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6. Air Quality

6.1 Introduction

- 6.1.1 This chapter of the Environmental Statement (ES) considers the potential effects of the Proposed Phillips 66 Development and the Proposed VPI Development separately and cumulatively ('the Proposed Developments') on air quality.
- 6.1.2 Impacts during the construction, operation and decommissioning phases of the Proposed Developments are assessed. In particular, the chapter considers potential impacts on identified human health and ecological receptors in terms of:
- dust generation during construction;
 - emissions from road traffic and Non-Road Mobile Machinery (NRMM) during construction;
 - process emissions from the operational phase of the Proposed Developments; and
 - the potential effects of the eventual decommissioning of the Proposed Developments.
- 6.1.3 This chapter is supported by the following appendices and figures, found in Volume II and Volume III of this ES, respectively:
- Appendix 6A: Air Quality – Construction Phase;
 - Appendix 6B: Air Quality – Operational Phase;
 - Appendix 6C: Air Quality – Assessment of Amine Degradation Products; and,
 - Figures 6.1 to 6.17.

6.2 Legislation and Planning Policy Context

Legislative Background

- 6.2.1 The United Kingdom (UK) is no longer a member of the European Union (EU). Most EU legislation as it applied to the UK on 31st December 2020 is now a part of UK domestic legislation, under the control of the UK's Parliaments and Assemblies as a form of domestic legislation known as 'retained EU legislation'. This is set out in Sections 2 and 3 of the European Union (Withdrawal) Act 2018. Section 4 of the European Union (Withdrawal) Act 2018 ensures that most remaining EU rights and obligations, including directly effective rights within EU treaties, continue to be recognised and available in domestic law after exit.

Air Quality Legislation

- 6.2.2 The principal air quality legislation within the UK is the Air Quality Standards Regulations 2010 ('the AQS Regulations'), which transpose the requirements of the European Ambient Air Quality Directive 2008 (European Commission, 2008) and the 2004 fourth Air Quality Daughter Directive (European Commission, 2004). The AQS Regulations set air quality limits for a number of major air pollutants that have the potential to impact public health, such as nitrogen dioxide (NO₂), sulphur dioxide (SO₂), carbon monoxide (CO), and particulate matter (PM₁₀, which is particulate matter of 10 micrometres (µm) diameter or less). The AQS Regulations also include an exposure reduction objective for PM_{2.5} in urban areas and a national target value for PM_{2.5} (PM_{2.5} is particulate matter of 2.5µm diameter or less).
- 6.2.3 The Environment Act 2021 ('the Environment Act') requires the UK Government to produce a National Air Quality Strategy (NAQS), set out in 2007 and subsequent amendments in 2011 (Department for Environment, Food and Rural Affairs (Defra), 2011), containing air quality

objectives and timescales to meet those objectives. These objectives apply to outdoor locations where people are regularly present and do not apply to occupational, indoor or in-vehicle exposure. The human health objectives that are applicable to this assessment are set out in Table 6.1.

Table 6.1: National Air Quality Strategy (NAQS) objectives – protection of human health

Pollutant	Source	Concentration ($\mu\text{g}/\text{m}^3$)	Measured as
Nitrogen dioxide (NO_2)	EU air quality limit value	40	Annual mean
		200	1-hour mean, not to be exceeded more than 18 times a year
Sulphur dioxide (SO_2)	UK Air Quality Strategy Objective	266	15-minute mean, not to be exceeded more than 35 times a year
	EU Air Quality Limit Values	350	1-hour mean, not to be exceeded more than 24 hours a year
	EU Air Quality Limit Values	125	24-hour mean, not to be exceeded more than 3 times a year
Particulate matter (PM_{10})	EU air quality limit value	40	Annual mean
		50	24-hour mean, not to be exceeded more than 35 times a year
Particulate matter ($\text{PM}_{2.5}$)	EU air quality target value	25	Annual mean
Carbon monoxide (CO)	EU air quality limit value	10,000	Maximum daily running 8-hour mean

6.2.4 The Environment Act requires local authorities to undertake an assessment of local air quality to establish whether the objectives are being achieved, and to designate Air Quality Management Areas (AQMA) if improvements are necessary to meet the objectives. Where an AQMA has been designated, the local authority must draw up an Air Quality Action Plan (AQAP) describing the measures that will be put in place to assist in achieving the objectives. Defra has responsibility for coordinating assessments and AQAP for the UK as a whole.

6.2.5 No AQMAs have been declared for the Proposed Development Sites ('the Sites') or surrounding nearby areas. The nearest AQMA to the study area (defined in Section 6.3), is approximately 12.6 km to the east of the Sites in Grimsby and is designated for the exceedance of the annual mean NO_2 concentration. Based on Defra forecast models and local authority monitoring data, no exceedances of the EU standards have been identified in the vicinity of the Proposed Development Sites.

6.2.6 The impact of emissions from the Proposed Developments on sensitive ecological receptors are quantified within this assessment in two ways:

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

- 6.2.7 The critical levels for the protection of vegetation and ecosystems are defined as “concentrations of pollutants in the atmosphere above which direct adverse effects on...plants [and] ecosystems...may occur according to present knowledge,” and critical loads are defined as “a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge” (Centre for Ecology and Hydrology (CEH) and Air Pollution Information System (APIS) website (2022).
- 6.2.8 The critical levels applied in this assessment are set out in Table 6.2 and apply regardless of the habitat type present at the habitat receptor. In the cases of sulphur dioxide and ammonia (NH₃), the greater sensitivity of lichens and bryophytes to this pollutant is reflected in the application of two critical levels, with a stricter critical level to be applied to locations where such species are present.

Table 6.2: Critical Levels (CL) – protection of vegetation and ecosystems

Pollutant	Source	Concentration (µg/m ³)	Measured as
Oxides of nitrogen (NO _x)	EU air quality limit value	30	Annual mean
	UK target value	75	Daily mean
Sulphur dioxide (SO ₂)	Environment Agency Environmental Permit Guidance	20	Annual mean, for sensitive lichen communities & bryophytes and ecosystems where lichens and bryophytes are an important part of the ecosystem’s integrity
	Environment Agency Environmental Permit Guidance	10	Annual mean, For all higher plants (all other ecosystems)
Ammonia (NH ₃)	UK target value for lichen and bryophytes	1	Annual mean
	UK target value	3	Annual mean

- 6.2.9 Critical load criteria for the deposition of nutrient nitrogen and acidifying species are dependent on the habitat type and species present and are specific to the sensitive receptors considered within the assessment. The critical loads are detailed on the APIS website (CEH and APIS, 2022).

Industrial Emissions Directive

- 6.2.10 The EU’s Industrial Emissions Directive (IED) (European Commission, 2010) provides operational limits and controls to which regulated plant must comply, including Emission Limit Values (ELV) for pollutant releases into the air.
- 6.2.11 The operator of a plant covered by the IED is required to employ Best Available Techniques (BAT) for the prevention or minimisation of emissions to the environment, to ensure a high level of protection of the environment as a whole. European BAT reference documents (‘BRefs’) are published for each industrial sector under the IED, and they include BAT-Associated Emission Levels (BAT-AEL) which are expected to be met through the application of BAT. These levels may be the same as those published in the IED, or they may be more stringent.
- 6.2.12 As an emerging technology, there are currently no finalised EU BRef or BAT-AELs for Post-combustion Carbon Capture plant (PCC). The Environment Agency has prepared BAT

guidance for Post-Combustion Carbon Dioxide Capture using Amine-Based Technologies (Environment Agency, 2021), however this also does not propose any BAT-AEL at this stage, as it is intended that these will be developed once PCC becomes operational in the UK, and collated monitoring data can confirm suitable levels for which the BAT-AEL should be set. It should be noted that the EA guidance does not have the same legal status as BRefs published under the IED.

- 6.2.13 The emission limits assessed for the Proposed Developments are discussed in Appendix 6B: Air Quality - Operational Phase (ES Volume II).

Environmental Permitting Regulations

- 6.2.14 The Environmental Permitting (England and Wales) Regulations 2016 ('EP Regulations') (as amended) apply to regulated installations and transpose the requirements of the IED into UK legislation. Large Combustion Plant (i.e. the existing VPI Immingham Combined Heat and Power (CHP) Plant), Refineries (i.e. the existing Phillips 66 Ltd Humber Refinery) and Carbon Capture and Storage are all listed activities under the EP Regulations, and therefore they require an Environmental Permit to operate, issued by the Environment Agency. Performance against the relevant ELVs or BAT-AELs, as defined in the IED and associated BRefs, would be regulated through the Environmental Permit.
- 6.2.15 Where legislative ambient air quality limits or objectives are not specified for the pollutant species potentially released from the Proposed Developments, Environmental Assessment Levels (EAL), published in the Environment Agency's Risk Assessments for Specific Activities: Environmental Permits guidance, referred to as the 'Environment Agency's Risk Assessment guidance' (Defra and Environment Agency, 2016) can be used to assess potential health effects on the general population. This includes an EAL for hourly concentrations of CO and annual average and hourly EALs for NH₃, which can result from the operational Proposed Developments.
- 6.2.16 As well as the combustion emissions from the operational Proposed Developments, emissions of amines and their breakdown products could occur directly from the PCC plants, and potentially their breakdown (oxidation) products could further occur in the atmosphere following release. Such pollutant species are generally not included in the latest version of the Environment Agency's Risk Assessment guidance; however, the Environment Agency has recently derived an EAL for one amine species, Mono-ethanolamine (MEA). The amine species within the Shell CANSOLV solvent has not been confirmed, however in the absence of other suitable EALs, this EAL has been used for the purpose of assessment of amine emissions from the Proposed Developments. The Environment Agency is looking to derive EALs for a number of other amine species which are considered likely to be used within amine-based carbon capture solvents, with a target date for publication of an EAL consultation document detailing further EALs of April 2023. Should more suitable EALs for the Shell CANSOLV solvent be made available, the assessment of amines from the Proposed Developments will be reviewed through the Environmental Permit variation application process for the two Proposed Developments.
- 6.2.17 It is also known that some amines can potentially degrade (chemically react with oxygen) and form nitrosamines and nitramines (collectively referred to as N-amines) both during the carbon capture process itself and also in the environment, following release to the atmosphere. Therefore, the impacts of both directly released N-amines and the N-amines produced through atmospheric degradation of released amines have also been considered in the assessment provided in Appendix 6C: Air Quality – Assessment of Amine Degradation Products (ES Volume II).
- 6.2.18 The Environment Agency has recently adopted an EAL for N-nitrosodimethylamine (NDMA), of 0.2 nanograms (ng)/m³. It is understood that NDMA has been used for the EAL because this is considered to be one of the most toxic nitrosamines, and therefore results in a conservative EAL. In addition, it is understood that the Environment Agency propose to compare the total N-amine concentration from plant emissions with the NDMA EAL, although

it should be recognised that some of the degradation products will be less harmful, and therefore this is a very conservative assumption.

- 6.2.19 Other degradation products, such as amides may also result from the proposed PCC plants, and therefore these have also been included in the assessment. The EALs applicable for this assessment for the protection of human health are presented in Table 6.3.

