological Receptor (Point)
- Ecological Receptor (Area)

Noise Levels dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- >65

NOTES

Noise model source: SoundPLAN v8.2

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60668866

FIGURE TITLE

Predicted Construction Noise Levels (L_{Aeq}) from the Phillips 66 and VPI Site at Noise Sensitive Receptors, Height Above Ground 0.5m

FIGURE NUMBER

Figure D3

Appendix F Literature Review – Effects of Sulphates on Ecology Receptors

Introduction

A review of the literature available on ecotoxicity of sulphate to aquatic organisms and potential effects on aquatic ecosystems demonstrated that there is no certainty regarding the effect levels of sulphate to aquatic organisms, including fish and macroinvertebrates.

Government bodies such as the Environment Agency in the UK state that '*reducing [Sulphate] concentrations is not, in itself, an objective of mine water treatment in the UK, […], partly because its impact on surface watercourses is usually limited, and partly because of the great difficulty of removing sulphate using conventional treatment technologies*' (Environment Agency, 2009).

Again, in the UK, the UKTAG advisory group describe sulphate '*a chemical that had no effect on the ecology' (UKTAG, 2008). Consequently, they have derived standards 'only for chemicals where there is general confidence that they cause biological impacts*' (UKTAG, 2008).

These statements are to be taken with caution, but they highlight the fact that sulphate it is not considered to be a priority in setting out quality standards for the protection of aquatic life.

Environmental Quality Standards

The literature review has found that, with the exception of Canadian British Columbia and a couple of states in the United States (Illinois and Iowa), there are no widely used Environmental Quality Standards (EQS) for sulphate as there are for pollutants that are known to be toxic to aquatic life e.g. heavy metals, pesticides. An EQS for sulphate was not included for implementation of the European Water Framework Directive (WFD) 2000/60/EC. The only published EQSs with regulatory value from the areas of North America referred to above are summarised in Table F1.

In Europe, a review of literature regarding ecotoxicity of sulphate was undertaken in 2018 by the Stockholm University (Department of Environmental Science and Analytical Chemistry (ACES) Stockholm University, 2018), with the objective to deriver possible EQSs for sulphate under the WFD; however these have not been formally adopted (see Table F2).

Other authors (Elphick et al., 2011) recommend different guidelines for the protection of aquatic life (see Table F3). The great variability between the standards set out in British Colombia and the United States, and those proposed in Sweden and by other authors highlight that there is substantial uncertainty on the maximum levels of sulphate that should be adopted to protect aquatic organisms.

Table F1: Published Environmental Quality Standards for sulphate in North America ($SO4_2^-$)

Authority	Water hardness (mg $CaCO_3$/L)	EQS - 30-day average (mg $SO4_2^-$/L)
British Columbia MOE (Province of British Columbia – Ministry of Environment, 2003)	Very soft Water (0-30)	128
	Soft to Moderately Water (31-75)	218
	Moderately Soft / Hard to Hard Water (76-180)	309
	Very Hard Water (181-250)	429
States of Illinois and Iowa (Illinois Environmental Protection Agency Bureau of Water, 2008 and Iowa Department of Natural Resources, 2009)	Soft Water (0-100)	500
	Moderately Hard / Hard Water (100-500)	(1276.7 + 5.508 (hardness) –1.457 (chloride)* 0.65 (if Cl >25 mg/L) (-57.478 + 5.79 (hardness) + 54.163 (chloride) * 0.65 (if Cl 5 to 25 mg/L)

	Very Hard Water (>500)	2000 (if Cl >25 mg/L) 500 (if Cl <5 mg/L)

Table F2: Proposed Environmental Quality Standards for sulphate ($SO4_2^-$) (from Department of Environmental Science and Analytical Chemistry (ACES) Stockholm University)

Water hardness (mg $CaCO_3$/L)	Annual Average (mg $SO4_2^-$/L)	Maximum Allowable Concentration (mg $SO4_2^-$/L)
Very Soft Water (<50)	n/a	59.6
Soft Water (40-50)	15	95.7
Moderately Soft / Hard Water (80-100)	41.9	158
Hard Water (>160)	56	317.8

Table F3: Guidelines for Sulphate levels for the Protection of Aquatic Life (Elphick et al., 2011))

Water hardness (mg $CaCO_3$/L)	Guideline Levels (mg $SO4_2^-$/L)
Soft water (10 – 40)	129
Moderately hard water (80 – 100)	644
Hard water (150 – 250)	752

Ecotoxicity

A literature review on the toxicity of sulphates to aquatic organisms has been undertaken to enable understanding of the potential ecological effects of sulphate discharge to the South Killingholme Drain and Rosper Road Pools. Several laboratory studies have shown that sulphate has the potential for lethal and sub-lethal effects on aquatic organisms including fish and invertebrates, and therefore there is potential for effects on waterbird species that feed on Rosper Road Pools (which has hydrological connectivity to South Killingholme Drain). A summary of the potentially relevant studies is provided in Table F4.

Table F4: Published Studies on Effects of Sulphates on Ecology Receptors

Reference	Summary of Study and Results
Davies T.D (2006) Sulphate toxicity to the aquatic moss, Fontinalis antipyretica, Chemosphere	Water hardness influences the toxicity of sulphate. Water chemistry should be considered when setting discharge limits
Moreno-Casas, P.A. & Aral, A. (2009) Conference Paper: Environmental Impact and Toxicology of Sulphate. Enviromine 2009, Santiago, Chile	Most countries in the world recommend a drinking water standard for sulphate between 250 and 500 mg/L, often based on taste and odour thresholds. Many Latin-American surface waters have been affected by mining activities with high sulphate concentrations well above recommended limits of 250-500 mg/L for drinking water and 500-1,000 mg/L for discharge into surface water bodies. Most countries in the world recommend a sulphate discharge limit to the environment of 1,000 mg/L, although there have been some exemptions for mining activity in South America e.g. 2,000 mg/L at El Teniente copper mine.
Iowa Department of Natural Resources Consultation Package (2009) Water Quality Standards Review: Chloride, Sulfate and Total Dissolved Solids	Ambient sulphate concentrations in Iowa streams are 37 mg/L (50th percentile), 97 mg/L (90th percentile) and 400 mg/L (maximum value). There is currently no federal water quality criteria for the protection of freshwater aquatic life protection. The state water quality standard includes a recommended livestock watering guideline value of 1,000 mg/L. Fish can have greater tolerance to sulphate than macroinvertebrates. Hardness mitigates the toxicity of sulphate to aquatic life.

Elphick J.R., Davies M., Gilron G., Canaria E.C., Lo B. & Bailey H.C. (2011) An aquatic toxicological evaluation of sulfate: the case for considering hardness as a modifying factor in setting water quality guidelines. Environmental Toxicology and Chemistry 2011 Jan 30(1): 247 - 53	Elevated concentrations of sulphate occur commonly in anthropogenically impacted and natural waters. A variety of organisms (species of invertebrate, fish, algae, moss and an amphibian) were tested for chronic toxicity to develop a robust dataset that could be used to develop water quality guidelines for sulphate, following methods employed in developing Canadian water quality guidance. Studied the importance of water hardness in respect of sulphate toxicity. Concluded that sulphate tends to be less toxic to aquatic organisms in hard waters than soft waters.
Rantamo, K., Arola, H., Aroviita, J., Hamalainen, H., Hannula, M., Laaksonen, R., Laamanen, T., Leppanen, M.T., Salmelin, J., Syrijanen, J.T., Taskinen, A., Turunen, J. and Ekholm, P. (2022) Risk Assessment of Gypsum Amendment on Agricultural Fields: Effects of Sulfate on Riverine Biota. Environmental Toxicology and Chemistry 41(1): 108-121	Gypsum (CaSO4 ·2H2 O) amendment is a promising way of decreasing the phosphorus loading of arable lands, and thus preventing aquatic eutrophication. However, in freshwaters with low sulfate concentrations, gypsum-released sulfate may pose a threat to the biota. Laboratory experiments with *Unio crassus* mussels and gypsum-spiked river after showed significant effects on foot movement activity, which was more intense with the highest sulphate concentration (1,100 mg/L(than with the control. Survival of the glochidia[21] after 24 and 48 hours of exposure was not significantly affected by sulphate concentrations up to 1,000 mg/L. The length grown of the moss *Fontinalis antipyretica* after 24 and 48 hours of exposure was not significantly affected by sulphate concentrations up to 1,000 mg/L.
Environment Agency (2011) Chemical discharges from nuclear power stations: historical releases and implications for Best Available Techniques. Report – SC090012/R1. Environment Agency, Bristol	Presents the findings of a survey of non-radioactive chemical discharges form nuclear power stations in the UK, USA, France and Germany. Sulphate and chloride are the main components present in raw water discharges after treatment, with sulphate formed as sodium sulphate when sulphuric acid is neutralised with sodium hydrochloride. The study states that '*Sulphate and chloride are of relatively low ecotoxicity*' and that the main issues will be to ensure that they are *'….discharged as neutral salts (rather than in acid solutions)*'.
Wang, N., Dorman, R. A., Ingersoll, C. G., Hardesty, D. K., Brumbaugh, W. G., Hammer, E. J., ... Mount, D. R. (2016). Acute and chronic toxicity of sodium sulfate to four freshwater organisms in water-only exposures. Environmental Toxicology and Chemistry, 35(1), 115-127.	Acute and chronic toxicity of sulphate (tested as sodium sulphate) was determine in diluted well water (hardness 100 mg/L and pH 8.2) with a cladoceran (water flea), a midge, a unionid mussel and a fish (flathead minnow). The cladoceran and mussel were acutely more sensitive to sulphate than the midge and fathead minnow. Increasing chloride in test water from 10 mg Cl/L to 25 mg Cl/L did not influence sulphate toxicity to fish. Increasing potassium in test water from 1 mg K/L to 3 mg K/L substantially reduce the toxicity of sulphate.
Mount D.R., Gulley D.D., Hockett R.J., Garrison T.D. & Evans J.M. (1997) Statistical models to predict the toxicity of major ions to Ceriodaphnia dubia, Daphnia magna and Pimephales promelas (Fathead minnows). Environmental Toxicology and Chemistry, Vol.16, No. 10, pp. 2009-2019.	Study tested the toxicity of over 2,900 ion solutions using the daphnids *Ceriodaphnia dubia* and *Daphnia magna* and a fish (fathead minnow) to provide a predictive tool to assess toxicity attributable to major ions. Toxicity of Cl-, SO4 2- and K+ was reduced in solutions enriched with more than one cation.

[21] Microscopic larvae of the *Unio crassus* mussel

Appendix G Additional Noise Assessment

G.1 Baseline Noise Monitoring and Modelling

Locations

Baseline noise monitoring was undertaken at the locations shown below to gather more information on the current baseline noise conditions at Rosper Road Pools and fields to the north, which are used by Humber Estuary SSSI/ SPA/ SAC/ Ramsar site birds. These locations were chosen by the noise and ecology teams to be representative of key areas within Rosper Road Pools and nearby fields where waterbirds would be likely to present, to enable a comparison of the changes in noise levels during construction and operation of the proposed Humber Zero developments. Location Eco 4 was purposefully located towards the central part of Rosper Road Pools as this is where the avocet nesting islands are.

Figure G1.1 – Baseline Noise Monitoring Locations

Methodology

The methodology for baseline noise monitoring is set out in Chapter 7 (Noise and Vibration). The existing baseline sound climate in the vicinity of the Proposed Humber Zero Developments is dominated by sound from the industrial/ commercial operations at the Phillips 66 Humber Refinery and VPI Immingham CHP Plant and other nearby industrial operations as well as rail noise and road traffic noise from A160 and other local roads.

Sound level monitoring was undertaken to the requirements of BS 7445 1: 2003 ‘Description and measurement of environmental noise. Guide to quantities and procedures’ (BSI, 2003), in particular regarding instrumentation and monitoring methodology.

All measurements were taken at approximately 1.5 m above ground level, and were positioned at least 3.5 m from any reflecting surface, other than the ground (i.e. free-field measurements). Each sound level meter was set to log the LAF10, LAeq, LAF90 and LAFmax parameters.

A summary of the dates, times and equipment used in the baseline noise modelling at receptors Eco1, Eco2 , Eco3 and Eco 4 is set out below.

Location	Co-ordinates	Date Monitored	Monitoring times (day)	Monitoring times (night)	Equipment Used
Ecology 1	53.64341, -0.22531	24/08/2023	11:39 - 12:41	23:05 - 23:35	Sound level meter Rion NL-52 (Serial No: 00386762) Calibrator: Rion NC-74(Serial No: 34425539)
Ecology 2	53.63925, -0.23245	24/08/2023	12:56 - 13:56	23:47 - 00:18	Sound level meter Rion NL-52 (Serial No: 00386762) Calibrator: Rion NC-74(Serial No: 34425539)
Ecology 3	53.6373, -0.22405	24/08/2023 (day) 25/08/2023 (night)	15:09 - 16:09	00:28 - 00:58	Sound level meter Rion NL-52 (Serial No: 00386762) Calibrator: Rion NC-74(Serial No: 34425539)
Ecology 4	53.63531, -0.22481	24/08/2023 (day) 25/08/2023 (night)	16:15 - 17:15	01:03 - 01:33	Sound level meter Rion NL-52(Serial No: 00386762) Calibrator: Rion NC-74(Serial No: 34425539)

Noise Modelling Assumptions

Table 7B.1 in Appendix 7B of ES Chapter 7 (Noise and Vibration) identifies the assumptions made in the modelling work in respect of the type of construction plant and associated sound power levels (from "*British Standard BS 5228: Code of practice for noise and vibration control on construction and open sites*") for the Proposed Development. This is provided below for information.

Extracted from ES Appendix 7B - Table 7B.1: Indicative construction plant and associated sound power levels (L_{Aw}) used for the Proposed Phillips 66 Development.

