

Table of Contents

9.	Water Environment and Flood Risk	9-1
9.1	Introduction.....	9-1
9.2	Legislation and Planning Policy Context.....	9-1
9.3	Assessment Methodology and Significance Criteria.....	9-9
9.4	Baseline Conditions.....	9-18
9.5	Development Design and Impact Avoidance	9-35
9.6	Likely Impacts and Effects of the Proposed Developments.....	9-49
9.7	Mitigation and Enhancement Measures	9-60
9.8	Residual Effects and Conclusions	9-62
9.9	References	9-68

Tables

Table 9.1: Defining the importance/sensitivity of the receptor ¹	9-11
Table 9.2: Determining magnitude of change	9-13
Table 9.3: Matrix for assessing significance of effect.....	9-14
Table 9.4: Summary of consultation responses that have informed the scope and methodology of the surface water environment assessment.....	9-16
Table 9.5: Summary of current surrounding land use of the Sites	9-19
Table 9.6: Geology and soils beneath the VPI Site.....	9-21
Table 9.7: Geology and soils beneath the Phillips 66 Site	9-21
Table 9.8: Aquifer designations within the VPI Site and Phillips 66 Site	9-22
Table 9.9: Identified surface waterbodies for the Sites	9-25
Table 9.10: Water Framework Directive waterbodies and attributes (WFD Cycle 3, 2019)	9-26
Table 9.11: Water quality indicators from South Killingholme Drain (EA monitoring data, 2015-2020).....	9-28
Table 9.12: Active licenced abstractions within 1km of the Sites	9-31
Table 9.13: Active discharge permits (active) within 1km of the Sites.....	9-32

9. Water Environment and Flood Risk

9.1 Introduction

- 9.1.1 This chapter of the Environmental Statement (ES) identifies and addresses the potential impacts and effects of the proposed Post-Combustion Carbon Capture (PCC) developments located at VPI Immingham's Combined Heat and Power (CHP) Plant and Phillips 66 Ltd.'s Humber Refinery (referred to as 'the Proposed Developments') separately as well as cumulatively, on the surface water environment and flood risk. For this assessment, the surface water environment includes watercourses, canals and lakes but not ponds (which are assessed in the ecological assessment in Chapter 12: Ecology and Nature Conservation). Impacts and effects on water quality, water resources and hydromorphology are considered on relevant receptors.
- 9.1.2 The chapter also describes the consultation that has been undertaken during the EIA, the scope of the assessment and assessment methodology, and a summary of the baseline information that has informed the assessment.
- 9.1.3 This chapter, and its associated figures and appendices (detailed below) are intended to be read as part of the wider ES with particular reference to the introductory chapters of this ES (Chapters 1 - 5).
- 9.1.4 It should also be read alongside ES Chapter 12: Ecology and Conservation, which considers the effects on protected species and designated sites, and ES Chapter 10: Geology, Hydrogeology and Land Contamination, which considers effects on groundwater receptors.
- 9.1.5 This assessment is supported by a number of specific studies that are included in the following technical appendices found in ES Volume II:
- Appendix 9A Flood Risk Assessment (FRA);
 - Appendix 9B Water Framework Directive: Screening Assessment; and
 - Appendix 9C Drainage Strategies.
- 9.1.6 This assessment is also supported by a number of figures, found in ES Volume III:
- Figure 9.1: Site Location and Surface Water Features;
 - Figure 9.2: Water Framework Directive waterbodies; and
 - Figure 9.3: Fluvial and Tidal Flood Risk.
- 9.1.7 The assessment is based on design and drainage philosophy documents developed by the Applicants (see Appendix 9C), the data from which has been summarised in this chapter.

9.2 Legislation and Planning Policy Context

- 9.2.1 The United Kingdom (UK) Acts, Regulations and Orders and planning policy that are considered the key legislative and policy drivers for the protection and enhancement of the water environment and flood risk assessment, are summarised in the following section.

Legislation

- 9.2.2 The potential impact of the Proposed Developments on the water environment is considered in relation to the following national legislation (regulations primarily dealing with the UK's exit from the European Union are not listed):
- Environment Act 2021 (which sets a requirement on Government to publish new targets for water quality and biodiversity);

- Water Act 2014;
- Floods and Water Management Act 2010;
- Marine and Coastal Access Act 2009;
- Environment Act 1995;
- Land Drainage Act 1991 (as amended);
- Water Resources Act 1991 (as amended);
- Water Industry Act 1991;
- Environment Protection Act 1990;
- Salmon and Freshwater Fisheries Act 1975 (as amended);
- Control of Pollution Act 1974;
- Bathing Water (Amendment) (England) Regulations 2018;
- The Water Environment (Water Framework Directive) (England Wales) Regulations 2017;
- Environmental Permitting (England and Wales) Regulations 2016;
- Control of Major Accident Hazards (COMAH) Regulations (2015);
- Environmental Damage (Prevention and Remediation) Regulations 2015;
- Eels (England and Wales) Regulations 2009;
- Groundwater (England and Wales) Regulations 2009;
- Flood Risk Regulations 2009;
- Control of Substances Hazardous to Human Health (COSHH) Regulations 2002; and
- Control of Pollution (Oil Storage) (England) Regulations 2001.

National Policy

National Policy Statements

- 9.2.3 While National Policy Statements apply to Nationally Significant Infrastructure Projects (NSIPs) rather than local planning applications, in accordance with the National Planning Policy Framework (NPPF) (Department for Communities and Local Government, 2012a), they can be a material consideration nevertheless they can have points of relevance for the determination of local planning applications.
- 9.2.4 The Overarching National Policy Statement (NPS) for Energy (EN-1) (DECC, 2011a) is relevant to this assessment with the main sections being:
- Section 4.10: Pollution control and other environmental regulatory regimes;
 - Section 4.9: Climate Change Adaptation. This sector advises that the resilience of a project to climate change should be assessed in the ES and that future increased risk of flooding would be covered in a FRA.
 - Section 5.15: Water Quality and Resources. Stating that: “*Where the project is likely to have effects on the water environment, the applicant should undertake an assessment of the existing status of, and impacts of the proposed project on, water quality, water resources and physical characteristics of the water environment as part of the ES or equivalent.*” (Paragraph 5.15.2); and
 - Paragraph 5.15.3 which provides advice on what an Environmental Statement (ES) should describe including:
 - “*the existing quality of waters affected by the proposed project and the impacts of the proposed project on water quality, noting any relevant existing discharges, proposed new discharges and proposed changes to discharges;*”

- “existing water resources affected by the proposed project and the impacts of the proposed project on water resources, noting any relevant existing abstraction rates, proposed new abstraction rates and proposed changes to abstraction rates (including any impact on, or use of mains supplies and reference to Catchment Abstraction Management Strategies (CAMS));”
 - “existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project and any impact of physical modifications to these characteristics; and”
 - “any impacts of the proposed project on waterbodies or protected areas under the WFD and source protection zones (SPZ) around potable groundwater abstractions.”
 - Paragraphs 5.16.5–5.16.10 outline the decision-making process with regards to water pollution, and more weight is attributed to any impacts that would have an adverse effect on the achievement of environmental objectives established under the WFD. Within paragraphs 5.16.11-5.15.13 it is stated that whether mitigation measures over and above those included within an application are needed should be considered by the Secretary of State.
- 9.2.5 Section 5.7 (Flood Risk) details that “projects of 1 hectare (ha) or greater in Flood Zone 1 in England and all proposals for energy projects located in Flood Zones 2 and 3 in England should be accompanied by a FRA”.
- 9.2.6 The minimum requirements for FRAs set out in NPS EN-1 are that they should:
- “Be proportionate to the risk and appropriate to the scale, nature and location of the project;”
 - “Consider the risk of flooding arising from the project in addition to the risk of flooding to the project;”
 - “Take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made;”
 - “Be undertaken by competent people, as early as possible in the process of preparing the proposal;”
 - “Consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure;”
 - “Consider the vulnerability of those using the Sites, including arrangements for safe access;”
 - “Consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made;”
 - “Consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;”
 - “Include the assessment of the remaining (known as ‘residual’) risk after risk reduction have been taken into account and demonstrate that this is acceptable for the particular project;”
 - “Consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems;”
 - “Consider if there is a need to be safe and remain operational during a worst-case flood event over the development’s lifetime; and”
 - “Be supported by appropriate data and information, including historical information on previous events.”

- 9.2.7 The NPS for Fossil Fuel Electricity Generating Infrastructure (NPS EN-2) (DECC, 2011b) is also of relevance to the Proposed VPI Development, which states that “*where a project is likely to have effects on water quality or resources, the applicant for development consent should undertake an assessment which should particularly demonstrate that appropriate measures will be put in place to avoid or minimise adverse impacts of abstraction and discharge of cooling water. The applicant for development consent should demonstrate measures to minimise adverse impacts on water quality and resources*”.

National Planning Policy Framework

- 9.2.8 The NPPF (Department for Communities and Local Government, 2012a), published by the Ministry of Housing, Communities and Local Government was updated in July 2021, superseding previously published versions. The NPPF has three overarching objectives to contribute to the achievement of sustainable development, one of which is the ‘environmental objective’. This objective includes the requirement of “*helping to improve biodiversity, using natural resources prudently, and minimising waste and pollution*” (Paragraph 8c). The NPPF also contains a number of statements which are relevant to water quality and flood risk. These include:

- strategic policies should set out an overall strategy for the pattern, scale and quality of development, and make provision for conservation and enhancement of the natural, built and historic environment. This includes landscapes and green infrastructure, and planning measures to address climate change mitigation and adaptation (paragraph 20d);
- plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts. Development should not cause unacceptable levels of water pollution and should help improve water quality wherever possible (paragraph 149); and
- planning policies should contribute and enhance the natural environment by preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as water quality, taking into account relevant information such as river basin management plans (paragraph 170e).

Planning Practice Guidance

- 9.2.9 The Planning Practice Guidance (PPG) Water Supply, Wastewater and Water Quality (last updated 2022) provides guidance for local planning authorities on assessing the significance of water environment effects of the Proposed Developments. The guidance highlights that adequate water and wastewater infrastructure is needed to support sustainable development.
- 9.2.10 The NPPF (Department for Communities and Local Government, 2012a) and the Flood Risk and Coastal Change NPPG (Department for Communities and Local Government, 2022) recommends that Local Plans should be supported by a Strategic FRA (SFRA) and should develop policies to manage flood risk from all sources taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities (LLFAs) and Internal Drainage Boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid, where possible, flood risk to public and property and manage any residual risk, taking account of the impacts of climate change.