Table 6.3: Environmental Assessment Levels (EAL) – Human Health

Pollutant	Concentration Measured as ($\mu\text{g}/\text{m}^3$)	Source of EAL
CO	30,000	Hourly mean
Ammonia (NH_3)	180	Annual mean
	2,500	Hourly mean
Total Amines	400	Hourly mean
	100	Daily mean
Nitrosamines	0.2ng/m ³	Annual mean
Amide	18	Hourly mean
	0.6	Annual mean

EA Risk Assessment Guidance.

¹ EAL for Acrylamide used, as the lowest EAL of any amide listed in the Environment Agency Risk Assessment Guidance, therefore ensuring a conservative assessment.

- 6.2.20 Throughout the remainder of this chapter and the associated technical appendices, NAQS objectives, critical levels and EALs are collectively referred to as Air Quality Assessment Levels (AQAL).

Sensitive Ecosystems

- 6.2.21 The UK is bound by the terms of Council Directive 92/43/EEC, on the conservation of natural habitats and of wild fauna and flora ('Habitats Directive'), Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds ('Wild Birds Directive') and the Convention on Wetlands of International Importance especially as Wildfowl Habitats ('Ramsar sites') (United Nations, 1994). The Conservation of Habitats and Species Regulations 2017 as amended ('the 2017 Regulations') provide for the protection of European Sites created under these, i.e. Special Areas of Conservation (SAC) designated pursuant to the Habitats Directive and Special Protection Areas (SPA) and provisional SPA (pSPA) classified under the Wild Birds Directive. Specific provisions of the European Directives are also applied to SAC, and candidate SAC (cSAC), which requires these sites to be given special consideration, and for further assessment to be undertaken for any development which is likely to lead to a significant effect upon them. Special consideration within this quality chapter has also been given to SPA, pSPA and Ramsar sites.

National Planning Policy

- 6.2.22 The revised National Planning Policy Framework (NPPF) (Ministry of Housing, Communities & Local Government (MHCLG) 2019a) concisely sets out national policies and principles on land use planning. Air quality is considered as an important element of the natural environment. On conserving and enhancing the natural environment, Paragraph 174 of the NPPF states that:

“(e) The planning system should contribute to and enhance the natural and local environment by: ...preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability...”

6.2.23 Air quality in the UK has been managed through the Local Air Quality Management (LAQM) regime using NAQS objectives. The effect of a proposed development on the achievement of such policies and plans are matters that may be a material consideration by planning authorities, when making decisions for individual planning applications. Paragraph 186 of the NPPF states that:

“Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan.”

6.2.24 The different roles of a planning authority and a pollution control authority are addressed by the NPPF in paragraph 188:

“The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a particular development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities.”

6.2.25 The Planning Practice Guidance (PPG) was updated on 24 June 2021 (MHCLG, 2019b), with specific reference to air quality. The PPG states that the planning system should consider the potential effect of new developments on air quality where relevant limits have been exceeded or are near the limit. Concerns also arise where the development is likely to adversely affect the implementation of air quality strategies and action plans and/ or, in particular, lead to a breach of EU legislation (including that applicable to wildlife). In addition, dust can also be a planning concern, for example, because of the effect on local amenity.

6.2.26 When deciding whether air quality is relevant to an application, the PPG states that a number of factors should be taken into consideration including if the development will:

- significantly affect traffic in the immediate vicinity of the proposed development site or further afield. This could be by generating or increasing traffic congestion; significantly changing traffic volumes, vehicle speed or both; or, significantly altering the traffic composition on local roads. Other matters to consider include whether the proposal involves the development of a bus station, coach or lorry park; adds to turnover in a large car park; or result in construction sites that would generate large Heavy Goods Vehicle flows over a period of a year or more;
- introduce new point sources of air pollution. This could include furnaces which require prior notification to local authorities; or extraction systems (including chimneys) which require approval under pollution control legislation or biomass boilers or biomass-fuelled Combined Heat and Power (CHP) plant; centralised boilers or CHP plant burning other fuels within or close to an air quality management area or introduce relevant combustion within a Smoke Control Area;
- expose people to existing sources of air pollutants. This could be by building new homes, workplaces or other development in places with poor air quality;
- give rise to potentially unacceptable impact (such as dust) during construction for nearby sensitive locations; and
- affect biodiversity. In particular, is it likely to result in deposition or concentration of pollutants that significantly affect a European-designated wildlife site and is not directly

connected with or necessary to the management of the site, or does it otherwise affect biodiversity, particularly designated wildlife sites.

6.2.27 Regarding how detailed an air quality assessment needs to be, the PPG states:

“Assessments need to be proportionate to the nature and scale of development proposed and the potential impacts (taking into account existing air quality conditions), and because of this are likely to be locationally specific.”

Local Policy

6.2.28 North Lincolnshire Council (NLC) adopted the North Lincolnshire Local Development Framework – Core Strategy in 2011 (NLC, 2011) (‘the Core Strategy’). While there are no policies that are specifically targeted at air quality and pollution, pollution is considered in several other policies, namely:

- Spatial Objective 10: Creating A Quality Environment; and
- CS5: Delivering Quality Design in North Lincolnshire.

6.2.29 Pollution is also considered as part of the section covering transport and the environment.

6.2.30 Spatial Objective 7: Efficient Use and Management of Resources states:

“To ensure the efficient use of resources, maximising recycling of minerals and waste products, minimising pollution, maintaining and improving air, soil and water quality, and employing sustainable building practices in new development.”

6.2.31 Policy CS18: Sustainable Resource Use and Climate Change, states that:

“The Council will actively promote development that utilises natural resources as efficiently and sustainably as possible. This will include...

(10) Ensuring development and land use helps to protect people and the environment from unsafe, unhealthy and polluted environments, by protecting and improving the quality of the air, land and water.”

(11) Supporting renewable sources of energy in appropriate locations, where possible, and ensuring that development maximises the use of combined heat and power, particularly at the South Humber Bank employment site and where energy demands for more than 2MW are required for development.

(12) Supporting new technology and development for carbon capture and the best available clean and efficient energy technology, particularly in relation to the heavy industrial users in North Lincolnshire, to help reduce CO₂ emissions.

6.2.32 The Core Strategy retained a number of policies from the NLC Local Plan 2003 (NLC, 2003), including Policy DS1 – General Requirements, which states:

“A high standard of design is expected in all developments in both built-up areas and the countryside and proposals for poorly designed development will be refused. All proposals will be considered against the criteria set out below:

...

Amenity

iii) No unacceptable loss of amenity to neighbouring land uses should result in terms of noise, smell, fumes, dust or other nuisance, or through the effects of overlooking or overshadowing; and

...

v) no pollution of water, air or land should result which poses a danger or creates detrimental environmental conditions.”

6.2.33 Policy DS11 – Polluting Activities states:

“Planning permission for development, including extensions to existing premises and changes of use, will only be permitted where it can be demonstrated that the levels of potentially polluting emissions, including effluent, leachates, smoke, fumes, gases, dust, steam, smell or noise do not pose a danger by way of toxic release; result in land contamination; pose a threat to current and future surface or underground water resources; or create adverse environmental conditions likely to affect nearby developments and adjacent areas.”

Other Guidance

6.2.34 Defra has published technical guidance LAQM TG (16) (Defra, 2021) to assist local authorities in fulfilling their duties in relation to Local Air Quality Management. Parts of this guidance, and associated tools, are also useful in assessing the impacts of individual developments within the planning process.

6.2.35 The Highways England (HE) publication the Design Manual for Roads and Bridges (DMRB) (HE, 2021) has been used to screen potential traffic air quality impacts to determine those impacts that may require more detailed assessment, and in the assessment of traffic air quality effects and the evaluation of significance.

6.2.36 The Institute of Air Quality Management (IAQM) in collaboration with Environmental Protection UK (EPUK) has published several guidance documents relating to the potential effects of dust generation during construction works and development control including:

- Guidance on the assessment of dust from demolition and construction v1.1, (IAQM, 2014 - updated 2016);
- Guidance on the assessment of mineral dust impacts for planning version 1.1 (IAQM 2016); and
- Land-Use Planning & Development Control: Planning for Air Quality. v1.2 (IAQM and EPUK, 2017).

6.3 Assessment Methodology and Significance Criteria

Impact Assessment and Significance Criteria

6.3.1 The potential emissions to air from construction and operation of the Proposed Developments has been determined or estimated, and key local receptors have been identified, together with the current local ambient air quality. Emissions associated with decommissioning are assumed to be consistent with those for construction, as detailed in Section 6.5.

6.3.2 The potential pollutant concentrations resulting from the projected emissions arising from the construction and operational phases of the Proposed Developments have been predicted using atmospheric dispersion modelling techniques, where appropriate, which enabled the assessment of the impacts associated with the Proposed Developments on the existing local ambient air quality and in particular on the identified sensitive receptors. The assessment methodology for each type of emission is outlined below, with further detail being provided in the accompanying technical appendices (Appendix 6A: Air Quality - Construction Phase, Appendix 6B: Air Quality - Operational Phase and Appendix 6C: Air Quality – Assessment of Amine Degradation Products, ES Volume II).

Construction Phase – Construction Dust Assessment

- 6.3.3 The movement and handling of soils and spoil during construction activities for the Proposed Developments is anticipated to lead to the generation of some short-term airborne dust. The occurrence and significance of dust generated by earth moving operations is difficult to estimate and depends heavily upon the nature of the activity being carried out and the meteorological and ground conditions at the actual time and location of the work.
- 6.3.4 At present, there are no statutory UK or EU standards relating to the assessment or control of dust. The emphasis of the regulation and control of construction dust, therefore, is through the adoption of Best Practicable Means (BPM) when working on site to mitigate any potential impacts. It is intended that significant adverse environmental effects are avoided at the design stage and through embedded mitigation where possible, including the use of good working practices to minimise dust formation which is detailed further in the Mitigation and Enhancement Measures section of this chapter.
- 6.3.5 The IAQM provides guidance for good practice and for qualitative assessment of risk of dust emissions from construction and demolition activities (IAQM, 2014). The guidance considers the risk of dust emissions from unmitigated activities to cause human health impacts (associated with PM₁₀), dust soiling impacts, and ecological impacts (such as physical smothering, and chemical impacts for example from deposition of alkaline materials). The appraisal of risk is based on the scale and nature of activities and on the sensitivity of receptors, and the outcome of the appraisal is used to determine the level of good practice mitigation required for adequate control of dust.
- 6.3.6 The assessment undertaken for the Proposed Developments is consistent with the overarching approach to the assessment of the impacts of construction, and the application of example descriptors of impact and risk set out in IAQM guidance. It considers the significance of potential impacts with no mitigation and recommends mitigation measures appropriate to the identified risks to receptors. The steps in the assessment are to:
- identify receptors within the appropriate study area for the Sites;
 - identify the magnitude of impact through consideration of the scale, duration and location of activities being carried out (including demolition, earthworks, construction and trackout, where construction vehicles could carry mud onto the public highway);
 - establish the sensitivity of the area through determination of the sensitivity of receptors and their distance from construction activities;
 - determine the risk of significant impacts on receptors occurring as a result of the magnitude of impact and the sensitivity of the area, assuming no additional mitigation (beyond the identified development design and impact avoidance measures) is applied;
 - determine the level of mitigation required based on the level of risk, to reduce potential impacts at receptors to insignificant or negligible; and
 - summarise the potential residual effects of the mitigated works.
- 6.3.7 The criteria for assessment of magnitude, sensitivity, and risk for construction dust are summarised in Tables 6A.1 – 6A.6 Appendix 6A: Air Quality - Construction Phase (ES Volume II).