Plant Item	Source (BS 5228 table and row reference)	Number in Operation	% On-time	Sound power level L_{Aw} dB
Enabling and Earthworks				
Compressors	C.3.19	2	100	106
Hand Held Pneumatic Breaker	C.1.6	2	100	114
Dump Truck (tipping fill)	C.2.30	1	100	107
Dump Truck (pass-by)	C.2.31	2	100	118
Lorry (delivery and collection)	C.2.34	2	100	111
Tracked Excavator	C.3.23	3	100	101
Concrete Mixer Truck	C.4.20	3	100	113
Wheeled Mobile Telescopic Crane	C.4.38	1	100	106
Tower Crane	C.4.48	1	100	104
Lorry with Lifting Boom	C.4.53	1	100	105
Diesel Generator for Site Cabins	C.4.76	1	100	89
Diesel Generator for Site Lighting	C.4.86	1	100	93
Road Sweeper	C.4.90	1	100	104
Angle Grinder	C.4.93	1	100	108
Foundations				
Compressors	C.3.19	3	100	108
Dump Truck (tipping fill)	C.2.30	1	100	107
Dump Truck (pass-by)	C.2.31	2	100	118
Lorry (delivery and collection)	C.2.34	5	100	115
CFA Piling Rig	C.3.21	2	100	110
Hand-Held Welder (welding piles)	C.3.31	1	100	101
Generator for Welding	C.3.32	1	100	101
Tracked Excavator	C.3.23	5	100	103
Concrete Mixer Truck	C.4.20	13	100	119
Truck Mounted Concrete Pump and Boom Arm	C.4.29	2	100	111
Wheeled Mobile Telescopic Crane	C.4.38	2	100	109
Tower Crane	C.4.48	1	100	104
Diesel Generator for Site Cabins	C.8.23	2	100	93
Diesel Generator for Site Lighting	C.8.23	1	100	90
Road Sweeper	C.4.90	1	100	104
Angle Grinder	C.4.93	1	100	108
Electric Water Pump	C.11.3	1	100	97

Plant Item	Source (BS 5228 table and row reference)	Number in Operation	% On-time	Sound power level L_{Aw} dB
Mechanical and Electrical				
Compressors	C.3.19	3	100	108
Lorry (delivery and collection)	C.2.34	5	100	115
Wheeled Mobile Telescopic Crane	C.4.38	2	100	109
Tower Crane	C.4.48	1	100	104
Lorry with Lifting Boom	C.4.53	1	100	105
Lifting Platform	C.4.57	1	100	95
Fork Lift Truck	C.4.62	1	100	94
Mini Tracked Excavator	C.4.67	1	100	102
Electric Core Drill (Drilling Concrete)	C.4.69	1	100	113
Concrete Floor Cutter	C.4.73	1	100	112
Hand-Held Circular Saw (Cutting Paving Slabs)	C.4.73	1	100	112
Diesel Generator for Site Cabins	C.4.76	2	100	92
Diesel Generator for Site Lighting	C.4.86	1	100	93
Road Sweeper	C.4.90	1	100	104
Angle Grinder	C.4.93	1	100	108
Hand-Held Cordless Nail Gun	C.4.95	1	100	101
Electric Water Pump	C.11.3	1	100	97

G.2 Construction Phase Assessment

Noise contours have been prepared for the construction phase to show the predicted LAeq and LAmax at the ecology receptors. A summary of the predicted changes in LAeq and LAmax as a result of construction are presented in Table G2.1 below. The modelling demonstrates that there are no predicted exceedances of Natural England's suggested 3 dBA 'rule-of-thumb' change in noise level threshold at the ecology receptors.

Table G2.1: Predicted Construction Noise Changes at Ecology Receptors (Proposed Phillips 66 Development)

Receptor Location	LAeq (Figure G2.1)			LAmax (Figure G2.2)		
	Ambient	Construction	Increase above ambient	Ambient	Construction	Increase above ambient
Daytime						
Eco 1	44	45	+1	60	10	No change
Eco 2	73	31	No change	93	1	No change
Eco 3	51	44	No change	69	9	No change

Eco 4	53	45	No change	70	15	No change
Nighttime						
Eco 1	48	45	No change	46	10	No change
Eco 2	64	31	No change	59	1	No change
Eco 3	50	44	No change	49	9	No change
Eco 4	52	45	No change	50	15	No change

Figure G2.1 – Proposed Phillips 66 Development Construction (alone) LAeq

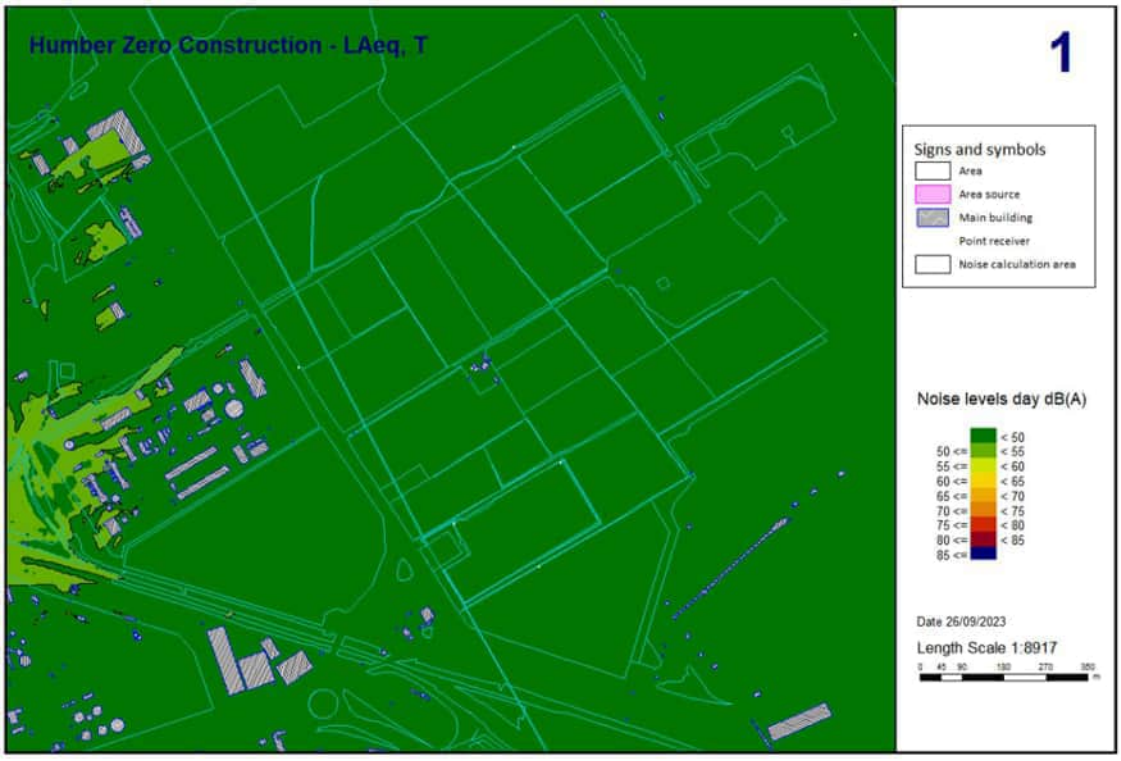
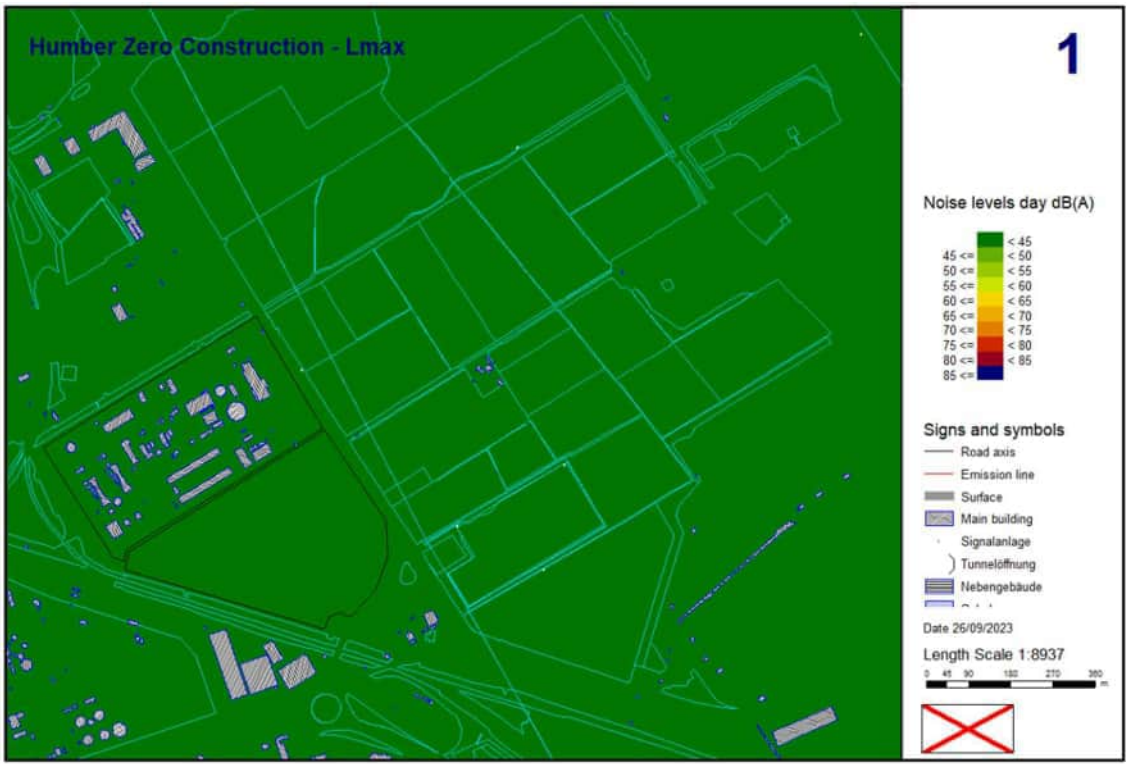


Figure G2.2 – Proposed Phillips 66 Development Construction (alone) LAmax



G.3 Operational Phase Assessment

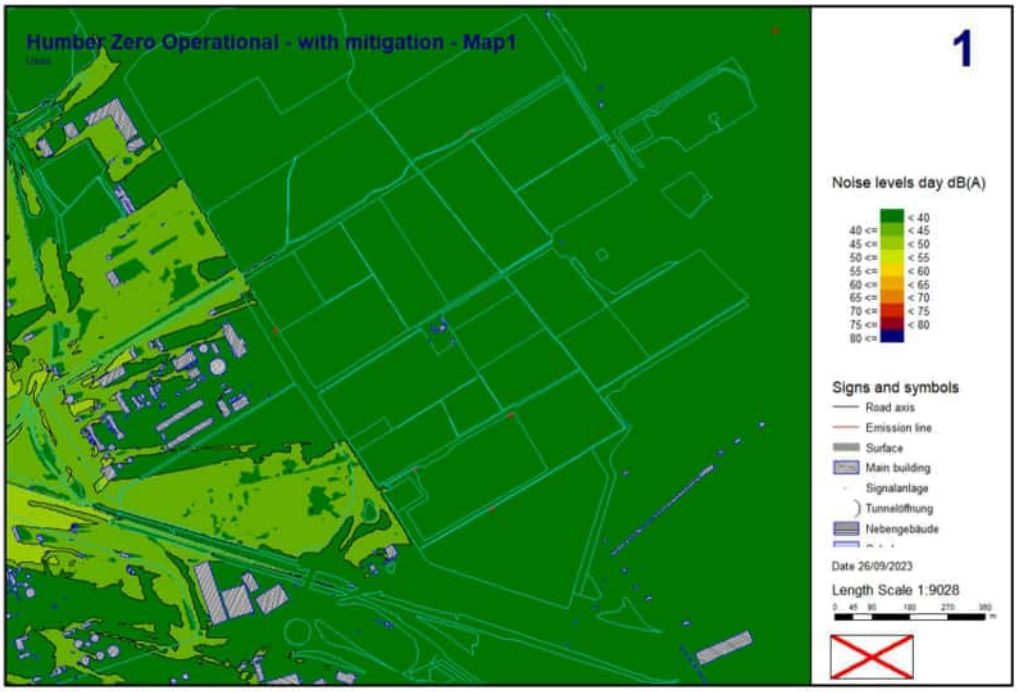
A noise contour has been prepared for the operational phase to show the predicted LAeq at the ecology receptors. A summary of the predicted changes in LAeq as a result of operation are presented in Table G3.1 below. The modelling demonstrates that there are no predicted exceedances of Natural England's suggested 3 dBA 'rule-of-thumb' threshold at the ecology receptors. A 'with mitigation' scenario has been modelled for the operational phase as this includes noise mitigation measures required to mitigate impacts on residential (human) receptors and is not related to ecological mitigation (as no ecological mitigation is required).

Table G3.1: Predicted Operational Noise Changes at Ecology Receptors (Proposed Phillips 66 Development)

Receptor Location	**LAeq (Figure G3.1)**		
	Ambient	**Operation**	**Increase above ambient**
Daytime			
Eco 1	44	25	No change
Eco 2	73	37	No change
Eco 3	51	33	No change
Eco 4	53	36	No change
Nighttime			
Eco 1	48	25	No change

Receptor Location	LAeq (Figure G3.1)		
	Ambient	Operation	Increase above ambient
Eco 2	64	37	No change
Eco 3	50	33	No change
Eco 4	52	36	No change

Figure G3.1 – Proposed Phillips 66 Development Operation (alone) LAeq



G.4 In Combination Assessment

Proposed Phillips 66 Development Construction In Combination with Proposed VPI Development Construction

A noise contour map has been prepared to show the predicted LAeq and LAmax at the ecology receptors for the construction of the Proposed Phillips 66 Development in combination with construction of the Proposed VPI Development (assuming overlap of the construction phases) (see Figures G4.1 and G4.2). For all scenarios and all receptors except for the predicted cumulative change in LAeq at receptor Eco 1, there are no changes exceeding 3 dBA (see Table G4.1). At receptor Eco 1 there is a predicted 5 dBA increase in LAeq assuming construction activities proceed at the same time. Although this is higher than the 3 dBA 'rule of thumb' indicated by Natural England as a change in magnitude potentially resulting in disturbance, both the ambient noise levels and cumulative construction noise levels at this receptor are below 50 dB LAeq, which is equivalent to the sound of moderate rainfall and below even noise levels arising from normal conversation (60 dBA). It is therefore reasonable to conclude that the cumulative effects of construction noise at this location would not result in disturbance to waterbirds, and therefore there would be no likely significant effects on SPA/ Ramsar waterbirds using functionally linked land resulting from the construction of the Proposed Phillips 66 Development in combination with construction of the Proposed VPI Development.