Environmental Improvement Plan

- 9.2.11 The Environmental Improvement Plan 2023 was recently published by Defra in January 2023 and represents the first revision of the Governments 25 Year Environmental Plan. The original plan set out the UK Governments goals for improving the environment within a generation and leaving it in a better state than we found it. The plan covers the provision of clean air and

water; protection and enhancement of habitats, wildlife and biosecurity; reducing the risk from environmental hazards and mitigating and adapting to climate change; using resources more sustainable and efficiently, minimizing waste and managing exposure to chemicals; enhancing beauty, heritage and engagement with the natural environment. 10 goals were set out by the original plan and this document reviewed the progress made against each goal, specific targets and commitments and the plan to continue to deliver these goals. One of these specific goals is improving water environmental quality. Since 2018 Defra has increased funding to Catchment Sensitive Farming programme, tackled nutrient pollution by requiring water companies to upgrade treatment works by amending the Levelling Up and Regeneration Bill, published the Storm Overflows Discharge Reduction Plan, improved planning requirements to support availability of water and published Strategic Policy Statement for Ofwat. Further investment and actions has been put into improving flood defences and well as a new policy statement, national flood and coastal erosion risk management strategy and flood and coastal resilience fund.

A Green Future: Our 25 Year Plan to Improve the Environment

- 9.2.12 In 2018, the Department for Environment, Food and Rural Affairs (Defra) published ‘A Green Future: Our 25 Year Environment Plan’ (Defra, 2018) setting out the UK Governments goals for improving the environment within a generation and leaving it in a better state than we found it. The plan covers the provision of clean air and water; protection and enhancement of habitats, wildlife and biosecurity; reducing the risk from environmental hazards and mitigating and adapting to climate change; using resources more sustainable and efficiently, minimizing waste and managing exposure to chemicals; enhancing beauty, heritage and engagement with the natural environment.
- 9.2.13 The Environment Plan includes specific goals to achieve good environmental status in our seas, reduce the environmental impact of water abstraction, meet the objectives of River Basin Management Plans under the WFD, reduce leakage from water mains, improve the quality of bathing waters, restore protected freshwater sites to a favourable condition, and do more to protect communities and businesses from the impact of flooding, coastal erosion and drought. At the heart of the Plan’s delivery is the natural capital approach with the aspiring goal of a net gain in biodiversity from new development.

Future Water, The Government’s Water Strategy for England

- 9.2.14 The Government’s Future Water Strategy (Defra, 2011b) published in June 2011 sets out the Government’s long-term vision for water and the framework for water management in England. It aims to enable sustainable and secure water supplies whilst ensuring an improved and protected water environment. Future Water brings together the issues of water demand, supply and water quality in the natural environment as well as surface water drainage and river/coastal flooding into a single coherent long-term strategy, in the context of the need to reduce greenhouse gas emissions.
- 9.2.15 The Future Water Strategy also considers the issue of charging for water. The water environment and water quality have great economic, biodiversity, amenity and recreational value, playing an important role in many aspects of modern-day society, and thus the functions provided must be sustainably managed to ensure they remain available to future generations without compromising environmental quality.

Sustainable Drainage Systems Guidance

- 9.2.16 Planning policy encourages developers to include sustainable drainage systems (SuDS) in their proposals where practicable. SuDS provide a way to attenuate runoff from a site to the rate agreed with the Environment Agency (EA) to avoid increasing flood risk, but they are also important in reducing the quantities and concentration of diffuse urban pollutants found in the runoff.
- 9.2.17 Defra published guidance on the use, design and construction of SuDS in ‘Non-statutory technical standards for SuDS’ (Defra, 2015). The standards set out the following:

- peak runoff rates should be as close as is reasonably practicable to the greenfield rate, but should never exceed the pre-development runoff rate;
- the drainage system should be designed so that flooding does not occur on any part of a development site for a 1 in 30 year rainfall event, and that no flooding of a building (including basement) would occur during a 1 in 100 year rainfall event; and
- pumping should only be used when it is not reasonably practicable to discharge by gravity.

Other Guidance

9.2.18 Other industry good practice guidance on the planning for and design of SuDS is provided by:

- C753 The SuDS Manual (CIRIA, 2015a);
- the Design Manual for Roads and Bridges (DMRB) CD532 Vegetated Drainage Systems for Highways Runoff (Highways England, 2020); and
- DMRB CG 501 Design of Highway Drainage Systems (Highways England, 2020).

9.2.19 Section 9.5 of this chapter (Development Design and Impact Avoidance) provides a list of best practice guidance with regards to the management of pollution risks on construction sites.

River Basin Management Plan

9.2.20 River Basin Management Plans (RBMPs) are prepared by the Environment Agency for six-year cycles and set out how organisations, stakeholders and communities will work together to improve the water environment.

9.2.21 The most recent plans were published in October 2022 (one year late) and will remain in place until after 2027. The waterbodies within the Study Area fall under the Louth, Grimsby and Ancholme Management Catchment within the Humber RBMP (Defra, 2016).

Local Policy

North Lincolnshire Council Development Plan Policy

9.2.22 The Development Plan for North Lincolnshire comprises the North Lincolnshire Local Development Framework (LDF) and the ‘Saved Policies’ of the North Lincolnshire Local Plan (North Lincolnshire Council (NLC), 2007).

9.2.23 The LDF comprises a suite of Development Plan Documents (DPDs) that set out the local planning policy for the area for the period to 2026. The DPD documents that are considered to be of relevance to the Proposed Developments are:

- the Core Strategy (adopted June 2011) (NLC, 2011); and
- the Housing and Employment Land Allocations DPD and Proposals Map (adopted March 2016) (NLC, 2016a).

9.2.24 The North Lincolnshire Local Plan was adopted in May 2003. This plan has been largely replaced by the LDF, although a number of its policies have been saved, and are still therefore potentially material to the determination of planning applications.

9.2.25 Policies within the NLC Core Strategy relevant to flood risk and surface water management include:

- **Policy CS2: Delivering More Sustainable Development** - A ‘sequential approach’ will also be applied to ensure that development is, where possible, directed to those areas that have the lowest probability of flooding, taking account the vulnerability of the type of development proposed, its contribution to creating sustainable communities and achieving the sustainable development objectives of the plan. Where development does take place in the floodplain, mitigation measures should be applied to ensure that the development is safe;

- **Policy CS12: South Humber Bank Strategic Employment Site (SHBSES) -** Development will be assisted by a drainage programme. The outcome will be to include surface water and sewage management solutions to accommodate development of the SHBSES without harming the natural environment. Safeguard and improve the flood defences of the SHBSES from tidal flooding through partnership working with the Environment Agency and its Humber Flood Risk Management Strategy, North Lincolnshire and North East Lincolnshire Councils, Yorkshire Forward, landowners and industry. This will include managing the predicted effects of climate change in harmony with the development of port related activities by managing and minimising the risk of flooding;
- **Policy CS18: Sustainable Resource Use and Climate Change -** Requiring the use of Sustainable Urban Drainage Systems (SuDS) where practicable and supporting the necessary improvement of flood defences and surface water infrastructure required against the actions of climate change, and preventing development in high flood risk areas wherever practicable and possible; and
- **Policy CS19: Flood Risk -** The council will support development proposals that avoid areas of current or future flood risk, and which do not increase the risk of flooding elsewhere. This will involve a risk based sequential approach to determine the suitability of land for development that uses the principle of locating development, where possible, on land that has a lower flood risk, and relates land use to its vulnerability to flood. Development in areas of high flood risk will only be permitted where it meets the requirements of the Exception Test and, in addition, development will be required, wherever practicable, to incorporate SuDS to manage surface water drainage.

9.2.26 The 'Saved' policies of the Local Plan (NLC, 2003 and 2007) that it is considered may be relevant to the determination of the planning applications include:

- **Policy DS13: Groundwater Protection and Land Drainage –** All development proposals must take account of the need to secure effective land drainage measures and groundwater protection in order to control the level of water in the land drainage system.
- **Policy DS14: Foul Sewage and Surface Water Drainage –** The Council will require satisfactory provision to be made for the disposal of foul and surface water from new development, either by agreeing details before planning permission is granted, or by imposing conditions on a planning permission or completing planning agreements to achieve the same outcome.
- **Policy DS15: Water Resources –** Development will not be permitted which would adversely affect the quality and quantity of water resources or adversely affect nature conservation, fisheries and amenity by means of pollution from the development or water abstraction, unless adequate measures are undertaken to reduce the impact to an acceptable level.
- **Policy DS16: Flood Risk –** Development will not be permitted within floodplains where it would;
 - increase the number of people or buildings at risk; or
 - impede the flow of floodwater; or
 - impede access for the future maintenance of watercourses; or
 - reduce the storage capacity of the floodplain; or
 - undermine the integrity of existing flood defences unless adequate protection or mitigation measures are undertaken.

9.2.27 NLC is currently in the process of preparing a new Local Plan. A 'Publication Draft' of the new Local Plan was subject to public consultation in October and November 2021. It is anticipated that the Local Plan will be submitted to the Secretary of State for Levelling Up, Housing and Communities for examination during 2022 with adoption following during 2023.

Internal Drainage Board Byelaws

- 9.2.28 Internal Drainage Boards (IDBs) are responsible for managing water levels in the watercourses designated to each IDB and work in partnership with other authorities to actively manage and reduce the risk of flooding within the Board's district. They have permissive powers under the Land Drainage Act 1991 (as amended by the 1994 Act) to undertake maintenance on any water feature within their district other than 'Main Rivers' and to supervise all matters relating to the drainage of land within their districts.
- 9.2.29 Permissive powers means that IDBs are permitted to undertake works on ordinary watercourses but the responsibility remains with the riparian owner as the IDBs are not obligated. IDBs can undertake works on watercourses outside their drainage district in order to benefit the district. IDBs may make byelaws, approved by the relevant Minister, for securing the efficient working of the drainage systems.
- 9.2.30 North East Lindsey IDB (NELIDB) operates in the study area for the Proposed Developments. Any developer working in the NELIDB area should review the following byelaws (NELIDB, 2019):
- Byelaw 3: Control of introduction of water and increase in flow or volume of water;
 - Byelaw 4: Control of sluices etc.;
 - Byelaw 6: Diversion or stopping up of watercourses;
 - Byelaw 7: Detrimental Substances not to be Put Into Watercourses;
 - Byelaw 10: No obstructions within 7m of the edge of the watercourse;
 - Byelaw 15: Banks not to be Used for Storage;
 - Byelaw 16: Not to Dredge or Raise Gravel, Sand etc.;
 - Byelaw 17: Fences, excavations, pipes etc.; and
 - Byelaw 19: Interference with Sluices.