Construction and Operational Phase – Traffic Assessment

- 6.3.8 The incomplete combustion of fuel in vehicle engines results in the presence of combustion products of CO, PM₁₀, and PM_{2.5} in exhaust emissions as well as hydrocarbons (HC) such as benzene and 1,3-butadiene. Similarly, but to a lesser extent, any sulphur in the fuel can be converted to SO₂ that is then released to atmosphere. In addition, at the high temperatures and pressures found within vehicle engines, some of the nitrogen in the air and the fuel is oxidised to form oxides of nitrogen, mainly in the form of nitric oxide (NO), which is then converted to NO₂ in the atmosphere. NO₂ is associated with adverse effects on human health.

Better emission control technology and fuel specifications are reducing emissions per vehicle across the UK vehicle fleet over the long term.

- 6.3.9 Although SO₂, CO, benzene, and 1,3-butadiene are present in motor vehicle exhaust emissions, detailed consideration of the associated impacts on local air quality is not considered relevant in the context of this Proposed Developments. This is because the released concentrations of these pollutants are low enough so as to not be likely to give rise to significant effects. In addition, no areas within the administrative boundaries of NLC are considered to be at risk of exceeding the relevant objectives for these pollutants, therefore the risks to the attainment of the relevant air quality objectives in the vicinity of the Proposed Developments are considered negligible. Emissions of SO₂, CO, benzene, and 1, 3-butadiene from road traffic are therefore not considered further within this assessment.
- 6.3.10 The exhaust emissions from road vehicles that do have the potential to affect the ambient concentrations of pollutants are NO₂, PM₁₀ and PM_{2.5}. Therefore, the assessment of the significance of road traffic air quality impacts only considers these pollutants.
- 6.3.11 DMRB LA105 guidance (HE, 2019) sets out criteria to establish the need for an air quality assessment from road traffic. The guidance considers the following changes in traffic anticipated as a result of a proposed development, to identify the need for further evaluation:
- Annual Average Daily Traffic (AADT) flows of more than 1,000 vehicles;
 - 200 Heavy Duty Vehicles (HDV, all vehicles greater than 3.5 tonnes gross weight, including buses);
 - a change in the speed band; or
 - a change in carriageway alignment by >5 m.
- 6.3.12 Guidance published by the IAQM/ EPUK (IAQM/ EPUK, 2017) proposes a lower threshold in AADT flow to warrant a detailed air quality assessment of a change of 500 Light Duty Vehicles (LDV, all vehicles less than 3.5 tonnes gross weight) or 100 HDV when outside of an AQMA. For changes in traffic below these criteria, significant changes in air quality are not expected.
- 6.3.13 As the guidance published by the IAQM proposes a lower threshold in AADT flow to warrant a detailed air quality assessment to be carried out, this results in a more conservative assessment of the air quality impacts of construction traffic, and therefore this has been applied to this assessment.
- 6.3.14 During the construction phase of the Proposed Developments, it is predicted that the peak HGV movements for the Proposed Phillips 66 Development will be a maximum of 230 HDVs AADT and 1,654 LDVs AADT. For the Proposed VPI Development, there will be a peak of 211 HDVs AADT and 1,314 LDV AADTs. Consequently, a detailed assessment of construction traffic has been undertaken and is presented in detail in Appendix 6A: Air Quality - Construction Phase (ES Volume II). In the assessment, it is assumed that this is the construction flows would be at this peak level for an entire year, however in practice this is unlikely. The assessment therefore provides a suitably conservative assessment approach.
- 6.3.15 Chapter 8: Traffic and Transport sets out that during the operational of the Proposed Development that there would be no more than an additional 10 HDVs and 100 LDVs on the local road network (Para. 8.3.15). Movements of this magnitude are significantly below the IAQM screening criteria, and therefore it is considered that operational traffic would not give rise to significant effects.

Operational Phase – Process Emissions from the Operational Plant

- 6.3.16 Emissions from the Proposed Developments, assumed to be operational at the earliest in 2027¹, has been assessed using the Environment Agency's Risk Assessment methodology

¹ Timescales for commercial operation are linked to the development of a CO₂ gathering network (or networks) into which the Proposed Developments will connect.

(Defra and Environment Agency, 2016), in order to identify where proposed emissions can be screened out as being unlikely to cause significant effects. Detailed dispersion modelling using the atmospheric dispersion model ADMS (currently ADMS 5.2.2) has been used to calculate the concentrations of pollutants at identified receptors. These concentrations have been compared with the defined AQAL for each pollutant species, as summarised in Table 6.1 to Table 6.3.

- 6.3.17 Dispersion modelling calculates the predicted concentrations arising from the emissions to atmosphere, based on Gaussian approximation techniques. The model employed has been developed for UK regulatory use. Appendix 6B: Air Quality – Operational Assessment (ES Volume II) details the model inputs for the assessment, with further details on the amine assessment presented in Appendix 6C: Air Quality - Assessment of Amine Degradation Products (ES Volume II).
- 6.3.18 The assessment has considered the Baseline Assessment of the existing emissions from the VPI Immingham CHP Plant and the existing emissions from the Philips 66 Humber Refinery FCC operating both in isolation, and in-combination. The Future Assessment has then been assessed for the Proposed VPI Development and the Proposed Philips 66 Development in isolation and then again in-combination (both Proposed Developments) with the PCC plants on both sites being operational.
- 6.3.19 It has been assumed that the Proposed Developments operate continuously, as this is considered to represent the worst-case scenario in terms of the annual average operational emissions, as detailed in Appendix 6B: Air Quality - Operational Phase (ES Volume II).
- 6.3.20 The assessment of worst-case long-term (annual mean) and short-term (daily and hourly mean) emissions resulting from the operation of the Proposed Developments has been undertaken by comparing the maximum process contributions ('PC') that occurs at any identified human health receptor, in order to ensure a worst-case assessment in terms of human health impacts) with the annual and hourly mean AQAL, taking into consideration the baseline air quality, in accordance with Environment Agency's Risk Assessment methodology (Defra and Environment Agency, 2017).
- 6.3.21 An assessment of nutrient nitrogen enrichment has been undertaken by applying published deposition velocities to the predicted annual average NO₂ and NH₃ concentrations at the identified ecological sites, determined through dispersion modelling, to calculate nitrogen deposition rates (expressed as kilograms per hectare per year, Kg/ha/yr). These deposition rates have then been compared to the Critical Loads for nitrogen published by UK APIS (CEH and APIS, 2022), taking into consideration the baseline air quality.
- 6.3.22 Potential increases in acidity on designated ecological receptors from depositional contributions of NO₂, SO₂ and NH₃ from the Proposed Developments have also been considered. Acid deposition is derived from nitrogen and sulphur deposition modelling values using standard conversion factors and expressed as kilograms of nitrogen or sulphur equivalent per hectare per year (K_{eq}/ha/yr). The PC acid deposition rates and baseline deposition rates have been used within the APIS Critical Load Function Tool (CEH and APIS, 2022) to determine whether the contribution will result in exceedance of the defined acidity Critical Loads for the most sensitive feature.
- 6.3.23 Several non-statutory habitat sites have also been assessed for both nutrient nitrogen and acid deposition, due to the proximity of these sites to the Proposed Developments. These include Local Wildlife Sites (LWS) and Sites of Importance for Nature Conservation (SINC). For these sites, there is little data available with regards to habitat types present and therefore the relevant Critical Loads Classes to be applied, and therefore PC have been considered against an assumed appropriate Critical Load determined for the appropriate habitat type, as informed by Chapter 13: Ecology and Nature Conservation (ES Volume I).
- 6.3.24 An assessment of cumulative impacts with other committed developments that could interact with the operational impacts and effects of the Proposed Developments has been carried out and is presented in Appendix 6B: Air Quality – Operational Assessment (ES Volume II) and

summarised in Chapter 18: Cumulative and Combined Effects (ES Volume I). The impact of cumulative operational emissions on nutrient nitrogen deposition on habitats is considered in Chapter 13: Ecology and Nature Conservation and the Reports to Inform Habitat Regulations Assessment which accompany the Proposed Developments' planning applications.

Evaluation of Significance – Construction Phase Dust Assessment

- 6.3.25 For potential amenity effects, such as those related to dust deposition, the aim is to bring forward a scheme, to include mitigation measures as necessary that minimise the potential for amenity, human health, and ecological impacts as a result of the Proposed Developments' construction works.
- 6.3.26 The IAQM guidance (IAQM, 2014) does not provide a method for the evaluation of impacts on receptors from construction dust, rather a means to determine the level of mitigation required to avoid significant impacts on receptors. The guidance indicates that application of appropriate mitigation should ensure that residual effects will normally be 'not significant'. Such control measures are proposed to be included in the Construction Environmental Management Plan (CEMP) (see Outline CEMP at Appendix 4A (ES Volume II)).

Evaluation of Significance – Traffic and Operational Emissions Assessment

- 6.3.27 The evaluation of the significance of air quality effects from the traffic and operational point sources has been based on the criteria referenced in IAQM/ EPUK guidance (IAQM/ EPUK, 2017), and in the Environment Agency's EPR Risk Assessment guidance (Defra and Environment Agency, 2016). The predicted changes in pollutant concentrations are compared to AQAL to determine the magnitude of change.
- 6.3.28 For a change of a given magnitude, the 'Land-Use Planning & Development Control: Planning for Air Quality (IAQM/ EPUK, 2017) provides recommendations for describing the magnitude of long-term impacts at individual receptors and describing the significance (Table 6.4) of such impacts. This terminology has been changed where appropriate in order to maintain consistency with the rest of this ES – where the IAQM uses 'substantial' this has been changed to 'major', and 'slight' has been changed to 'minor'.

Table 6.4: Air quality impact descriptors for long term changes in ambient pollutant concentrations

Long term averaging concentration at receptor	Percentage Change in Annual Mean Concentrations				
	Up To 0.5% Imperceptible	0.5 – 1% Very Low	2-5% Low	6-10% Medium	>10% High
75% or less of AQAL	Negligible	Negligible	Negligible	Minor	Moderate
76-94% of AQAL	Negligible	Negligible	Minor	Moderate	Moderate
95-102% of AQAL	Negligible	Minor	Moderate	Moderate	Major
103-109% of AQAL	Negligible	Moderate	Moderate	Major	Major
110% or more of AQAL	Negligible	Moderate	Major	Major	Major

AQAL = Air Quality Assessment Level (NAQS objective or EAL)

- 6.3.29 The guidance (IAQM/ EPUK, 2017) is not explicit in the identification of whether any of the above impact descriptors should be considered to result in a 'significant' or 'not significant' effects, rather it indicates that the descriptors should be applied to individual receptors and a 'moderate' adverse impact at one receptor may not mean that the overall impact has a significant effect; other factors need to be considered. However, it indicates further that 'negligible' impacts are likely to lead to effects that are 'not significant' and 'major' impacts

describe the potential for 'significant' effects. The judgment of significance of effects adopted within this assessment is discussed below.

