Humber Zero Non-Technical Summary

VPI Immingham and Phillips 66 Limited

Project number: 60668866

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Quality information

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List of Abbreviations

Abbreviation	Definition
BAT	Best Available Techniques
BPM	Best Practicable Means
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Usage and Storage
CEMP	Construction Environmental Management Plan
CHP	Combined Heat and Power
CO_2	Carbon dioxide
COMAH	Control of Major Accident Hazards
DEMP	Decommissioning Environmental Management Plan
EIA	Environmental Impact Assessment
EMS	European Marine Site
ES	Environmental Statement
FCC	Fluid Catalytic Cracker
GHG	Greenhouse gas
GT1	Gas turbine 1
GT2	Gas turbine 2
HGVs	Heavy Goods Vehicles
HLCP	Humber Low Carbon Pipelines
Km	kilometre
LGV	Light Goods Vehicle
m	metre
MMP	Materials Management Plan
Mtpa	Megatonnes per annum
NCA	National Character Area
NLC	North Lincolnshire Council
NO_x	Nitrogen Oxide
NTS	Non-Technical Summary
PCC	Post-Combustion Carbon Capture
PRoW	Public Right of Way
SAC	Special Area of Conservation
SCR	Selective Catalytic Reduction
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
WFD	Water Framework Directive
ZTV	Zone of Theoretical Visibility

List of Terms

Term	Definition
The Applicants	VPI Immingham LLP and Phillips 66 Ltd
The Proposed Developments	The collective terms used to describe the Proposed Phillips 66 Development and the Proposed VPI Development, which are both assessed in the same ES
Phillips 66 Site	The planning application boundary for the Proposed Phillips 66 Development
VPI Site	The planning application boundary for the Proposed VPI Development
The Site	The combined indicative application site boundary, comprising the Phillips 66 Site and the VPI Site (see NTS Figure 2.1)
The Proposed Phillips 66 Development	PCC retrofit to the Fluid Catalytic Cracker (FCC) stack at the Humber Refinery
The Proposed VPI Development	PCC retrofit to two gas turbines (GT1 and GT2) and two auxiliary gas boilers at the VPI Immingham CHP Plant

1. Introduction and Assessment Methods

1.1 This document presents a Non-Technical Summary (NTS) of the Environmental Statement (ES) that has been prepared to accompany the two planning applications for VPI Immingham LLP and Phillips 66 Limited ('the Applicants'). These applications are for the construction, operation and maintenance of two proposed Post-Combustion Carbon Capture (PCC) developments and associated facilities at VPI Immingham's Combined Heat and Power (CHP) Power Plant and Phillips 66 Limited's Humber Refinery ('the Proposed Developments'), to the east of South Killingholme in North Lincolnshire. In this NTS, and throughout the ES, the developments are collectively referred to as 'the Proposed Developments', and separately as 'the Proposed VPI Development' and 'the Proposed Phillips 66 Development'.

1.2 The Proposed Developments will be consented under the Town and Country Planning Act 1990. Two planning applications will be submitted – one for the Proposed VPI Development and one for the Proposed Phillips 66 Development – but in recognition of the inter-related nature of the Proposed Developments and to demonstrate that the cumulative effects of the Proposed Developments have been fully assessed, a combined ES and associated NTS has been prepared.

1.3 The Proposed Developments aim to form the basis for a potential cluster of decarbonisation projects in the future, collectively known as Humber Zero.

1.4 The Proposed Developments will prevent the emission of up to 3.8 megatonnes per annum (Mtpa) of carbon dioxide (CO_2) via:

- 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').

1.5 The CO_2 transportation network that the Proposed Developments will connect into is also under development by others. There are two potential networks that the Proposed Developments could be connected to - the proposed Viking CCS CO_2 transportation and storage network (promoted by Harbour Energy) which is anticipated to commence on land immediately south of the VPI Site, and/ or the East Coast Cluster Humber Low Carbon Pipelines (HLCP), also known as Zero Carbon Humber (promoted by National Grid). Both pipeline networks will run close to the Site and the decision as to which network will be connected to initially will be made following Government funding announcements. It is likely that access to both transportation networks would be available in the long-term.

1.6 The purpose of this NTS is to describe the Proposed Developments and provide an overview of the key findings of the Environmental Impact Assessment (EIA), as reported in the ES.

1.7 All definitions of the elements and parts of the Proposed Developments are defined in the List of Terms at the front of this document.

The Applicants

1.8 VPI Immingham LLP owns and operates the gas-fired CHP Plant located on Rosper Road in Immingham. The plant operates 24/7 to provide the electricity and steam that is critical to the operation of the neighbouring refineries and also to supply electricity to the National Grid.

1.9 Phillips 66 Limited owns and operates the Humber Refinery at Eastfield Road, South Killingholme. The Humber Refinery is a highly integrated, energy efficient refinery which manufactures both fuels and specialist products. It is Europe's only supplier of graphite coke

for Electric Vehicle batteries and consumer goods and is a UK leader in the production of lower carbon liquid fuels.

1.10 The design of the Proposed Developments demonstrates the Applicants' commitment to decarbonisation.

Carbon Capture, Usage and Storage

1.11 Carbon Capture, Usage and Storage (CCUS) is a process that treats the flue gas and removes CO_2 emissions at source (for example at the point of emission from a power station or industrial installation) and then compresses the CO_2 so that it can be safely transported and injected into secure underground geological storage sites (depleted oil or gas caverns or saline aquifers). The CO_2 is permanently stored in the underground storage sites, preventing it from being released into the atmosphere. CCUS is crucial to reducing CO_2 emissions and achieving the UK Government's commitment to Net Zero in terms of greenhouse gas emissions by 2050. **Figure NTS 1.1** shows what is involved in the process.

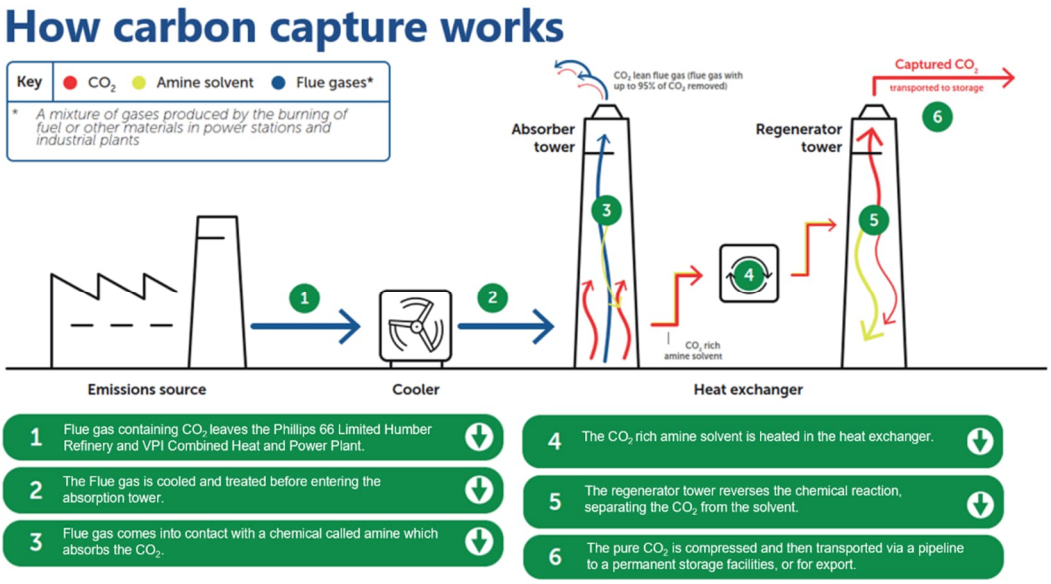


Figure NTS 1.1: Summary of the post-combustion carbon capture (PCC) process

Environmental Impact Assessment Methodology

1.12 An EIA is an environmental assessment process to ensure that consenting decisions are made with knowledge of the likely significant environmental effects of a future development. The EIA presented in the ES (Volumes I - III) follows a standard EIA methodology, described here.

1.13 EIA is undertaken to help to anticipate changes (or 'impacts') that may occur to the environment as a result of the Proposed Developments during their construction, operation (including maintenance and use) and (where possible and relevant) decommissioning. The changes are compared to the environmental conditions that would have occurred without the Proposed Developments ('the baseline conditions').

1.14 The EIA process identifies potentially sensitive 'receptors' that may be affected by these changes (e.g., people living near the Sites, local flora and fauna) and assesses the extent to which these receptors may be affected by the predicted changes and whether or not the receptors are likely to experience a 'significant effect'.

1.15 Where possible, the EIA uses standard methodologies, based on legislation, defined standards and accepted industry criteria which are set out in detail within Chapters 6 to 17 of

the ES Volume I. Effects on receptors can be adverse (negative), neutral (neither negative, nor positive) or beneficial (positive). They can also be temporary (e.g., noise during construction) or permanent (e.g., the views of the completed buildings).

1.16 Adverse and beneficial effects are described as 'significant' or 'not significant'. In general, the classification of an effect is based on the magnitude (scale) of the impact and sensitivity or value/ importance of the receptor, using the matrix shown in Table NTS 1.1. Moderate and major effects are generally considered to be 'significant' for the purposes of the EIA Regulations in accordance with standard EIA practice.

Table NTS 1.1: Significance of effects matrix ('significant' effects are shaded in orange)

Magnitude of Impact	Sensitivity of Receptor				
	Negligible	Low	Medium	High	Very High
High	Minor	Moderate	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate	Moderate
Negligible	Negligible	Negligible	Negligible	Minor	Minor

1.17 Where the EIA predicts a significant adverse effect on one or more receptors, mitigation measures are identified where possible to avoid or minimise the effect, or to reduce the likelihood of the effect happening.

EIA Scope

1.18 EIA Scoping is the process of identifying relevant topics that should be included in the EIA and reported in the ES (as well as topics that are not relevant and so can be 'scoped out'). An EIA Scoping Report and a request for an EIA Scoping Opinion from the local planning authority (North Lincolnshire Council) under Regulation 15 of the Town and Country Planning EIA Regulations, was submitted on 25 January 2022 and a Scoping Opinion was received from the North Lincolnshire Council on 11 March 2022. The ES is based on the Scoping Opinion and therefore includes assessments of the following environmental topics:

- Chapter 6: Air Quality;
- Chapter 7: Noise and Vibration;
- Chapter 8: Traffic and Transport;
- Chapter 9: Water Resources and Flood Risk;
- Chapter 10: Landscape and Visual Amenity;
- Chapter 11: Cultural Heritage;
- Chapter 12: Ecology and Nature Conservation;
- Chapter 13: Geology, Hydrogeology and Contaminated Land;
- Chapter 14: Materials and Waste;
- Chapter 15: Climate Change;
- Chapter 16: Major Accidents and Disasters;
- Chapter 17: Socio-Economics and Human Health; and
- Chapter 18: Cumulative and Combined Effects.

1.19 The findings of these technical assessments are summarised in Section 6 of this NTS.

Consultation

1.20 Consultation is important in the preparation of planning applications and in the EIA process. Consultation with key stakeholders has been ongoing throughout the EIA process and a period of public consultation has also been undertaken in May – July 2022; comments raised have been addressed in the ES, where applicable.

1.21 Responses received during the public consultation have been considered in the preparation of the applications and supporting documentation, as set out in the Consultation Report that will form part of the planning application.