Other Policy

Humber Flood Risk Management Strategy

- 9.2.31 The Humber Strategy (Environment Agency, 2008) sets out the Environment Agency's vision for managing the risk of flooding from the Humber Estuary to respond to climate change and sea level rise. The Strategy sets out the Environment Agency's general approach to managing the estuary's flood defences.
- 9.2.32 The Proposed Development Sites ('the Sites') are situated within Flood Area 24 in the Humber FRMS, where defences will be improved as necessary to protect people, businesses and nationally important industry from tidal flooding.

Grimsby and Ancholme Catchment Flood Management Plan

- 9.2.33 In 2009, a Catchment Flood Management Plan (CFMP) was produced by the Environment Agency for the Grimsby and Ancholme catchment addressing the scale and extent of flooding both now and in the future and setting policies for managing flood risk.
- 9.2.34 In the area considered in relation to the study area, (Sub-area 4 Immingham, Grimsby and Buck Beck) the CFMP addresses the risk posed by the tidal risk from the Humber Estuary, tide locking of local watercourses and the pumping of drainage channels.
- 9.2.35 The vision and preferred management policy for the sub-area is Policy option 4: "*Areas of low, moderate or high flood risk where the Environment Agency are already managing the flood risk effectively but where further actions may be taken to keep pace with climate change*".

NLC Local Flood Risk Management Strategy

- 9.2.36 As a LLFA, NLC has a responsibility to develop a Local Flood Risk Management Strategy (LFRMS) which sets out a clear plan for future flood risk management in the region, ensuring

people, businesses communities and other risk management authorities have an active role in how flood risk is managed.

- 9.2.37 The LFRMS sets out how NLC intends to manage local flood risks, as well as contribute to management from non-local sources, and to engage and inform residents on their own responsibilities and enable them to contribute to the management of flood risk.

North Lincolnshire Strategic FRA

- 9.2.38 NLC Level 1 SFRA was published in 2012 to support the assessment of development sites in relation to flood risk. The SFRA was completed in consultation with the Environment Agency and North East Lindsey IDB to provide information on the probability of flooding. The report also takes into account the impacts of climate change.
- 9.2.39 It is intended that the SFRA will be used by NLC's planning and building control department to inform the application of the Sequential Test when allocating land or determining applications, in line with the NPPF.
- 9.2.40 The SFRA locates the study area within the Eastern Coastal Area where the main source of flooding is a combination of large waves and high-water levels in the Humber Estuary. A more detailed assessment has been undertaken as part of the SFRA for Flood Compartment 1T3 – Immingham and North Killingholme (which the Post Combustion Carbon Capture project area) which indicates the South Killingholme area is liable to flooding should a breach of the flood defences occur.

NLC Sustainable Drainage Systems and Flood Risk Guidance

- 9.2.41 The purpose of this document is to provide developers and designers with guidance on sustainable drainage systems (SuDS) expected to be submitted with planning applications to NLC. This guide is based on The SuDS Manual 753 (CIRIA, 2015a) in conjunction with the National Planning Policy Framework (NPPF).

9.3 Assessment Methodology and Significance Criteria

Impact Assessment and Significance Criteria

- 9.3.1 The significance of effects will be determined using the principles of the guidance and criteria set out in the Design Manual for Roads and Bridges (DMRB) LA113 Road Drainage and the Water Environment (Highways England, 2020) and DMRB LA 104 Environmental Assessment and Monitoring (Highways England, 2020).
- 9.3.2 Although these assessment criteria were developed for road infrastructure projects, this method is suitable for use on any development project and it provides a robust and well tested method for predicting the significance of effects. The criteria that will be used to determine receptors importance is presented in Table 9.1.
- 9.3.3 In accordance with the stages of the methodology, there are three stages to the assessment of effects on the water environment, which are as follows:
- **Identification of Receptors.** Each identified receptor is assigned a level of importance (low to very high) based on a combination of attributes (such as the size of the watercourses, WFD designation, water supply and other uses, biodiversity, and recreation etc.) and on receptors to flood risk based on the vulnerability of the receptor to flooding;
 - **Identification of Potential Impacts.** The magnitude of potential and residual impact (or change) (classed as negligible, minor, moderate or major adverse / beneficial) is determined based on the criteria listed in Table 9.2 and the assessor's professional judgment; and
 - **Assessment of the Significance of Effects.** This is typically a function of the importance of a **receptor** and magnitude of the impact results in an assessment of the

overall significance of the effect on the receptor using the matrix presented in Table 9.3. The significance of each identified effect (both potential and residual) is classed as very large, large, moderate, slight or neutral and either beneficial or adverse significance.

- 9.3.4 Effects may be adverse and beneficial, direct or indirect, and permanent or temporary (including comments as to whether the effect could be reversed in the future). The duration of the effect may also be either 'short-term', 'medium-term' or 'long-term'. Short-term is considered to be up to 0 - 5 years, medium-term is considered to be between 5 and 15 years and long-term is considered to be greater than 15 years.
- 9.3.5 Approaches to mitigating potential impacts during construction and operational phases have been described with reference to good practice guidance and design.

Determining Importance of a Receptor

- 9.3.6 For the water environment, the 'importance' of a receptor rather than the 'sensitivity' of a receptor is most relevant, as sensitivity depends on the scale and dilution potential of a water body, which may be highest in the smallest of water bodies, which are typically the least important (e.g. field drainage ditches are more sensitive to pollution impacts than larger flowing watercourses). The importance of affected receptors has been considered on a scale of very high, high, medium, low or negligible. The importance of the receptor will be defined using the criteria in Table 9.1.

Table 9.1: Defining the importance/sensitivity of the receptor¹

Importance	General Criteria	Surface Water	Flood Risk	Hydromorphology ²
Very high	The receptor has little or no ability to absorb change without fundamentally altering its present character, is of very high environmental value, or of international importance.	Major salmonid fishery. Watercourse having a WFD classification as shown in a River Basin Management Plan (RBMP) and Q95 \geq 1.0 m ³ /s; site protected/ designated under international or UK habitat legislation (SAC, SPA, SSSI, WPZ, Ramsar Site. Critical social or economic uses (e.g. public water supply and navigation).	Essential Infrastructure or highly vulnerable development.	Unmodified, near to or pristine conditions, with well-developed and diverse geomorphic forms and processes characteristic of river and lake type.
High	Receptor of national or regional importance with a low ability to absorb change without fundamentally altering its present character.	Watercourse having a WFD classification as shown in a River Basin Management Plan (RBMP) and Q95 < 1.0m ³ /s; Major Cyprinid Fishery; species protected under international or UK habitat legislation. Critical social or economic uses (e.g. water supply and navigation). Important social or economic uses such as water supply, navigation or mineral extraction.	More vulnerable development.	Conforms closely to natural, unaltered state and will often exhibit well-developed and diverse geomorphic forms and processes characteristic of river and lake type. Deviates from natural conditions due to direct and/or indirect channel, floodplain, bank modifications and/or catchment development pressures.
Medium	Receptor of regional or local importance, with medium ability to absorb, adapt to or recover from change without significantly altering its present character.	Watercourse detailed in the Digital River Network but not having a WFD classification as shown in a RBMP. May be designated as a local wildlife Site (LWS) and support a small/ limited population of protected species. Limited social or economic uses.	Less vulnerable development.	Shows signs of previous alteration and/ or minor flow/ water level regulation but still retains some natural features or may be recovering towards conditions indicative of the higher category.
Low	The receptor is of local importance and tolerant of change without detriment to its character (i.e. has some ability to absorb, adapt to or recover from change).	Surface water sewer, agricultural drainage ditch; non-aquifer WFD Class 'Poor' or undesignated in its own right. Low aquatic fauna and flora biodiversity and no protected species. Minimal economic or social uses.	Water compatible development.	Substantially modified by past land use, previous engineering works or flow/ water level regulation. Watercourses likely to possess an artificial cross-sector (e.g., trapezoidal) and will probably be deficient in bedforms and bankside vegetation. Watercourses may also be realigned or channelised with hard bank protection, or culverted and enclosed. May be significantly

Importance	General Criteria	Surface Water	Flood Risk	Hydromorphology ²
				impounded or abstracted for water resources use. Could be impacted by navigation, with associated high degree of flow regulation and bank protection, and probable strategic need for maintenance dredging. Artificial and minor drains and ditches will fall into this category.
Negligible	Receptor is resistant to change and is of little or no environmental value.	Not applicable.	Not applicable.	Not applicable.

Note 1: Professional judgement is applied when assigning an importance category to all water features. The WFD status of a watercourse is not an overriding factor, and, in many instances, it may be appropriate to upgrade a watercourse which is currently at poor or moderate status to a category of higher importance to reflect its overall value in terms of other attributes and WFD targets for the watercourse. Likewise, a watercourse may be below Good Ecological Status, this does not mean that a poorer quality discharge can be emitted. All controlled waters are protected from pollution under the Environmental Permitting (England and Wales) Regulations 2016 and the Water Resources Act 1991 (as amended), and future WFD targets also need to be considered.

Note 2: Based on the water body 'Reach Conservation Status' presently being adopted for a major infrastructure project (and developed originally by Atkins) and developed from Environment Agency conservation status guidance as LA113 does not provide any criteria for morphology.

Determining the Magnitude of Change

- 9.3.7 The magnitude of change has been considered as the change experienced from the baseline conditions at the sensitive receptor and has been considered on a scale of large, medium, minor or negligible.
- 9.3.8 The magnitude of change will be determined based on the criteria in Table 9.2 taking into account the likelihood of the effect occurring. The likelihood of an impact occurring is based on a scale of certain, likely or unlikely. Likelihood has been considered in the case of water resources only, as likelihood is inherently included within the flood risk assessment.