Table G4.1 – Predicted Construction Noise Changes – Proposed Phillips 66 Development in combination with Proposed VPI Development

Receptor Location	LAeq (Figure G4.1)			LAmax (Figure G4.2)		
	Ambient	Construction	Increase above ambient	Ambient	Construction	Increase above ambient
Daytime						
Eco 1	44	49	+5	60	21	No change
Eco 2	73	53	No change	93	29	No change
Eco 3	51	52	+1	69	28	No change
Eco 4	53	53	No change	70	28	No change
Nighttime						
Eco 1	48	49	+1	46	21	No change
Eco 2	64	53	No change	59	29	No change
Eco 3	50	52	+2	49	28	No change
Eco 4	52	53	+1	50	28	No change

Figure G4.1 – Proposed Phillips 66 Development Construction in combination with Proposed VPI Development Construction (LAeq)

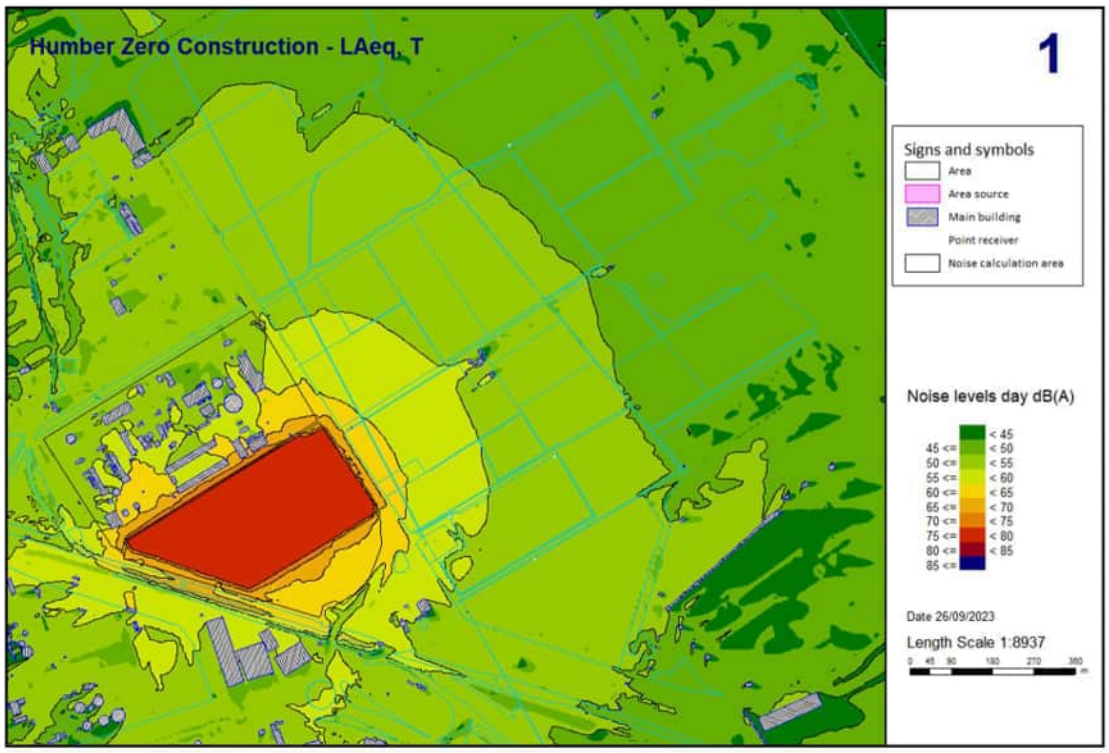
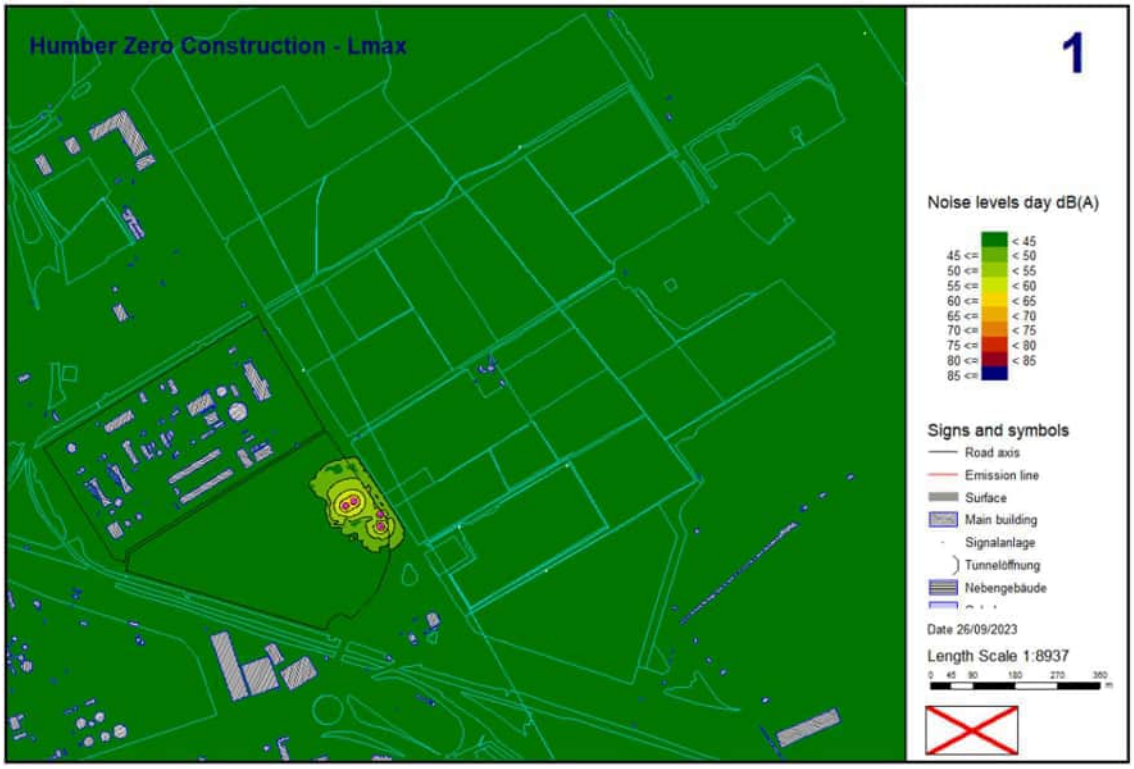


Figure G4.2 – Proposed Phillips 66 Development Construction in combination with Proposed VPI Development Construction (LAmax)



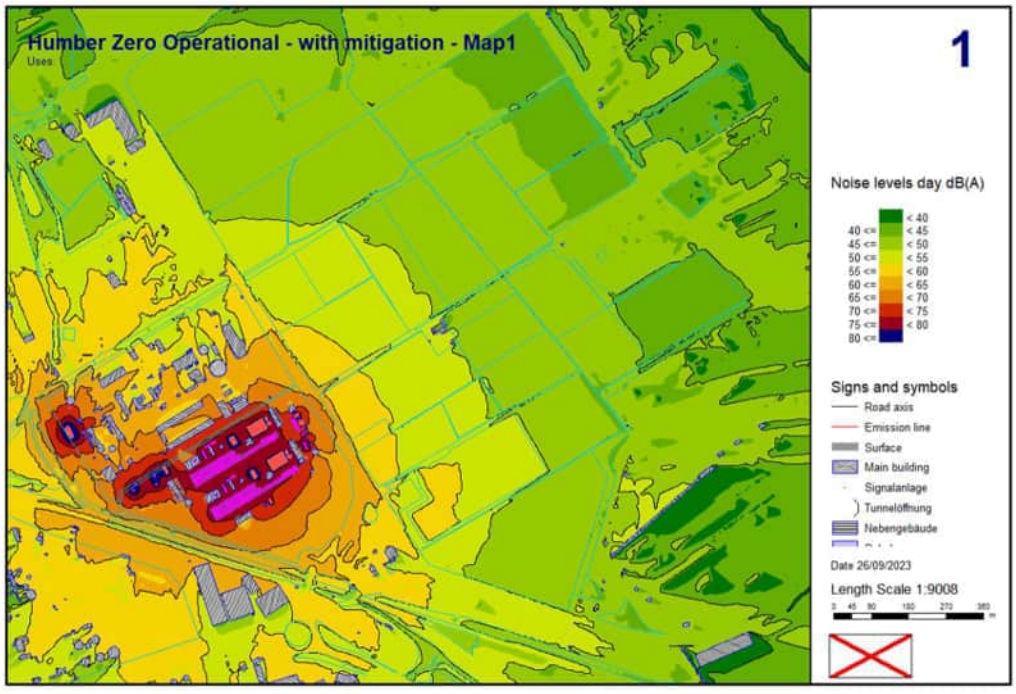
Proposed Phillips 66 Development Operation In Combination with Proposed VPI Development Operation

A noise contour map has been prepared to show the predicted LAeq at the ecology receptors for the operation of the Proposed Phillips 66 Development in combination with the Proposed VPI Development (see Figures G4.3). For both the daytime and nighttime scenarios at all receptors there are no changes exceeding 3 dBA (see Table G4.2). It is therefore reasonable to conclude that the cumulative effects of operational noise would not result in disturbance to waterbirds, and therefore there would be no likely significant effects on SPA/ Ramsar waterbirds using functionally linked land resulting from the operation of the Proposed Phillips 66 Development in combination with the Proposed VPI Development.

Table G4.2 – Predicted Operational Noise Changes – Proposed Phillips 66 Development in combination with Proposed VPI Development

Receptor Location	LAeq (Figure G4.3)		
	Ambient	Cumulative Operation	Cumulative Increase above Ambient
Daytime			
Eco 1	44	46	+2 dBA
Eco 2	73	60	No change
Eco 3	51	50	No change
Eco 4	53	51	No change
Nighttime			
Eco 1	48	46	No change
Eco 2	64	60	No change
Eco 3	50	50	No change
Eco 4	52	51	No change

Figure G4.3 – Proposed Phillips 66 Development Operation in combination with Proposed VPI Development Operation (LAeq)



Proposed Phillips 66 Development Construction In Combination with Construction of Proposed VPI Development and Land off Westgate, Immingham and Viking CCS

Additional modelling has been undertaken to show the predicted LAeq at the ecology receptors for the construction of the Proposed Phillips 66 Development in combination with construction of the Proposed VPI Development, the Land off Westgate, Immingham proposed development, which is located immediately south of and adjacent to Rosper Road Pools and receptor Eco 4, and the Viking CCS project, which is located immediately south of the Proposed VPI Development. For the Land off Westgate, Immingham development, two scenarios are considered (open storage and building option as per Associated British Ports' hybrid planning application), and the modelling has been undertaken with the proposed mitigation for that development (9m noise barrier).

For both the daytime and nighttime scenarios at receptors Eco 1, Eco 3 and Eco 4 there are predicted in-combination construction noise level changes exceeding Natural England's suggested 3 dBA 'rule of thumb' (see Table G4.3). This is due to the proximity of construction at the Land off Westgate, Immingham site to Rosper Road Pools. This increase would only arise in a situation where all projects are under construction simultaneously and all projects undertake their noisiest construction activities at the closest point to Rosper Road Pools and the fields to the north simultaneously. This is not considered a likely occurrence. However, even assuming the worst case scenario, the cumulative construction noise level increases at Eco 1, Eco 3 and Eco 4 (the receptors within Rosper Road Pools) of up to 8 dBA does not result in noise levels exceeding 58 dB LAeq at these receptors, which to put into context is below noise levels arising from normal conversation (60 dBA). It is therefore reasonable to conclude that the cumulative effects of construction noise at this location would not result in disturbance to waterbirds using either Rosper Road Pools or the functionally linked land to the north.

Table G4.3 – Predicted Construction Noise Changes – Proposed Phillips 66 Development in combination with Proposed VPI Development and Land off Westgate, Immingham and Viking CCS

Receptor Location	LAeq: Proposed Phillips 66 Development in combination with Proposed VPI Development, Land off Westgate, Immingham (Open Storage Option) and Viking CCS			LAeq: Proposed Phillips 66 Development in combination with Proposed VPI Development, Land off Westgate, Immingham (Building Option) and Viking CCS		
	Ambient	Construction	Increase above ambient	Ambient	Construction	Increase above ambient
Daytime						
Eco 1	44	52	+8	44	52	+8
Eco 2	73	58	No change	73	58	No change
Eco 3	51	56	+5	51	56	+5
Eco 4	53	58	+5	53	58	+5
Nighttime						
Eco 1	48	52	+4	48	52	+4
Eco 2	64	58	No change	64	58	No change
Eco 3	50	56	+6	50	56	+6
Eco 4	52	58	+6	52	58	+6

Proposed Phillips 66 Operation In Combination with Operation of Proposed VPI Development and Land off Westgate, Immingham and Viking CCS

Additional modelling has been undertaken to show the predicted LAeq at the ecology receptors for the operation of the Proposed Phillips 66 Development in combination the operation of the Proposed VPI Development and the Land off Westgate, Immingham proposed development, which is located immediately south of and adjacent to Rosper Road Pools and receptor Eco 4, and the proposed Viking CCS development, which is located immediately south of the Proposed VPI Development.

For both the daytime and nighttime scenarios at all ecology receptors there are no predicted operational noise level changes exceeding Natural England's 3 dBA 'rule of thumb' with either of the Land off Westgate, Immingham development scenario (see Table G4.5). It is therefore reasonable to conclude that the cumulative effects of operational noise would not result in disturbance to waterbirds, and therefore there would be no likely significant effects on SPA/ Ramsar waterbirds using functionally linked land resulting from the operation of the Proposed Phillips 66 Development in combination with Land off Westgate, Immingham and Viking CCS.