- 6.3.30 The Environment Agency's EPR risk assessment screening criteria for comparison of PC with AQAL states that an emission may be considered insignificant (or negligible) where:
- short term PC $\leq 10\%$ of the AQAL; and
 - long term PC $\leq 1\%$ of the AQAL.
- 6.3.31 Where an emission cannot be screened out as insignificant, the second stage of screening considers the PC in the context of the existing background pollutant concentrations; the predicted environmental concentration (PEC) is considered acceptable where:
- short term PC $< 20\%$ of the short-term AQAL minus twice the long-term background concentration; and
 - long term PEC (PC + background concentration) $< 70\%$ of the AQAL.
- 6.3.32 For local nature sites, such as LWS, the Environment Agency's guidance states that where the short or long-term PC is less than 100% of the respective standard, then there are unlikely to be significant effects due to changes in air quality. There is no need to assess the PEC.
- 6.3.33 Where the PEC is not predicted to exceed the AQAL and the proposed emissions comply with the BAT-AEL (or equivalent requirements) the emissions are typically considered acceptable by the Environment Agency.
- 6.3.34 The IAQM guidance indicates that the Environment Agency's threshold criterion of 10% of the short term AQAL is sufficiently small in magnitude to be regarded as having an 'insignificant' effect. The IAQM guidance deviates from the Environment Agency's Risk Assessment guidance (discussed below) with respect to the background contribution; the IAQM guidance indicates that severity of peak short-term concentrations can be described without the need to reference background concentrations as the PC is used to measure impact, not the overall concentration at a receptor. The peak short-term PC from an elevated source is described as follows:
- PC $\leq 10\%$ of the AQAL represents an 'insignificant' (negligible) impact;
 - PC 11-20% of the AQAL is small in magnitude representing a minor impact;
 - PC 21-50% of the AQAL is medium in magnitude representing a moderate impact; and
 - PC $> 51\%$ of the AQAL is large in magnitude representing a 'substantial' (major) impact.
- 6.3.35 The impact of point source emissions on ecological receptors, through deposition of nutrient nitrogen or acidity, has been evaluated using the Environment Agency and Natural England insignificance criterion of 1% of the long-term objective, as above.
- 6.3.36 Where emissions are not screened as insignificant (negligible), the descriptive terms for the air quality effect outlined in Table 6.4 above have been applied.

Evaluation of Significance – Proposed Developments In-Combination

- 6.3.37 Following the assessment of each individual air quality effect (construction dust, traffic and operational plant), the significance of all of the reported effects is then considered for the Proposed Developments in overall terms, recognising that construction dust and construction traffic will occur in the same time period, but that operational effects would occur at a later date. The potential for the Proposed Developments to contribute to, or interfere with, the successful implementation of policies and strategies for the management of local air quality are considered if relevant, but the principal focus is any change to the likelihood of future achievement of the NAQS (which also relate to compliance with local authority goals for LAQM and objectives set for the protection of human health).

- 6.3.38 In terms of the significance of the effects (consequences) of any adverse impacts, an effect is reported as being either 'not significant' or as being 'significant'. If the overall effect of the development on local air quality or on amenity is found to be 'moderate' or 'major' this is deemed to be 'significant' for EIA purposes. Effects found to be 'minor' or 'negligible' are considered to be 'not significant'.

Study Area

- 6.3.39 The study areas for the assessments carried out have been defined according to the appropriate guidance for the type of assessment being carried out (i.e. construction dust and NRMM, and the operational Proposed Developments), and therefore vary for the various assessments.
- 6.3.40 The study area for the construction dust NRMM emissions has been applied in line with IAQM guidance (IAQM, 2014), extending:
- up to 350 m beyond the Site boundaries and 50 m from the construction traffic routes (up to 500 m from the Site entrances), for human health receptors; and
 - up to 50 m from the Site boundaries and construction traffic routes (up to 500 m from the Site entrances) for ecological receptors.
- 6.3.41 The study area for the operational Proposed Developments point source emissions extends up to 15 km from the PCC plant stacks, in order to assess the potential impacts on sensitive ecological receptors, in line with the Environment Agency Risk Assessment Guidance (Defra and Environment Agency, 2016):
- SPA, SAC, Ramsar sites and SSSI within 15 km; and
 - Local Nature Sites (including ancient woodlands, LWS, National and Local Nature Reserves (NNR and LNR) and SINC) within 2 km.
- 6.3.42 In terms of human health receptors, the predicted impacts from the operational Proposed Developments become negligible well within 2 km and therefore sensitive receptors for the human health impacts only are concentrated within a 2 km study area.

Sources of Information/ Data

- 6.3.43 The physical parameters for the modelling of emissions from the Proposed Developments' stacks have been sourced from existing emissions data for the Baseline Assessment and concept design data provided by design studies prepared for the Future Assessment of the Proposed Developments. Future pollutant mass emission rates have been calculated by AECOM, based on engineering and licensor data, the relevant emission limits or BAT-AELs. They are summarised in Appendix 6B: Air Quality - Operational Phase (ES Volume II).
- 6.3.44 The dispersion modelling of point source emissions has taken into consideration the sensitivity of predicted results to model input variables, and to ultimately identify the realistic worst-case results for inclusion in the assessment. These variables include:
- the operational Proposed Developments have been assumed to operate on a continuous basis i.e. for 8,760 hour per year, although in practice the plants would require routine maintenance periods;
 - meteorological data, for which five years' recent data (2017-2021) from a representative meteorological station (Humber Airport) have been used, with the highest result being reported for all years assessed; and
 - inclusion of buildings, structures and local topography that could affect dispersion from the source into the modelling scenarios; and
 - emission concentrations for the process are calculated based on the use of BAT-AEL concentrations, Environmental Permit Emission Limit Values or licensor maximum

envisaged emission concentrations; in practice annual average rates would be below these values to enable continued compliance with Environmental Permit.

Use of the Rochdale Envelope

- 6.3.45 A focused use of the Rochdale Envelope approach has been adopted to present a worst-case assessment of potential environmental effects of the different parameters of the Proposed Developments that cannot yet be fixed. The parameters included within the Rochdale Envelope are described in Chapter 3: Project Description, Need and Alternatives Considered (ES Volume I).
- 6.3.46 For this assessment, emission parameters for the Proposed Developments have been derived taking into account worst-case long-term operating scenarios and flow rates so that the emissions leading to the worst-case predicted impacts have been used in the assessment, in order to ensure that it is conservative.
- 6.3.47 The operational Proposed Developments are assumed to be running 24 hours a day at full load, for 8,760 hours per year, however it is likely that operating loads will vary and annual run times will be lower. Assuming continuous operation throughout the year is considered to lead to worst-case annual average impacts.
- 6.3.48 The building dimensions included within the assessment are the maximum dimensions under consideration. It is envisaged that should the actual buildings be smaller in size, specifically in height, than those used in the assessment, then this would have the potential to reduce the plume downwash effects associated with buildings in close proximity to stack(s), therefore improving emission dispersion. This would lead to a reduction in the level of impact predicted in the assessment.

Limitations

- 6.3.49 It is recognised that during commissioning, start-up and shut down there may be short periods where emissions are higher than those assessed for this ES, however there is currently limited data on the duration and release concentration of these emissions. It is anticipated that this information will not become available until after detailed design and therefore these emissions will be assessed then, as part of the Environment Permit process for both Sites.

Consultation

- 6.3.50 A scoping opinion was received from North Lincolnshire Council on 11 March 2022, which largely accepted the proposed assessment methodology, whilst ensuring that the IAQM/EPUK titled Land-Use Planning & Development Control: Planning for Air Quality methodology was used for the assessment.
- 6.3.51 Additional responses were made by the Environment Agency, which although did not comment on Air Quality, noted that Environmental Permit variations would be required for the two operators. The full scoping opinion is provided in Appendix 1B in ES Volume II.
- 6.3.52 A number of informal discussions have been held with the Environment Agency, to keep them informed of the Proposed Developments, and to discuss Environmental Permitting issues.

6.4 Baseline Conditions

- 6.4.1 In order to assess the potential impacts and effects of the Proposed Developments, it is necessary to determine the environmental conditions that currently exist on the Sites and in the surrounding area, for comparison. These are known as the existing baseline conditions. Baseline conditions are determined using the results of site surveys and investigations or desk-based data searches, or a combination of these, as appropriate.

- 6.4.2 It is also relevant for the EIA to consider future baseline conditions taking account of any planned or likely changes to the existing baseline, for comparison against the future 'With Development' scenarios (Construction, Opening/ Operation and Decommissioning).

Existing Baseline - Sensitive Receptors

- 6.4.3 During the construction phase, based on IAQM guidance (IAQM, 2014), receptors potentially affected by dust soiling and short-term concentrations of PM₁₀ generated during construction activities are limited to those located within 350 m of the nearest construction activity, and/ or within 50 m of a public road used by construction traffic that is within 500 m of the construction site entrance. Ecological receptors are limited to those located within 50 m of the nearest construction activity and/ or within 50 m of a public road used by construction traffic that is within 500 m of the construction site entrance.
- 6.4.4 Receptors potentially affected by operational emissions from the Proposed Developments including local residential and amenity receptors have been identified through site knowledge, desk study of local mapping and consultation. Through the dispersion modelling, isopleth figures of pollutant concentration dispersion have been examined, to identify the receptors that will receive the highest point source contributions so that the assessment of impact can be made at these receptors. Those receptors considered to be representative of impacts in the vicinity of the Proposed Developments have been modelled as discrete receptors.
- 6.4.5 Ecological receptors potentially affected by operational emissions have been identified through desk study of Defra Magic mapping (Defra, 2022a) and consultation (see Chapter 13: Ecology and Nature Conservation). Statutory designated sites including SAC, SPA, Ramsar sites and SSSI up to 15 km from the Sites have been considered. Several non-statutory designated sites including LWS and SINC within 2 km have also been considered. Further details of these sites and reasons for designations are provided in Chapter 13.
- 6.4.6 Identified receptors are detailed in Table 6.5 below and are shown in Figures 6.1: Air Quality – Construction Study Area, Figure 6.2: Air Quality – Operation Study Area Human Health Receptors and Figure 6.3: Air Quality – Operation Study Area Ecological Receptors (ES Volume III). (CD = Construction Dust Receptor (for human health impacts), OR = Operational Receptor (for human health impacts), OE = Operational Ecology Receptor).