Table 9.2: Determining magnitude of change

Level of Magnitude	Definition of Magnitude and Examples
Large Adverse	<u>Results in a loss of attribute and/ or quality and integrity of the attribute.</u> For example, loss of a fishery; decrease in surface water ecological or chemical WFD status or groundwater qualitative or quantitative WFD status. Loss of regionally important public water supply. Change in flood risk to receptor from low or medium to high.
Medium Adverse	<u>Results in impact on integrity of attribute, or loss of part of attribute.</u> For example, partial loss of a fishery; measurable decrease in surface water ecological or chemical quality, or flow; reversible change in the yield or quality of an aquifer; such that existing users are affected, but not changing any WFD status. Change in flood risk to receptor from low to medium.
Minor Adverse	<u>Results in some measurable change in attribute's quality or vulnerability.</u> For example, measurable decrease in surface water ecological or chemical quality, or flow; decrease in yield or quality of aquifer; not affecting existing users or changing any WFD status. Change in flood risk to receptor from no risk to low risk.
Negligible	<u>Results in impact on attribute, but of insufficient magnitude to affect the use or integrity.</u> For example, negligible change discharges to watercourse or changes to an aquifer which lead to no change in the attribute's integrity.
Minor Beneficial	<u>Results in some beneficial impact on attribute or a reduced risk of negative impact occurring.</u> For example, measurable increase in surface water ecological or chemical quality; increase in yield or quality of aquifer not affecting existing users or changing any WFD status. Change in flood risk to receptor from low risk to no risk.
Medium Beneficial	<u>Results in moderate improvement of attribute quality.</u> For example, measurable increase in surface water quality or in the yield or quality of aquifer benefiting existing users but not changing any WFD status. Change in flood risk to receptor from medium to low.
Large Beneficial	<u>Results in a major improvement of attribute quality.</u> For example, measurable increase in surface water quality or in the yield or quality of aquifer benefiting existing users leading to an improvement in WFD status. Removal of an existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse. Change in flood risk to receptor from high to medium or low.
No Change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Determining the Level of Effect

- 9.3.9 The importance of the receptor (Table 9.1) and the magnitude of change (Table 9.2) are determined independently from each other and are then used to determine the overall significance of effects (Table 9.3). The level of effect has been based on professional judgement and Table 9.3 has been a tool which has assisted with this process.

Table 9.3: Matrix for assessing significance of effect

Magnitude of Impact	Importance of Receptors				
	Very High	High	Medium	Low	Negligible
Large	Major	Major	Moderate or Major	Minor or Moderate	Negligible
Medium	Major	Moderate or Major	Moderate	Minor	Negligible
Minor	Moderate or Major	Minor or Moderate	Minor	Negligible to Minor	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
No Change	Negligible	Negligible	Negligible	Negligible	Negligible

9.3.10 Whilst Table 9.3 provides ranges, the level of effect is confirmed as a single level and not a range, informed by professional judgement. For each effect, it has been concluded whether the effect is 'beneficial' or 'adverse'. A statement is also made as to whether the level of effect is 'significant' or 'not significant', again based on professional judgement. Effects of moderate or greater are considered 'Significant' in EIA terms.

9.3.11 The following terms have been used to define the significance of the effects identified and these can be 'beneficial' or 'adverse':

- **Major effect:** where the Proposed Developments are likely to cause a considerable change from the baseline conditions and the receptor has limited adaptability, tolerance or recoverability or is of the highest sensitivity. This effect is considered to be 'significant';
- **Moderate effect:** where the Proposed Developments are is likely to cause either a considerable change from the baseline conditions at a receptor which has a degree of adaptability, tolerance or recoverability or a less than considerable change at a receptor that has limited adaptability, tolerance or recoverability. This level of effect is also considered 'significant';
- **Minor effect:** where the Proposed Developments are is likely to cause a small, but noticeable change from the baseline conditions on a receptor which has limited adaptability, tolerance or recoverability or is of the highest sensitivity; or where the Project is likely to cause a considerable change from the baseline conditions at a receptor which can adapt, is tolerant of the change or/and can recover from the change. This effect is considered 'not significant' but will be subject to professional judgement; and
- **Negligible:** where the Proposed Developments are is unlikely to cause a noticeable change at a receptor, despite its level of sensitivity or there is a considerable change at a receptor which is not considered sensitive to a change. This effect is 'not significant'.

9.3.12 Potential permanent impacts to the physical form of water bodies (e.g. a new bridge) will be assessed under the operation phase of the Proposed Developments. Where water bodies may be lost the construction works to remove them will not be reported as the loss of the feature will be the greater impact (and to avoid double reporting of the effect).

Study Area

9.3.13 The primary study area for the purposes of assessment within this chapter is the area within which there is likely to be direct flow pathways and impacts to surface water bodies or changes in flood risk. This area is approximately 1 km buffered from the Sites boundaries.

- 9.3.14 The study area includes the two Sites in which the Proposed Developments are located. The sites overlap slightly with the VPI Site covering 28.51 ha and the Phillips 66 Site 15.68 ha. The location of the Proposed Developments are shown in Figure 9.1 (ES Volume III).
- 9.3.15 For the purposes of determining the importance of the water features potentially impacted by the Proposed Developments it is sometimes necessary to also consider a study area extending beyond 1 km from the Sites' boundaries along watercourses. This is because there is the potential for impacts to watercourses on the Sites to propagate downstream, thus it is important to consider other attributes of these watercourses beyond the Proposed Developments boundaries when determining their importance.
- 9.3.16 Based on professional judgement and taking into account the type of development and the size of watercourses present, this study area comprises a few kilometres along watercourses from the Sites. The downstream catchment area immediately east and south of the Proposed Developments is comprised of agricultural areas, industrial estates associated with the Port of Immingham and the residential area of Immingham.
- 9.3.17 Additional indirect effects may also occur to other water environment receptors distant from the Study Area through increased demand on potable water supplies and foul water treatment.

Sources of Information/ Data

- 9.3.18 Desk based research has been undertaken to identify the waterbodies within and adjacent to the Proposed Developments, and to gather and critically evaluate relevant data and information on their condition and attributes. The key background reports, websites and data used for the desk-based baseline include the following data sources:
- NLC's Core Strategy (2011) (NLC, 2011);
 - British Geological Survey's Geological Mapping Viewer, 'Geoindex' (British Geological Society, no date (n.d.);
 - Environment Agency's Catchment Data Explorer (Environment Agency, (n.d.a);
 - Environment Agency's Guidance on discharges to surface water and groundwater: environmental permits (Environment Agency, 2016);
 - Environment Agency's Flood Risk Maps (Environment Agency, n.d.b);
 - Centre for Ecology and Hydrology (CEH)'s National River Flow Archive (CEH, n.d.);
 - Cranfield University's 'Soilscapes' (Cranfield University, n.d.);
 - Met Office's Climate averages data (Met Office, n.d.);
 - Defra's Multi-Agency Geographic Information for the Countryside (MAGiC) website (Defra, n.d.);
 - Ordnance Survey (OS) maps and aerial photography (Bing, n.d.);
 - data requested from the Environment Agency with regard flood risk, including flood extent mapping, extreme tidal still water levels, historic flood records and hazard, depth and velocity mapping;
 - Chapters 3 and 4 in ES Volume I and Appendix 9A in ES Volume II.

Site Visit

- 9.3.19 A site walkover was carried out in cold, dry conditions on the 27th January 2023 by an Associate Water Scientist from AECOM. The walkover made visual and olfactory observations of water quality, hydromorphology and habitats of the South Killingholme Drain from the VPI Site effluent discharge along Rosper Road and towards the ABP Immingham Port (where access was prohibited). The survey also included the reach of South Killingholme Drain that is proposed to be realigned from Rosper Road to where it emerges from a culvert beneath the refinery. Lastly, the hydrological connectivity of South Killingholme Drain with the Rosper

Roads Pools Local Wildlife Site (LWS) was also investigated. Please note that the site visit coincided with the ebb tide with water levels falling and flow leaving South Killingholme Drain into the estuary. Please refer to Appendix 9B WFD Screening for further details and some site photos.

Consultation

- 9.3.20 An EIA Scoping Opinion was requested from NLC in January 2022 (Appendix 1A ES Volume II). The response from NLC was received in February 2022 (see Appendix 1B in ES Volume II) and a summary of the comments relevant to this assessment are outlined in Table 9.4, along with indications of how they have been addressed within the ES.

Table 9.4: Summary of consultation responses that have informed the scope and methodology of the surface water environment assessment

Consultation Response	Response Provided in the ES	Relevant Section of Chapter/ ES
Environment Agency		
We note that risk of pollution to surface watercourses within or near the Sites during construction and operation will be included within the scope of the EIA. This should include detailed risk assessment of the construction and operation of the proposed CO ₂ pipeline that will link the two sites as indicated in Figure 6 (page 82) of the [EIA Scoping] report. The indicative pipeline route appears to cross a tributary of the North Killingholme Main Drain. Appropriate mitigation measures during the construction and operational phase of the development should be identified to protect water quality in this tributary plus the designated wildlife sites identified further downstream	Risk of pollution to surface waters included within this chapter.	Chapter 9 (this chapter)
Section 6.5.4 [of the EIA Scoping Report] refers to pollution risk due to possible effluent treatment plants. The applicant should investigate the practicality of discharging either industrial or ‘domestic’ effluent from the site(s) to the main Anglian Water sewerage system	The Phillips 66 Site drains to the main Humber Refinery effluent treatment plant, which is existing infrastructure, and therefore the most suitable treatment option. The Proposed VPI Development will utilise the existing plant treatment for ‘domestic’ sewage which currently ties into the Anglian Water sewerage system.	Chapter 3: Proposed Developments Description, Need and Alternatives
With reference to water resource quantity, rather than quality, the applicant should be aware that water availability is a major constraining factor for industrial development in this area. This is because the Catchment Abstraction Management Strategy that covers the South Humber Bank states that “ <i>the groundwater unit balance shows more water has been abstracted based on recent amounts than the amount available. We (the EA) will not grant further consumptive licences.</i> ”	Water consumption has been minimised as part of the Proposed Developments as both propose air cooling rather than water cooling as far as possible. The additional water demand will be obtained through Anglian Water rather than abstracting from groundwater.	Chapter 3: Proposed Developments Description, Need and Alternatives
The FRA should consider all sources of flooding, which may include tidal, fluvial, ground water, drainage systems, reservoirs, canals and ordinary watercourses. The FRA should	A FRA has been developed that considered all sources of flooding.	Appendix 9A: FRA.