Table G4.5 – Predicted Operational Noise Changes – Proposed Phillips 66 Development in combination with Proposed VPI Development and Land off Westgate, Immingham and Viking CCS

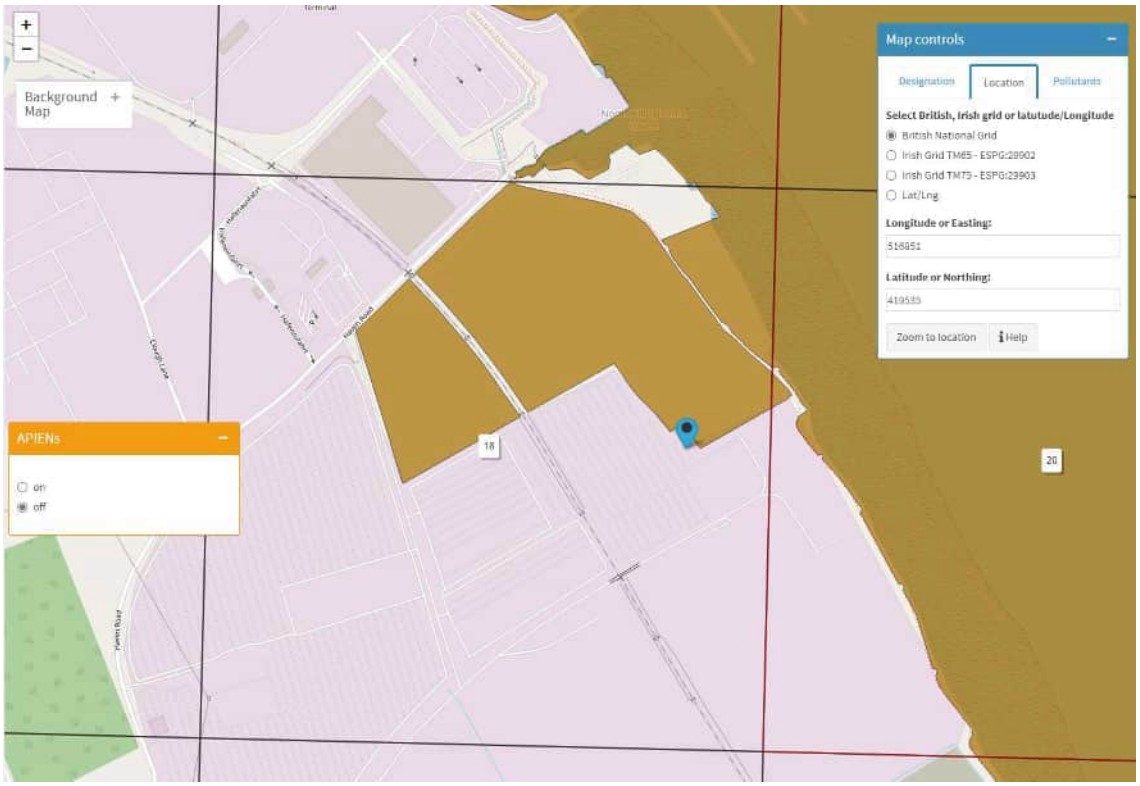
Receptor Location	LAeq: Proposed Phillips 66 Development in combination with Proposed VPI Development and Land off Westgate, Immingham (Open Storage Option) and Viking CCS			LAeq: Proposed Phillips 66 Development in combination with Proposed VPI Development and Land off Westgate, Immingham (Building Option) and Viking CCS		
	Ambient	Operation	Increase above ambient	Ambient	Operation	Increase above ambient
Daytime						
Eco 1	44	46	+2	44	46	+2
Eco 2	73	60	No change	73	60	No change
Eco 3	51	50	No change	51	50	No change
Eco 4	53	52	No change	53	52	No change
Nighttime						
Eco 1	48	46	No change	48	46	No change
Eco 2	64	60	No change	64	60	No change
Eco 3	50	50	No change	50	50	No change
Eco 4	52	52	No change	52	52	No change

Appendix H Additional Air Quality Information

Selection of Ecological Receptors

The ecological receptors were selected based on the screening distances associated with the Environmental Agency's Risk Assessment methodology, based on SPAs, SACs and SSSIs within 15km for "large emitters" and 2 km for LNR, LWS and SINCs.

The grid references provided for the receptors, and therefore the point where the impact has been assessed, was taken to be the closest point each receptor to the point of release, taking into consideration the prevailing wind direction from the southwest. The location of the grid reference (516851, 419535) provided for the OE2 Receptor (North Killingholme Haven Pits) is shown on the figure (taken from a screenshot of the APIS web GIS) below to be slightly outside of the southern boundary of the site, however it is not considered that this would affect the conclusions of the assessment carried out and is more likely to over-estimate the impacts at the worst case point of the receptor given that it is slightly closer to the point source that the boundary of the receptor.



Information on the habitats present at the selected receptor sites was based on the information available on the Air Pollution and Information Service (APIS) website and were correct at the time that the assessment was carried out. In addition, these were consistent with information provided for the planning application submitted to North Lincolnshire Council for the VPI Energy Park A in 2018 and the DCO application for the VPI OCGT in 2019, both of which have been consented.

Further clarification on the receptor sites identified within the Humber Estuary SAC/ SPA/ Ramsar for assessment within ES Chapter 6 (Air Quality) has been requested by Natural England and is provided in a modified version of Table 6B.11 (see Table H.1) that was presented in Chapter 6. Habitat types for receptor OE1d and OE2 have been updated following further consultation with Natural England.

Table H.1 – Further Clarification on Ecological Receptor Sites used in Air Quality Modelling

Receptor I.D.	Ecology Site	Habitat Type and Location	Grid Reference x, y	Comments
OE1a	Humber Estuary	Coastal stable dunes grasslands - acid type – Cleethorpes	531500, 408013	The coastal stable dunes (acid type) at Cleethorpes are the closest of this habitat type to the Proposed Phililps 66 Development within the potential zone of influence of changes in air quality.
OE1b		Coastal stable dunes grasslands - calcareous type – Spurn Point	539700, 411020	The coastal stable dunes (calcareous type) at Spurn Point are the closest of this habitat type to the Proposed Phililps 66 Development within the potential zone of influence of changes in air quality.
OE1c		Shifting coastal dunes – Saltfeet	544956, 394570	The coastal shifting dunes at Saltfleet are the closest of this habitat type to the Proposed Phililps 66 Development within the potential zone of influence of changes in air quality.
OE1d		Wetland and reedbed - Killingholme Pits	516851, 419535	The Defra Priority Habitat Inventory shows North Killingholme Haven Pits as saline lagoon and deciduous woodland; and this habitat was therefore aligned to the 'northern wet heath' habitat type in the air quality assessment (which adopted the same approach as other air quality assessments undertaken for nearby projects). However, this has now been updated to wetland and reedbed habitat type based on further information provided by Natural England. Although not a qualifying habitat of the Humber Estuary SAC designation, the habitat supports important numbers of SPA/ Ramsar birds and was therefore scoped into the assessment as a precaution.
OE1e		Pioneer, low, mid upper saltmarshes	517353, 419059	This was the closest location of this habitat type to the Proposed Phillips 66 Development; the assessment considered a number of locations supporting this habitat type up and down the coast of this location, and the worst affected location was used in the assessment work.
OE1f		Low and medium altitude hay meadows	513431, 423906	Although this is not a qualifying habitat of the Humber Estuary designation, the SPA results on APIS list this habitat as important for curlew, ruff and golden plover and this is why it was included within the AQ modelling,
OE2	North Killingholme Haven Pits SSSI	Upper saltmarshes	516851, 419535	The AQ assessment originally aligned this habitat to the 'Atlantic upper-mid and mid-low salt marshes' habitat feature that is shown on the APIS website as being sensitive to nitrogen at this location. However, this has now been updated following further consultation with Natural England and is considered as upper saltmarshes based on the habitats present. The more conservative Critical Load for N deposition is therefore applied.

Appendix I Technical Note on DeSOx Process

ARUP

Technical Note

Project title	Humber Zero (Phillips 66)
Job number	296344-00
File reference	
cc	Andrew Taylor, North Lincolnshire Council
Prepared by	Kirsty Cobb for Phillips 66
Date	23 November 2023
Subject	Phillips 66 technical note on deSOx for Natural England

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1. Introduction

This technical note has been prepared in response to the email from Emma Brading (Natural England) on 17th November 2023, which noted the following outstanding question:

"We previously asked for clarification on the in-use efficiency of the proposed sulphate mitigation. However, we do not feel that this was sufficiently addressed in the response dated 17th August.

Question: Natural England currently has concerns around the certainty of the proposed mitigation related to desulfurization of the development, using a technique which is reported to remove 50 % of the sulphates, therefore leading to emissions of 900 mg/L at a minimum. Please could you provide information on if this is an up to 50 % efficiency or a real world consistent 50 % efficiency? Real world efficiency data should be stated and more information provided on how this has been derived.

The answer provided stated: *'The deSOx additive has demonstrated effectiveness at removing SOx from the FCC flue gas up to around 50%, however effectiveness reduces i.e. removal rates diminish at higher additive addition rates. This is reflected in the "around 50%" reduction in concentration reported in the Report to Inform HRA (paragraph 6.4).'*

To provide certainty to the HRA conclusions we advise that further details are provided on how this efficiency rate has been derived, e.g from real world monitoring and/or evidence from literature.

If you are able to provide this information we will continue to work towards formalising our advice."

2. Phillips 66 Response

2.1 Explanation of the deSOx process

To understand how the deSOx works, it's necessary to understand how the Fluidised Catalytic Cracker (FCC) works. This short video might be helpful to visualise my explanation below:

- https://www.youtube.com/watch?v=QhJkQr0Dfkw

DeSOx is SOx reduction additive that is injected directly to the FCC Regenerator. The FCC consists of a Reactor and Regenerator section. In the Reactor section the hydrocarbon feed is heated and cracked through contact with a 'sand like' catalyst. This cracking leaves behind coke and sulphur from the hydrocarbon feed on the catalyst which needs to be removed in the Regenerator in order to reuse the catalyst. The cracked hydrocarbon products flow out of the top of the Reactor and on for further processing and the catalyst flows into the Regenerator section. In the Regenerator air is introduced which combusts the coke and sulphur producing the FCC flue gas. This is why the FCC flue gas is high in CO_2 (as a result of combustion of the coke) and contains SOx (as a result of combustion of the sulphur). The deSOx additive works by converting and capturing the SOx to a form in which it is carried with the regenerated catalyst back to the Reactor section where it is released as H_2S instead. This H_2S stays with the hydrocarbon products and either remains with the products or is removed later in the process, ending up as elemental sulphur produced by the refinery sulphur plants.

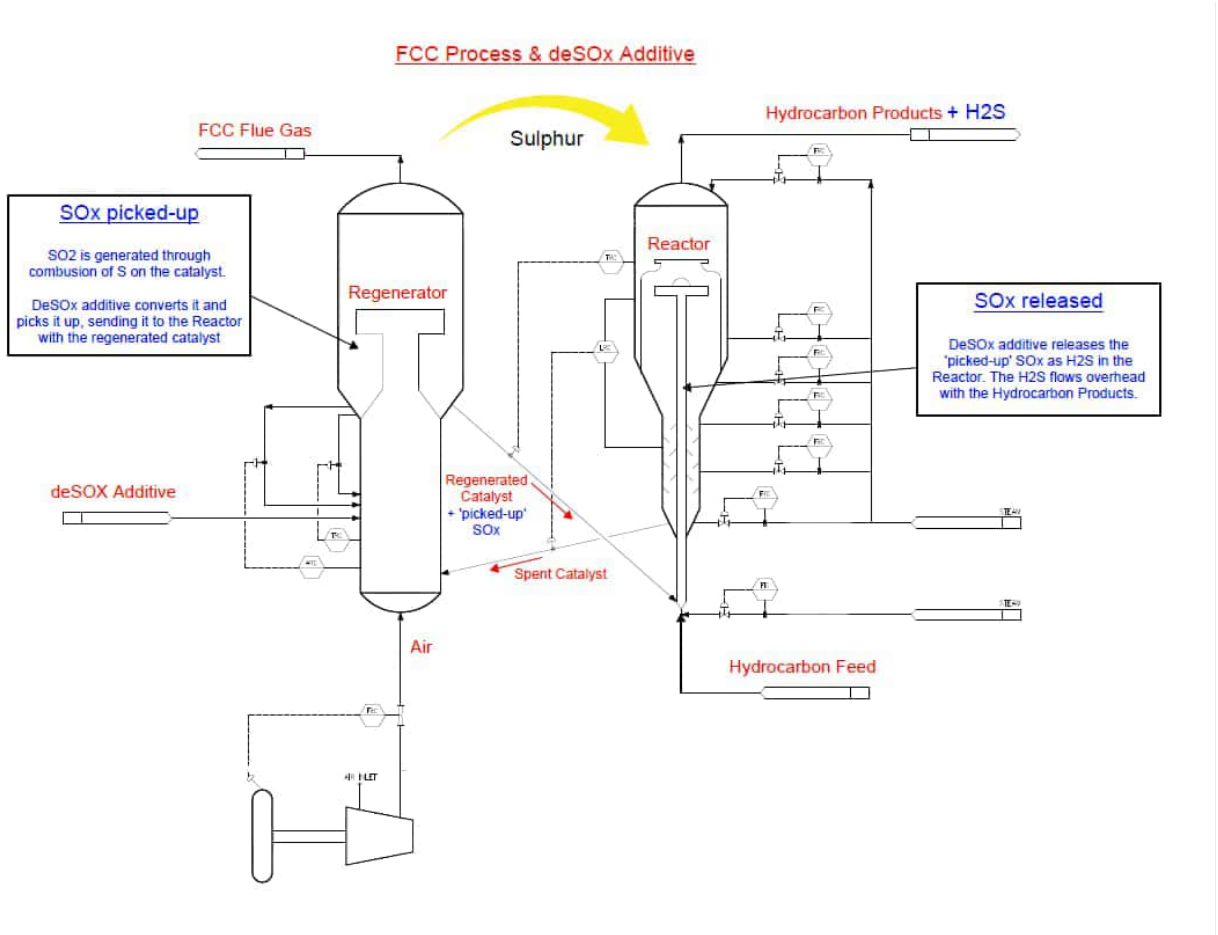

Figure 1 FCC Process and deSOx Additive

2.2 Explanation of 'real world' data used to inform effectiveness of deSOx

deSOx additive is a chemical specifically formulated to work as part of the FCC process and therefore is not used elsewhere on the refinery. DeSOx was first introduced into the FCC in 2011 and is our method for reducing the SOx in the flue gas to meet the air emission limits. The normal operating case we have provided for the design of the proposed new Wet Gas Scrubber as part of the CO_2 capture plant pre-treatment, is based on a flue gas containing 0.03 vol% SO_2. This assumption is based on operating the FCC without the use of deSOx additive. The chart below demonstrates the historic levels of SO_2 in our flue gas prior to the introduction of deSOx and since, showing we typically operate around 0.01 vol% SO_2 since 2011. This is the basis for the assumption we could achieve a 50% reduction in the SOx in the flue gas feed to the Wet Gas Scrubber and consequently in the sulphates that result in the effluent.