Environmental Statement Structure

1.22 The structure of the ES is outlined in Table NTS 1.2.

Table NTS 1.2: Format of the Environmental Statement

ES Volume	Content
Volume I – Main Chapters	Chapter 1 – presents an introduction to the Proposed Developments and the EIA methodology. Chapters 2-4 – present a description of the Sites, the Proposed Developments, their construction, operation and decommissioning, consideration of alternatives and design evolution. Chapter 5 – presents a summary of relevant legislation and planning policy. Chapters 6-17 – present the findings of the environmental assessments, likely significant effects identified, and mitigation, monitoring and enhancement measures proposed. Chapter 18 – provides an assessment of the potential for cumulative and combined effects to occur as a result of the Proposed Developments and other proposed developments. Chapter 19 – provides a summary of the likely significant residual environmental effects identified.
Volume II - Appendices	Presents additional information to support the environmental assessments in Volume I.
Volume III - Figures	Presents figures that accompany ES Volume I.
NTS	A stand-alone summary of the ES in non-technical language.

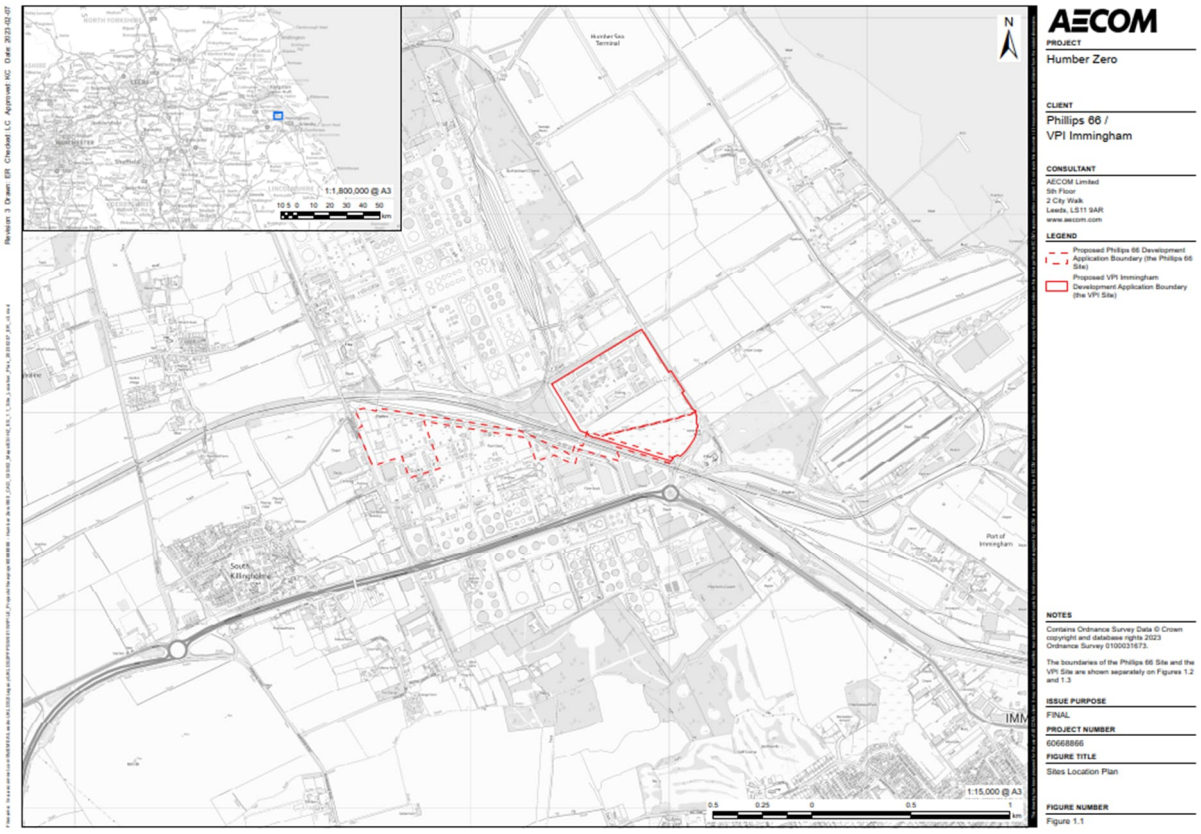
2. Description of the Existing Environment

The Sites and Surroundings

2.1 The Sites lie 1.6 km north of Immingham town and 1.5 km west of the Humber Estuary. The boundaries of the Sites are shown in Figure NTS 2.1. The Sites are located within the administrative boundary of North Lincolnshire Council (NLC), in the ward of Ferry.

2.2 The Phillips 66 Site comprises 15.68 hectares of land, largely within with the operational Humber Refinery, accessed from Eastfield Road, but also includes land to the east of the Refinery for pipeline and cable connections, including a crossing of the Network Rail railway line between the Port of Immingham and Ulceby which will need to be crossed by pipelines and cables.

Figure NTS 2.1: The Sites' Boundaries (copied from Figure 1.1 ES Volume III)



2.3 The VPI Site comprises 28.51 hectares of land to the south of the operational VPI Immingham CHP Plant site, accessed from Rosper Road and separated from the Phillips 66 Site by the Network Rail railway line.

Potential Sensitive Receptors

2.4 A number of environmental receptors have been identified within and outside the boundaries of the Sites. Distances are provided as the shortest distance between the receptor and the closest point of the Sites.

2.5 Key receptors for each topic area have been identified as part of the assessment process and details are included in the relevant technical chapters (Chapters 6 - 17 of ES Volume I). A brief summary is also provided below.

Residential Receptors

2.6 The Sites are situated in a heavily industrialised area with limited residential receptors nearby.

2.7 The nearest residential settlements are the villages of South Killingholme (approximately 0.5 km west of the Phillips 66 Site) and North Killingholme (approximately 0.8 km north-west of the Phillips 66 Site). The town of Immingham is also located approximately 1.6 km to the south of the Sites. The closest residential receptors to the Sites are 545 m west of the Phillips 66 Site (in South Killingholme) and 340 m east of the VPI Site (on Marsh Lane).

Ecological Receptors

2.8 The Humber Estuary Site of Special Scientific Interest (SSSI)/ Special Protection Area (SPA)/ Special Area of Conservation (SAC)/ Ramsar site is located approximately 1.5 km east of the Sites (at its nearest point).

2.9 There are no other European sites within 5 km of the Sites. Further, there no other European sites within 15 km.

2.10 North Killingholme Haven Pits SSSI is located approximately 2.2 km north of the VPI Site/ 2.7 km north of the Phillips 66 Site.

2.11 There are four locally designated sites within 2 km of the Sites, with the closest being Rosper Road Pools Local Wildlife Site (LWS) 130 m to the east of the VPI Site and 500 m east of the Phillips 66 Site.

2.12 The Phillips 66 Site itself is not considered to be sensitive with respect to biodiversity, given the industrial land uses in and around the Phillips 66 Site, although great crested newts are present in the wider area.

2.13 The VPI Site, south of the existing VPI Immingham CHP Plant, comprises a mosaic of habitats including but not limited to grassland, bramble, scrub, broadleaved woodland and drains and ditches.

Transport Receptors including Public Rights of Way

2.14 The Proposed Developments are located on land to the north of A160 Humber Road, Immingham, within the administrative boundary of North Lincolnshire Council which, as a unitary authority, is responsible for both Planning and Highways matters.

2.15 The existing VPI Immingham CHP Plant site is accessed from Rosper Road, a single-carriageway road that serves the industrial area of Killingholme and Humber Terminal. Rosper Road joins the Humber Road at the A160 roundabout and railway crossing approximately 0.3 km to the south of the VPI Site.

2.16 The existing Phillips 66 Humber Refinery is accessed from Eastfield Road, a single carriage road that serves the industrial area of Killingholme, and the A160. Eastfield Road joins the A160 junction approximately 0.4 km south of the Phillips 66 Site.

2.17 Public Right of Way SKIL91A is shown on the Definitive Map crossing the VPI Site south of the VPI Immingham CHP Plant, between the existing railway line and Rosper Road. This Public Right of Way has not been physically present on the VPI Site for many years and an application to extinguish it is currently being processed.

Air Quality Receptors

2.18 The nearest Air Quality Management Area is 12.6 km to the south-east of the Sites in Grimsby.

Geological and Groundwater Receptors

2.19 The local geology for both Sites is characterised by Tidal Flat Deposits, Devensian Till – Diamicton superficial deposits which overlie Burnham Chalk Formation – Chalk. Made Ground is also expected across parts of the Sites, given the historical phases of development that have taken place.

2.20 The Environment Agency classifies the underlying superficial geology as Secondary (undifferentiated) and the Burnham Chalk Formation as a Principal aquifer. The Sites lie within a Total Catchment Groundwater Source Protection Zone (SPZ).

Surface Water and Flood Risk Receptors

2.21 South Killingholme Drain runs eastwards through the southern part of the Phillips 66 Humber Refinery, crossing under the railway and into the VPI Site before heading south-east along Rosper Road and ultimately entering the Humber Estuary at South Killingholme Haven.

2.22 Other surface watercourses and waterbodies in the vicinity of the Sites include:

- North Beck Drain, approximately 4.8 km south-east of both Sites;
- Skitter Beck/ East Halton Beck, approximately 4-6 km west/ south-west of the Phillips 66 Site;
- the Humber Estuary, approximately 1.5 km to the east of both Sites;
- a series of unnamed land drains; and
- Rosper Road Pools, an artificial flood relief reservoir approximately 130 m east of the VPI Site.

2.23 The Environment Agency 'Flood map for planning' indicates that the majority of the Phillips 66 Site is located within Flood Zone 1 (low risk of flooding) with only the easternmost part of the Phillips 66 Site being in Flood Zones 2 and 3. The VPI Site is located within Flood Zone 3 (high risk of flooding).

Cultural Heritage Receptors

2.24 The Sites are not considered to fall within the setting of any listed buildings, conservation areas, registered parks and gardens, or Scheduled Monuments.

2.25 There are 33 listed buildings within 5 km of the Sites, four of which are located within 1 km of the Sites. The closest are:

- The Nook, grade II, approximately 450 m west of the Phillips 66 Site (over 1 km from the VPI Site);
- The Baptist Chapel, grade II, approximately 570 m south of the Phillips 66 Site (over 1 km from the VPI Site);
- The Church of St Denys, grade I, approximately 930 m north-west of the Phillips 66 Site (over 1 km from the VPI Site); and
- The Old Vicarage, grade II, approximately 950 m north-west of the Phillips 66 Site (over 1 km from the VPI Site).

Landscape and Visual Receptors

2.26 The key visual receptors are described above in 'Residential Receptors'. Visual receptors also include Public Rights of Way.

2.27 The Sites fall within the Humber Estuary National Character Area 41 (Natural England, 2012), which relates to the low-lying estuarine landscape, and the wider landscape study area also includes National Character Area 42 Lincolnshire Coast and Marshes) which relates to the character of the river and coastline.

2.28 The North Lincolnshire Landscape Character Assessment (North Lincolnshire Council, 1999) defines the area that the Sites are located within as the Industrial Landscape Character Type South Humber Gateway, which is dominated by industry, with remnant pockets of flat open farmland, woodland and natural coastal habitats.

3. The Proposed Developments

Components of the Proposed Developments

3.1 The Proposed Developments are described in detail in Chapter 3: Proposed Developments Description, Need and Alternatives Considered (ES Volume I).

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

- FCC flue gas waste heat exchanger for energy recovery;
- ducting (including ducting over an existing internal access road) to connect the FCC unit to the Phillips 66 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;
- low pressure and high pressure CO_2 vent stacks for use during start up, shut down and emergencies only;
- 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.

3.3 The Proposed VPI Development will include the following components:

- ducting to connect GT1, GT2 and the auxiliary boilers to the VPI PCC plant;
- two PCC units (or 'trains'), each with associated blower, direct contact cooler, absorber, stack, stripper/ regenerator, thermal reclaimer unit and air-cooled heat exchangers;
- a CO_2 vent stack for use during start up, shut down and emergencies only;
- CO_2 compression facility with associated air-cooled heat exchangers;
- 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;
- on-site electrical substations;
- caustic, solvent and other chemical offloading and storage facilities;
- utilities (including chillers, steam generator, hydrogen package and air compressors)
- internal access roads;
- surface water drainage system

- realignment of the existing ditch (South Killingholme Drain) within the VPI Site;
- construction and maintenance laydown areas; and
- a new site access from Rosper Road.