Consultation Response	Response Provided in the ES	Relevant Section of Chapter/ ES
<p>demonstrate that the proposed development will be safe for its lifetime, without increasing risk elsewhere and where possible reducing flood risk overall. The FRA should also provide evidence that appropriate mitigation measures including flood resilience techniques have been incorporated into the development</p>		
<p>The Environment Agency’s Hazard Mapping should be used to inform the FRA. Our Hazard Mapping shows the consequences should a breach or overtopping of our sea defences occur, including the likely flood depths, velocities and overall hazard that could impact the Sites over its lifetime. The modelled depths vary considerably across the Sites</p>	<p>The FRA considered breach and overtopping of the sea defences.</p>	<p>Appendix 9A: FRA</p>
<p>The FRA should identify the vulnerability classification of the proposal, the expected lifetime of the development and whether the Sites needs to remain operational in case of flooding. For development defined as essential infrastructure, we advise that all critical infrastructure and equipment should be located above the modelled flood depth in case of a breach during a 0.1% (1 in 1000) annual probability event, including climate change depending on lifetime of development.</p>	<p>The FRA and the ES has considered the flood risk vulnerability of the Proposed Developments</p>	<p>Chapter 9 (this chapter) and Appendix 9A: FRA</p>
<p>Finished floor levels generally should be raised as high as practicable and, if these will be below the flood depth, suitable flood resistance/ resilience measures identified with consideration of operational needs. Single storey buildings should be built with finished floor levels above the predicted flood depth (referring to the tidal hazard map for the 0.5% annual probability event breach scenario, allowing for climate change). If this is not practicable an area of safe refuge will need to be provided (preferably) or an appropriate flood warning and evacuation plan submitted to and approved by the local planning authority.</p>	<p>The FRA has considered flood depths and suitable mitigation</p>	<p>Appendix 9A: FRA.</p>
Natural England		
<p>The assessment should take account of the risks of water pollution and how these can be managed or reduced. A number of water dependent protected nature conservation sites have been identified as failing condition due to elevated nutrient levels and nutrient neutrality is consequently required to enable development to proceed without causing further damage to these sites. The ES needs to take account of any strategic solutions for nutrient neutrality or Diffuse Water Pollution Plans, which may be being developed or implemented to mitigate and address the impacts of elevated nutrient levels. Further information can be obtained from the Local Planning Authority.</p>	<p>Nutrient neutrality is not considered a requirement for the Proposed Developments as they are not located within the catchment of a designated site where such measures apply. However, water pollution risks are considered in terms of the construction, operation and decommissioning of the Proposed Developments.</p>	<p>Chapter 6: Air Quality and Chapter 9: Section 9.6</p>

9.4 Baseline Conditions

- 9.4.1 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 each Site and in the surrounding area to identify potential receptors. These are known as the existing baseline conditions. The data sources used to determine the baseline conditions are summarised in Section 9.3.
- 9.4.2 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, Operation and Decommissioning).
- 9.4.3 Natural catchment characteristics are typically controlled by variations in land use, rainfall, hydrology, geology and soils, and topography, and these are described below. The site context and surface water features are shown on Figure 9.1.

Land Use

- 9.4.4 The Sites and the existing land use are described in Chapter 2: Site and Surroundings, a summary is provided below.

Phillips 66 Site

- 9.4.5 The Phillips 66 Site is largely within the operational Humber Refinery, but also includes land to the east of the Refinery for pipeline and cable connections, including part of the railway line which will be crossed by these connections.
- 9.4.6 The existing land use of the Phillips 66 Site is generally associated with the operational Humber Refinery, and includes open storage and temporary uses (e.g. site cabins), car parking and vacant land.

VPI Site

- 9.4.7 The VPI Site includes the operational VPI Immingham CHP Plant site and land to the south of the operational CHP Plant, accessed from Rosper Road.
- 9.4.8 The area for the proposed VPI PCC plant is to the south of the existing CHP Plant and comprises grassland with an open drain (South Killingholme Drain) running through the centre (Plate 9.1), with areas of hardstanding and existing below ground utilities. The area was previously used for laydown during the construction of the CHP Plant.
- 9.4.9 The VPI Site is within and immediately to the south of the operational VPI Immingham CHP Plant, accessed from Rosper Road and separated from the majority of the Phillips 66 Site by the Network Rail railway line.
- 9.4.10 The existing land use of the VPI Site is grassland, areas of hardstanding (previous laydown area) existing below ground utilities, and a drain (South Killingholme Drain).



Plate 9.1. Vegetation surrounding the South Killingholme Drain

Surrounding Land-Use

9.4.11 Table 9.5 summarises the key features and current land use of the surrounding area of the Sites. This is a review of desk-based sources including aerial photography.

Table 9.5: Summary of current surrounding land use of the Sites

Direction	Summary
North	There are fields and areas of hardstanding associated with car parks and a few isolated ware-house buildings within 500 m north of the Sites. Land to the north-east, mostly consists of agricultural fields, a factory located 800 m from the Sites and areas of hardstanding located approximately 1.4 km north and north-east. These areas of hardstanding are associated with vehicle storage facilities, car dealerships and car brokers. A large-scale industrial site is located approximately 350 m north-west of the Sites boundary which extends for over 1.5 km. Infrastructure associated with this include railway lines, pipelines and tanks. Several drains and small surface water features are identified on OS maps within 1 km.
West	Eastfield Road is located immediately to the west of the Phillips 66 Site. A large building assumed to be a warehouse, car parks and a building are located approximately 60 m west from the Phillips 66 Site. Google Maps satellite imagery indicates the area surrounding the warehouse consists of hardstanding and lorry trailer storage. A further lorry trailer storage site and associated buildings is located approximately 60 m south-west from the Phillips 66 Site. A surface water feature is denoted approximately 220 m south-west. Beyond this, the land use mostly consists of agricultural/ open fields, until the village of South Killingholme which is located approximately 440 m west from the Phillips 66 Site. Land use beyond South Killingholme consists of agricultural land. Several drains are identified on OS mapping within 1 km.

Direction Summary

South	<p>A dual carriageway road (A160 Humber Road) is located immediately south of the Sites and is orientated east to west parallel to the southern Sites border. This road adjoins to Manby Roundabout located immediately south-east from the Sites. Humber Road is located adjacent to the southern Sites' boundary and is orientated north-east to south-west. This adjoins to Rosper Road Immingham West Fire Station is located approximately 100 m south-east of the Sites. Roads to the east of Manby Roundabout adjoin to the ABP Immingham Dock West Gate. Further industrial infrastructure comprising tanks, drains and pipelines is located within 100 m south of the Sites. Large scale buildings associated with a depot are located approximately 140 m south-east from the southern Sites' boundary. Agricultural fields and open countryside are located beyond the industrial land use. The town of Immingham is located 1.85 km south-east from the Sites. Drains are identified on OS mapping within 1 km. Beyond this, the land is dominated by agriculture.</p>
East	<p>Rosper Road is located immediately adjacent to the eastern Sites' boundary orientated north-west to south-east. The road continues into Humber Road and separates into a branch of Humber Road, orientated north-east to south-west. Beyond this, land use mostly consists of agricultural fields. The artificial Rosper Road Pools are located 130 m east of the VPI Site and 500 m east of the Phillips 66 Site. Further drains are also shown within 1 km. Industrial land use is located approximately 600 m south-east of the Sites associated with coal storage, haulage, depots, warehouses and the Immingham Port Ferry Terminal located approximately 1.8 km east of the Sites. Beyond the terminal lies the Humber Estuary which flows northwest to southeast. Immingham Dock and infrastructure associated with tanks and oil refineries is located approximately 2.4 km south-east.</p>

Source: Google Maps (Google, n.d.), Envirocheck Report (285387654_1_1) (Envirocheck, Envirocheck Report 285387654_1_1, 2021) and Envirocheck Report (292199669_1_1) (Envirocheck, Envirocheck Report 292199669_1_1, 2022)

Topography

VPI Site

- 9.4.12 The topography of the VPI Site has been obtained from OS mapping and LiDAR imagery, and is generally flat and low-lying at an elevation of below 10 mAOD. The VPI Site increases in elevation to the west, with a low point of approximately 2.7 mAOD adjacent to Rosper Road and a high point of approximately 6.2 mAOD at the western edge of the VPI Site.

Phillips 66 Site

- 9.4.13 The topography of the Phillips 66 Site has been obtained from OS mapping and LiDAR imagery, and is generally flat and low-lying. The proposed Phillips 66 PCC plant area is on slightly higher ground to the main Humber Refinery, at an elevation of 9.0-13.4 mAOD. The remainder of the Phillips 66 Site is at an elevation of 6-7 mAOD.

Rainfall

- 9.4.14 The nearest weather station on the Met Office website (Met Office, n.d.) with historical data is located at Hull, approximately 14.5 km north of the northern extents of the Sites, at NGR TA090293. Based on the average climate data ((for the period 1991 to 2020 (as the most recent data available)) for this weather station, it is estimated that the Study Area experiences an average of 693 mm of rainfall per year, with it raining more than 1 mm on around 125 days per year. This is a relatively low level of rainfall for England. For more information on storm rainfall events see Appendix 9A: FRA (ES Volume II).
- 9.4.15 The average rainfall varies throughout the year, with the wettest period being in the late summer to autumn, and driest in late winter to early spring. Average monthly rainfall is generally less than 65 mm throughout the year, except in June, October and November when it is between 66 and 70 mm. March is the driest month with an average of approximately 43 mm between 1991 and 2020.

Geology

- 9.4.16 Information on the solid and superficial geology of the study area is described in Chapter 10: Geology, Soils and Contamination (ES Volume I), this is summarised below.

VPI Site

- 9.4.17 Table 9.6 outlines the published geology beneath the VPI Site.

Table 9.6: Geology and soils beneath the VPI Site

Stratum		Expected Location
Soils		The soils overlying the Tidal Flat Deposits on the VPI Site are described as “loamy and clayey soils of coastal flats with naturally high groundwater” on Soilscales. The soils overlying Devensian Till (Diamicton) are anticipated to be “slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils”.
Artificial ground	Made Ground	Although the BGS GeoIndex map for Artificial Ground indicates there is no Made Ground on the VPI Site, it is anticipated that Made Ground will be present beneath the existing VPI Immingham CHP Plant in the north of the VPI Site.
Superficial deposits	Tidal Flat Deposits – Clay and Silt	The southern half of the VPI Site (undeveloped area of the VPI Site), apart from a small area in the south and a small area adjacent to the north-west to south-east trending VPI Site boundary. The deposits are also anticipated in the north-east corner of the VPI Site.
	Till, Devensian – Diamicton	The entire VPI Site, underlying the Tidal Flat deposits.
Bedrock	Burnham Chalk Formation	The entire VPI Site, underlying the Devensian Till deposits.

Source: BGS GeoIndex (British Geological Survey, 2022a) and BGS Lexicon of Named Rock Units (British Geological Survey, 2022b)

Phillips 66 Site

- 9.4.18 Table 9.7 provides a summary of the published geology beneath the Phillips 66 Site.