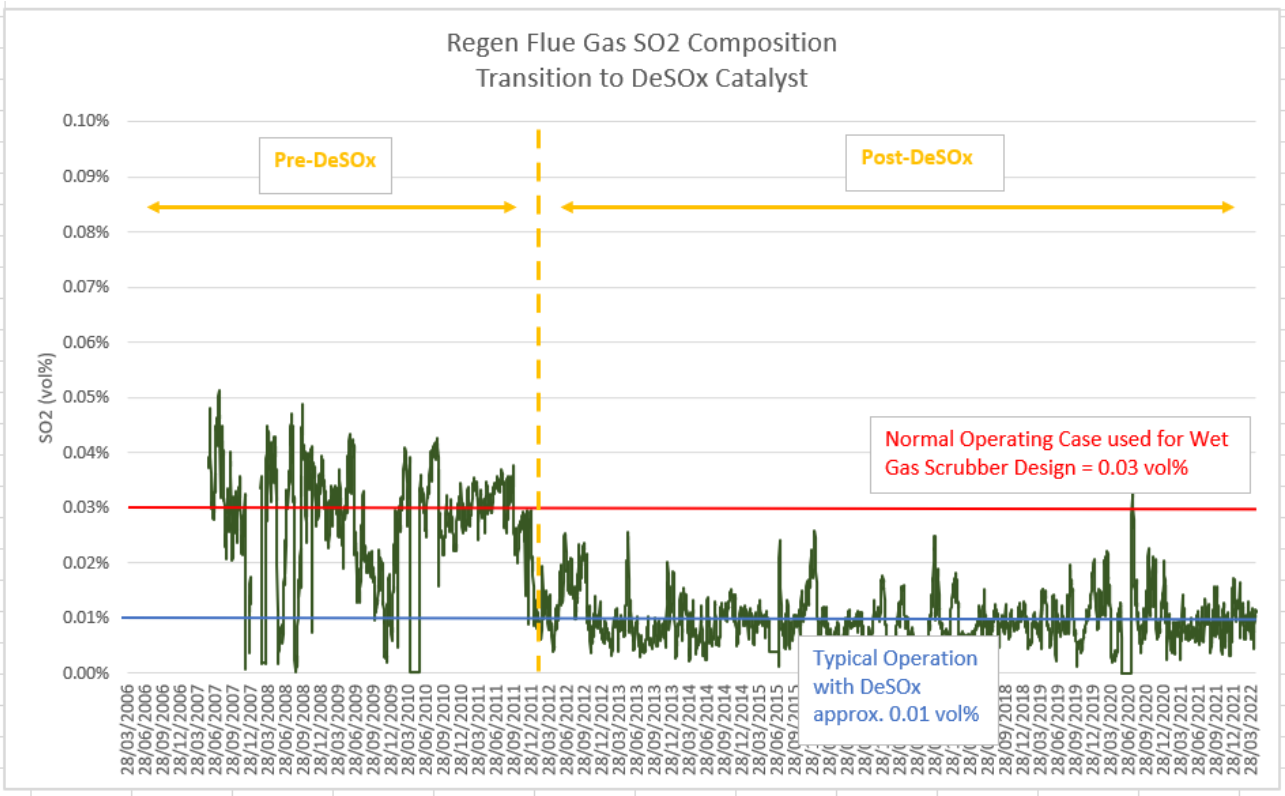

Figure 2 Regen Flue Gas SO_2 Composition Transition to DeSOx Catalyst

2.3 Explanation of assumption that 'around 50%' sulphate removal will be achieved

The chart below demonstrates the % reduction in flue gas SOx that can be achieved per kg/day of deSOx additive used. Today we add approximately 165 kg/day for a 70-80% reduction in SOx. If you wished to increase the SOx removal by an additional 10% it would add an additional ~100 kg/day and an operating cost of ~£600,000/year (subject to supply, pricing influences and inflation). This increases our reliance on deSOx additive supply and could financially disadvantage the Phillips 66 Humber Refinery vs. other refineries who are only obligated to meet the air emissions limits. The other potential impact is that the cost could be assigned to the carbon capture plant OPEX cost, which would be recovered through the proposed government business model for industrial carbon capture and therefore increases the levelised cost of abatement.

Figure 3 USB™ - M60 addition rate vs. SOx reduction %

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Appendix B Monitoring data

B.1 Water Quality monitoring

B.1.1 Site 1

	Sample ID / Site Number:		Site 1							
	NGR:		TA 17048 17175 or TA 16877 17402							
	Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/11/2023	23/11/2023
	Sample Time		14:45:00	14:23	15:23	11:15	11:37	11:20	10:45	13:28
	High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29:00	14:50:00	14:50:00
Field Parameters	**Parameters**	**Units**								
	Temperature	°C	21.44	23.2	22.64	22.74	17.69	17.38	14.131	14.694
	Conductivity	µS/cm	1776	2404.9	2640	4188.5	2064.9	2966.6	1952.9	2095.9
	TDS	mg/l	1244	1619	1790	2845	1560	2257	1602	1700
	Salinity	psu	0.98	1.28	1.43	2.33	1.24	1.83	1.28	1.36
	DO	% sat	117.4	151.2	110.4	100.3	46	94.2	83.4	107.2
	DO	mg/l	10.34	12.83	9.46	8.53	4.35	8.93	8.5	10.81
	pH	pH units	8.1	8.31	8.1	7.91	7.69	8.48	7.67	7.85
	Turbidity	FNU	4.69	*766.41**	2.35	2.58	2.3	2.9	3.17	2.63
Laboratory Parameters	**Parameters**	**Units**								
	pH	pH units	8.20	8.30	8.20	7.70	7.40	7.90	-	-
	Hardness	mg CaCO3/L	670	604	794	800	568	696	-	-
	Ca Hardness	mg CaCO3/L	670	604	794	800	568	696	704.00	692
	Mg Hardness	mg CaCO3/L	0.00	0.00	0.00	-	-	-	-	-
	Conductivity	µS/cm	1424	1912	2170	3333	1842	2380		
	Chemical Oxygen Demand Index	mg/L	34	37	27	29	68	63	40.00	35
	Sodium (Na)	mg/L	173.4	281.4	262.2	396.0	153.6	346.9	209.60	452.3
	Ammonia-N	mg/L	0.70	<0.1	0.90	0.80	2.20	1.10	2.80	6.4
	Monoethanolamine	mg/L	<0.1	<0.1	5.50	<0.1	<0.1	<0.1	<0.1	<0.1
	Methylamine	mg/L	<0.1	<0.1	<0.1	<0.1	0.80	<0.1	<0.1	<0.1

Sample ID / Site Number:		Site 1							
NGR:		TA 17048 17175 or TA 16877 17402							
Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/11/2023	23/11/2023
Sample Time		14:45:00	14:23	15:23	11:15	11:37	11:20	10:45	13:28
High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29:00	14:50:00	14:50:00
Diethanolamine	mg/L	<0.1	<0.1	<0.1	2.20	<0.1	<0.1	<0.1	<0.1
Potassium (K)	mg/L	14.20	21.20	5.00	2.70	13.70	68.80	14.60	15.8
Methyl diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	80.70	<0.1	<0.1
2-dimethylaminoethanol	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium (Ca)	mg/L	289.80	345.10	<0.1	460.20	183.50	356.00	0.90	1.5
Basic Nitrogen	mg/L	<1	<1	6.70	3.30	3.60	82.10	3.60	8.3
Total Kjeldahl Nitrogen	mg/L	<1	<1	2.20	1.40	2.70	13.80	3.00	6.8
Fluoride (F-)	mg/L	0.64	0.49	0.29	1.40	0.15	0.57	0.71	0.4
Chloride (Cl-)	mg/L	190	130	160	230	200	160	100.00	150
Acetate	mg/L	<0.10	<0.10	<0.10	<0.10	0.83	0.75	1.00	1.3
Bromide (Br-)	mg/L	<0.10	<0.10	0.62	3.10	<0.10	1.30	<0.10	<0.10
Nitrate	mg/L	32	47	52	41	30	61	75.00	120
Nitrate-N	mg/L	7.2	11.0	12.0	9.2	6.9	14.0	17.00	27
Phosphate	mg/L	2.5	1.3	2.3	4.2	2.0	2.6	<0.10	<0.10
Phosphate-P	mg/L	0.81	0.44	0.77	1.40	0.66	0.84	<0.10	<0.10
Sulphate	**mg/L**	**540**	**660**	**880**	**460**	**650**	**480**	**400.00**	**750**
Nitrite	mg/L	0.01	-	-	-	-	-	-	-
Total Inorganic Nitrogen	mg/L	32.71	-	-	-	-	-	-	-

Note* Disturbed bed / macrophytes, very shallow depth of water, reading unlikely to be representative and excluded from assessment.

B.1.2 Site 2

	Sample ID / Site Number:		Site 2							
	NGR:		TA 17012 17179							
	Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/11/2023	23/11/2023
	Sample Time		15:00	14:27	15:30	11:20	11:44	11:22	10:36	13:22
	High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29:00	14:50:00	14:50:00
Field Parameters	**Parameters**	**Units**								
	Temperature	°C	21.51	22.08	22.45	23.106	20.4	19.844	16.853	16.774
	Conductivity	µS/cm	2080	2287.8	2590	4139	2180.1	4056.2	2466.8	2430
	TDS	mg/l	1448	1575	1760	2791	1553	2924	1899	1874
	Salinity	psu	1.14	1.25	1.4	2.28	1.23	2.41	1.53	1.51
	DO	% sat	109.4	114.3	86.1	89.6	81.6	94.7	99.3	100.6
	DO	mg/l	9.6	9.9	7.35	7.57	7.3	8.52	9.54	9.68
	pH	pH units	7.88	7.79	8.02	7.92	7.87	8.34	7.62	7.68
	Turbidity	FNU	3.93	6.08	1.55	4.4	1.98	4.29	1.49	1.74
Laboratory Parameters	**Parameters**	**Units**								
	pH	pH units	8.20	8.20	8.10	8.20	8.00	8.10	-	-
	Hardness	mg CaCO3/L	390.00	668.00	872.00	996.00	740.00	912.00	-	-
	Ca Hardness	mg CaCO3/L	390.00	668.00	872.00	996.00	740.00	912.00	896	980.00
	Mg Hardness	mg CaCO3/L	0.00	0.00	0.00	0.00	-	-	-	-
	Conductivity	µS/cm	1650	1884	2182	3300	1847	3010	-	-
	Chemical Oxygen Demand Index	mg/L	34	34	62	31	54	90	43	49
	Sodium (Na)	mg/L	199.1	261.9	31.3	395.5	136.2	<0.1	192.1	257.3
	Ammonia-N	mg/L	0.30	<0.1	<0.1	0.80	1.90	234.10	2.3	3.40
	Monoethanolamine	mg/L	<0.1	<0.1	<0.1	2.40	<0.1	6.90	<0.1	<0.1
	Methylamine	mg/L	<0.1	<0.1	<0.1	4.10	<0.1	<0.1	<0.1	<0.1
	Diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	4.20	<0.1	<0.1

Sample ID / Site Number:		Site 2							
NGR:		TA 17012 17179							
Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/11/2023	23/11/2023
Sample Time		15:00	14:27	15:30	11:20	11:44	11:22	10:36	13:22
High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29:00	14:50:00	14:50:00
Potassium (K)	mg/L	16.70	23.80	4.30	70.30	26.10	<0.1	20.7	21.70
Methyl diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	3.70	<0.1	<0.1	<0.1
2-dimethylaminoethanol	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium (Ca)	mg/L	255.20	356.20	90.40	465.90	270.30	35.10	<0.1	<0.1
Basic Nitrogen	mg/L	<1	<1	<1	7.50	6.10	312.10	3	4.40
Total Kjeldahl Nitrogen	mg/L	<1	<1	<1	3.20	2.60	250.50	2.5	3.60
Fluoride (F-)	mg/L	<0.10	0.18	<0.10	1.30	0.59	0.69	0.13	0.34
Chloride (Cl-)	mg/L	160	130	170	230	190	270	130	93
Acetate	mg/L	3.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bromide (Br-)	mg/L	<0.10	<0.10	<0.10	3.10	0.94	3.20	<0.10	<0.10
Nitrate	mg/L	44.00	54.00	61.00	37.00	43.00	130.00	150	100.00
Nitrate-N	mg/L	9.9	12.0	14.0	8.4	9.7	28.0	33	23.0
Phosphate	mg/L	2.6	2.7	3.1	3.1	1.9	5.3	<0.10	<0.10
Phosphate-P	mg/L	0.8	0.9	1.0	1.0	0.6	1.7	<0.10	<0.10
Sulphate	**mg/L**	760	690	810	430	550	920	**860**	**580**
Nitrite	mg/L	0.00	-	-	-	-	-		
Total Inorganic Nitrogen	mg/L	44.30	-	-	-	-	-		

B.1.3 Site 3

	Sample ID / Site Number:		Site 3					
	NGR:		TA 16584 16689					
	Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023
	Sample Time		11:35	12:00	11:10	10:40	10:20	10:30
	High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29
Laboratory Parameters	**Parameters**	**Units**						
	pH	pH units	8.6	8.4	8.7	8.2	8.1	8.3
	Hardness	mg CaCO3/L	328	220	282	334	296	264
	Ca Hardness	mg CaCO3/L	328	220	282	334	296	264
	Mg Hardness	mg CaCO3/L	0	0	0	0		
	Conductivity	µS/cm	1616	1984	2038	2150	1824	1984
	Chemical Oxygen Demand Index	mg/L	74	62	53	17	89	80
	Sodium (Na)	mg/L	362.5	533.3	360.6	253.4	332.3	398.7
	Ammonia-N	mg/L	1.9	0.7	1	1.1	0.5	1.3
	Monoethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Methylamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Potassium (K)	mg/L	39.1	14.7	37	41.4	14.8	13.7
	Methyl diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	2.6	<0.1
	2-dimethylaminoethanol	mg/L	<0.1	<0.1	<0.1	<0.1	22.7	<0.1
	Calcium (Ca)	mg/L	140.7	141.2	148.5	126.2	0.5	<0.1
	Basic Nitrogen	mg/L	2.4	<1	1.3	1.4	26	1.6
	Total Kjeldahl Nitrogen	mg/L	2	<1	1.1	1.1	<1	1.4
	Fluoride (F-)	mg/L	7.4	<0.10	3.6	4.4	0.29	0.32
	Chloride (Cl-)	mg/L	160	160	150	270	180	120
	Acetate	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	Bromide (Br-)	mg/L	<0.10	<0.10	0.47	1.1	<0.10	<0.10
	Nitrate	mg/L	31	46	36	35	41	61

	Sample ID / Site Number:		**Site 3**					
	NGR:		TA 16584 16689					
	Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023
	Sample Time		11:35	12:00	11:10	10:40	10:20	10:30
	High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29
	Nitrate-N	mg/L	7.1	10	8.1	7.9	9.3	12
	Phosphate	mg/L	10	5.7	20	5.2	3.4	3.1
	Phosphate-P	mg/L	3.4	1.9	6.7	1.7	1.1	1
	Sulphate	**mg/L**	**220**	**230**	**250**	**240**	**280**	**250**