3.4 Figures NTS3.1 and NTS3.2 show indicative layouts of the Proposed Developments.

Figure NTS 3.1: The Proposed Phillips 66 Development Indicative Layout (copied from Figure 3.1 ES Volume III)

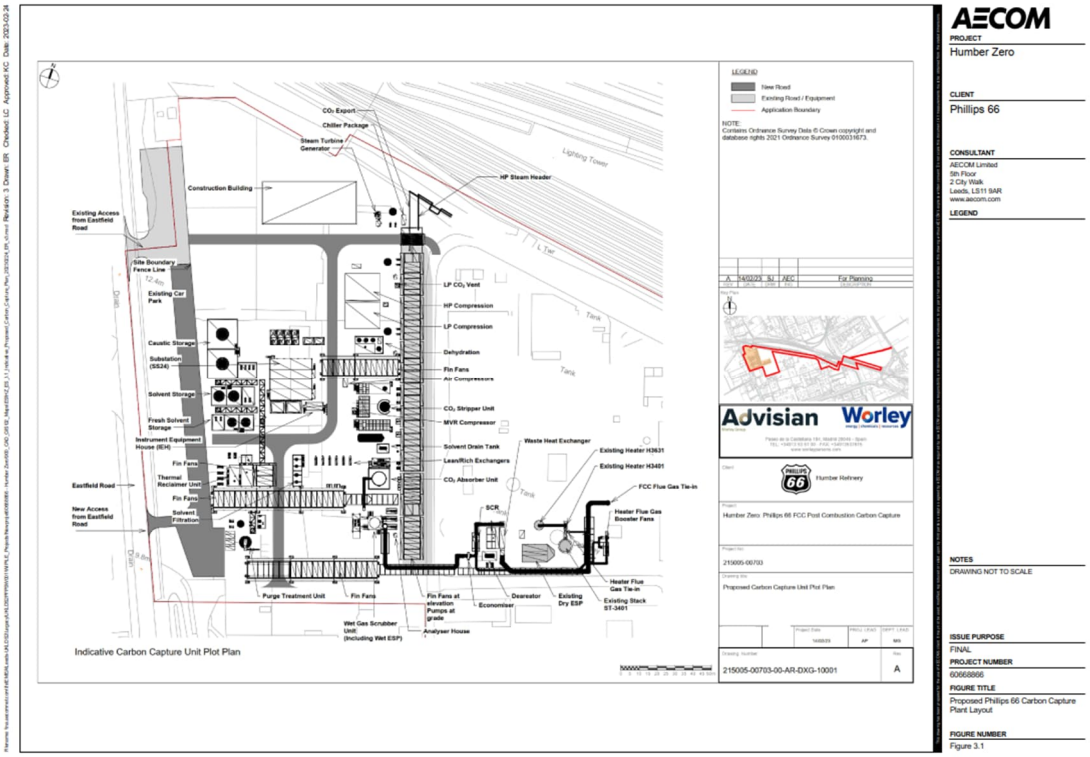
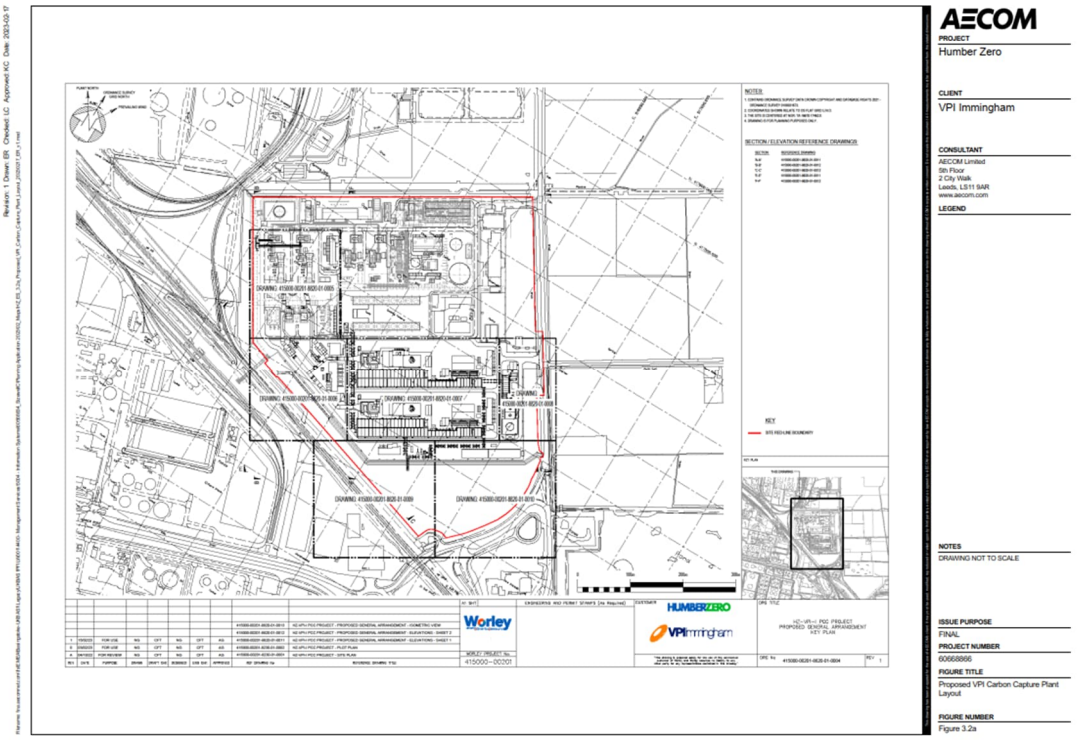


Figure NTS 3.2: The Proposed VPI Development Indicative Layout (copied from Figure 3.2a ES Volume III)



Rochdale Envelope and Design Parameters

3.5 The detailed designs of the Proposed Developments are not yet completed. However, the final designs will be within the parameters assessed within the ES.

3.6 Where design details cannot yet be finalised, a conservative approach has been adopted whereby the option that gives rise to the worst-case potential environmental impacts and effects has been assessed in the ES. This is known as the Rochdale Envelope approach and is further explained in Advice Note Nine: Using the Rochdale Envelope (Planning Inspectorate, 2018a).

Construction of the Proposed Developments

3.7 Construction of the Proposed Developments could (subject to the necessary consents being granted and government policy/ funding support being in place to enable final investment decisions being made) potentially start in Quarter 2 of 2024 for the Phillips 66 Development and Quarter 3 of 2024 for the VPI Development.

3.8 The Applicants would appoint contractor(s) to undertake the construction phase of the Proposed Development. The Applicants would retain overall responsibility for the project and would ensure that the works would be undertaken in accordance with the applicable legal requirements.

3.9 An indicative construction programme for the Proposed Phillips 66 Development is outlined in Table NTS 3.1, and an indicative construction programme for the Proposed VPI Development is outlined in Table NTS 3.2.

Table NTS 3.1: Indicative construction and commissioning programme for the Proposed Phillips 66 Development

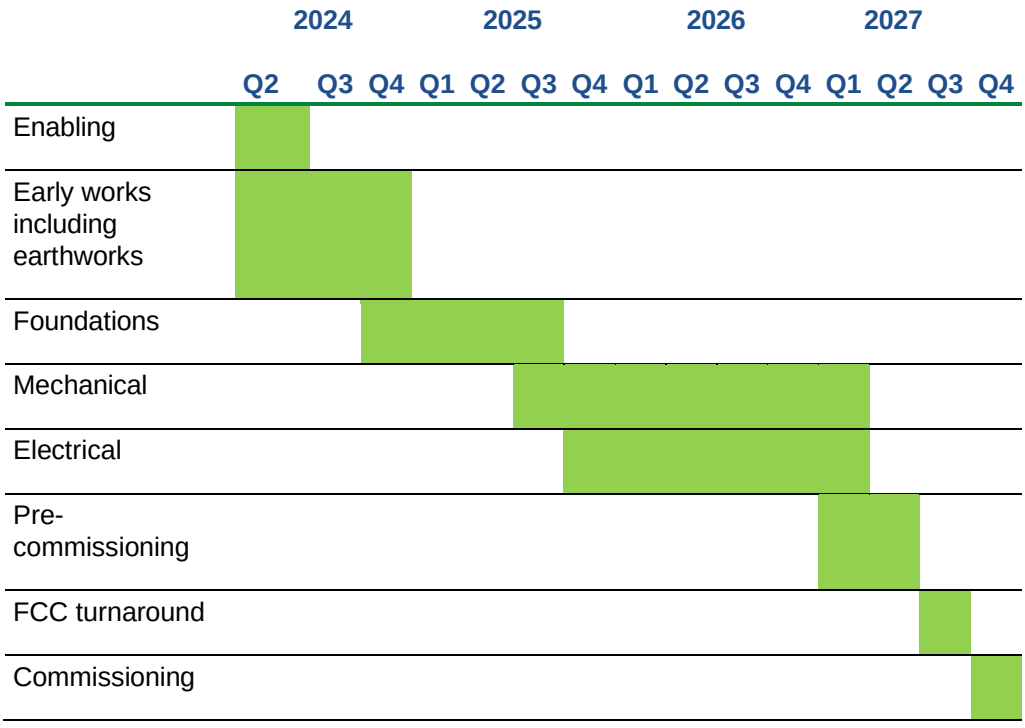
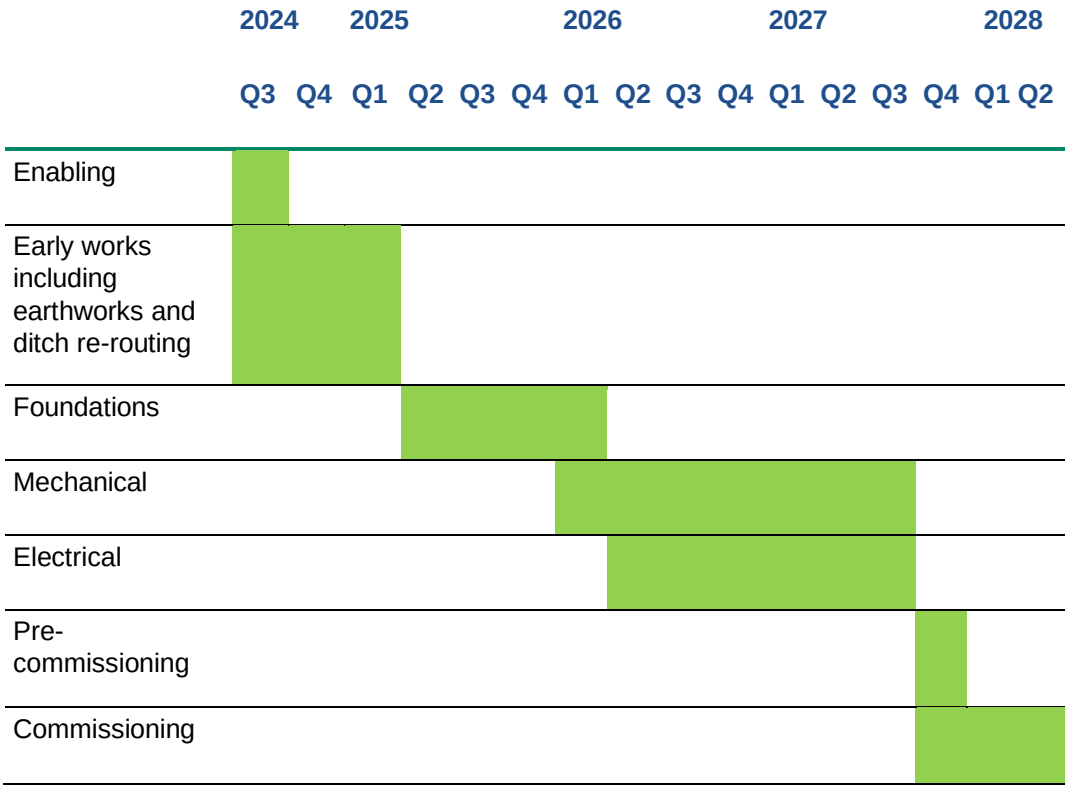


Table NTS 3.2: Indicative construction and commissioning programme for the Proposed VPI Development



3.10 It is estimated that there will be circa 790 people contracted to work on the Proposed Phillips 66 Development at the peak of its construction and circa 840 people contracted to work on the Proposed VPI Development at the peak of its construction.