Table 9.7: Geology and soils beneath the Phillips 66 Site

Stratum		Expected Location
Soils		The soils overlying the Devensian Till (Diamicton) deposits across the entire Phillips 66 Site are described as “slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils”. The soils that may be present on the northern Phillips 66 Site boundary, underlain by Tidal Flat Deposits (Clay and Silt) are described as “loamy and clayey soils of coastal flats with naturally high groundwater” with a loamy and clayey texture and naturally wet drainage. The soils which overlap into the VPI Site parallel to the railway lines and beneath the existing track are also described as “loamy and clayey soils of coastal flats with naturally high groundwater” with a loamy and clayey texture and naturally wet drainage.
Artificial Ground	Made Ground	The BGS GeoIndex Artificial Ground map does not indicate that Made Ground is present on the Phillips 66 Site. However, it is anticipated that Made Ground will be present across the Phillips 66 Site.

Stratum		Expected Location
Superficial Deposits	Tidal Flat Deposits – Clay and Silt	A thin strip encroaching on the northern Phillips 66 Site boundary in the east of the Phillips 66 Site underlying the railway lines and sidings. and a small area of vegetated land that overlaps with the VPI Site. A small area of vegetated land that overlaps with the VPI Site and the existing track in the VPI site are also underlain by Tidal Flat Deposits.
	Till, Devensian – Diamicton	The entire Phillips 66 Site, underlying the Tidal Flat deposits.
Bedrock	Bedrock: Burnham Chalk Formation	The entire Phillips 66 Site, underlying the Devensian Till deposits.

Source: BGS GeoIndex (British Geological Survey, 2022a) and BGS Lexicon of Named Rock Units (British Geological Survey, 2022b)

9.4.19 ES Chapter 10: Geology, Hydrogeology and Land Contamination provides more information.

Hydrogeology

9.4.20 The aquifer designations for the VPI Site and Phillips 66 Site are provided in Table 9.8 below

Table 9.8: Aquifer designations within the VPI Site and Phillips 66 Site

Strata	Relevant Feature	Aquifer Designation
Tidal Flat Deposits (Clay and Silt)	Superficial Aquifer Designation	Unproductive Aquifer
Devensian Till (Diamicton)	Superficial Aquifer Designation	Secondary Undifferentiated Aquifer
Burnham Chalk Formation	Bedrock Aquifer Designation	Principal Aquifer

Source: Envirocheck Report (2021; 2022)

9.4.21 ES Chapter 10: Geology, Hydrogeology and Land Contamination provides more information.

Surface Water Features

9.4.22 The Proposed Developments are located close to the mouth of the Humber Estuary, and the local area is drained by a number of short watercourses which form part of a coastal ditch system, with limited catchment areas.

9.4.23 The following surface water features have been identified within the 1 km study area, and also considering the wider study area where hydrological connections may exist:

- North Beck Drain;
- South Killingholme Drain;
- South Killingholme Drain Branch 1;
- Local drains;
- Humber Estuary; and
- Rosper Road Pools.

9.4.24 These are shown on Figure 9.1 (ES Volume III) and are described below.

9.4.25 The Environment Agency's Catchment Data Explorer website (Environment Agency, n.d) confirms that the coastal water body in the Study Area is contained within the Humber River Basin District, the Humber Transitional and Coastal (TraC) Management Catchment, and the Humber Estuary TraC Operational Catchment.

- 9.4.26 The fluvial water bodies surrounding the Sites are contained within the Humber River Basin District, Louth Grimsby and Ancholme Management Catchment and ultimately the Becks Northern Operational Catchment. The catchment covers an area of 839.9 km².
- 9.4.27 There are two WFD designated surface water bodies local to the Study Area, one estuarine water body (Humber Lower water body) and one river (North Beck Drain).
- 9.4.28 The WFD attributes of these waterbodies are contained in Table 9.10.

North Beck Drain

- 9.4.29 The Study Area is located in the North Beck Drain WFD Catchment which covers an area of approximately 56.65 km². North Beck Drain (EA water body I.D.GB104029067575) is an EA Main River and is located approximately 4.8 km south-east from the Sites. North Beck Drain flows from the south-west to north-east discharging into the Humber Estuary at TA 21548 15278. North Beck Drain is designated as a heavily modified water body.
- 9.4.30 Although the Study area is located within the North Beck Drain Catchment there are no hydrological connections with the Study Area, as both Proposed Developments are located within the catchment of South Killingholme Drain which flows directly to the Humber Estuary, therefore the North Beck Drain is not considered further in the assessment. Please refer to Appendix 9B Water Framework Directive: Screening for further consideration of this.

South Killingholme Drain and South Killingholme Drain Branch 1 (also known as Watercourse 9 and 9A)

- 9.4.31 South Killingholme Drain is an Ordinary Watercourse that falls under the jurisdiction of the North-East Lindsey Internal Drainage Board (IDB).
- 9.4.32 The watercourse is comprised of two drains noted as South Killingholme Drain (Watercourse 9 on NELIDB mapping) and South Killingholme Drain Branch 1 (Watercourse 9A on NELIDB mapping), as shown on Figure 9.1.
- 9.4.33 The main channel (Watercourse 9 – South Killingholme Drain) flows from north to south parallel to Rosper Road, near to the eastern boundary of the VPI Site. The watercourse continues to flow south towards Humber Road where it turns generally east flowing to the north of the Port of Immingham. The watercourse discharges to the Humber Estuary at South Killingholme Haven within the port area. Access into the port has been restricted but we believe that this discharge is via sluice gates. Either way, when the tide is high the flow in the watercourse is prevented from discharging and the watercourse is effectively ‘tide locked’. This has a significant effect on the flow regime. The other major control on the flow regime is the dominance of surface water runoff and treated effluent from industrial sites, which it is estimated may make up around 97% of the flow. Upstream of the Phillips 66 refinery the feeder channels to the South Killingholme Drain and modified and ephemeral.
- 9.4.34 The watercourse has an open hydrological connection to the Rosper Road Pools Local Wildlife Site via a shallow weir that may be 0.2 m high. Water flows into the pools when the flow to the estuary is tide locked and there is a high volume of surface water runoff. The frequency of this occurrence is not known. Please refer to the photographs available in Appendix 9B Water Framework Directive: Screening.
- 9.4.35 A branch of the watercourse (Watercourse 9A - South Killingholme Drain Branch 1) flows in an open channel across the VPI Site from the railway line from west to east where it emerges from a culvert under the refinery Site. The watercourse passes out of the VPI Site beneath Rosper Road via short, twin arch culverts and into the main channel of the South Killingholme Drain (i.e. Watercourse 9 on NELIDB mapping). This watercourse originates to the west of the Phillips 66 Humber Refinery near South Killingholme, where it flows adjacent to Humber Road prior to flowing north and east through the Humber Refinery and beneath the railway line (in culvert), returning to open channel as it crosses the VPI Site. The channel is culverted in multiple locations upstream of and within the Phillips 66 Site.

- 9.4.36 Photographs from a site visit undertaken of the VPI Site show that the South Killingholme Drain Branch 1 is a heavily modified, trapezoidal watercourse with little variation in flow and habitat type. The banks are well vegetated, but are steep and over deep, and so it is not expected that there would be any significant lateral connectivity between the channel and its floodplain. Information presented in the FRA indicates that the bed material was 50 mm to 75 mm of black sludge of organic material, beneath which is a soft sticky brown clay with some sand. This becomes firm between 25 mm and 50 mm and is assumed to be puddle clay. The base of the initial section of the drain within the VPI Site was found to be hard and may be concrete lined.
- 9.4.37 South Killingholme Drain and Branch 1 have a direct hydrological connection to both the VPI Site and the Phillips 66 Site via the existing and future site discharges.
- 9.4.38 Historic maps (NLS, n.d.) indicates there have been changes to the upstream catchment and channel of the drain since available maps of the area from 1892-1914. The outfall historically received flows from the catchment of the NELIDB Harborough Marsh Drain Branch 4, however this channel and associated catchment upstream Manby Road was diverted south with the construction of the port railway. South Killingholme Marsh Drain and Branch 1 are shown on historic maps, however they both appear to be agricultural drains given the straight planform and alignment with field boundaries. South Killingholme Drain Branch 1 historically flows through the Phillips 66 Site and was diverted south around the Phillips 66 Site. Therefore, based on historic maps and observations on site, the catchment is heavily modified and the South Killingholme Drains are partially or entirely artificial, with only a 1 km reach upstream of the coast being a 'natural' stream channel.

Local Drains

- 9.4.39 A number of small unnamed land drains run parallel with the Humber Refinery boundary and the area surrounding the Sites. The area surrounding the Phillips 66 and VPI Sites is drained via a network of small land drainage ditches that convey surface water from the surrounding greenfield areas via South Killingholme Drain, or via other adjacent artificial IDB waterbodies.

Wider Land Drainage Network

- 9.4.40 A series of land drains are located to the north and west of the Study Area and form part of the wider land drainage network in the area. These smaller land drainage channels generally direct flow north of the Study Area discharging to Skitter Beck/ East Halton Beck. Based on aerial imagery, mapping available via the IDB and knowledge of the VPI Site it is considered that the Study Area is not hydrologically connected to this wider drainage network and therefore these water features are not considered further in this assessment.

Humber Estuary

- 9.4.41 The Humber Estuary is split into three WFD waterbodies by the Environment Agency. These are the Upper Humber (Trent Falls to the Faxfleet Ness), the Middle Humber (Faxfleet Ness to Goxhill Haven), and the Lower Humber (Goxhill Haven to Spurn Point). The Study Area and surrounding watercourses naturally drain and outfall to the Lower Humber water body, which has been considered in this assessment.
- 9.4.42 The Humber Estuary has a large tidal range (7.2 m), due to its position within the North Sea basin, producing a mean spring tidal range of 5.7 m at Spurn. The tidal range is amplified as it propagates up the Estuary; being 7.4 m at Salt End, and 6.9 m at Hessle (being 45 km inland). It is because of these large tidal ranges that the Humber is classified as a macro-tidal Estuary.
- 9.4.43 It is considered that the Humber Lower has an indirect hydrological connectivity with the Study Area via the South Killingholme Drain (Watercourses 9 and 9A).

Rosper Road Pools

- 9.4.44 Rosper Road Pools is an Artificial Flood Relief Reservoir that is located to the south-east of the Sites, to the east of Rosper Road (see Figure 9.1). Although artificial, the Pools provide bird habitats and are designated as a Local Wildlife Site (LWS) (see Chapter 13: Ecology for more information).
- 9.4.45 This surface water feature has an indirect hydrological connectivity with the Sites via South Killingholme Drain and Branch 1 (i.e. NELIDB Watercourse 9 and 9A). When there is a high flow along the drains and the tide is preventing flows into the estuary, water levels may rise and if sufficient may flow over a shallow weir into Rosper Road Pools. A return outfall back into the South Killingholme Drain is present a short distance downstream, although its function may be impeded by siltation in the pools.