B.1.4 Site 4

	Sample ID / Site Number:		Site 4							
	NGR:		TA 17104 17001							
	Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/10/2023	23/10/2023
	Sample Time		13:15	13:45	14:15	11:38	14:00	11:37	10:16	13:44
	High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29	14:50:00	14:50:00
Field Parameters	**Parameters**	**Units**								
	Temperature	°C	25.8	28.288	26.6	26.8	20.462	22.032	18.596	19.177
	Conductivity	µS/cm	2180	2683.2	2591	3474	182.6	3109.6	2492.1	2399.6
	TDS	mg/l	1394	1641	1618	2185	132	2143	1846	1755
	Salinity	psu	1.1	1.29	1.27	1.75	0.1	1.73	1.48	1.4
	DO	% sat	75.2	95.7	96.1	91.3	65.5	90.9	94.9	90.9
	DO	mg/l	6.04	7.4	7.63	7.23	5.9	7.86	8.8	8.34
	pH	pH units	8.32	8.4	8.24	7.9	8.62	8.2	7.91	8.03
	Turbidity	FNU	6.57	2.53	1.96	3.4	10.76	3.33	2.26	2.42
Laboratory Parameters	**Parameters**	**Units**								
	pH	pH units	8.6	8.5	8.7	8.2	8.1	8.4	-	-
	Hardness	mg CaCO3/L	288	244	278	372	328	252	-	-
	Ca Hardness	mg CaCO3/L	288	244	278	372	328	252	324	320.00
	Mg Hardness	mg CaCO3/L	0	0	0	0	-	-	-	-
	Conductivity	µS/cm	1598	1969	2010	2136	1706	1833	-	-
	Chemical Oxygen Demand Index (ST-COD)	mg/L	72	10	41	21	95	71	54.00	53
	Sodium (Na)	mg/L	340.8	517.1	369.9	178.4	254.1	358.5	342.30	353.1
	Ammonia-N	mg/L	2	0.5	1	<0.1	3.7	1.5	4.40	4.5
	Monoethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Methylamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Diethanolamine	mg/L	<0.1	<0.1	<0.1	3.4	<0.1	<0.1	<0.1	<0.1

Sample ID / Site Number:		Site 4							
NGR:		TA 17104 17001							
Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/10/2023	23/10/2023
Sample Time		13:15	13:45	14:15	11:38	14:00	11:37	10:16	13:44
High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29	14:50:00	14:50:00
Potassium (K)	mg/L	35.9	15	39	34.5	12.2	1.3	11.6	9.8
Methyl diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-dimethylaminoethanol	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	15.6	<0.1	<0.1
Calcium (Ca)	mg/L	137	142.1	152.1	118	137.7	151.4	0.9	<0.1
Basic Nitrogen	mg/L	2.6	<1	1.3	3.4	4.7	17.6	5.7	5.7
Total Kjeldahl Nitrogen	mg/L	2.1	<1	1.1	<1	3.9	1.6	4.7	4.7
Fluoride (F-)	mg/L	4.1	0.56	2.9	3.3	0.53	0.89	0.28	0.57
Chloride (Cl-)	mg/L	160	150	150	270	170	120	210	190
Acetate	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	4.9	2.5
Bromide (Br-)	mg/L	<0.10	<0.10	<0.10	1.2	<0.10	<0.10	0.89	0.89
Nitrate	mg/L	31	41	37	50	39	54	42	41
Nitrate-N	mg/L	6.9	9.4	8.3	11	8.9	12	9.4	9.2
Phosphate	mg/L	8.9	5.1	20	4.3	2.6	3.1	1	<0.10
Phosphate-P	mg/L	2.9	1.7	6.4	1.4	0.86	1	0.33	<0.10
Sulphate	**mg/L**	230	210	240	270	260	230	**280**	**290**
Nitrite	mg/L	2.15	-	-	-	-	-	-	-
Total Inorganic Nitrogen	mg/L	35.15	-	-	-	-	-	-	-

B.1.5 Site 5

	Sample ID / Site Number:		Site 5					
	NGR:		TA 17308 16970					
	Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023
	Sample Time		14:00	13:30	14:00	11:55	12:21	11:50
	High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29
Field Parameters	**Parameters**	**Units**						
	Temperature	°C	24	22.399	21.45	20.46	21.16	14.616
	Conductivity	µS/cm	2029	2105.7	2015	182.6	1938.1	3061.3
	TDS	mg/l	1353	1440	1407	130	1359	2482
	Salinity	psu	1.09	1.14	1.11	0.09	1.07	2.03
	DO	% sat	87.7	46.9	59	61.6	55.7	90.4
	DO	mg/l	7.35	4.04	5.08	5.55	4.92	9.08
	pH	pH units	8.09	8.56	8.38	8.62	7.96	9.39
	Turbidity	FNU	6.18	*883.19**	15.4	10.26	6.67	4.51
Laboratory Parameters	**Parameters**	**Units**						
	pH	pH units	8.5	8.4	8.6	8.7	8	8.8
	Hardness	mg CaCO3/L	484	224	318	402	436	384
	Ca Hardness	mg CaCO3/L	484	224	318	402	436	384
	Mg Hardness	mg CaCO3/L	0	0	0	0		
	Conductivity	µS/cm	1568	1764	1884	2160	1737	1764
	Chemical Oxygen Demand Index (ST-COD)	mg/L	54	101	63	18	73	58
	Sodium (Na)	mg/L	283.8	397.9	295.3	201	216.6	280.9
	Ammonia-N	mg/L	1.4	4.2	2.3	0.4	3.2	0.8
	Monoethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Methylamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Potassium (K)	mg/L	29.2	31.1	24	34.6	14.5	21.2
	Methyl diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Sample ID / Site Number:		Site 5					
NGR:		TA 17308 16970					
Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023
Sample Time		14:00	13:30	14:00	11:55	12:21	11:50
High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29
2-dimethylaminoethanol	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium (Ca)	mg/L	196.3	141.4	150.6	3	182.1	3.9
Basic Nitrogen	mg/L	1.8	5.4	2.9	<1	4.1	1.1
Total Kjeldahl Nitrogen	mg/L	1.5	4.5	2.4	<1	3.4	<1
Fluoride (F-)	mg/L	1	0.52	0.73	2.1	0.32	0.63
Chloride (Cl-)	mg/L	160	160	190	180	180	160
Acetate	mg/L	<0.10	<0.10	<0.10	1.6	<0.10	<0.10
Bromide (Br-)	mg/L	0.6	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrate	mg/L	31	<0.10	1.4	2.3	40	18
Nitrate-N	mg/L	7	<0.10	0.31	0.52	8.9	4.1
Phosphate	mg/L	5.9	12	9	2.6	2.8	3.4
Phosphate-P	mg/L	1.9	3.8	3	0.86	0.92	1.1
Sulphate	**mg/L**	370	160	330	380	390	340
Nitrite	mg/L	1.36	-	-	-	-	-

Note* Disturbed bed / macrophytes, very shallow depth of water, reading unlikely to be representative and excluded from assessment.

B.1.6 Site 6

	Sample ID / Site Number:		**Site 6**							
	NGR:		TA 17377 16738							
	Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/11/2023	23/11/2023
	Sample Time		14:15	12:46	15:40	12:15	12:37	12:15	09:56	14:05
	High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29	14:50:00	14:50:00
Field Parameters	**Parameters**	**Units**								
	Temperature	°C	24	25.271	25.86	26.39	20.19	19.863	16.845	17.475
	Conductivity	µS/cm	2004	2684.5	2490	3545	1739	3582.8	2246.8	2268.8
	TDS	mg/l	1340	1721	1586	2245	1245	2582	1730	1722
	Salinity	psu	1.05	1.36	1.25	1.81	0.98	2.11	1.38	1.38
	DO	% sat	82.5	120.4	99.7	111.3	55.9	86.4	85.3	90
	DO	mg/l	6.9	9.74	8.06	8.87	5.03	7.78	8.2	8.54
	pH	pH units	8.16	8.19	8.27	8.2	8.04	8.52	8.21	8
	Turbidity	FNU	6.88	2.96	1.69	3.61	4.52	4.08	2.96	2.3
Laboratory Parameters	**Parameters**	**Units**								
	pH	pH units	8.4	8.4	8.6	8.3	8.1	8.2	8.30	8.30
	Hardness	mg CaCO3/L	412	404	374	674	380	628	392	560
	Ca Hardness	mg CaCO3/L	412	404	374	674	-	628	392	560
	Mg Hardness	mg CaCO3/L	0	0	0	0	-	-	-	-
	Conductivity	µS/cm	1589	1966	2061	2700	1712	2200	2051	2120
	Chemical Oxygen Demand Index (ST-COD)	mg/L	55	51	65	21	66	70	50	49
	Sodium (Na)	mg/L	297.3	378.2	318.9	264.4	214.4	400.3	271.9	239.4
	Ammonia-N	mg/L	1.5	<0.1	0.9	0.6	0.7	1.7	3.6	2.9
	Monoethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	11.8	<0.1	<0.1	<0.1
	Methylamine	mg/L	<0.1	<0.1	<0.1	<0.1	1.2	<0.1	<0.1	<0.1
	Diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Sample ID / Site Number:		Site 6							
NGR:		TA 17377 16738							
Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/11/2023	23/11/2023
Sample Time		14:15	12:46	15:40	12:15	12:37	12:15	09:56	14:05
High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29	14:50:00	14:50:00
Potassium (K)	mg/L	28.5	18.1	31.9	46.4	<0.1	18.9	19.7	11.1
Methyl diethanolamine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-dimethylaminoethanol	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium (Ca)	mg/L	209.1	226.7	188.8	216.2	164.5	<0.1	3.1	<0.1
Basic Nitrogen	mg/L	1.9	<1	1.1	<1	14	2.2	4.6	3.8
Total Kjeldahl Nitrogen	mg/L	1.6	<1	<1	<1	4	1.8	3.8	3.1
Fluoride (F-)	mg/L	1.7	0.55	2.6	2.7	2	0.17	0.55	0.56
Chloride (Cl-)	mg/L	160	140	150	290	190	160	170	150
Acetate	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.5	<0.10
Bromide (Br-)	mg/L	<0.10	<0.10	<0.10	2.5	<0.10	1.6	0.71	0.57
Nitrate	mg/L	31	42	38	44	33	72	58	79
Nitrate-N	mg/L	6.9	9.5	8.6	9.9	7.5	16	13	18
Phosphate	mg/L	6.6	4.5	17	5.4	3.9	3.1	<0.10	<0.10
Phosphate-P	mg/L	2.2	1.5	5.5	1.8	1.3	1	<0.10	<0.10
Sulphate	**mg/L**	360	370	380	440	410	470	380	470
Nitrite	mg/L	1.25	-	-	-	-	-	-	-
Total Inorganic Nitrogen	mg/L	33.75	-	-	-	-	-	-	-

B.1.7 Site 7

	Sample ID / Site Number:		Site 7						
	NGR:		TA 18701 18035						
	Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/11/2023
	Sample Time		12:15	11:16	15:00	10:40	10:30	11:02	11:25
	High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29	14:50:00
Field Parameters	**Parameters**	**Units**							
	Temperature	°C	-	17.975	18.63	18.378	17.85	15.39	9.544
	Conductivity	µS/cm	-	16165.3	9540	30052	13570	10515	9330.1
	TDS	mg/l	-	12136	7320	22362	8166	6655	8605
	Salinity	psu	-	11.11	6.68	21.7	7.48	6.3	7.63
	DO	% sat	-	93	92.2	86.7	91.4	95.4	95.6
	DO	mg/l	-	8.24	8.26	7.16	8.28	9.15	10.39
	pH	pH units	-	7.73	7.63	7.48	7.69	7.26	7.62
	Turbidity	FNU	-	201.16	442	193	265	118.3	87.13
Laboratory Parameters	**Parameters**	**Units**							
	pH	pH units	8	8	8.1	7.9	7.9	8	-
	Hardness	mg CaCO3/L	3780	676	358	832	760	880	-
	Ca Hardness	mg CaCO3/L	3780	676	358	832		880	600
	Mg Hardness	mg CaCO3/L	0	0	0	0	-	-	-
	Conductivity	µS/cm	27600	27100	28300	36700	37000	36000	-
	Chemical Oxygen Demand Index	mg/L	84	99	53	89	113	140	32
	Sodium (Na)	mg/L	6869.8	6022.2	3519.5	7518.1	7690.9	7604.3	3384.1
	Ammonia-N	mg/L	21.4	<1.0	4.6	13.8	46.2	19.9	31.8
	Monoethanolamine	mg/L	<0.1	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1
	Methylamine	mg/L	<0.1	<1.0	<1.0	<1.0	38.3	<1.0	<0.1
	Diethanolamine	mg/L	<0.1	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1
	Potassium (K)	mg/L	99.9	223.7	139.9	267.7	<1.0	276	126.5
	Methyl diethanolamine	mg/L	<0.1	<1.0	<1.0	23.9	<1.0	<1.0	<0.1

Sample ID / Site Number:		Site 7						
NGR:		TA 18701 18035						
Sampled Date:		26/07/2023	16/08/2023	23/08/2023	06/09/2023	19/09/2023	05/10/2023	23/11/2023
Sample Time		12:15	11:16	15:00	10:40	10:30	11:02	11:25
High Tide Time		11:50	06:47	10:26	10:59	08:59	10:29	14:50:00
2-dimethylaminoethanol	mg/L	<0.1	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1
Calcium (Ca)	mg/L	319.7	421.3	280.5	449.9	4.7	484.2	0.7
Basic Nitrogen	mg/L	27.6	<10.0	<10.0	41.6	97.7	25.6	40.8
Total Kjeldahl Nitrogen	mg/L	22.7	<10.0	<10.0	18.4	66.2	21.1	33.6
Fluoride (F-)	mg/L	0.72	<1.0	<1.0	<1.0	1.5	<1.0	0.21
Chloride (Cl-)	mg/L	12000	7600	10000	14000	14000	14000	7700
Acetate	mg/L	0.89	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10
Bromide (Br-)	mg/L	38	20	30	37	39	39	27
Nitrate	mg/L	10	5.2	7.5	5.2	6.4	14	13
Nitrate-N	mg/L	2.3	1.2	1.7	1.2	1.4	3.1	3
Phosphate	mg/L	2.1	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10
Phosphate-P	mg/L	0.67	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10
Sulphate	**mg/L**	1800	900	1300	1800	1900	1900	1200
Nitrite	mg/L	0	-	-	-	-	-	-
Total Inorganic Nitrogen	mg/L	31.4	-	-	-	-	-	-

B.1.8 Site 8

	Sample ID / Site Number:		**Site 8**
	NGR:		TA 17368 16847
	Sampled Date:		05/10/2023
	Sample Time		12:03
	High Tide Time		10:29
Field Parameters	**Parameters**	**Units**	
	Temperature	°C	14.284
	Conductivity	µS/cm	2979
	TDS	mg/l	2435
	Salinity	psu	1.99
	DO	% sat	110.1
	DO	mg/l	11.14
	pH	pH units	9.67
	Turbidity	FNU	7.13
Laboratory Parameters	**Parameters**	**Units**	
	pH	pH units	9.2
	Hardness	mg CaCO3/L	326
	Ca Hardness	mg CaCO3/L	326
	Mg Hardness	mg CaCO3/L	
	Conductivity	µS/cm	2133
	Chemical Oxygen Demand Index	mg/L	163
	Sodium (Na)	mg/L	387.2
	Ammonia-N	mg/L	1.5
	Monoethanolamine	mg/L	<0.1
	Methylamine	mg/L	<0.1
	Diethanolamine	mg/L	<0.1
	Potassium (K)	mg/L	22
	Methyl diethanolamine	mg/L	<0.1