Table 6.5: Identified receptors with potential for air quality impacts from the Proposed Developments

ID (refer to Figures 6.1 – 6.3 in ES Volume III)	Receptor Name	Designation	Grid Reference		Distance and direction from the Red Line Boundary for CD receptors, or the closest PCC Plant Stack for Operational Receptors
			X	Y	
CD1	Humber Refinery	Industrial	515717	416572	0 m west
CD2	VPI Immingham	Industrial	516729	416865	0 m east
CD3	Lindsey Oil Refinery	Industrial	515444	417112	100 m north
CD4	Staple Road, South Killingholme	Residential	515115	416417	500 m west
CD5	Town Street, South Killingholme	Residential	515369	415983	760 m west
CD6	Killingholme Primary School	School	514930	416090	865 m west
CD7	Church Lane, North Killingholme	Residential	514763	417331	680 m north-west
CD8	Mill Lane, Immingham	Residential	517187	414976	1.9 km south
CD9	Church Lane, Immingham	Residential	517765	415255	1.9 km south
CD10	Woodlands Avenue, Immingham	Residential	517994	415282	1.8 km south
CD11	Manby Road, Immingham	Commercial	516910	416538	280 m south
CD12	Marsh Lane, South Killingholme	Residential	517330	417311	370 m east
CD13	Baptist Chapel Lane	Residential	515826	415680	1.0 km south
CD14	Faulding Lane	Residential	515694	415620	1.1 km south
CD15	Brick Lane	Residential	514224	418565	1.9 km north-west
CD16	Immingham Road/ Habrough Road	Residential	516334	414357	2.4 km south
CD17	Killingholme Road/Mill Hill Stables	Residential	515288	415020	1.7 km south-west
CD18	East Halton Road	Residential	514202	418538	1.9 km north-west
CD19	Rosper Road Pools	Ecological	517224	416937	80 m east
CD20	Eastfield Road Pit	Ecological	515350	417040	75 m north-east

ID (refer to Figures 6.1 – 6.3 in ES Volume III)	Receptor Name	Designation	Grid Reference		Distance and direction from the Red Line Boundary for CD receptors, or the closest PCC Plant Stack for Operational Receptors
			X	Y	
OR1	Hazel Dene, Marsh Lane	Residential	517330	417311	680 m east
OR2 ¹	Station House, Station Road	Residential	517333	418345	1.5 km north-east
OR3	Fairfield House, North Garth	Residential	514687	418769	2.1 km north-west
OR4	Old Vicarage, North Garth	Residential	514428	418197	1.8 km north-west
OR5	Manor Farm, North Killingholme	Residential	514515	417653	1.3 km north-west
OR6	Church Lane, North Killingholme	Residential	514763	417331	950 m north-west
OR7	Westfield Farm, North Killingholme	Residential	514708	416785	860 m west
OR8	Melrose, South Killingholme	Residential	515115	416417	600 m west
OR9	Town St/ Humber Road, South Killingholme	Residential	515516	416120	650 m south
OR10	South Killingholme Primary School	School	514880	416120	950 m south-west
OR11	East End Farm	Residential	515935	415730	900 m south
OR12	Immingham	Residential	517765	415255	2 km south
OR13	Allerton Primary School, Immingham	School	518016	414882	2.5 km south-east
OE1	Humber Estuary	SAC, SPA, Ramsar, SSSI	518100	418131	1.8 km north-east
OE2	North Killingholme Haven Pits	SSSI	516851	419535	2.6 km north
OE3	Swallow Wold	SSSI	516950	404990	11.7 km south
OE4	Wrawby Moor	SSSI	503350	411120	13.3 km south-west
OE5	Eastfield Road Railway Embankment	LWS	515313	417108	390 m north-west
OE6	Burkinshaws Covert	LWS	516432	417874	910 m north

ID (refer to Figures 6.1 – 6.3 in ES Volume III)	Receptor Name	Designation	Grid Reference		Distance and direction from the Red Line Boundary for CD receptors, or the closest PCC Plant Stack for Operational Receptors
			X	Y	
OE7	Rosper Road Pools	LWS	517224	416937	500 m east
OE8	Chase Hill Wood	LWS	515702	418875	2 km north
OE9	Mayflower Wood Meadow	LWS	516000	415920	950 m south-east
OE10	Homestead Park Pond	LWS/ SINC	517935	415625	1.8 km south-east
OE11	Eastfield Road Pit	SINC	515350	417040	300 m north-west

Note: ¹ OR2 is currently understood to be an unoccupied residence owned by Able Humber Ports Limited, which is proposed to be demolished as part of Able Marine Energy Park enabling works.

- 6.4.7 There are three additional SSSI within 15 km of the Proposed Developments Stacks (Kirmington Pits, Kelsey Hill Gravel Pits and South Ferriby Chalk Pit) which are designated due to their geological features. It is therefore considered that these sites will not be affected by emissions from the Proposed Developments, as the Critical Levels and Critical Loads assigned to such sites are for the protection of vegetation and ecosystems only, and therefore they have been screened from further assessment.
- 6.4.8 In addition, it is understood that the Station Road Fields LWS that was located 500 m east of the Proposed Developments Stacks, has been lost due to the AMEP development, and this is therefore screened out of further assessment.

Baseline Air Quality

- 6.4.9 Existing air quality conditions in the vicinity of the Sites has been evaluated through a review of Local Authority air quality management reports, Defra published data and other sources. The key pollutants of concern resulting from construction and operation of the Proposed Developments and that have potentially elevated background concentrations from other sources are NO_x, NO₂, CO, SO₂, NH₃, PM₁₀ and PM_{2.5}, therefore the assessment of baseline conditions within this chapter considers these pollutants only.
- 6.4.10 Baseline concentrations of the other pollutants such amines, nitrosamines and nitramines are considered in Appendix 6C: Air Quality - Assessment of Amine Degradation Products (ES Volume II).
- 6.4.11 There is a single AQMA designated for 24-hour mean PM₁₀ within the administrative boundary of NLC. However, the AQMA is approximately 22 km west of the Sites and covers an area surrounding the steelworks to the east of Scunthorpe. Given the prevailing wind direction in the vicinity of the Proposed Developments (i.e. from the south-west), it is considered unlikely that the emissions from the Proposed Developments would affect the AQMA.
- 6.4.12 The neighbouring council area to NLC (North East Lincolnshire) has the nearest AQMA to the study area, approximately 12.6 km to the south-east of the Sites in Grimsby and is designated for the exceedance of the annual mean NO₂ concentration. Again, given the distance from the Proposed Developments, and the prevailing wind direction in the area (from the south-west), it is considered unlikely that this would be affected by emissions from the Proposed Developments.
- 6.4.13 NLC undertook automatic monitoring at 12 sites within their administrative area in 2022 and undertook monitoring for NO₂ using diffusion tubes at 22 locations.
- 6.4.14 Of these monitoring sites, two are within close proximity to the Sites. The nearest automatic monitor is located approximately 0.8 km west of the Sites at Killingholme School (CM6 shown in Figure 6.2 ES Volume III), and the other is located approximately 2.6 km south of the Sites at Woodlands Avenue, Immingham. They both monitor NO₂, and the former monitoring location also monitors PM₁₀ and SO₂.
- 6.4.15 As part of this study, AECOM undertook baseline NO₂ monitoring in the vicinity of the site from between the beginning of February and end of or April 2022. The period mean data in Table 6.6 displays the three months of monitoring. Annualisation was performed in line with LAQM.TG22. The Automatic Urban and Rural Network monitoring sites used in the annualisation process were Hull Freetown, Immingham Woodlands Avenue, York Bootham. The diffusion tubes were provided by Staffordshire Highways Laboratory 20% TEA in water, the national bias adjustment factor was 0.84.

Table 6-6: Project specific monitoring

Site ID	Grid Reference		Site Type	Period Mean (µg/m ³)	Annualised Mean (µg/m ³)
	X (m)	Y(m)			
DT1	514250	415754	Roadside	24.63	18.55
DT2	515298	416124	Roadside	28.87	21.74

DT3	514220	417179	Roadside	21.47	16.17
DT4	517082	417092	Roadside	28.55	25.91
DT5	518076	414530	Roadside	25.03	18.85

- 6.4.16 The COVID-19 pandemic and lock-downs as part of the government response during 2020 and 2021 saw a significant decrease in industrial activities and road traffic across the UK, and a decrease in pollutant concentrations as a result. As such, monitoring data obtained during this time is not considered to be representative of normal conditions, and has not been used within this assessment. The last complete year that is considered to be representative is 2019, and this data has been used in this assessment.
- 6.4.17 The annual mean concentration in 2019 for NO₂ at Killingholme School was 15 µg/m³, and the annual mean PM₁₀ concentration was 19 µg/m³. The annual mean SO₂ concentration was 3.4 µg/m³, while the maximum 15 minute and 1 hour means were reported to be 192 and 157 µg/m³ respectively, indicating that there are periods where SO₂ concentrations can be elevated, however there were no exceedances recorded in 2019.
- 6.4.18 In 2019, a PM₁₀ concentration of 31 µg/m³ at the Killingholme East Halton Road continuous monitor was reported, indicating that there is a potential for elevated concentrations of particulate matter in the vicinity of the Sites, although it is not clear as to the source at this location as concentrations in 2018 were reported to be 20 µg/m³.
- 6.4.19 At the AURN monitoring location in Immingham, the annual mean NO₂ concentration in 2019 was measured as 13.5 µg/m³, again with no exceedances.
- 6.4.20 The nearest NO₂ diffusion tubes to the Sites are approximately 0.9 km to the west (shown in Figure 6.2 ES Volume III). Annual mean concentrations of NO₂ at these locations range between 17 – 29 µg/m³, with no location reporting an exceedance.
- 6.4.21 The results of the monitoring indicate that air quality with NLC's administrative area is largely good.
- 6.4.22 The data for the monitoring sites that are considered to be relevant for the study area of the Proposed Developments are detailed in Table 6.7 and Table 6.8 and the locations of all the monitoring sites (automatic and diffusion tubes) used in the assessment are shown in Figure 6.4 (ES Volume III).

Table 6.7: NLC monitored annual mean nitrogen dioxide concentrations

Site ID	Monitoring Location	Site Type	Grid Reference		2019 Annual Mean conc ^a (µg/m ³)
			x	y	
CM6	North Killingholme School	Urban Industrial (Automatic)	514880	416133	15
N/A	Immingham Woodlands Avenue AURN	Urban Background (Automatic)	518277	415116	13.5
DT13	Ulceby Road Killingholme	Roadside (Diffusion Tube)	514573	415901	17
DT14	School Road Killingholme	Roadside (Diffusion Tube)	514782	415971	29
DT15	Humber Road Chip Shop	Urban Background (Diffusion Tube)	515452	416107	18

DT16	Humber Road, LP 695	Roadside (Diffusion Tube)	515279	416085	25
DT22	East Halton Road Killingholme	Roadside (Diffusion Tube)	514141	417483	21

Table 6.8: NLC monitored annual mean PM₁₀ concentrations

Site ID	Monitoring Location	Site Type	Grid reference		2019 Annual mean conc ⁿ (µg/m ³)
			X	Y	
CM6	North Killingholme School	Urban Industrial (Automatic)	514880	416133	19
CM8	East Halton Road Killingholme	Other	514148	417514	31

- 6.4.23 Background data has also been obtained from Defra published maps (Defra, 2022b) for the locations of likely maximum impact from point source emissions from the Proposed Developments, and at identified sensitive receptor locations.
- 6.4.24 Background mapping data for 2018 (based on 2018 background maps) is conservatively assumed to be representative of the opening (2027) baseline; as general trends are showing a reduction in both NO₂ and PM₁₀ concentrations over time, this is considered to be a conservative assumption.
- 6.4.25 Background data from the Defra background maps for the receptors in the vicinity of the Proposed Developments is provided in Table 6.9 and indicates NO₂, SO₂, CO, PM₁₀ and PM_{2.5} concentrations are consistently well below the relevant AQAL. Short term background concentrations are assumed to be twice the annual mean, in line with the Environment Agency’s guidance.
- 6.4.26 For ecological site receptors, background data has been sourced from APIS (APIS, 2022), for the years 2018-2020. These are reported in Table 6.10.