Surface Water Features Summary

- 9.4.46 The location and relevance of each watercourse with respect to the Sites are summarised in Table 9.9 below.

Table 9.9: Identified surface waterbodies for the Sites

Water feature	Type of water feature	Location	Hydrological connection	
			VPI Site	Phillips 66 Site
Local Drains	Artificial drains (Ordinary Water-courses)	Running parallel with and directly adjacent to the southern VPI Site boundary.	Yes	No
		Running parallel with and directly adjacent to the eastern VPI Site boundary and Rosper Road.	Yes	No
		Running parallel with and directly adjacent to the northern VPI Site boundary.	Yes	No
		Running VPI parallel with and directly adjacent to the western VPI Site boundary.	Yes	No
		Beyond the Phillips 66 Site boundary, approximately 48 m west of the proposed Phillips 66 PCC plant development area, located to the west of Eastfield Road, running parallel with and directly adjacent to the road corridor.	No	Yes
		Located between the southern Phillips 66 Site boundary and the Humber Road	No	Yes
South Killingholme Drain Branch 1	IDB land drain (NELIDB Water-course 9A)	Running parallel with and directly adjacent to the railway line, and flows from the Phillips 66 Site through the VPI Site in open channel.	Yes	Yes
South Killingholme Drain	IDB land drain (NELIDB Water-course 9)	Immediately beyond the eastern boundary of the VPI Site, to the east of Rosper Road.	Yes	Yes
Rosper Road Pools	Artificial flood relief reservoir	Located approximately 130 m east of the VPI Site, likely receiving flows from South Killingholme Drain	Yes	Yes
Humber Estuary (Humber Lower)	Estuarine WFD designated Main River	Located approximately 1.5 km to the east of the VPI Site Phillips 66 Site	Yes	Yes
Water Storage Lagoon	N/A	Located in the south-east corner of the Humber Refinery, south of the Phillips 66 Site. Approximately 50 m to the west of the VPI Site.	N/a	N/a

Water feature	Type of water feature	Location	Hydrological connection	
			VPI Site	Phillips 66 Site
		The artificial settling ponds are associated with the industrial buildings, and are not considered as a separate receptor, and instead form part of the drainage network.		
Series of local drains that drain to Marsh Drain	Artificial drains (ordinary water-courses)	Approximately 50 m to the west of the VPI Site	No	No
		Approximately 120 m to the north of the VPI Site	No	No
North Beck Drain	WFD designated Main River	Approximately 4.8 km south-east from the Sites boundaries, with no hydrological connection.	No	No

9.4.47 Only those water features that have been identified above as having a hydrological connection with the VPI Site or the Phillips 66 Site will be taken forward through the impact assessment.

Water Framework Directive

9.4.48 There are two WFD designated surface water bodies local to the Study Area, one estuarine water body (Humber Lower water body) and one river (North Beck Drain). The WFD attributes of these waterbodies are contained in Table 9.10 below and shown on Figure 9.2.

9.4.49 The classification of waterbodies is reported in the 2019 Cycle 2 of the RBMP, however these classifications remain valid for the 2022 WFD Cycle 3. The Humber RBMP (EA, 2015) assesses the pressures facing the water environment in the Humber River basin district and lists actions to address them.

Table 9.10: Water Framework Directive waterbodies and attributes (WFD Cycle 3, 2019)

Water body Name (ID)	North Beck Drain (GB104029067575)	Humber lower water body (GB530402609201)
Operational catchment	Becks Northern	Humber Estuary TraC
Water body type	River	Transitional water
Hydromorphological designation	Heavily modified	Heavily modified
Current Status/ Potential (2019)	Ecological Moderate	Moderate
	Chemical Fail	Fail
	Overall Moderate	Moderate
Chemical Failing Elements	Mercury and its Compounds, PBDE	Benzo(g-h-i) perylene, Benzo(b)fluoranthene, Mercury and its Compounds, PBDE, PFOS, Tributyltin Compounds, Cypermethrin, Dichlorvos
Reasons for not achieving good status	Suspect data, flow	Physical modification, Suspect data.
Objectives	Good by 2027	Good by 2027

- 9.4.50 Some surface water bodies are designated as ‘artificial’ or ‘heavily modified’. This is because they may have been created or modified for a particular use such as water supply, flood protection, navigation or urban infrastructure.
- 9.4.51 According to the Humber RBMP, artificial and heavily modified waterbodies are not able to achieve natural conditions. Instead, the classification and objectives for these waterbodies, and the biology they represent, are measured against ‘ecological potential’ rather than status. For an artificial or heavily modified water body to achieve good ecological potential, the chemistry must be ‘good’. Chemical status is assessed by compliance with the environmental standards for Priority Substances as listed in The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. Chemical status is recorded as either ‘good’ or ‘fail’, in terms of whether the chemical status is compliant with environmental standards.
- 9.4.52 In addition, any modifications to the structural or physical nature of the water body that harm biology must only be those essential for its valid use. All other such modifications must have been altered or managed to reduce or remove their adverse impact, so that there is the potential for biology to be as close as possible to that of a similar natural water body. Often though, the biology will still be impacted, and biological status of the water body may be less than ‘good’. The ecological status takes into account physio-chemical elements, biological elements, specific pollutants and hydromorphology. Further ecological assessments of effects for the Humber Estuary are included in Chapter 9: Ecology (ES Volume I).

Lower Humber

- 9.4.53 The stretch of the Humber Estuary nearest to the Sites (defined in the WFD as ‘GB530402609201 – Lower Humber’) is classified as a transitional water and a heavily modified watercourse due to flood protection and navigation modifications.
- 9.4.54 The Humber RBMP Cycle 2 (2019) classifies the Lower Humber water body as currently being at moderate ecological potential. The water body is currently failing to meet Good Chemical Status under the WFD Cycle 2 classifications (2019) due to failures for Benzo(g-h-i)perylene, Benzo(g-h-i)perylene, Mercury and Its Compounds, Perfluorooctane sulphonate (PFOS), Polybrominated diphenyl ethers (PBDEs) and Tributyltin Compounds. All other priority substances, priority hazardous substances, specific pollutants and other pollutants are at Good status or higher, or have not been assessed, and a fail for chemical status. As such, the current overall potential is moderate, with an objective of maintaining moderate overall potential by 2027.
- 9.4.55 The reasons cited for the continued failure of the water body to meet its WFD objectives include disproportionate cost and technical infeasibility.
- 9.4.56 A number of mitigation measures relating to port activities are already ‘in place’ within the Lower Humber water body, these include:
- managing disturbance;
 - site selection (dredged material disposal), e.g. to avoid sensitive areas;
 - sediment management;
 - reduce sediment resuspension;
 - reduce impact of dredging; and
 - prepare a dredging/ disposal strategy.
- 9.4.57 The Humber Estuary has high suspended sediment content, derived from the eroding boulder clay cliffs along the Holderness coast, but also from riverine sediments. Within the vicinity of the Sites, the Humber Estuary is not classified for bathing water quality. The nearest bathing water monitoring point is at Cleethorpes approximately 16 km south-east of the Sites.

Other Water Features

- 9.4.58 South Killingholme Drain (including Branch 1) and other local land drains are not designated under the WFD in its own right but as part of North Beck Drain (GB104029067575). However, it has no known hydrological connection to this watercourse, and the influence of industrial drainage, management by the IDB, and tide locking conditions, mean that the WFD classification for North Beck Drain may not be a true reflection of the status of this watercourse.
- 9.4.59 Irrespective of the fact that South Killingholme Drain is included within the catchment of North Beck Drain WFD water body catchment, where a watercourse is not designated itself, the downstream WFD water body would usually be used as the proxy for WFD classification. However, this is the Humber Lower transitional water body, which has a significantly and materially different character to South Killingholme Drain, and thus the estuaries WFD classifications are not representative of the South Killingholme Drain.
- 9.4.60 The other standing water features (e.g. the Rosper Road Pools and water storage lagoon) are not classified under the WFD.

Water Quality

South Killingholme Drain

- 9.4.61 There is an Environment Agency water quality monitoring on South Killingholme Drain, just upstream of its crossing at Rosper Road (TA 17125 17002). Table 9.11 shows results from this monitoring station for key indicators of water quality, from January 2015 – January 2020 (note that some majority of water quality data is from 2015-2017, and no data available past 2020).

Table 9.11: Water quality indicators from South Killingholme Drain (EA monitoring data, 2015-2020)

Determinand	Average	Minimum	Maximum
pH	8.22	7.96	8.50
Temperature of Water (°C)	19.5	9.0	27.8
Conductivity at 25 °C (µs/cm)	2621	1816	3263
Biochemical Oxygen Demand (mg/l)	3.04	1.03	8.30
Chemical Oxygen Demand (mg/l)	69	44	138
Ammoniacal Nitrogen as N (mg/l)	0.966	0.034	7.33
Nitrogen, Total Oxidised as N (mg/l)	15.6	5.0	31.4
Nitrate as N (mg/l)	15.4	4.8	31.1
Solids, Suspended at 105 °C (mg/l)	14	3	179
Hardness, Total as CaCO ₃ (mg/l)	451	183	889
Alkalinity to pH 4.5 as CaCO ₃ (mg/l)	657	476	848
Sulphide as S (mg/l)	0.011	0.010	0.016
Orthophosphate, reactive as P (mg/l)	0.404	0.138	1.06
Oxygen, Dissolved, % Saturation (mg/l)	84.2	31.3	132.3
Oxygen, Dissolved as O ₂ (mg/l)	7.67	2.92	11.40

Notes:

The Environment Agency sampling point and Rosper Road includes inputs of surface water from and process effluent/surface water from VPI Immingham CHP Power Station. It is believed that similar flows from the Lindsey Refinery do not enter this watercourse (anecdotal information from site staff).

Results reported as less than the limit of detection have been entered as the limit of detection in calculating the average.