3.11 Normal construction working hours for the Proposed Phillips 66 Development could be 24/7 where required, as per the existing Humber Refinery operating and maintenance working hours.

3.12 Normal construction working hours for the Proposed VPI Development will be 07:00 and 19:00 Monday to Friday (except Bank Holidays) and 07:00 to 13:00 on Saturdays (the hours defined by British Standard 5228: Code of practice for noise and vibration control on construction and open sites (British Standards Institute, 2009) as 'daytime' hours), with no working on Sundays and Bank Holidays. However, it is likely that some construction activities may need to be undertaken outside of these normal working hours and could be 24/7, limited to manage critical periods where required, principally because certain construction activities cannot be stopped, such as concrete pouring, pipework testing and commissioning but also potentially to manage the construction programme. Where on-site works are to be conducted outside the normal construction working hours, they will comply with any restrictions agreed with the local planning authority, in particular regarding control of noise.

3.13 A detailed Construction Environmental Management Plan (CEMP) will be prepared prior to construction setting out the key measures to be employed during construction to control and minimise the impacts on the environment. The submission, approval and implementation of this will be secured by a planning condition. An Outline CEMP is provided at Appendix 4A in ES Volume II.

Operation of the Proposed Developments

3.14 The facilities will be designed to operate 24 hours per day, 7 days per week, with programmed offline periods for maintenance.

3.15 The Proposed Developments will have an initial design life of 25 years, although this could be extended.

3.16 The Proposed Developments will be operated as part of the wider Humber Refinery and CHP Plant operations. The Proposed Phillips 66 Development will create approximately 15 new full time equivalent jobs and the Proposed VPI Development will create approximately 50 new full time equivalent roles.

3.17 The operation of the Proposed Developments will be regulated by the Environment Agency through respective Environmental Permits. These permits will control normal emissions to the environment from the plant and would also consider potential abnormal operation scenarios and prevention or minimisation of accidents, through the use of management procedures and process monitoring.

3.18 Routine maintenance will be planned and scheduled via the maintenance management system to ensure the Proposed Developments operate safely. This will occur approximately every three to six years.

3.19 Access to the Sites during operation will be via Eastfield Road and Rosper Road.

Decommissioning of the Proposed Developments

3.20 At the end of their operating lives, the Proposed Developments will be decommissioned in accordance with relevant standards and best practices and in accordance with Environmental Permit conditions and any relevant legal requirements.

3.21 Decommissioning Plans (including Decommissioning Environmental Management Plans (DEMPs)) would be produced at the time of decommissioning each Proposed Development and agreed with the Environment Agency as part of the Environmental Permitting and site surrender process. The DEMPs would consider in detail all potential environmental risks on the Sites and contain guidance on how risks can be removed or mitigated during the decommissioning and demolition.

4. Consideration of Alternatives

4.1 The EIA Regulations state that an ES should include a description of reasonable and relevant alternatives studied by an applicant and the main reasons for selecting the chosen development, taking into account the environmental effects.

4.2 In summary, alternatives and their associated environmental effects have been considered during the evolution of the Proposed Developments including:

- alternative sites;
- alternative technologies;
- alternative design options/ layouts and design evolution;
- the 'do nothing' alternative.

Alternative Sites

4.3 The nature of the Proposed Developments involve retrofitting existing infrastructure with carbon capture technologies so proximity to the existing infrastructure is a key consideration. The Sites were chosen for their availability and proximity to the existing CHP Plant and FCC stack.

Alternative Technologies

4.4 No alternative technologies to post combustion carbon capture have been identified to reduce the Humber Refinery FCC's CO_2 emissions by the same or similar level. The FCC is a refinery process that generates CO_2 (i.e. there is no option to use another lower carbon alternative), meaning the only option is to capture the CO_2 emissions generated.

4.5 Alternative technologies to reduce the VPI Immingham CHP Plant's CO_2 include hydrogen firing. At present there is not sufficient hydrogen available for firing the VPI Immingham CHP Plant GT1 and GT2 within the project timescales, so carbon capture is the only available option to capture the CO_2 emissions generated by these units.

Alternative Design Options/ Layouts and Design Evolution

4.6 Alternative design options have been explored during the design process for each of the Proposed Developments.

4.7 For both of the Proposed Developments:

- air and water cooling technologies were considered, and due to water resource constraints within the region, air cooling was selected wherever possible;
- the selected carbon capture technology licensors were chosen amongst competing alternatives as the most efficient technologies to provide a 95% carbon capture rate; and
- the Proposed Developments have been designed to allow for connection to either of the potential CO_2 transport and storage networks for operational and commercial flexibility.

4.8 For the Proposed Phillips 66 Development, options to pre-treat the FCC flue gas before carbon capture were considered, so that sufficient levels of sulphur oxides, nitrogen oxides and particulates could be removed.

4.9 Layout options comprising two larger or three smaller 'trains' (PCC units) were considered for the Proposed VPI Development. Ultimately, a layout option comprising two trains was selected to reduce the area of land required.

Do Nothing Alternative

4.10 It was considered that a 'do-nothing' scenario was not appropriate given the established national need for industrial decarbonisation to meet the UK's Net Zero targets. The carbon capture offered by the Proposed Developments of up to 3.8 Mtpa would not be realised, nor would the investment in the local economy to secure the future of local industries and associated jobs by aligning with a net zero pathway.

5. Summary of Environmental Effects

5.1 This section provides a summary of the likely environmental effects predicted to occur as a result of the construction, operation, maintenance and decommissioning of the Proposed Developments.

5.2 An assessment of the environmental effects of the Proposed Developments during their construction and operation (including maintenance) has been completed for each of the topics that have been scoped into the EIA. During the eventual decommissioning of the Proposed Developments, for the purposes of the EIA the effects are considered likely to be comparable to, or less than, those for construction activities (and controlled similarly) and therefore although these are discussed in each chapter of the ES, decommissioning effects have not been specifically mentioned within this NTS unless otherwise stated.

Air Quality

5.3 Chapter 6: Air Quality in ES Volume I considers potential impacts and effects from the Proposed Developments on both human health and ecological receptors.

5.4 The air quality assessment uses screening tools and computer models to predict the dispersion of air emissions from the Proposed Developments including pollutant emissions and dust associated with the construction of the Proposed Developments and pollutant emissions from the proposed stacks (chimneys) of the operational development. These predict concentrations of pollutants in ambient air which are compared to national air quality standards where available, or other appropriate levels as agreed with regulators.

5.5 The assessment considers potential impacts on identified human health and ecological receptors, assessing the effects of:

- construction dust;
- exhaust emissions from construction site plant and machinery and construction road traffic;
- process emissions from the operational plant; and
- decommissioning.

Likely Impacts and Effects

5.6 Through the use of standard construction management measures, which reduce dust and emissions from site clearance and site preparation activities, emissions to air from construction activities are assessed to have no significant adverse effects on human or ecological receptors. Management measures would include standard best practice such as appropriate storage of materials, suppression of dust from soil movement and material storage, cleaning of vehicles and locating construction plant away from sensitive receptors, implemented via the CEMP. Effects of construction dust are therefore assessed as **not significant**.

5.7 Based on expected vehicle movements, construction traffic air quality impacts are considered to be **not significant** for any human and ecological receptors. No additional mitigation other than the implementation of the CEMP has been identified as necessary for the construction phase of the Proposed Development.

5.8 Emissions from operational road traffic are anticipated to be low and are below the threshold criteria requiring detailed assessment. It is therefore considered that the impacts of operational traffic emissions are **not significant**.

5.9 During operation, impacts could arise due to process emissions from the operational Proposed Developments (stack emissions, including ammonia based emissions which are assessed in respect of human health). An assessment of operational effects of the Proposed

Developments has been undertaken using atmospheric dispersion modelling and taking into account a number of conservative assumptions.

5.10 Predicted ground level concentrations of relevant air pollutants (principally nitrogen oxides, ammonia (relevant to the Phillips 66 Site only) and amines and their degradation product (n-amines)) due to air emissions from the operation of the Proposed Developments have been assessed. Effects as a result of the Proposed Developments at the identified human receptors are within the required standards and are assessed as **not significant**.

5.11 The deposition of pollutants on sensitive ecological receptors from the air emissions of nitrogen oxides, sulphur dioxides and ammonia has also been calculated. Effects from the Proposed Developments emissions are assessed to be **not significant**.

5.12 Emissions from the Proposed Developments during operation will be carefully controlled and regulated by the Environment Agency through the Environmental Permits and in accordance with the use of Best Available Techniques (BAT). The Permits must be granted prior to operation of the Proposed Developments. The Applicants are working with the Environment Agency and other parties to determine BAT for carbon capture plants given the 'first of a kind' nature of the Proposed Developments. Permit applications have been prepared by the Applicants for submission to the Environment Agency for determination alongside the planning applications.

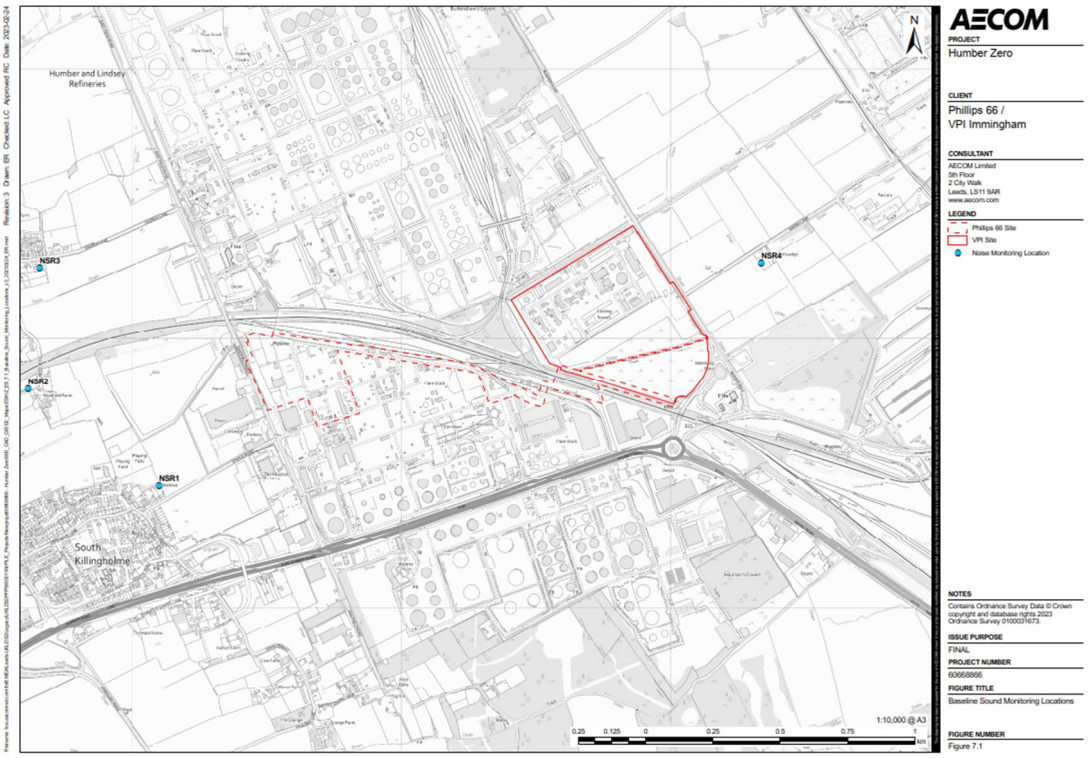
5.13 Emissions and dust generation associated with decommissioning area assumed to be consistent with those for construction, therefore no further assessment on decommissioning was considered. Appropriate best practice mitigation measures will be applied during decommissioning via a Decommissioning Environmental Management Plan.