Table 6.9: Defra background maps pollutant concentrations - 2018

Receptors	Grid Reference of Centre Point	Annual Mean Concentration (µg/m ³)				
		NO ₂	SO ₂	CO ^a	PM ₁₀	PM _{2.5}
CD1, C4	515500, 416500	12.6	12.6	272	15.1	9.0
CD2, CD11	516500, 416500	13.0	8.5	273	15.6	9.2
CD3	515500, 417500	12.2	12.1	267	16.5	9.1
CD5, CD13, CD14, CD17	515500, 415500	11.8	7.5	271	16.1	9.0
CD6	514500, 416500	11.4	7.7	272	16.2	9.0
CD7	514500, 417500	11.2	8.8	268	15.1	8.7
CD8	517500, 414500	13.2	7.2	272	14.7	8.9
CD9, CD10	517500, 415500	12.5	7.0	272	13.9	8.5
CD12	517500, 417500	13.7	9.8	266	15.2	8.8
CD15, CD18	514500, 418500	11.6	11.9	267	17.7	8.9

CD16	516500, 414500	12.0	7.3	272	16.3	9.1
OR1	517330, 417311	13.7	9.8	116	15.2	8.8
OR2	517333, 418345	14.4	9.8	114	15.0	8.7
OR3	514687, 418769	11.6	11.9	116	17.7	8.9
OR4	514428, 418197	11.6	11.9	116	17.7	8.9
OR5	514515, 417653	11.2	8.8	117	15.1	8.7
OR6	514763, 417331	11.2	8.8	117	15.1	8.7
OR7	514708, 416785	11.4	7.7	118	16.2	9.0
OR8	515115, 416417	12.6	12.6	118	15.1	9.0
OR9	515516, 416120	12.6	12.6	118	15.1	9.0
OR10	514880, 416120	11.4	7.7	118	16.2	9.0
OR11	515935, 415730	11.8	11.8	118	11.8	11.8
OR12	517765, 415255	12.5	7.0	118	13.9	8.5
OR13	518016, 414882	14.1	7.9	118	14.6	8.9

^a Background concentrations of CO are from the 2001 background maps scaled to 2018 concentrations

- 6.4.27 The Defra NO₂ background mapping data is consistent with the automatic monitoring data from the Urban Background monitoring locations in NLC's administrative area, and the Defra PM₁₀ concentration is consistent with concentrations monitored at CM6 (a rural monitor).
- 6.4.28 Baseline pollutant concentrations at human health receptors show that concentrations of all pollutants are well below all AQAL for all pollutants, indicating that there are no potential breaches of the standards in the vicinity of the Proposed Developments.

Table 6.10 Background pollutant concentration - ecological receptors (2018 - 2020)

Receptor ID	Ecology Site	Habitat type and location	Grid Reference		Background Concentration and Deposition Rates				
			X	Y	NOx (µg/m ³)	SO ₂ (µg/m ³)	NH ₃ (µg/m ³)	Acid Deposition (N:S Kg _{eq} /ha/yr)	Nitrogen Deposition (Kg/ha/yr)
OE1a	Humber Estuary	Coastal stable dunes grasslands - acid type – Cleethorpes	531500	408010	15.6	1.4	2.4	1.42:0.18	20.3
OE1b		Coastal stable dunes grasslands - calcareous type – Spurn Point	539700	411020	17.4	1.1	2.1	1.27:0.15	19.2
OE1c		Shifting coastal dunes – Saltfleet	544956	394570	10.7	0.8	2.1	1.29:0.13	18.5
OE1d		Northern wet heath – North Killingholme Pits	516851	419535	20.1	3.8	2.1	1.48:0.31	20.4
OE1e		Pioneer, low, mid upper saltmarshes	516990	419690	20.1	3.8	2.1	1.48:0.31	20.4
OE1f		Low and medium altitude hay meadows	513431	423906	13.9	1.9	2.3	1.49:0.22	20.3
OE2	North Killingholme Haven Pits	Pioneer, low, mid upper saltmarshes	516851	419535	20.1	3.8	2.1	1.48:0.31	20.4
OE3	Swallow Wold	Sub-Atlantic semi-dry calcareous grassland	516950	404990	11.3	1.0	2.4	1.58:0.17	22.3
OE4a	Wrawby Moor	Non-Mediterranean dry acid and neutral closed grassland	503350	411120	12.4	1.7	3.1	1.73:0.19	24.9

Receptor ID	Ecology Site	Habitat type and location	Grid Reference		Background Concentration and Deposition Rates				
			X	Y	NO _x (µg/m ³)	SO ₂ (µg/m ³)	NH ₃ (µg/m ³)	Acid Deposition (N:S Kg _{eq} /ha/yr)	Nitrogen Deposition (Kg/ha/yr)
OE4b		Meso- and eutrophic <i>Quercus</i> woodland	503350	411120	12.4	1.7	3.1	2.97:0.23	42.6
OE5	Eastfield Road Railway Embankment	Neutral grassland	515313	417108	15.7	3.6	2.1	1.46:0.38	20.4
OE6	Burkinshaws Covert	Broadleaved woodland	516432	417874	16.2	3.4	2.1	1.46:0.38	20.4
OE8	Rosper Road Pools	Broadleaved woodland	517224	416937	17.5	3.4	2.1	1.46:0.38	20.4
OE9	Chase Hill Wood	Neutral grassland	515702	418875	17.2	3.5	2.1	2.44:0.45	34.2
OE10	Mayflower Wood Meadow	Standing open water and neutral grassland	516000	415920	14.6	3.3	2.1	1.46:0.38	20.4
OE11	Homestead Park Pond	Calcareous grassland	517935	415625	15.9	3.4	2.1	1.46:0.38	20.4
OE12	Eastfield Road Pit	Neutral grassland	515350	417040	15.7	3.6	2.1	1.46:0.38	20.4

- 6.4.29 The background data selected for the assessment is detailed and justified within the accompanying appendices to this chapter (Appendix 6A: Air Quality - Construction Phase and Appendix 6B: Air Quality - Operational Phase (ES Volume II)).

Future Baseline

- 6.4.30 Background concentrations of pollutants are expected to decrease in the future due to changes in technology and the types of emission sources; however, to provide a conservative prediction of pollutant concentrations in the future, the current baseline background concentrations are used for the future operational assessment scenarios, assuming no decrease in background concentrations.

6.5 Development Design and Impact Avoidance

Construction Phase

Construction Environmental Management Plan (CEMP)

- 6.5.1 Emissions of dust and particulates from the construction phases of the Proposed Developments will be controlled in accordance with industry best practice, through incorporation of appropriate control measures according to the risks posed by the activities undertaken, as determined through this assessment process. The management of dust and particulates and application of adequate mitigation measures will be enforced through embedding measures in the CEMP. An Outline CEMP is included as Appendix 4A (ES Volume II). The final CEMP will be developed by the appointed contractor in accordance with the principles set out in the Outline CEMP.
- 6.5.2 Based on an initial assessment of the Sites and surrounding area, of its sensitivity to dust impacts and the likely risk of impacts arising from each of the key construction activities (earthworks, construction and 'trackout' of material onto roads (see Appendix 6A: Air Quality - Construction Phase (ES Volume II))), appropriate embedded measures to be implemented during construction (good site techniques drawn from the 'high risk' site schedule in IAQM guidance) that have been identified are:
- avoid mechanical roughening or grinding of concrete surfaces, where appropriate;
 - store sand and aggregates in bunded areas and store cement powder and fine materials in silos, where appropriate;
 - use water suppression and regular cleaning to minimise mud on roads, and control dust during earth moving activities;
 - cover vehicles leaving the construction site that are carrying waste materials or spoil;
 - employ wheel wash systems at site exits;
 - restrict, where practicable, the use of unmade road accesses;
 - minimising duration of storage of topsoil or spoil during pipeline construction; and
 - prohibit open fires on site.
- 6.5.3 Good practice will also be employed for the siting and operation of NRMM to control associated emissions, including:
- minimise vehicle and plant idling;
 - where reasonably practicable, locating static plant away from sensitive boundaries or receptors; and
 - minimise operating time outside of core working hours/ daylight hours.

Operation Phase

IED/ BAT-AEL Emission Limit Value (ELV) compliance

- 6.5.4 The Proposed Developments will be designed such that process emissions to air comply with the ELV requirements specified in the IED, or, if tighter, the relevant BRefs. This will be regulated by the Environment Agency through the Environmental Permits required for the operation of the Proposed Developments. The Environmental Permits may also include additional ELV for species not covered under the IED or LCP BRef.

Stack Height(s)

- 6.5.5 The proposed heights of the PCC plants' absorber stacks for the Proposed Developments have been assessed as a worst-case with consideration given to minimisation of ground-level air quality impacts and the visual impacts of taller stacks, based on current worst-case building massings of the main structures of the Proposed Developments.
- 6.5.6 Dispersion modelling has been undertaken to determine the optimum height of the PCC plants' absorber stacks at the current stage of design, through comparison of the maximum impacts at human health and ecological receptors, to result in impacts at sensitive receptors that are considered to be acceptable.
- 6.5.7 At the detailed design stage, should the final building dimensions be reduced from those assessed in this ES, it may be possible to use lower stack heights to achieve the same level of effect as presented in this chapter.

Emissions Control

- 6.5.8 The impact assessment is based on emissions performance from the PCC plants that project engineers and Shell have confirmed is achievable using appropriate process control techniques.
- 6.5.9 Emissions of amines will be controlled in accordance with the use of BAT through the use of water wash stages and demisters prior to the flue gas exiting the PCC plants' absorber stacks; the use of water wash enables solvent that is carried over in the flue gas to be captured and returned to the process for re-use.
- 6.5.10 Emissions of NO_x from the Phillips 66 FCC will be controlled through the use of Selective Catalytic Reduction (SCR) as part of the Proposed Phillips 66 Development so as to minimise NO_x carry over into the Phillips 66 PCC plant, and carry over of SO₂ and particulate emissions into the Phillips 66 PCC plant will be minimised by a Wet Gas Scrubber. This will result in a reduction in the mass emissions of these species over the existing emissions.
- 6.5.11 No further emissions control is required as part of the Proposed VPI Development.