Sample ID / Site Number:		Site 8
NGR:		TA 17368 16847
Sampled Date:		05/10/2023
Sample Time		12:03
High Tide Time		10:29
2-dimethylaminoethanol	mg/L	<0.1
Calcium (Ca)	mg/L	183.3
Basic Nitrogen	mg/L	2
Total Kjeldahl Nitrogen	mg/L	1.6
Fluoride (F-)	mg/L	0.62
Chloride (Cl-)	mg/L	160
Acetate	mg/L	<0.10
Bromide (Br-)	mg/L	<0.10
Nitrate	mg/L	14
Nitrate-N	mg/L	3.2
Phosphate	mg/L	2.2
Phosphate-P	mg/L	0.71
Sulphate	**mg/L**	330

B.1.8 Site 9

	Sample ID / Site Number:		Site 9	
	NGR:		TA 17709 16628	TA 17709 16628
	Sampled Date:		23/11/2023	23/11/2023
	Sample Time		09:35	14:16
	High Tide Time		14:50	14:50
Field Parameters	**Parameters**	**Units**		
	Temperature	°C	16.622	16.944
	Conductivity	µS/cm	2320.7	2146.3
	TDS	mg/l	1796	1649
	Salinity	psu	1.44	1.32
	DO	% sat	83.9	89.1
	DO	mg/l	8.1	8.56
	pH	pH units	8.29	8.12
	Turbidity	FNU	7.27	3.65
Laboratory Parameters	**Parameters**	**Units**		
	pH	pH units	8.30	8.40
	Hardness	mg CaCO3/L	0	0
	Ca Hardness	mg CaCO3/L	504	448
	Mg Hardness	mg CaCO3/L		
	Conductivity	µS/cm	2046	2034
	Chemical Oxygen Demand Index	mg/L	49	49
	Sodium (Na)	mg/L	248.8	331.9
	Ammonia-N	mg/L	3.5	4.3
	Monoethanolamine	mg/L	<0.1	<0.1
	Methylamine	mg/L	<0.1	<0.1
	Diethanolamine	mg/L	<0.1	<0.1
	Potassium (K)	mg/L	11.1	10.4
	Methyl diethanolamine	mg/L	<0.1	<0.1

Sample ID / Site Number:		Site 9	
NGR:		TA 17709 16628	TA 17709 16628
Sampled Date:		23/11/2023	23/11/2023
Sample Time		09:35	14:16
High Tide Time		14:50	14:50
2-dimethylaminoethanol	mg/L	<0.1	<0.1
Calcium (Ca)	mg/L	<0.1	<0.1
Basic Nitrogen	mg/L	4.5	5.5
Total Kjeldahl Nitrogen	mg/L	3.7	4.5
Fluoride (F-)	mg/L	0.53	0.5
Chloride (Cl-)	mg/L	170	160
Acetate	mg/L	<0.10	1
Bromide (Br-)	mg/L	<0.10	<0.10
Nitrate	mg/L	72	55
Nitrate-N	mg/L	16	12
Phosphate	mg/L	<0.10	<0.10
Phosphate-P	mg/L	<0.10	<0.10
Sulphate	**mg/L**	**450**	**370**

B.2 Flow monitoring

Humber Zero Flow Monitoring - 30 seconds fixed average			
Date and time	16/08/2023	Gauged by	AH & TC
NGR	TA 17284 16823 Lat long:	Accuracy:	3m
Left Post - Height of tape above ground level.	N/A	Right nail - Height of tape above ground level. (Nail on the tree)	N/A
Gauging direction datum	Gauging starts at left post, looking downstream		
Comments (Weather)	Wetted width: 2.5 m. Centre of channel approx depth 0.4 m.		

ASSUMED

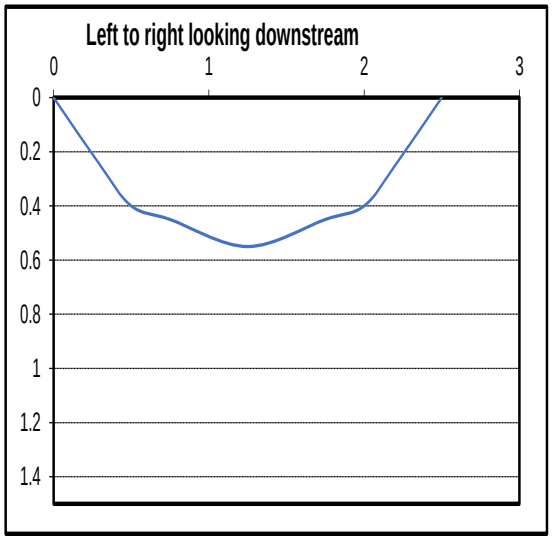
HumberZero P66 Refinery

AECOM

Mean Section Method

Distance from left post	Tape Distance	Depth to Bed from bank top (left bank looking d/s)	Depth of Water	Comments	Instrument Depth	Fixed Average	SD	Width of segment	Mean Depth	Segment CSA	Average Segment Velocity	Discharge in segment	Discharge in segment
(m)	(m)	(m)	(m)		(m)	(M/sec)		m	m	m2	m/s	m3/s	l/s
	0		0		0	0	0	0	0	0.000	0.000	0.000	0.000
Bank = 0	0.3	1.7	0.25	In water, approx 30cm from bank	0.1	0.022	0.012	0.3	0.125	0.038	0.011	0.000	0.413
	0.5	1.85	0.400	50cm from bank	0.1	0.147	0.015	0.2	0.325	0.065	0.085	0.005	5.493
	0.75	1.9	0.450	75cm from bank	0.1	0.158	0.034	0.25	0.425	0.106	0.153	0.016	16.203
	1.25	2	0.550	Centre of channel	0.1	0.158	0.034	0.5	0.5	0.250	0.158	0.040	39.500
	1.75	1.9	0.450	Estimated - mirrored from other bank	0.1	0.158	0.034	0.5	0.5	0.250	0.158	0.040	39.500
	2	1.85	0.400	Estimated - mirrored from other bank	0.1	0.147	0.015	0.25	0.425	0.106	0.153	0.016	16.203
	2.2	1.7	0.250	Estimated - mirrored from other bank	0.1	0.022	0.012	0.2	0.325	0.065	0.085	0.005	5.493
	2.5		0.000	Estimated - mirrored from other bank		0		0.3	0.125	0.038	0.011	0.000	0.413

Flow Meter details	Valeport 801 - propeller	TOTAL Flows:	123.22 L/s
			0.123 m3/s



Humber Zero Flow Monitoring - 30 seconds fixed average														
Date and time	23/08/2023			Gauged by	TC, OT and AR									
NGR	TA 17289 16804	Lat long:				Accuracy:								
Left Post - Height of tape above ground level.	N/A			Just downstream of logger installation		N/A								
Gauging direction datum	Gauging starts on left bank (looking downstream) and reaching out until almost mid-channel													
Comments (Weather)	Wetted width: 2.5 m. Centre of channel approx depth 0.5 m.													

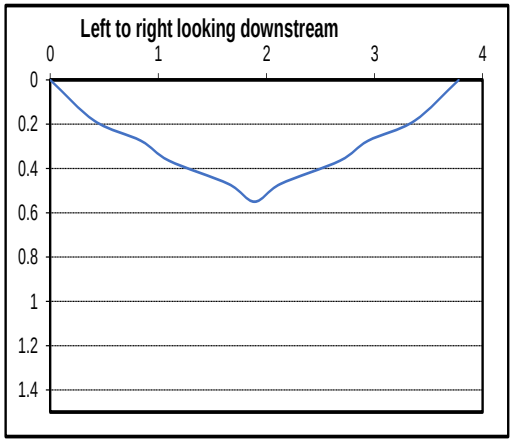
ASSUMED

HumberZero P66 Refinery

AECOM

Mean Section Method

Distance from left bank	Tape Distance	Depth to Bed from bank top (left bank looking d/s)	Depth of Water	Comments	Instrument Depth	Fixed Average	SD	Width of segment	Mean Depth	Segment CSA	Average Segment Velocity	Discharge in segment	Discharge in segment
(m)	(m)	(m)	(m)		(m)	(M/sec)		m	m	m2	m/s	m3/s	l/s
	0		0		0	0	0	0.00	0.00	0.000	0.000	0.000	0.000
Bank = 0	0.41	1.7	0.185	Adjacent to bank but away from taper from edge	0.1	0.069	0.017	0.41	0.09	0.038	0.035	0.001	1.308
	0.84	1.85	0.275	Nearside	0.1	0.137	0.015	0.43	0.23	0.099	0.103	0.010	10.187
	1.1	1.9	0.365	1/4 channel	0.1	0.226	0.017	0.26	0.32	0.083	0.182	0.015	15.101
	1.65	2	0.470	1/3 channel	0.1	0.107	0.011	0.55	0.42	0.230	0.167	0.038	38.233
	1.89	1.9	0.550	Mid-channel	0.1	0.072	0.015	0.24	0.51	0.122	0.090	0.011	10.955
	2.13	2	0.470	Estimated - mirrored from other bank	0.1	0.107		0.24	0.51	0.122	0.090	0.011	10.955
	2.68	1.9	0.365	Estimated - mirrored from other bank	0.1	0.226		0.55	0.42	0.230	0.167	0.038	38.233
	2.94	1.85	0.275	Estimated - mirrored from other bank	0.1	0.137		0.26	0.32	0.083	0.182	0.015	15.101
	3.37	1.7	0.185	Estimated - mirrored from other bank	0.1	0.069		0.43	0.23	0.099	0.103	0.010	10.187
	3.78	0	0.000	Estimated - mirrored from other bank	0.1	0		0.41	0.09	0.038	0.035	0.001	1.308



Flow Meter details	Valeport 801 - propeller

TOTAL Flows:	151.57 L/s
	0.152 m3/s

Humber Zero Flow Monitoring - 30 seconds fixed average			
Date and time	06/09/2023	Gauged by	TC, CD
NGR	TA 17289 16804 Lat long:	Accuracy:	
Left Post - Height of tape above ground level.	N/A	Just downstream of logger installation	N/A
Gauging direction datum	Gauging starts on left bank (looking downstream) and reaching out until almost mid-channel		
Comments (Weather)	Wetted width: 2.5 m. Centre of channel approx depth 0.5 m.		

ASSUMED

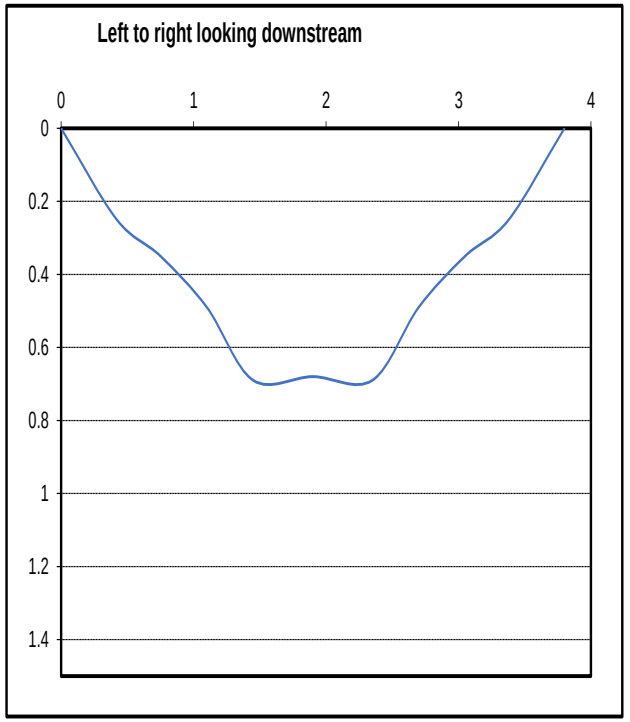
HumberZero P66 Refinery

AECOM

Mean Section Method

Distance from left bank	Tape Distance	Depth to Bed from bank top (left bank looking d/s)	Depth of Water	Comments	Instrument Depth	Fixed Average	SD	Width of segment	Mean Depth	Segment CSA	Average Segment Velocity	Discharge in segment	Discharge in segment
(m)	(m)	(m)	(m)		(m)	(M/sec)		m	m	m2	m/s	m3/s	l/s
	0		0		0	0	0	0	0	0.000	0	0	0.000
Bank = 0	0.42	0.25	0.25	Adjacent to bank but away from taper from edge	0.1	0.15	0.019	0.42	0.125	0.053	0.0725	0.00380625	3.806
	0.75	0.350	0.350	Nearside	0.1	0.19	0.018	0.33	0.3	0.099	0.1665	0.0164835	16.484
	1.1	0.490	0.490	1/4 channel	0.1	0.16	0.021	0.35	0.42	0.147	0.1735	0.0255045	25.505
	1.45	0.690	0.690	1/3 channel	0.1	0.07	0.015	0.35	0.59	0.207	0.112	0.023128	23.128
	1.9	0.680	0.680	Mid-channel	0.1	0.07	0.019	0.45	0.685	0.308	0.066	0.0203445	20.345
	2.35	0.690	0.690	Estimated - mirrored from other bank	0.1	0.065		0.45	0.685	0.308	0.066	0.0203445	20.345
	2.7	0.490	0.490	Estimated - mirrored from other bank	0.1	0.159		0.35	0.59	0.207	0.112	0.023128	23.128
	3.05	0.350	0.350	Estimated - mirrored from other bank	0.1	0.188		0.35	0.42	0.147	0.1735	0.0255045	25.505
	3.38	0.250	0.250	Estimated - mirrored from other bank	0.1	0.145		0.33	0.3	0.099	0.1665	0.0164835	16.484
	3.8	0.000	0.000	Estimated - mirrored from other bank	0.1	0		0.42	0.125	0.053	0.0725	0.00380625	3.806

Flow Meter details	Valeport 801 - propeller	TOTAL Flows:	178.53 L/s
			0.179 m3/s



Humber Zero Flow Monitoring - 30 seconds fixed average													
Date and time	19/09/2023			Gauged by	TC, CD								
NGR	TA 17289 16804	Lat long:			Accuracy:								
Left Post - Height of tape above ground level.	N/A			Just downstream of logger installation		N/A							
Gauging direction datum	Gauging starts on left bank (looking downstream) and reaching out until almost mid-channel												
Comments (Weather)	Wetted width: 2.5 m. Centre of channel approx depth 0.5 m.												