Noise and Vibration

5.14 A noise and vibration assessment has been undertaken and is presented in Chapter 7: Noise and Vibration (ES Volume I).

5.15 Key noise sensitive receptor locations have been selected which are considered to be representative of the nearest and potentially most sensitive existing receptors in all directions around the Proposed Developments (see **Figure NTS 5.1**). It is considered that if noise and vibration levels are suitably controlled at the nearest receptor identified, then noise and vibration levels will be suitably controlled at other sensitive receptors in the surrounding area.

Figure NTS 5.1: Noise Sensitive Receptors (copied from Figure 7.1 ES Volume III)



5.16 Noise levels during construction and operation of the Proposed Developments have been predicted by computer modelling and the results compared with measured baseline noise levels at the identified receptors during the day, evening and night. National standards have been applied to determine whether there is the potential for significant effects without further mitigation measures being applied. It is assumed that the decommissioning works will be similar to the construction works.

5.17 The assessment has also considered the potential for vibration effects from construction (and decommissioning) and operation of the Proposed Developments. There are no residential receptors in close proximity to the Proposed Developments which have the potential to be affected by construction vibration. However, there is the potential for some vibration impacts upon buildings/structures within the existing Phillips 66 Site and/or VPI Site. Vibration is likely to occur for a short period of the construction works, however, is not anticipated to occur adjacent to sensitive buildings or structures.

Likely Impacts and Effects

5.18 Noise is likely to be generated throughout the construction phase through works such as initial site preparation, earthworks and excavation, construction of buildings and infrastructure including piling, operation of temporary facilities, as well as from construction traffic on the local road network.

5.19 Construction noise effects at all residential receptors during construction of the Proposed Developments within core daytime working hours are predicted to be **not significant**.

5.20 It may be necessary for some construction activities to take place continuously over day, evening and night periods during peak construction times of the Proposed Developments, although the exact nature of these works is unknown at this stage. If some construction works take place over night-time periods, assuming the same intensity of working as for the daytime, there would be the potential for significant adverse noise effects at the closest receptors, in the absence of additional mitigation. Construction activities taking place outside core working hours will therefore be planned, managed and controlled appropriately so they do not exceed the appropriate limits to be agreed with North Lincolnshire Council.

5.21 The control and monitoring of construction noise is proposed to be secured by planning conditions. The preferred approach for controlling construction noise and vibration is to reduce levels at source, where reasonably practicable and to use best practicable means for construction noise mitigation. On the basis that mitigation is employed such that the relevant noise limits are met and the mitigation measures set out in the CEMP are followed, residual (after mitigation) effects are assessed as **not significant**. Further detailed assessments will be undertaken once contractors are appointed and working methods are established.

5.22 It is anticipated that there will be either no change or a very low change in road traffic noise due to construction traffic associated with the Proposed Developments. Therefore, effects at local residential receptors are predicted to be **not significant**.

5.23 Vibration effects on existing structures on each of the Sites is assessed to be **not significant**.

5.24 Operational road traffic will be low and below the threshold criteria requiring detailed assessment. It is therefore considered that the impacts of operational traffic emissions are **not significant**.

5.25 Modelling software has been used to assess the likely effects of operational noise at noise sensitive receptors using conservative assumptions to provide a worst-case assessment, assessing both the Proposed Phillips 66 Development and the Proposed VPI Development together. Without additional mitigation, there could be significant effects at some properties, particularly at night and during weekends when background noise levels are lower.

5.26 Application of practical sound mitigation to reduce relevant noise at source within the Proposed Developments will therefore be undertaken during detailed design to achieve an acceptable noise level at the nearest receptors. This mitigation will result in effects that are classified as **not significant**. These measures would demonstrate use of BAT for the control of noise for the Environmental Permit.

5.27 During decommissioning, appropriate best practice mitigation measures will be applied during any decommissioning works and documented in a Decommissioning Environmental Management Plan.

Traffic and Transport

5.28 An assessment has been undertaken which considers the potential effects of the construction and operation (including maintenance) of the Proposed Developments on traffic and transport; this is presented within Chapter 8: Traffic and Transportation (ES Volume I) and is supported by Appendix 8A: Transport Assessment, Appendix 8B: Construction Traffic Management Plan and Appendix 8C: Construction Worker Travel Plan (ES Volume II). The decommissioning phase of the Proposed Developments has been scoped out of the assessment as the impacts are expected to be similar or less than those during the construction period.

5.29 The assessment considers the predicted number of vehicle movements generated during the construction of the Proposed Developments, and the sensitivity (including pedestrian and cyclist safety) and capacity of the local road network. Public Rights of Way, including footpaths and cycle route networks, that cross roads within the study area have also been considered and have helped define the sensitivity of the road links.

5.30 Assessment of operational traffic was scoped out of the assessment due to the low levels of traffic that will be generated.

Likely Impacts and Effects

5.31 As baseline traffic flows on the road network are projected to increase year on year, to undertake a worst-case assessment, future baseline traffic flows have been assessed for the anticipated year of peak HGV movements and the anticipated year of peak total traffic movements for the construction phases of the Proposed Developments. For the Proposed VPI Development these are 2026 and 2027, respectively, and for the Proposed Phillips 66 Development, these are both 2025.

5.32 The additional traffic due to the Proposed Developments construction activities will result in temporary increases of traffic flows, including HGVs, on the roads leading to the Sites. The effects of construction traffic on pedestrian amenity, severance, fear and intimidation, highway safety, pedestrian and cyclist amenity, driver delay and hazardous loads have been assessed using relevant guidance. Effects at all road sections and junctions within the study area are anticipated to be **not significant**, with the exception of four road sections which, without appropriate controls, will experience a **significant adverse** effect in terms of impacting pedestrian and cyclist amenity as a result of the Proposed Developments. However, with the implementation of traffic management measures (as set out in the Construction Traffic Management Plan and Construction Worker Travel Plan), the residual effects are all reduced to **not significant**.

5.33 During the operational phase the operational traffic generation is expected to be low (up to 10 HGV trips and up to 100 car/ LGV trips per day) and below the threshold requiring detailed assessment. As such operational traffic effects are considered to be **not significant**.

Water Environment and Flood Risk

5.34 An assessment has been undertaken which considers the potential effects of the Proposed Developments on the water environment and flood risk, presented in Chapter 9: Water Resources and Flood Risk (ES Volume I).

5.35 The VPI Site lies within Flood Zone 3. Online mapping does not differentiate between tidal or fluvial source of risk, however the VPI Site is not considered to be at risk from flooding from fluvial main rivers. The risk of flooding from tidal sources (the Humber Estuary) relates to the risk of a breach in the flood defences along the Estuary, but the probability of this occurring is low as the flood defences are managed by the Environment Agency.

5.36 The Phillips 66 Site lies mainly within Flood Zone 1 (with the exception of the small area that overlaps with the VPI Site, which is in Flood Zone 3) and is not considered to be at risk of flooding from any main rivers.

5.37 The nearest main river is the Stallingborough North Beck Drain located approximately 5.5 km south-east of the Sites, which also has flood defenses.

5.38 There are two Water Framework Directive (WFD) designated surface water bodies local to the Sites – one estuarine waterbody (Humber Lower waterbody) and one river (North Beck Drain).

5.39 Drainage strategies have been prepared for each of the Proposed Developments. Surface water and process effluent from the Proposed Phillips 66 Development will be routed via the existing Humber Refinery Effluent Treatment Plant to the South Killingholme Drain, and foul drainage will be discharged via an Anglian Water sewer. Surface water from the Proposed VPI Development will be collected and attenuated within the VPI Site before discharge to the South Killingholme Drain, with shut-off valves for areas where there is a risk of contamination (e.g. loading and unloading areas) so that contaminated water can be tankered off site for disposal if necessary.

5.40 Water consumption for each of the Proposed Developments has been minimised by the use of air cooling rather than water cooling wherever possible. The additional water demand (approximately 10% increase above the existing Humber Refinery and CHP Plant water demand) will be obtained via existing Anglian Water supply connections.

Likely Impacts and Effects

5.41 Construction activities can result in disturbance of soils and changes to groundwater and surface water runoff. There is also a risk that leaks and spillages of hazardous substances could pollute nearby surface water features. However, through the use of a CEMP and embedded mitigation, including water quality monitoring, no significant adverse effects are predicted for the water environment during construction. The effect on all waterbodies is considered **not significant**.

5.42 Currently, the VPI Site is considered to be at a 'high' risk of flooding from tidal sources, and the Phillips 66 Site is considered to be at a 'low' risk. Based on a modelled future scenario for the year 2115 (using data provided by the Environment Agency) the overtopping of flood defences was assessed. The modelling confirmed that the VPI Site would be located within an 'Extreme' hazard area, and the Proposed Phillips 66 Site would be located within an area of 'Moderate' to 'Extreme' hazard area, both with a maximum water depth of 1.6 m. Whilst this would present a significant hazard, the likelihood of overtopping occurring is low.

5.43 A range of mitigation measures (including Flood Emergency Response Plans and allocation of a place of safe refuge in the event of a flood) are proposed to mitigate the residual flood risk so that people at the Proposed Developments are safe and to make the Proposed Developments resilient to flooding where possible.

5.44 Part of the South Killingholme Drain (within the VPI Site) will be permanently diverted as a result of the Proposed VPI Development. The localised and temporary impacts on the morphology (shape) of the drain has been assessed in terms of the watercourses the drain feeds into.

5.45 Potential impacts of the Proposed Developments on the Water Framework Directive status of water bodies have also been considered and assessed.

5.46 Drainage systems will be installed for each of the Proposed Developments as described above. Additional surface water runoff from the Proposed Developments will be managed and attenuated within the Sites (with attenuation sized to allow for increases in stormwater volumes due to climate change) before being discharged at an agreed rate to South Killingholme Drain to avoid any increase in flood risk on or off site. Potentially contaminated runoff and process effluent will be collected and either treated on site prior to discharge (under a Permit), taken off site for treatment or discharged to sewer as appropriate.

5.47 The Proposed Phillips 66 Development will cause an increase in the concentration of sulphate (a mineral salt) entering South Killingholme Drain which cannot be completely mitigated. This will arise is due to the removal of sulphur dioxides from the FCC flue gas as part of the flue gas pre-treatment in the wet gas scrubber. A desulphurisation additive will be used to remove 50% of the sulphate from the effluent, and this will avoid a potentially significant adverse effect on the water environment including Rosper Road Pools (a local wildlife site that also supports birds associated with the Humber Estuary).

5.48 A detailed drainage strategy will be defined and prepared for each of the Proposed Developments in consultation with the Environment Agency, the Lead Local Flood Authorities (North Lincolnshire Council) and other bodies such as the local Internal Drainage Board, in accordance with planning conditions.

5.49 With these measures in place, the effects on surface water drainage and flood risk as a result of the Proposed Developments are anticipated to be **not significant.**

5.50 There is potential for impacts to the water environment to occur during decommissioning. It is assumed that all underground infrastructures will remain in-situ; however, all connection and access points will be sealed or grouted to ensure disconnection.