Decommissioning Phase

- 6.5.12 Appropriate best practice mitigation measures will be applied during any decommissioning works and documented in a Decommissioning Environmental Management Plan (DEMP); no additional mitigation for decommissioning of the Proposed Developments beyond such best practice is considered necessary at this stage. The predicted air quality effects of eventual decommissioning of the Proposed Developments are considered to be comparable to, or less than, those assessed for construction activities.

6.6 Likely Impacts and Effects of the Proposed Developments

- 6.6.1 This section identifies the likely impacts and effects resulting from the Proposed Developments. The magnitude of impacts are defined with reference to the relevant baseline conditions, and effects are determined in accordance with the identified methodology.

Construction Phase

Assessment of Construction Dust

- 6.6.2 The area sensitive to dust soiling and PM₁₀ health effects has been assessed, as detailed in Appendix 6A: Construction Phase (ES Volume II), from the sensitivity of receptors and the proximity of the Proposed Developments activities to these receptors.
- 6.6.3 Identified sensitive receptors to dust soiling and PM₁₀ effects from construction works are detailed in Table 6A.7 of Appendix 6A (ES Volume II). A number of residential receptors (high sensitivity) and ecological receptors (low to medium sensitivity where they are local wildlife sites; high sensitivity where they are internationally/ nationally designated i.e. the Humber Estuary SSSI, SPA, SAC, Ramsar site) have been identified within 350 m of the Sites. The assessment has considered risks from demolition/ site clearance works, earthworks, construction and trackout (of mud to the road) and, based on the potential scale of activities and the sensitivity of the receptor area (as defined in Appendix 6A), unmitigated dust impacts are considered to be 'low risk' for human health receptors, and 'low to medium risk' for ecological receptors. Therefore, mitigation measures appropriate to the scale of perceived risk would be applied as part of the CEMP.

Assessment of Construction Traffic

- 6.6.4 Receptors which may experience a change in pollutant climate as a result of additional road traffic in the construction phase have been assessed, as detailed in Appendix 6A: Construction Phase (ES Volume II).
- 6.6.5 The human health results have been presented for the peak in construction activities for the Proposed VPI Development and the Proposed Phillips 66 Development separately, although the traffic data for each period includes vehicles associated with both Proposed Developments. Significance criteria are presented with respect to those detailed in Section 6.3 and Table 6.4 of this chapter. The impacts at human health receptors are shown to be negligible.
- 6.6.6 At ecological sites, the impact of change in NO_x concentrations due to the Proposed Developments is small and the impact is negligible. For nitrogen deposition, however, despite the small change in concentration as a result of the Proposed Developments, the high baseline concentrations, which are more than double the AQAL mean that some of the impacts are described as moderate. As described in Appendix 6A: Construction Phase (ES Volume II), additional nitrogen will have a limited effect as there is likely to already be ample nitrogen for more competitive plants to respond. Further consideration of the potential effects of this increase in nitrogen deposition at these locations is provided in Chapter 13: Ecology and Biodiversity (ES Volume I).
- 6.6.7 As referred to earlier in this document, the assumption that traffic flows used in this assessment will be at peak level for a year is conservative. Coupled with other conservative assumptions made for the Construction Traffic Assessment methodology, detailed in Appendix 6A: Construction Phase (ES Volume II), predicted results presented are likely to be much higher than actual increases in pollutant concentrations.

Operational Phase

Process Emissions from the Operational PCC Plants

- 6.6.8 The maximum impacts of point source emissions from the proposed PCC plants at human health receptors as a result of the operational Proposed Developments has been determined from model outputs at discrete receptor locations and isopleth figures of pollutant dispersion. The maximum hourly, daily and annual mean predicted concentrations have been compared with the relevant AQALs, and are shown in Table 6.11 – Table 6.13.
- 6.6.9 The human health results have been presented for the Proposed VPI Development (Table 6.11) and the Proposed Phillips 66 Development (Table 6.12) and shows the difference in the predicted impacts compared with the Baseline Assessment of existing emissions from the two Sites, as compared to the significance criteria detailed in Section 6.3 and Table 6.4 of

this chapter. The impacts associated with the Baseline Assessments are provided in Appendix 6B: Air Quality – Operational Phase (ES Volume II). The in-combination results for the Proposed Developments operating together are shown in Table 6.13.

- 6.6.10 Isopleth figures showing the maximum predicted annual and short-term process contributions of NO₂ and NO_x are provided in Figures 6.6 – 6.17 (ES Volume III).
- 6.6.11 The methodology and the full result of the assessment of N-amines is provided in Appendix 6C: Air Quality Assessment of Amine Degradation Products (ES Volume II).

Table 6.11: Results of the operational impact assessment for human health impacts – Proposed VPI Development

Pollutant	Averaging Period	AQAL (µg/m³)	PC (µg/m³)	PC/ AQAL %	BC (µg/m³)	PEC (µg/m³)	PEC/ AQAL %	Change in PC over VPI Baseline Assessment	Impact Descriptor
NO ₂	Annual mean	40	1.9	4.7%	15.0	16.9	42%	+ 2.3%	Negligible
	1-hour mean (as the 99.79 th percentile of hourly averages)	200	31.5	15.7%	30.0	61.7	31%	+ 7.2%	Negligible
CO	1-hour mean (as the 100 th percentile of hourly averages)	30,000	239.6	0.8%	236.6	472.6	2%	+ 0.4%	Negligible
	Maximum daily running 8-hour mean	10,000	165.6	1.7%	236.6	402.5	4%	+ 0.8%	Negligible
PM ₁₀	Annual mean	40	0.03	0.1%	19.0	19.0	48%	+ 0.1%	Negligible
	24-hour mean (as the 90.41 th percentile of hourly averages)	50	0.17	0.3%	38.0	38.2	76%	+ 0.1%	Negligible
PM _{2.5}	Annual mean	20	0.03	0.1%	11.8	11.8	59%	+ 0.1%	Negligible
	15-minute mean (as the 99.9 th percentile)	266	6.3	2.4%	6.7	13.0	5%	+ 1.2%	Negligible
SO ₂	1-hour mean (as the 99.73 th percentile)	350	5.2	1.5%	6.7	11.9	3%	+ 0.6%	Negligible
	24-hour mean (as the 99.18 th percentile)	125	1.2	0.9%	3.4	4.5	4%	+ 0.3%	Negligible
NH ₃	Annual mean	180	0.1	0.1%	2.2	2.3	1%	+ 0.1%	Negligible
	1-hour mean (as the 100 th percentile of hourly averages)	2,500	2.3	0.1%	4.4	6.7	0%	+ 0.1%	Negligible
Total Amines	Daily mean (as the 100 th percentile of daily averages)	100	0.1	1.7%	-	0.02	1.7%	+ 1.7%	Negligible
	Hourly Mean	400	0.3	1.1%	-	0.3	1.1%	+ 1.1%	Negligible
Amide	Annual mean	0.6	0.002	0.3%	-	0.002	0.3%	+ 0.3%	Negligible
	1-hour mean (as the 100 th percentile of hourly averages)	18	0.04	0.2%	-	0.04	0.2%	+ 0.2%	Negligible
Total N-Amines	Annual mean	0.2ng/m ³	0.13	74%	-	0.13	66%	+ 66%	Moderate

Table 6.12: Results of the operational impact assessment for human health impacts – Proposed Phillips 66 Development

Pollutant	Averaging Period	AQAL ($\mu\text{g}/\text{m}^3$)	PC ($\mu\text{g}/\text{m}^3$)	PC/ AQAL %	BC ($\mu\text{g}/\text{m}^3$)	PEC ($\mu\text{g}/\text{m}^3$)	PEC/ AQAL %	Change in PC over VPI Baseline Assessment	Impact Descriptor
NO ₂	Annual mean	40	0.12	0.3%	15.0	15.1	38%	- 0.5%	Negligible
	1-hour mean (as the 99.79 th percentile of hourly averages)	200	2.6	1.3%	30.0	32.6	16%	- 0.7%	Negligible
CO	1-hour mean (as the 100 th percentile of hourly averages)	30,000	21.6	0.1%	236.6	258.2	1%	0%	Negligible
	Maximum daily running 8-hour mean	10,000	16.1	0.2%	236.6	252.7	3%	+ 0.1%	Negligible
PM ₁₀	Annual mean	40	0.28	0.7%	19.0	19.3	48%	+ 0.6%	Negligible
	24-hour mean (as the 90.41 th percentile of hourly averages)	50	0.26	0.5%	38.0	38.3	77%	+ 0.1%	Negligible
PM _{2.5}	Annual mean	20	0.28	1.4%	11.8	12.1	60%	+ 1.1%	Negligible
	15-minute mean (as the 99.9 th percentile)	266	18.1	6.8%	6.7	24.8	9%	- 2.7%	Negligible
SO ₂	1-hour mean (as the 99.73 th percentile)	350	15.4	4.4%	6.7	22.1	6%	- 1.4%	Negligible
	24-hour mean (as the 99.18 th percentile)	125	3.2	2.6%	3.4	6.6	5%	- 3.2%	Negligible
NH ₃	Annual mean	180	0.03	<0.1%	2.2	2.2	1%	0%	Negligible
	1-hour mean (as the 100 th percentile of hourly averages)	2,500	1.0	<0.1%	4.4	5.4	0.2%	0%	Negligible
Total Amines	Daily mean (as the 100 th percentile of daily averages)	100	0.06	0.1%	-	0.06	0.1%	+ 0.1%	Negligible
	Hourly Mean	400	0.2	<0.1%	-	0.2	<0.1%	+ <0.1%	Negligible
Amide	Annual mean	0.6	0.0001	<0.1%	-	0.0001	<0.1%	+ <0.1%	Negligible
	1-hour mean (as the 100 th percentile of hourly averages)	18	0.005	<0.1%	-	0.005	<0.1%	+ <0.1%	Negligible
Total N-Amines	Annual mean	0.2ng/m ³	0.057	29%	-	0.057	29%	+ 29%	Moderate

Table 6.13: Results of the operational impact assessment for human health impacts – in-combination Proposed Developments