ASSUMED

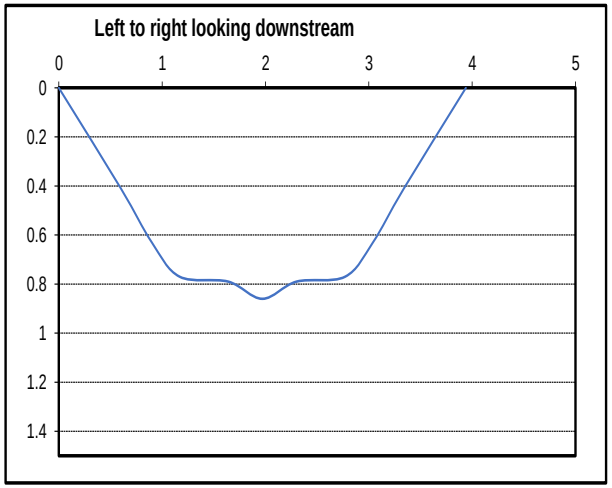
HumberZero P66 Refinery

AECOM

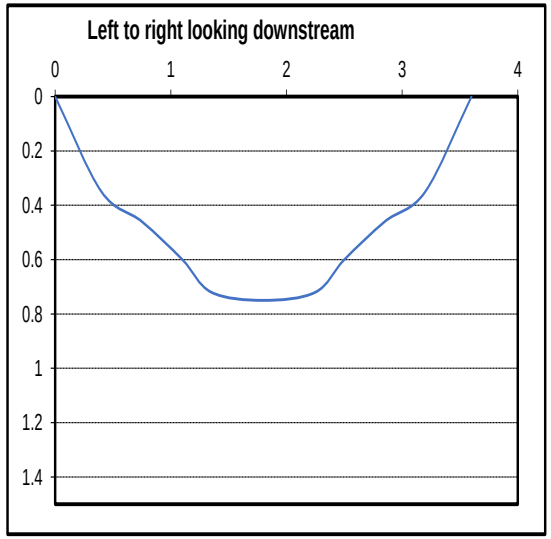
Mean Section Method

Distance from left bank	Tape Distance	Depth to surface water level from bank top (left bank looking d/s)	Depth of Water	Comments	Instrument Depth	Fixed Average	SD	Width of segment	Mean Depth	Segment CSA	Average Segment Velocity	Discharge in segment	Discharge in segment
(m)	(m)	(m)	(m)		(m)	(M/sec)		m	m	m2	m/s	m3/s	l/s
	0		0		0	0	0	0	0	0.000	0	0	0.000
Bank = 0	0.6	0.82	0.41	Adjacent to bank but away from taper from edge	0.37	0.179	0.012	0.6	0.205	0.123	0.0895	0.0110085	11.009
	0.9	0.82	0.630	Nearside	0.6	0.198	0.020	0.3	0.52	0.156	0.1885	0.029406	29.406
	1.17	0.82	0.770	1/4 channel	0.66	0.176	0.020	0.27	0.7	0.189	0.187	0.035343	35.343
	1.64	0.82	0.790	1/3 channel	0.65	0.067	0.032	0.47	0.78	0.367	0.1215	0.0445419	44.542
	1.97	0.82	0.860	Mid-channel	0.55	0.055	0.036	0.33	0.825	0.272	0.061	0.01660725	16.607
	2.3	0.82	0.790	Estimated - mirrored from other bank	0.1	0.067		0.33	0.825	0.272	0.061	0.01660725	16.607
	2.77	0.82	0.770	Estimated - mirrored from other bank	0.1	0.176		0.47	0.78	0.367	0.1215	0.0445419	44.542
	3.04	0.82	0.630	Estimated - mirrored from other bank	0.1	0.198		0.27	0.7	0.189	0.187	0.035343	35.343
	3.34	0.82	0.410	Estimated - mirrored from other bank	0.1	0.179		0.3	0.52	0.156	0.1885	0.029406	29.406
	3.94	0	0.000	Estimated - mirrored from other bank	0.1	0		0.6	0.205	0.123	0.0895	0.0110085	11.009

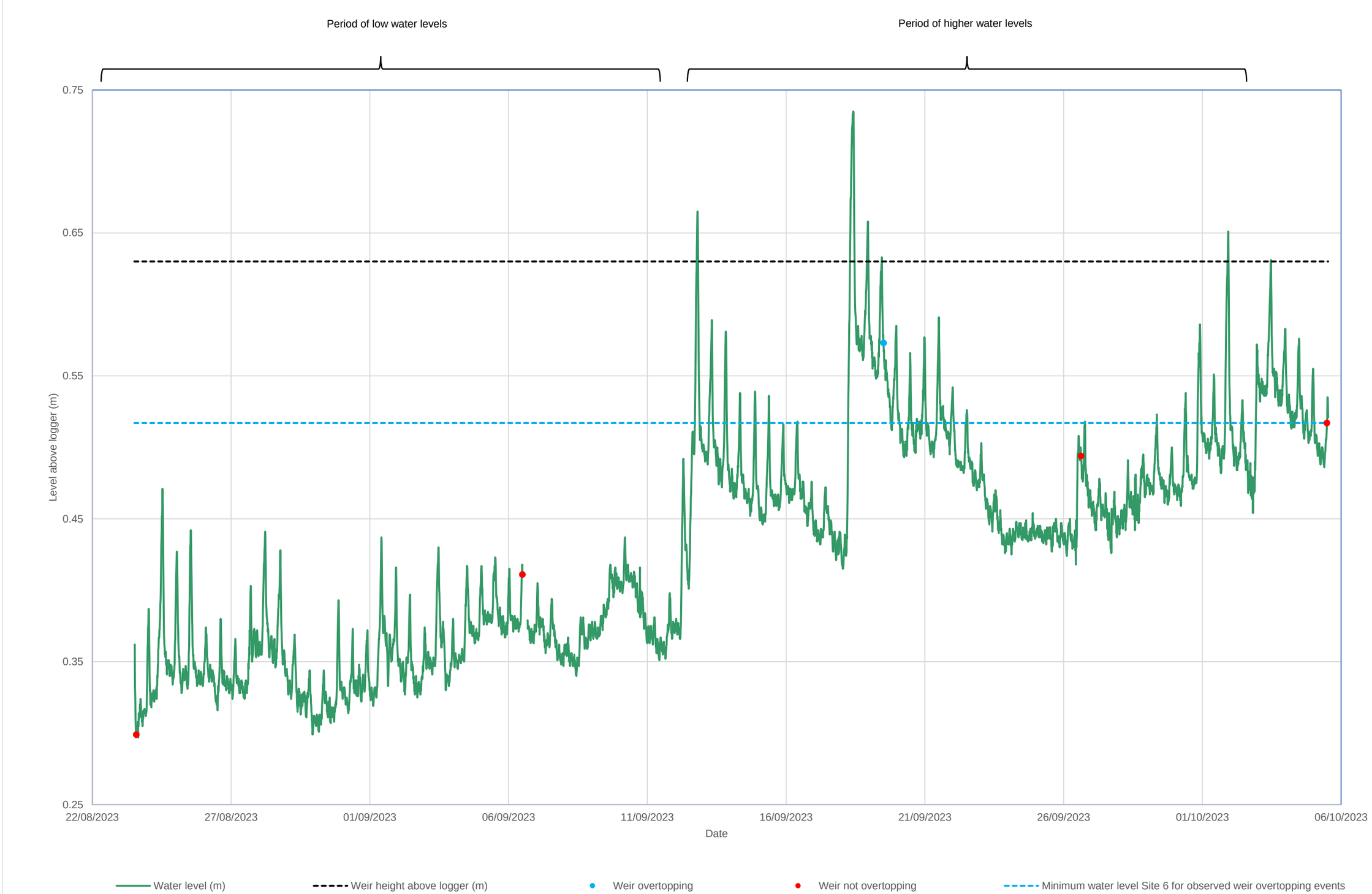
Flow Meter details	Valeport 801 - propeller	TOTAL Flows:	273.81 L/s
			0.274 m3/s



Humber Zero Flow Monitoring - 30 seconds fixed average														
Date and time	05/10/2023			Gauged by	TC, AH, AR			ASSUMED						
NGR	TA 17291 16808 Lat long:					Accuracy:								
Left Post - Height of tape above ground level.	N/A			Just downstream of logger installation		N/A		HumberZero P66 Refinery						
Gauging direction datum	Gauging starts on left bank (looking downstream) and reaching out until almost mid-channel													
Comments (Weather)	Wetted width 2,5-2.75m. Water is clear, fast flowing, macrophytes visible on surface (i.e. not fully submerged) indicates lower water level than previous visit.							Mean Section Method						
Distance from left bank	Tape Distance	Depth to surface water level from bank top (left bank looking d/s)	Depth of Water	Comments	Instrument Depth	Fixed Average	SD	Width of segment	Mean Depth	Segment CSA	Average Segment Velocity	Discharge in segment	Discharge in segment	
(m)	(m)	(m)	(m)		(m)	(M/sec)		m	m	m2	m/s	m3/s	l/s	
	0		0		0	0	0	0	0	0.000	0	0	0.000	
Bank = 0	0.4	0.68	0.35	Adjacent to bank but away from taper from edge	0.25	0.171	0.027	0.4	0.175	0.070	0.0855	0.005985	5.985	
	0.75	0.68	0.460	Nearside	0.3	0.208	0.031	0.35	0.405	0.142	0.1895	0.02686163	26.862	
	1.1	0.68	0.600	1/4 channel	0.55	0.14	0.029	0.35	0.53	0.186	0.174	0.032277	32.277	
	1.35	0.68	0.720	1/3 channel	0.55	0.14	0.039	0.25	0.66	0.165	0.14	0.0231	23.100	
	1.8	0.68	0.750	Mid-channel	0.65	0.181	0.016	0.45	0.735	0.331	0.1605	0.05308538	53.085	
	2.25	0.68	0.720	Estimated - mirrored from other bank	0.1	0.14		0.45	0.735	0.331	0.1605	0.05308538	53.085	
	2.5	0.68	0.600	Estimated - mirrored from other bank	0.1	0.14		0.25	0.66	0.165	0.14	0.0231	23.100	
	2.85	0.68	0.460	Estimated - mirrored from other bank	0.1	0.208		0.35	0.53	0.186	0.174	0.032277	32.277	
	3.2	0.68	0.350	Estimated - mirrored from other bank	0.1	0.171		0.35	0.405	0.142	0.1895	0.02686163	26.862	
	3.6	0.68	0.000	Estimated - mirrored from other bank	0.1	0		0.4	0.175	0.070	0.0855	0.005985	5.985	
Flow Meter details	Valeport 801 - propeller										TOTAL Flows:	282.62 L/s		
												0.283 m3/s		



B.3 Level monitoring


Period of low water levels
Period of higher water levels
0.75
0.65
0.55
0.45
0.35
0.25
Level above logger (m)
22/08/2023
27/08/2023
01/09/2023
06/09/2023
11/09/2023
16/09/2023
21/09/2023
26/09/2023
01/10/2023
06/10/2023
Date
Water level (m)
Weir height above logger (m)
Weir overtopping
Weir not overtopping
Minimum water level Site 6 for observed weir overtopping events

Appendix C Conceptual site model

SKD CHANNELS
1 'VPI' Branch (of SKD)
2 'Marsh Lane' Branch (of SKD)
3 South Killingholme Drain (SKD) (also refinery branch)
4 Rosper Road Pools Backwater Connection
5 South Killingholme Drain

FLOW CONTROL STRUCTURES
A Twin tidal flap gates
B 18m long c. 0.2 m high concrete weir
C Approximately 2 m wide 0.5 m high box culvert blocked during July vegetation clearance
D Approximately 2 m wide 0.5 m high box culvert
E Outfall to Humber Estuary within ABP Immingham Port. Structure unknown but expect protected by tidal flap.

Process and surface water discharge

Surface water flow with direction (two-way means may back up under tide-locking conditions)

Downstream direction

Immingham VPI continuous effluent discharge

Marsh Lane

Humber Estuary Ramsar / SAC / SPA / SSSI

Phillips 66 Refinery continuous effluent discharge plus surface water runoff following rainfall

Rosper Road

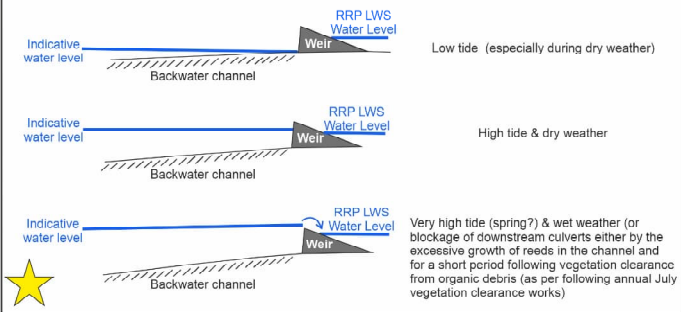
Rosper Road Pools LWS

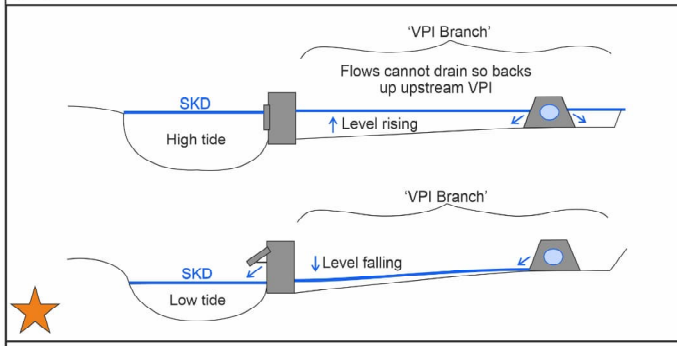
Intermittent surface water runoff from upstream of the refinery, potentially including A160 and Eastfield Road, and land around South Killingholme

ABP Immingham (Port)

Assumed additional surface water runoff from roads and land uses in and around the port area

It is assumed that the drain is either lined or otherwise has minimal connectivity to any groundwater





Client

Phillips 66
7th Floor,
200-202 Aldersgate Street,
London,
EC1A 4HD

PROVIDING ENERGY. IMPROVING LIVES.

Project Title

HUMBER ZERO CCS

Drawing Title

South Killingholme Drain and Rosper Road Pools LWS
Conceptual Site Model

Designed	Drawn	Checked	Approved	Date
OT	KSB	OT		27/09/23

Internal Project No	Suitability
60712174	
Scale @ A3	Zone
NA	X

AECOM