5.51 On this basis, decommissioning effects are expected to be limited to watercourses in close proximity to the Sites and will be the same as construction effects. Therefore, the impact avoidance measures for decommissioning would be similar to those identified above for the construction phase. The Proposed Developments would be subject to decommissioning under the conditions of the Environmental Permit including conditions relating to chemical/ polluting material handling, storage and use and emergency procedures in line with BAT. A detailed Decommissioning Environmental Management Plan would be prepared for each of the Proposed Developments to identify required measures to prevent pollution during this phase of the Proposed Developments, based on the detailed decommissioning plan.

Geology, Hydrogeology and Contaminated Land

5.52 An assessment has been undertaken which considers the potential effects of the construction, operation (including maintenance) and decommissioning of the Proposed Developments on geology, groundwater and land contamination and this is presented in Chapter 10: Geology, Hydrogeology and Land Contamination (ES Volume I).

5.53 A desk-based assessment of historical ground conditions information supplemented by a walkover has been used to identify the potential effects associated with ground conditions using a source-pathway-receptor risk based approach.

Likely Impacts and Effects

5.54 The construction phase may introduce new sources of contamination due to leaks and spillages and could disturb and mobilise existing contamination within soils. Historical and current areas of potential contamination have been identified.

5.55 Potential impacts during the construction phase include:

- direct human contact with contamination and inhalation of dust and/or soil derived vapours by on-site or off-site human health receptors;
- direct contact of development infrastructure with contaminated soils;
- impacts associated on human health and development infrastructure associated with migration of ground gas; and
- lateral and vertical migration of contamination through leachate, groundwater or surface run-off (including as a result of piling) to bedrock aquifers and superficial aquifers, and the North Beck Drain catchment.

5.56 Best practice measures will be adopted to minimise pollution risks including the adoption of working methods to manage contamination risk to soils, groundwater, surface water, implementation of appropriate pollution incident control plans and procedures and the safe storage of fuel, oils and equipment.

5.57 Impacts will be managed by appropriate construction mitigation measures (in accordance with the CEMP) and as such adverse effects are not anticipated and have been assessed as **not significant**. Additionally, a Materials Management Plan (MMP) will be prepared at the construction stage for each of the Proposed Developments to set out the procedures and measures that will be taken to classify, track, store, dispose of and possibly re-use all excavated materials that are expected to be encountered during the construction of the Proposed Developments.

5.58 Ground investigations considering ground conditions and quality have been (for the VPI Site) or will be (for the Phillips 66 Site) undertaken to confirm baseline conditions. Following analysis of the ground investigation results, implementation of the measures outlined within the CEMP, completion of piling risk assessments, and use of appropriate construction materials, all effects are considered to be **not significant**.

5.59 The VPI Site has not been previously developed so the 'loss' of this area from potential agricultural use has been assessed. The effect of the Proposed VPI Development is considered to be **significant adverse** assuming as a worst case that the land may be classified as Agricultural Land Classification Grade 3a ('best and most versatile' agricultural land). To mitigate this loss, measures will be set out within a Soil Management Strategy, which will include a Soil Resource Plan and a Soil Handling Strategy, which will confirm the different soil types and the most appropriate re-use for the different types of soils, handling methods and how soils should be handled, stored and replaced. The Proposed Phillips 66 Development will have **no significant effects** on agricultural land.

5.60 Potential impacts to soil quality and groundwater could potentially occur during operation as a result of accidental spills from the handling or leakage of fuels, lubricants, stored chemicals

and process liquids. Potential impacts are considered unlikely as the Proposed Developments will be operated in accordance with relevant regulations and legislation. With appropriate management, housekeeping and preventative maintenance practices (such as appropriate storage of potentially contaminating chemicals), as required by the Environmental Permits that will be needed for the operational Sites, any potential impacts to soil and groundwater will be minimised. As such, effects have been assessed as **not significant**.

5.61 Potential impacts due to direct contact or inhalation of dust, soil vapours or contamination during operation of the Proposed Developments will be mitigated through the adoption of safe working practises, and use of appropriate materials such as concrete to prevent direct contamination effects. Any effect is therefore considered to be **not significant**.

5.62 The effects at decommissioning are assessed to be similar that of the construction effects, and are therefore considered to be not significant provided appropriate mitigation plans and pollution prevention guidance is followed.

Landscape and Visual Amenity

5.63 An assessment has been undertaken which considers the potential effects of the construction, operation (including maintenance) and decommissioning of the Proposed Developments on landscape character and visual amenity and is presented in Chapter 11: Landscape and Visual Amenity (ES Volume I).

5.64 Baseline data has been gathered through desk study, review of aerial photography, consultation and site visits, including photography from key viewpoints.

5.65 Visibility within the study area is generally widespread, with the low-lying agricultural land allowing for long distance views which contain large, tall structures. Tree and shrub cover within the study area is generally sparse and the topography is low lying and flat. Immingham lies south-east of the Sites, and there are further residential areas to the north-west and west. The transport infrastructure comprises road and rail (passenger and freight). There are also a number of Public Rights of Way within the study area, however, these are limited.

5.66 The study area for landscape and visual effects includes areas where it is considered that there is potential for significant direct or indirect effects on landscape character or sensitive views due to the construction or operation of the Proposed Developments.

5.67 The area in which the Proposed Developments are likely to be visible has been defined using a computer model which shows the 'Zone of Theoretical Visibility' considering the largest possible dimensions for the Proposed Developments and tallest tower and stack heights up to 110 m above ground for the Proposed VPI Development, and up to 70 m above ground for the Proposed Phillips 66 Development. Representative viewpoints for the visual impact assessment were identified using the Zone of Theoretical Visibility and agreed with North Lincolnshire Council.

5.68 The study area for the landscape impact assessment includes a number of areas designated locally for their landscape character and/ or perceived qualities/ tranquillity, whilst being heavily influenced by industrial developments, as well as open farmland and wooded areas. At a national level the study area includes National Character Area (NCA) 41: Humber Estuary and NCA 42: Lincolnshire Coast and Marshes, which are influenced by the character of the river and the coastline, respectively. The Sites and their immediate surroundings are heavily influenced by power related industrial structures, and are both sited within or adjacent to the large industrial complexes of the VPI Immingham CHP Plant, Lindsey Oil Refinery, Phillips 66 Humber Refinery and Killingholme Power Stations.

Likely Impacts and Effects

5.69 The potential landscape impacts of the Proposed Developments primarily relate to the visibility of the proposed structures (temporary during construction and permanent during operation), and how this affects the overall landscape character of the area. As the Proposed Developments are located within an area characterised by large-scale industrial development, their presence fits with the context of the area and therefore it is assessed that there is a low

or very low impact on landscape character during construction (and decommissioning) and operation of the Proposed Developments. Effects on landscape character are therefore assessed as **not significant**.

5.70 The visual effects relating to future decommissioning of the Proposed Developments (anticipated after 2052) are considered to be similar to those of construction and as such were not discussed further within the assessment.

5.71 A total of eight representative viewpoints were chosen to illustrate the typical range of views of the Proposed Developments from within the 5 km study area as experienced from settlements, publicly accessible roads, and Public Rights of Way. To help interpret the visual effects of the Proposed Developments photographs were taken from each viewpoint, and photomontages (visual representations of the Proposed Developments using the maximum proposed heights of key elements) have been prepared for a selection of these viewpoints Examples are shown at **Figures NTS 5.2 and NTS 5.3**. All the photomontages can be found in ES Volume III as Figures 11.6 – 11.13.

Figure NTS 5.2: Viewpoint 3 (PRoW NKIL 100, Marsh Lane, Killingholme, looking south-west) (copied from Figure 11.21 ES Volume III)

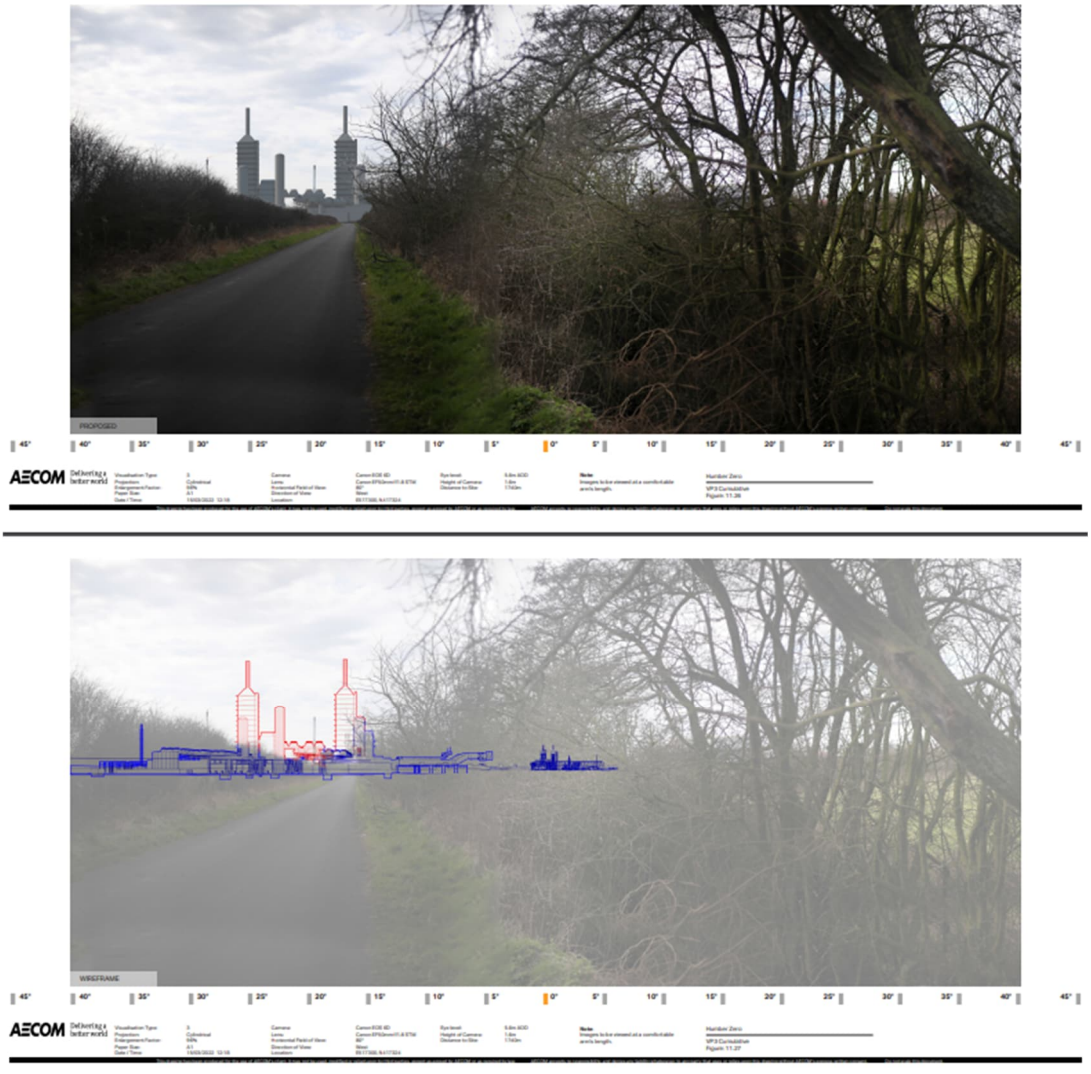


Figure NTS 5.3: Viewpoint 7 (PRoW NKIL 83 Church Lane, North Killingholme, looking east) (copied from Figure 11.28 ES Volume III)

5.72 The majority of the assessed viewpoints will experience no change to their view during construction and operation due to the existing screening from the localised intervening landform and existing structures within and surrounding the Sites. For the majority of the remaining viewpoints that do experience a visual impact, the visual effects are classified as **not significant** but one viewpoint, Viewpoint 3 (a residential property and Public Right of Way on Marsh Lane to the east of the VPI Site) will experience a **significant adverse** visual effect during construction and operation, due to its close proximity to and visibility of the Proposed VPI Development.