Pollutant	Averaging Period	AQAL (µg/m³)	PC (µg/m³)	PC/ AQAL %	BC (µg/m³)	PEC (µg/m³)	PEC/ AQAL %	Change in PC over VPI Baseline Assessment	Impact Descriptor
NO ₂	Annual mean	40	1.9	4.8%	15.0	16.9	42%	+ 1.8%	Negligible
	1-hour mean (as the 99.79 th percentile of hourly averages)	200	31.5	15.7%	30.0	61.5	31%	+ 7.0%	Negligible
CO	1-hour mean (as the 100 th percentile of hourly averages)	30,000	241.6	0.8%	236.6	478.2	2%	+ 0.4%	Negligible
	Maximum daily running 8-hour mean	10,000	162.2	1.6%	236.6	398.8	4%	+ 0.7%	Negligible
PM ₁₀	Annual mean	40	0.06	0.2%	19.0	19.1	48%	- 0.2%	Negligible
	24-hour mean (as the 90.41 th percentile of hourly averages)	50	0.34	0.7%	38.0	38.3	77%	+ 0.2%	Negligible
PM _{2.5}	Annual mean	20	0.06	0.3%	11.8	11.8	59%	0.0%	Negligible
	15-minute mean (as the 99.9 th percentile)	266	20.1	7.5%	6.7	26.8	10%	- 2.1%	Negligible
SO ₂	1-hour mean (as the 99.73 th percentile)	350	17.6	5.0%	6.7	24.3	7%	- 1.1%	Negligible
	24-hour mean (as the 99.18 th percentile)	125	3.4	2.7%	3.4	6.7	5%	- 3.2%	Negligible
NH ₃	Annual mean	180	0.1	0.1%	2.2	2.3	1%	+ 0.1%	Negligible
	1-hour mean (as the 100 th percentile of hourly averages)	2,500	2.6	0.1%	4.4	7.0	0.3%	+ 0.1%	Negligible
Total Amines	Daily mean (as the 100 th percentile of daily averages)	100	0.15	0.2%	-	0.15	0.2%	+ 0.2%	Negligible
	Hourly Mean	400	0.4	0.1%	-	0.4	0.1%	+ 0.1%	Negligible
Amide	Annual mean	0.6	0.002	0.3%	-	0.002	0.3%	+ 0.3%	Negligible
	1-hour mean (as the 100 th percentile of hourly averages)	18	0.04	0.2%	-	0.04	0.2%	+ 0.2%	Negligible
N-Amines	Annual mean	0.2ng/m ³	0.16	82%	-	0.16	82%	+ 82%	Moderate

- 6.6.12 The dispersion modelling includes a number of conservative assumptions in combination, including:
- reporting of the worst-case results from the five years of meteorological data modelled;
 - maximum building sizes within the assessed Rochdale Envelope;
 - maximum annual operation for the plant configuration assessed (8,760 hours, assuming continuous annual operation at full load);
 - operation of the PCC plants at the proposed Emission Limits values, when annual average emissions are likely to be below these; and
 - conservative estimates of background concentrations for the commencement of operation at the receptor locations.
- 6.6.13 Even with these conservative assumptions taken into account, the human health results at the worst-case impacted receptor are shown to be **negligible** for all pollutant species assessed, except for N-Amines.
- 6.6.14 Although the impacts of the total N-amine emission for the In-combination Proposed Developments is described as being **moderate adverse**, the results indicate that the PCs at all receptor locations remain below the AQAL for NDMA. The worst-case Indirect N-amine impacts are experienced at receptor OR2 and represent 82% of the NDMA AQAL, or 81% at the next worst impacted receptor.
- 6.6.15 The assessment of N-amines assumes that all the N-amine PCs occur as NDMA, as this is the only nitrosamine species that has a defined AQAL to compare against. It is considered that the N-amines formed from the Shell CANSOLV solvent are much less toxic than NDMA.
- 6.6.16 The nitrosamines that can form through the use of the CANSOLV solvents have undergone *In vitro* mutagenicity analysis and comparison with NDMA. The nitrosamines formed from the use of the proposed CANSOLV DC-103 solvent are named as ‘CANSOLV N-1’ and ‘CANSOLV N-3’. The study found that NDMA was a mutagen. CANSOLV N-3 was also found to be a mutagen, but 52 times less potent than NDMA. CANSOLV N-1 was found to be a weak mutagen with a mutagenic potency approximately 2,100 times less than that of NDMA. Use of NDMA to assess potential air quality effects is therefore considered to be highly conservative. CANSOLV N-1 would be the main nitrosamine formed from the CANSOLV DC-103 formulation, with CANSOLV N-3 being formed in lower amounts.
- 6.6.17 Additional discussion and interpretation of these impacts are provided in Appendix 6C: Air Quality Assessment of Amine Degradation Products (ES Volume II).
- 6.6.18 It is therefore considered that the impacts at all human health receptors will result in effects that are **not significant**.
- 6.6.19 The maximum impacts of point source emissions from the proposed PCC plants at ecological receptors as a result of the operational Proposed Developments has been determined from model outputs at discrete receptor locations.
- 6.6.20 A summary of the results for the Proposed VPI Development are shown in Table 6.14 and the Proposed Phillips 66 Development results are shown in Table 6.14. The results are shown for the worst impacted receptor and show the difference in the predicted impacts compared with the Baseline Assessment of existing emissions from the two Sites, as compared to the significance criteria detailed in Section 6.3 and Table 6.4 of this chapter. The impacts associated with the Baseline Assessments and the full results for all receptors are provided in Appendix 6B: Air Quality – Operational Phase (ES Volume II). The in-combination results for the Proposed Developments operating together are shown in Table 6.15.

Table 6-14: Results of the operational impact assessment for worst case ecological receptor – Proposed VPI Development

Pollutant	Averaging Period	AQAL (µg/m ³)	PC (µg/m ³)	PC/ AQAL %	BC (µg/m ³)	PEC (µg/m ³)	PEC/ AQAL %	Change in PC over VPI Baseline Assessment	Impact Descriptor
NO ₂	Annual mean	30	2.53	8.4%	20.1	22.7	76%	+ 4.7%	Minor
	Daily mean	75	17.7	24%	30.2	47.9	64%	+ 8.9%	Negligible
SO ₂	Annual mean	20	0.18	0.9%	3.8	3.9	20%	+ 0.5%	Negligible
NH ₃	Annual mean	3	0.11	4%	2.11	2.22	74%	+ 3.5%	Negligible

Table 6.15: Results of the operational impact assessment for worst case ecological receptor – Proposed Phillips 66 Development

Pollutant	Averaging Period	AQAL (µg/m ³)	PC (µg/m ³)	PC/ AQAL %	BC (µg/m ³)	PEC (µg/m ³)	PEC/ AQAL %	Change in PC over VPI Baseline Assessment	Impact Descriptor
NO ₂	Annual mean	30	0.30	1.0%	16.2	16.5	55%	- 1.3%	Negligible
	Daily mean	75	4.56	6%	23.6	28.2	38%	- 1.7%	Negligible
SO ₂	Annual mean	20	0.41	2.0%	3.4	3.8	19%	- 4.4%	Negligible
NH ₃	Annual mean	3	0.04	1.3%	2.11	2.15	72%	+ 0.5%	Negligible

Table 6-16: Results of the operational impact assessment for worst case ecological receptor – in-combination Proposed Developments

Pollutant	Averaging Period	AQAL (µg/m ³)	PC (µg/m ³)	PC/ AQAL %	BC (µg/m ³)	PEC (µg/m ³)	PEC/ AQAL %	Change in PC over VPI Baseline Assessment	Impact Descriptor
NO ₂	Annual mean	30	2.63	8.8%	20.1	22.8	76%	+ 3.9%	Minor
	Daily mean	75	17.7	24%	30.2	47.9	64%	+ 6.8%	Negligible
SO ₂	Annual mean	20	0.31	1.6%	3.8	4.1	20%	- 1.9%	Negligible
NH ₃	Annual mean	3	0.12	3.9%	2.11	2.23	74%	+ 3.6%	Negligible

- 6.6.21 All impacts are considered to be **negligible** at the ecological receptors, except for annual average NO_x at the worst-case impacted receptor (Humber Estuary (OE1)). The increase in the annual average NO_x PC at this receptor represents +4.7% of the AQAL for the Proposed VPI Development assessment, or +3.9% for the In-Combination Proposed Developments assessment. According to the significance criteria this represent a low magnitude of change, however as the PEC is 76% of the AQAL this represents a **minor adverse** impact. The background concentration used in the assessment will include the contribution from the existing VPI Site sources, and therefore these is some double counting of this in the results. In addition, this level of impact only occurs at the worst-case location of the ecological receptor, and over the majority of the Humber Estuary site the predicted PCs will be lower. It is therefore considered that the effect over the designated site as a whole will be **not significant**.
- 6.6.22 Deposition impacts are presented in Appendix 6B: Air Quality – Operational Phase (ES Volume II).

Decommissioning Phase

- 6.6.23 The predicted air quality effects of eventual decommissioning of the Proposed Developments are considered to be comparable to, or less than, those assessed for construction activities. This is based upon the assumption that groundwork, traffic movements and site work likely to be required to decommission the Proposed Developments would be less than that required for its construction.

6.7 Mitigation and Enhancement Measures

Construction Phase

- 6.7.1 Unmitigated dust impacts are considered to be ‘low risk’ for human health receptors, and ‘low to medium risk’ for ecological receptors. Mitigation measures appropriate to the scale of perceived risk will therefore be applied as part of the CEMP. The management of construction phase emissions, including dust and particulates, and the application of adequate mitigation measures will be enforced through the CEMP.
- 6.7.2 The impacts from traffic associated with the construction phase have been shown to be very small in Appendix 6A: Air Quality – Construction Phase. Additional mitigation measures are therefore unlikely to have any additional benefit. Despite this, it is recommended that site staff attempt to minimise journeys as far as practicable and share vehicles where possible.

Operation Phase

- 6.7.3 The air quality assessment of operational impacts has assumed that the ELVs will be met for the operational Proposed Development's as required under the IED and in accordance with use of BAT under the environmental permitting regime. The environmental effects from operation of the Proposed Developments have been identified as being not significant at all human health receptors for the operation of the Proposed Developments.
- 6.7.4 Detailed modelling of predicted impacts at ecological receptors indicates that potential effects at ecological receptors as a result of the operation of the Proposed Developments are largely considered to be not significant. Where this is not the case, i.e. for the impacts that are identified as minor adverse, further interpretation of the predicted effects at ecological receptors and the determination of the significance of these effects has therefore been assessed further in Chapter 13: Ecology and Nature Conservation and in the Reports to Inform Habitat Regulations Assessment Report.
- 6.7.5 No specific additional mitigation has been identified as necessary for the Proposed Developments other than the embedded mitigation measured outlined in Section 6.5.

Decommissioning Phase

- 6.7.6 Appropriate best practice mitigation measures will be applied during any decommissioning works and documented in a DEMP; no additional mitigation for decommissioning of the Proposed Developments beyond such best practice is considered necessary at this stage.

6.8 Residual Effects and Conclusions

- 6.8.1 The air quality assessment of construction impacts assumes that the measures outlined within Section 6.5 of this chapter would be incorporated into the design of the Proposed Developments, as they are standard best practice measures that are routinely applied across UK construction sites, and managed through the CEMP. No additional mitigation has been identified as necessary for the construction traffic for the Proposed Developments. For these reasons, the residual construction effects would be not significant.
- 6.8.2 The air quality assessment of impacts during operation of the Proposed Developments has assumed that the ELV will be met for the operational plants as required and in accordance with use of BAT under the environmental permitting regime. For this reason, the residual effects would be as reported within Section 6.6 of this chapter (i.e. not significant).
- 6.8.3 Consistent with construction mitigation, it has been assumed that relevant best practice mitigation measures would be in place during any decommissioning works. No additional mitigation has been identified as necessary for the decommissioning phase of the Proposed Developments and decommissioning effects are predicted to be comparable to, or less than, those assessed for construction activities (i.e. not significant).

Table 6.17: Summary of significant effects for the Proposed Developments individually and in-combination

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
Construction	No significant effects identified				
Operation	No significant effects identified.				
Decommissioning	No significant effects identified				

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