5.73 Impacts on transient views from the surrounding main transport routes and long-distance walking trails within the study area have also been considered but effects are considered to be **not significant** due to intervening structures, screening vegetation, elevations and direction of travel.

5.74 Opportunities for mitigation of effects on visual amenity are limited due to the size and scale of the Proposed Developments and construction plant, and it is considered that mitigation planting would not be effective at reducing visual effects.

5.75 Using the air quality modelling results, the visibility of the plumes produced from the absorber stacks at each of the Proposed Developments, and the wet gas scrubber at the Proposed Phillips 66 Development has been predicted. From the Proposed VPI Development the plumes are predicted to be visible 85% of the time, with average plumes being up to 123 m long. From the Proposed Phillips 66 Development the plumes are predicted to be visible up to 22% of the time, with the average plume length being up to 12 m, and up to 241 m on occasion. Whilst there will be a visual impact as a result of the visible plumes, these will be

visible within the context of multiple other stacks/ plumes in an already industrial landscape, and considered to be **not significant**.

Cultural Heritage

5.76 This assessment addresses the potential effects of the Proposed Developments on cultural heritage assets. It identifies the location, type and significance of cultural heritage assets and their setting, and reports on the predicted impacts of the Proposed Developments on these resources. The assessment considers the likely significance of effects upon cultural heritage assets by reference to their significance (importance) and the magnitude of any impacts and is presented in Chapter 12: Cultural Heritage (ES Volume I).

5.77 A detailed desk-based assessment is presented in Appendix 12A: Cultural Heritage Desk Based Assessment (ES Volume II) and the results of field investigation undertaken comprising a ground investigation watching brief and geophysical survey at the VPI Site are presented in Appendix 12B and Appendix 12C (ES Volume II). A trial trenching survey and paleoenvironmental assessment is ongoing at the VPI Site at the time of writing.

5.78 A summary of cultural heritage assets is included in Section 3 of this NTS.

Likely Impacts and Effects

5.79 The construction assessment considers the setting impacts on above ground scheduled monuments and built heritage, as the buildings and structures of the Proposed Developments are installed and constructed. It also considers potential effects on below-ground archaeology.

5.80 Construction of the Proposed Developments has the potential to affect heritage assets in the following ways:

- alteration of the setting of the assets due to visual intrusion (of the works/ elements of the works) and potential increased noise as heard from the asset;
- physical impacts on known or unknown below ground heritage assets arising from construction activities such as earthworks excavation, the formation of construction compounds and the installation of drainage and/ or service infrastructure;
- physical impacts on landscapes of historical, cultural or archaeological significance as a consequence of construction, such as the loss of important elements of the landscape as a result of site clearance; and
- the disturbance, compaction or removal of previously unrecorded sub-surface archaeological deposits through construction activities.

5.81 During operation impacts could include:

- alteration of the setting of an asset particularly its visual setting via the intrusion of from large or tall elements of the Proposed Developments (such as stacks and other tall buildings or structures) which may be visible from nearby heritage assets – as well as long term increases in noise as heard from the asset.

5.82 During decommissioning, a well-developed Decommissioning Environmental Management Plan would ensure that there is no impact beyond the already-disturbed footprint of the Proposed Development; therefore, it is not anticipated that decommissioning activities would have a direct physical impact upon archaeological remains beyond those reported in Chapter 12 (ES Volume I) relating to the construction of the Proposed Developments.

5.83 Additionally, whist there is the potential for temporary setting impacts during the removal of the infrastructure associated with the Proposed Developments, it is not anticipated that this will cause additional impacts to any assets setting, over and above those reported in this chapter relating to the construction and long-term presence of the Proposed Developments. On completion of decommissioning the setting of the cultural heritage assets will be restored to the baseline conditions.

5.84 Since no physical remains of designated assets (Listed Buildings, Registered Parks and Gardens and Scheduled Monuments) lie within the boundaries of the Sites, and as the Sites do not sit within the setting of any nearby designated assets, there will be no impacts and **no significant effects** upon any designated assets.

5.85 There are, however, a number of non-designated heritage assets that may be present within proximity to the Sites and within their boundaries. The majority of identified assets will experience no significant effects during the construction phase, but the following potentially **significant adverse** effects have been identified:

- loss of ancient foreshore and associated ancient tributaries (paleochannels) (if present) within the VPI Site and/or Phillips 66 Site (although there is low potential for this asset to be present within the Phillips 66 Site due to historic land uses);
- loss of Bronze Age to Roman Settlement assets (if present), which may be in association with an Iron Age to Roman Settlement asset (if present), located at the VPI Site; and
- loss of a rectilinear crop mark (if present) within the Phillips 66 Site (although there is low potential for this asset to be present within the Phillips 66 Site due to historic land uses).

5.86 Mitigation for effects on archaeological heritage assets will comprise:

- for the Proposed Phillips 66 Development where there is low potential for undesignated archaeological assets to remain below ground, a geotechnical survey will be monitored by a geoarchaeologist to determine whether any features survive, and this will be used to determine the need for, and design of, any further archaeological works; and
- for the VPI Site, the findings of the trial trenching survey and paleoenvironmental assessment (currently ongoing) together with the findings of the previous surveys will be used to determine the need for, and design of, any further archaeological works.

5.87 With the application of this mitigation, there will be **no significant** effects at the construction stage.

5.88 During operation, no significant effects to designated or non-designated heritage assets have been identified, including effects on setting of the closest listed buildings, due to distance and limited visibility of the Proposed Developments.

5.89 **No significant** effects on historical landscape character have been identified for the Proposed Developments during both the construction and operational phases.

Ecology and Nature Conservation

5.90 An assessment has been undertaken of the potential effects of the construction, operation (including maintenance) and decommissioning of the Proposed Developments on ecology and nature conservation in Chapter 13: Ecology and Nature Conservation (ES Volume I).

5.91 The baseline information has been determined through a combination of desk studies and field surveys, which are detailed in Appendix 13A (ES Volume II) and include habitat survey, bird surveys and protected species surveys.

5.92 There are seven ecological sites with nature conservation designations within 5 km of the Sites. Two are covered by statutory designations, whilst the remaining five are local non-statutory designated sites. The closest site is Rosper Road Pools, a Local Wildlife Site designated for its open water habitats, located approximately 130 m east of the VPI Site and 500 m east of the Phillips Site.

5.93 Reports to inform Habitats Regulations Assessments (to be undertaken by North Lincolnshire Council) have been prepared to consider any likely significant effects on the Humber Estuary Special Protection Area (SPA) and Special Area for Conservation (SAC).

5.94 Further site surveys will be undertaken in advance of decommissioning works to determine the status of protected species and to evaluate the habitats present that may be impacted. Relevant avoidance and mitigation measures would be specified and implemented with reference to the findings of the above surveys. For this reason, the decommissioning phase is not considered further within the assessment in Chapter 13 (ES Volume I).

Likely Impacts and Effects

Designated Sites

5.95 As a result of the construction and operation of the Proposed Developments it is predicted that there will be **no significant** effects on statutory or non-statutory designated sites within the study area due to the distance and lack of impact pathways between the designated sites and the Proposed Developments. It is considered that any discernible noise or visual disturbance to wintering birds using nearby habitats would be not significant, and no significant effects on water quality or flow rates to the nearby Rosper Road Pools Local Wildlife Site have been identified.

Habitats

5.96 The loss of vegetation within the Phillips 66 Site during construction, including a small section of hedge along Eastfield Road affected by the proposed new site access, is considered to be **not significant**.

5.97 The construction of the Proposed VPI Development will result in the loss of approximately 4 hectares of Open Mosaic Habitat and approximately 8 hectares of grassland which are considered to represent **significant adverse** effects. To mitigate the loss of habitat, new habitats will be created off-site.

5.98 Impacts on the South Killingholme Drain due to its realignment within the VPI Site as part of the Proposed VPI Development have been assessed. The Drain does not support protected species and has relatively low ecological value. The effects are considered to be **not significant**.

5.99 Changes in air quality as a result of operational emissions and potential changes in surface water quality (including increased sulphate concentration due to the Proposed Phillips 66 Development, which will be mitigated using a desulphurisation additive) during operation of the Proposed Developments have been assessed and concluded to be **not significant**.

Species

5.100 Impacts on species due to the loss of habitats within the VPI Site have been assessed. The effect on small heath butterfly within the grassland areas is considered to be a **significant adverse effect** but effects on other invertebrates and nesting birds are considered to be **not significant**. The effect on the small heath butterfly colony is proposed to be mitigated through off-site habitat creation and the translocation of pupa/ eggs if possible.

5.101 The potential for noise and visual disturbance to affect wintering birds associated with the Humber Estuary that may be using habitats to the east of the Sites has been assessed using outputs from the noise modelling assessment. These effects are considered to be **not significant**.

Biodiversity Net Gain

5.102 Both Proposed Developments are committed to achieve a 10% biodiversity net gain, as measured using a numerical metric developed by the Department for Environment, Food and Rural Affairs. This means the Proposed Developments will provide an overall increase in biodiversity value compared to the current baseline within the Sites.

5.103 As there are insufficient opportunities to meet these commitments on land within the Sites; 'off-site' solutions will be required, to be delivered independently for each Site. Biodiversity Net Gain reports are submitted with each of the planning applications.

5.104 As a result of the proposed mitigation and enhancements to achieve a 10% biodiversity net gain, the long term effects from the Proposed Phillips 66 Development will be **not significant**, and the Proposed VPI Development will provide a **significant beneficial** effect.

Climate Change

5.105 The assessment presented in Chapter 14: Climate Change (ES Volume I) addresses the potential effects of the Proposed Developments on climate change and considers the potential impact of future climate change on the Proposed Developments. The assessment addresses three separate aspects:

- lifecycle greenhouse gas (GHG) impact assessment;
- in-combination climate change impact assessment; and
- climate change resilience assessment.

Likely Impacts and Effects

5.106 The receptor for the GHG assessment is the global climate. The UK's carbon budgets are used as a proxy to assess the impacts to this receptor.

5.107 The Proposed Developments are decarbonisation projects designed to capture 95% of the CO_2 that would otherwise be emitted from two of the gas turbines and two auxiliary gas boilers at the VPI Immingham CHP Plant and the FCC stack at Phillips 66 Limited Humber Refinery. The GHG emissions associated with the construction and operation of the Proposed Developments without accounting for the GHG emissions abated are considered to be **not significant** and the Proposed Developments are in line with the UK Government's stated net zero trajectory. Taking account of the GHG emissions directly abated, the Proposed Developments can be assessed as having a GHG impact that is **beneficial** and **significant**, compared to a future baseline with the existing CHP plant and FCC operating without carbon capture.

5.108 No in-combination climate change impacts (impacts of climate change combined with impacts from the Proposed Development) were identified.

5.109 The potential impacts and effects of future climate change to the Proposed Developments have been assessed taking into account resilience measures that will be built into the design. These include use of drainage systems to mitigate flood risk, dust control management measures, design measures to allow the plant to continue to operate in more extreme temperatures and maintenance inspections. The embedded design measures are sufficient to reduce the likelihood or consequence of an impact occurring as a result of projected climate hazards. As such, no significant resilience risks have been identified and effects are therefore assessed as **not significant**.

Materials and Waste

5.110 The assessment presented in Chapter 15: Materials and Waste (ES Volume I) reports the assessment of the likely significant effects on materials and waste as a result of the Proposed Developments. The materials assessment focusses on the consumption of key construction materials, and the waste assessment considers the generation and management of waste on each Site.

5.111 The study area for non-hazardous waste covered the East Midlands and Yorkshire and the Humber wider region, which includes Lincolnshire, Derbyshire, Leicestershire, Northamptonshire and Nottinghamshire; and former Humberside, North Yorkshire, South Yorkshire, West Yorkshire as sub-regions, whilst the study area for hazardous waste covered England as a whole. For key construction materials the study area covered the United Kingdom.

Likely Impacts and Effects

5.112 Individually, for each of the Proposed Developments, the total percentage by weight of each construction material is no greater than 1% compared to the baseline consumption in the UK, so consumption of materials is considered to be **not significant**.

5.113 Construction waste volumes are based on estimates at this stage. For each of the Proposed developments it is assumed that the non-hazardous construction waste, including demolition and excavated waste, will be sent to landfill. As the amount of waste produced will require less than 1% of the available landfill capacity the effect is considered to be **not significant**.

5.114 Quantities of hazardous construction waste are anticipated to be small compared to the overall construction waste arising, and will require less than 0.1% of the hazardous waste landfill capacity, so the effect is considered to be **not significant**.

5.115 During operation, hazardous waste will be produced due to the nature of the operational processes at each of the Proposed Developments, however, the assessments identified that the volumes of hazardous waste likely to be generated will result in **no significant** effect on capacity of available hazardous waste landfill. The hazardous waste may be managed by high-temperature incineration or by physical-chemical treatment, or sent to landfill as a worst case.

5.116 Decommissioning waste volumes are considered to be similar to those generated during construction.

Major Accidents and Disasters

5.117 Chapter 16: Major Accidents and Disasters (ES Volume I) presents the assessment of the potential for major accidents and disasters to arise during the construction and operation of the Proposed Developments. The assessment considers the vulnerability of the Proposed Developments to existing hazards and assesses the potential for the Proposed Developments to cause significant environmental effects as a result of a major accident.

5.118 Major accidents are incidents such as fires and explosions that could result in serious harm to people. They also have the potential to cause widespread damage to property and the environment. Disasters can be naturally occurring events, such as earthquakes, landslides and flooding.

Likely Impacts and Effects

5.119 The Proposed Developments will be located at the Humber Refinery and VPI Immingham CHP Plant which are already regulated under the Control of Major Accident Hazards (COMAH) regime regulated by the Health and Safety Executive.

5.120 A number of hypothetical scenarios were identified for the Proposed Developments which could have significant consequences to people and the environment, but with a very low probability of occurrence.

5.121 The engineering design, construction and operation of the Proposed Developments will incorporate appropriate standards and mitigation measures necessary to reduce the risks of major accidents and disasters to an acceptable level, i.e., as low as is reasonably practicable (ALARP), which is the standard expected by the regulatory authorities (Health and Safety Executive and Environment Agency). As such, residual effects on sensitive receptors are not considered likely and effects are therefore assessed as **not significant**.

5.122 MA&D effects arising during the decommissioning phase of the Proposed Developments are considered comparable to those that would be experienced during the construction period. At that stage, a Decommissioning Environmental Management Plan would be submitted to the relevant planning authority and/ or HSE, depending on COMAH licence status, for approval. Appropriate best practice mitigation measures will be applied during any decommissioning works and documented in a Decommissioning Environmental Management Plan.

Socio-Economics and Human Health

5.123 An assessment has been undertaken of the potential socio-economic and health impacts of the Proposed Developments which considers the potential effects of construction, operation and decommissioning of the Proposed Developments. The assessment is presented in Chapter 17: Socio-economics (ES Volume I).

5.124 Economic benefits can arise directly (through employment of local people) and indirectly (e.g., during the construction phase, when contractors may be using local accommodation and other amenities). Adverse effects can also occur, for example, in relation to the wider implications of any demand on local services or worker accommodation. The assessment has taken into account the demographics of the area surrounding the Sites when considering the impacts which are likely to occur.

5.125 The assessment also considers the potential health impacts during each phase of the Proposed Developments, using information from other relevant assessments undertaken for the EIA including the air quality and noise assessments reported above.

Likely Impacts and Effects

5.126 The peak number of construction staff required during the construction of the Proposed Developments has been estimated to be approximately 1,633 jobs, with 843 at the VPI Site and 790 at the Phillips 66 Site. There will be an average of 349 construction jobs created at the VPI Site over the Proposed VPI Development construction period, and an average of 296 construction jobs created at the Phillips 66 Site over the Proposed Phillips 66 Development construction period. The net construction employment created by the construction phase of the Proposed Developments is considered to have a **significant beneficial** short-term effect in the local area through the creation of jobs directly and indirectly, and across a wide range of sectors and skills and benefits for the local economy. Although these jobs are temporary, they would provide a positive economic impact over the construction phase. Similar significant beneficial effects would also be seen during the decommissioning phase of both developments.

5.127 During the operational phase of the Proposed Developments, employment would be generated in operation, management and maintenance roles. Operation of the Proposed VPI Development is anticipated to create up to 50 full time equivalent jobs, and operation of the Proposed Phillips 66 Development is anticipated to create up to 15 full time equivalent jobs. Temporary and contractor employees associated with maintenance activities would also be employed as required. These operational effects are beneficial but **not significant**.

5.128 In terms of human health and wellbeing, the Proposed Developments incorporate embedded mitigation measures to avoid any significant human health effects which include:

- operational emissions to air will comply with the required standards and will not have any significant effect on human health;
- construction and operational noise impacts on nearby residential receptors will be managed using best practicable means (BPM) and design measures to avoid significant effects; and
- measures will be taken to prevent pollution of soils and water and to avoid risks to human health associated with potentially contaminated soil and dust during construction, operation and decommissioning.

5.129 These measures will help to ensure that impacts on the health and wellbeing of the local population, as well as construction workers and operational staff, are **not significant**.

Cumulative and Combined Effects

5.130 The purpose of Chapter 18: Cumulative and Combined Effects (ES Volume I) is to provide an assessment of the potential for cumulative effects to occur as a result of the Proposed Developments being built and operated at the same time as other committed developments

(e.g. disturbance effects on a residential property during the construction of several developments at the same time), and to consider the potential for combined effects to occur on receptors due to different types of effects from the Proposed Developments (e.g. the combined effects of dust, noise and visual intrusion on a residential property during construction of the Proposed Developments).

5.131 A number of other proposed developments that are also likely to be constructed and operated in future, and that have the potential to generate cumulative environmental effects together with the Proposed Developments have been identified. The other developments scoped into the cumulative impact assessment (in order of distance from the Sites, starting with the closest) are:

- Viking CCS Pipeline – a proposed CO_2 transportation pipeline which may export the captured CO_2 from the Proposed Developments, located partly within and to the south of the Sites and which is likely to be constructed at the same time as the Proposed Developments;
- Humber Low Carbon Pipelines, proposed CO_2 and hydrogen transportation pipelines which may export the captured CO_2 from the Proposed Developments, located approximately 2 km to the north of the Sites, which is likely to be constructed at the same time as the Proposed Developments;
- Gigastack – a proposed green hydrogen production facility immediately to the east of the VPI Site which is likely to be constructed at the same time as the Proposed Developments;
- Able Marine Energy Park Monopole Manufacturing Facility – located approximately 0.5 km from the Sites, which may be constructed at the same time as the Proposed Developments;
- VPI Immingham Open Cycle Gas Turbine – a proposed 299 megawatt gas-fired power station located to the north of the VPI Site, which may be constructed at the same time as the Proposed Developments;
- Land Adjacent to Westgate Entrance at the Port of Immingham – a proposed port-related development location 0.7 km to the south-east of the Site, which may be constructed at the same time as the Proposed Developments;
- Able Marine Energy Park Enabling Works – enabling works related to the proposed Able Marine Energy Park development, located to the east of the VPI Site;
- Able Marine Energy Park, a proposed new quay for marine energy installation components located to the north-east of the Sites;
- North Killingholme Power Project, a proposed 470 megawatt gas-fired power station located 3.1 km to the north of the Sites;
- Immingham Eastern Ro-Ro Terminal, a proposed new roll-on roll-off terminal in the south of the Port of Immingham. 3.6 km to the south of the Sites, which may be constructed at the same time as the Proposed Developments; and
- Immingham Green Energy Terminal, a proposed new green energy terminal to the south of the Port of Immingham, 4.5 km to the south of the Sites, which may be constructed at the same time as the Proposed Developments.

5.132 The potential for cumulative effects with these other developments has been considered for all of the environmental topics by a review of the available information (including published environmental information where available).

5.133 The assessment has concluded that based on currently available information, significant cumulative effects are unlikely for the majority of environmental topics. The only significant cumulative effects identified by the assessment are:

- **significant adverse** cumulative effects on archaeological assets that may be present within the Sites and the areas affected by the Viking CCS Pipeline and Land Adjacent to Westgate, Port of Immingham projects, which will be mitigated by each project

through a programme of archaeological evaluation agreed with North Lincolnshire Council;

- **significant beneficial** cumulative effects on employment associated with the construction of the Proposed Developments and the construction of the other 11 projects listed above.

5.134 **No significant** combined effects were identified during either construction or operation of the Proposed Developments.

6. Summary and Conclusions

6.1 The ES presents the findings of the EIA process that has been undertaken for the Proposed Developments and includes an assessment of the potential environmental impacts and effects of the Proposed Developments during construction, commissioning, operation (including maintenance) and decommissioning phases.

6.2 Section 5 of this NTS and Chapters 6 to 17 (ES Volume I) have considered the potential environmental impacts and effects of the Proposed Developments, including the identification of potential adverse and beneficial environmental effects that are considered significant both before and after mitigation and enhancement measures are taken into account.

6.3 A range of environmental impact avoidance, design and mitigation measures have been identified to mitigate and control environmental effects during construction, operation and decommissioning phases of the Proposed Development. These will be secured through appropriate planning conditions for the Proposed Developments, via other legislative requirements and through the Environmental Permits that will be required for operation.

6.4 The likely significant residual effects from the Proposed Phillips 66 Development include:

- capture of GHG emissions during operation resulting in a significant beneficial effect;
- employment generated by the Proposed Phillips 66 Development resulting in significant beneficial effects during the construction and decommissioning phases; and
- cumulative employment generated by the Proposed Phillips 66 Development and other proposed developments in the vicinity of the Phillips 66 Site resulting in significant beneficial effects during the construction phase.

6.5 The likely significant residual effects from the Proposed VPI Development include:

- loss of agricultural soils (less than 20 hectares of Grade 3 land) during construction resulting in a significant adverse effect;
- visual impacts for residential and Public Right of Way receptors at Viewpoint 3 (Marsh Lane) resulting in significant adverse effects during construction, operation and decommissioning;
- creation of habitat to achieve biodiversity net gain resulting in a significant beneficial effect for Open Mosaic Habitat, grassland/ scrub habitat and small heath butterfly;
- the capture of GHG emissions during operation resulting in a significant beneficial effect;
- employment generated by the Proposed VPI Development resulting in significant beneficial effects during the construction and decommissioning phases;
- cumulative effects on archaeological assets with the Viking CCS Pipeline and Land Adjacent to Westgate, Port of Immingham developments; and
- cumulative employment generated by the Proposed VPI Development and other proposed developments in the vicinity of the VPI Site resulting in significant beneficial effects during the construction phase.

7. References

Natural England (2012) National Character Area Profile: 41 Humber Estuary (NE344). Available at: http://publications.naturalengland.org.uk/publication/2285747

North Lincolnshire Council (1999) North Lincolnshire Landscape Character Assessment. Available at: https://m.northlincs.gov.uk/public/localplan/evidence/NLC%20Landscape%20Character%20Assessment%20v2%20(4).pdf