- 9.4.62 The data indicates that the water quality of South Killingholme Drain a relatively high pH, high alkalinity and high conductivity, likely due to the existing discharges to the watercourse (see Water Resources section below).
- 9.4.63 An Environmental Risk Assessment for South Killingholme Drain has been carried out for the permit for Phillips 66 Humber Refinery (Wood, 2022). This was supported by monitoring undertaken in South Killingholme Drain towards the outfall to Humber Estuary (i.e. NGR TA 1860 1702). The results indicate that there may be some saline intrusion into the lower reaches of South Killingholme Drain, due to high chloride levels, despite it being assumed that there is a tidal valve on the outfall (access has not been possible into the port). The water quality results indicate that the current water quality exceeds Environmental Quality Standards (EQS) for some metals, PAHs, PFOS and other determinands. This indicates that the South Killingholme Drain is acting largely as an effluent channel taking industrial discharges and surface water runoff from a range of industrial activities and land uses between South Killingholme and the Humber Estuary. Significant dilution of the existing effluent discharges does not take place until the flow meets the waters of the Humber at South Killingholme Haven.
- 9.4.64 It is recommended that additional water quality monitoring of South Killingholme Drain and other waterbodies is carried out to support the outcomes of the assessment.

Other Surface Waterbodies

- 9.4.65 There is no known water quality information for the local land drains, other waterbodies on site or the Rosper Road Pools. It is recommended that water quality monitoring of Rosper Road Pools is carried out.

Flow Rates

- 9.4.66 South Killingholme Drain is currently not monitored for flow rate of levels, therefore the discharge within the drain is estimated from available information. The Environmental Risk Assessment (Woods, 2022) estimated the runoff flow rates (excluding effluent discharges) within South Killingholme Drain at the outfall using Wallingford Hydro Solutions (WHS) LowFlow estimate. This estimated the runoff rate for a low flow event (Q_{95}) South Killingholme Drain as $0.002 \text{ m}^3/\text{s}$ (2 l/s) and $0.007 \text{ m}^3/\text{s}$ (7 l/s) for an average flow rate (Q_{50})¹. The current average daily surface water and effluent discharge rate to South Killingholme Drain from Phillips 66 and VPI is $0.117 \text{ m}^3/\text{s}$ (117 l/s) and $0.114 \text{ m}^3/\text{s}$ (114 l/s) respectively. Therefore, the average flow rate within South Killingholme drain is estimated to be $0.238 \text{ m}^3/\text{s}$ (238 l/s) at the catchment outfall, of which 97% is derived from Phillips 66 and VPI. This does not take into account any additional industrial discharges within the catchment (see Water Resources section).
- 9.4.67 The flow rate within the Humber Estuary is difficult to quantify, given that it is an estuary and therefore receives flows from the freshwater catchment as well as tidal flows. The main freshwater inputs to the Humber Estuary are from the River Ouse and Trent. The average freshwater inflow to the Humber Estuary is estimated to be between $200 \text{ m}^3/\text{s}$ (National Rivers Authority, 1992) and approximately $250 \text{ m}^3/\text{s}$ (Humber Estuary Services, n.d.). Tidal flow rates and volumes for the estuary are not available.

Environmental Designation and Biodiversity

- 9.4.68 Full details of the ecological designations and further ecological data is provided in Chapter 13: Ecology. The following is a summary with regards to designations that are relevant to surface water features.

¹ The Q_{95} flow rate is the flow which is exceeded 95% of the time, while the Q_{50} flow rate is the flow which is exceeded 50% of the time.

- 9.4.69 The Lower Humber Estuary contains a number of sites designated at the National, European and International levels for nature conservation importance. The Estuary is a Site of Special Scientific Interest (SSSI), a Special Protection Area (SPA), a Special Area of Conservation (SAC) and a Ramsar site.
- 9.4.70 With the exception of the Lower Humber, all the identified watercourses/ surface water features within the Study Area have no ecological classification under the WFD.
- 9.4.71 There are two non-statutory nature conservation designations within 1 km of the Sites, as follows:
- Burkinshaw's Covert LWS, located 0.66 km north-west of the VPI Site;
 - Rosper Road Pools LWS, located 0.13 km east of the VPI Site and 500 m east of the Phillips 66 Site.
- 9.4.72 Further details of the LWSs are summarised in Chapter 13: Ecology (ES Volume I). The only LWS relevant to the site is the Rosper Road Pools LWS.
- 9.4.73 A site walkover undertaken as part of the preliminary ecological appraisal (as outlined in Chapter 13: Ecology, ES Volume I) identifies the Rosper Road Pools as a large area of open water and associated edge habitat, with islands. It supports many breeding and wintering birds and water voles. The importance as a LWS has been incorporated into the importance of the Rosper Road Pools within the assessment.
- 9.4.74 There are no designated bathing waters or shellfish waters in close vicinity to the Sites.

Water Resources

Drinking Water Safeguard Zones

- 9.4.75 The Defra MAGIC Map (Defra, n.d.) indicates that neither of the Sites are located within a Drinking Water Safeguard Zone (Surface Water or Groundwater).

Nitrate Vulnerable Zones

- 9.4.76 The entire Phillips 66 Site and majority of the VPI Site are located within a Nitrate Vulnerable Zone (NVZ), crossing over three separate designated NVZs. These are the North Beck Drain NVZ, Skitter Beck/ East Halton NVZ and Lincolnshire Chalk NVZ. These designations will not be affected by the Proposed Developments.

Source Protection Zones

VPI Site

- 9.4.77 The Envirocheck Report (see Appendix 10A, ES Volume II) indicates the entire VPI Site is classified as a Source Protection Zone (SPZ) SPZ3 (total catchment) and is associated with an SPZ1 located approximately 1.09 km south-east from the VPI Site and an SPZ1 located 3.5 km north-west from the VPI Site. The Environment Agency defines an SPZ3 as "*the area around a supply source within which all the groundwater ends up at the abstraction point. This is the point from where the water is taken. This could extend some distance from the source point*". This may be associated with extensive industrial, commercial and public services groundwater abstraction and private water undertaking (raw water supply) groundwater abstraction located between 1.3 km and 1.97 km south-east of the VPI Site.
- 9.4.78 The area of National Rail Land is also designated as a SPZ3 (total catchment).

Phillips 66 Site

- 9.4.79 Information in the Envirocheck Report (see Appendix 10A, ES Volume II) indicates the entire Phillips 66 Site is classified as a SPZ3 (total catchment) and is associated with an SPZ1 located approximately 1.15 km south-east and 2.52 km north-west.

Abstractions

9.4.80 The Envirocheck Report (see Appendix 10A, ES Volume II) contains information related to abstractions in relation to the VPI Site and Phillips 66 Site. Some of this information is out of date and has been updated based on discussion with the Phillips 66 site owners. Available details of water abstractions, and their relation to the VPI and Phillips 66 Sites are shown in Table 9.12.

Table 9.12: Active licenced abstractions within 1km of the Sites

Type	Description	Relation to the VPI Site	Relation to the Phillips 66 Site
SW	Immingham Town Council operated abstraction for amenity use. Sourced from tributary of Haborough Marsh Drain	1.5 km south-east	1.5 km south-east
SW	Drax Biomass (Immingham) Limited operated abstraction for production of energy: evaporative cooling. Sourced from Humber estuary.	1.9 km north-east	2.4 km north-east
GW	Phillips 66 limited operated groundwater abstraction for: Other Industrial/Commercial/public Services: General Use (Carns Site). This is one licence covering four boreholes. The Envirocheck identifies a number of variations to this licence including the historic ownership by Calor Gas.	760 m – 1.3 km east	1.6-2 km east of eastern portion of the Phillips 66 Site.
GW	Phillips 66 Limited operated groundwater abstraction for Petrochemicals: Process Water (Refinery Site). This is one licence covering two boreholes. The Envirocheck identifies a number of variations to this licence including the historic ownership by Conoco.	830 m and 910 m west	Within the western part of the Phillips 66 Site
GW	Associated British Ports operated abstraction for Private Water Undertaking: Raw Water Supply. The Envirocheck identifies a number of variations to this licence.	1.4 km south-east	1.75 km south-east of eastern part of the Phillips 66 Site
GW	Davies Bore, North Killingholme. Agricultural use borehole from well and borehole.	2.0 km west	824 m north-west

VPI Site

9.4.81 There are no surface water or groundwater abstractions on the VPI Site.

9.4.82 There are two licenced groundwater abstractions within 1 km of the VPI Site (Table 9.12). There are a further two groundwater abstractions between 1 km and 2 km of the VPI Site, however these are outside of the study area. There are two surface water abstractions between 1 km and 2 km of the VPI Site, however these are outside of the study area and not in hydrological connectivity to the site.

Phillips 66 Site

9.4.83 There are no surface water abstractions within the Phillips 66 Site. There is one groundwater abstraction (covering two boreholes) within the Site owned by Phillips 66 Limited for process water (Table 9.12).

9.4.84 There is one further groundwater abstraction within 1 km of the VPI Site, and a further two licenced groundwater abstractions between 1-2 km of the Phillips 66 Site (Table 9.12), however these are outside of the study area. There are two surface water abstractions between 1 km and 2.5 km of the Phillips 66 Site, however these are outside of the study area and are not in hydrological connectivity to the Site.

Discharges to Surface Water

- 9.4.85 Information from the Groundsure Report indicates there are four Water Activity Permits (formerly Licensed Discharge Consent) records within a 0.5 km radius of the Sites. Of these, all but one licence are listed as 'revoked'. The active consent for the Lindsey Oil Refinery is for sewage discharge to the local land drain to the north-east of the Sites.
- 9.4.86 The Envirocheck Report (see Appendix 10A, ES Volume II) contains information related to abstractions within 1 km of the VPI Site and Phillips 66 Site, this has been verified against the Environment Agency's Environmental Data Discharges to Water and Groundwater online. Available details of discharge permits, and their relation to the VPI and Phillips 66 Sites are shown in Table 9.13.

Table 9.13: Active discharge permits (active) within 1km of the Sites

Description	Relation to the VPI Site	Relation to the Phillips 66 Site
Anglian Water Services limited public sewage: sewage overflow to freshwater stream/river. Storm Tank overflow to tributary of South Killingholme Drain.	1.1 km south-west	420 m south-west
Anglian Water Services limited public sewage: sewage overflow to freshwater stream/river. Pumping station overflow to tributary of South Killingholme Drain.	1.1 km south-west	420 m south-west
Phillips 66 Limited Trade discharge – process water to freshwater stream / river. Process water discharge to tributary of South Killingholme Drain.	1.1 km south-west	230 m south-west
Anglian Water Services limited public sewage: sewage overflow to freshwater stream/river. Pumping station overflow to tributary of South Killingholme Drain.	1.5 km south-west	660 m south-west
Humberside Fire Authority WWTW Sewage discharge to freshwater stream river. Discharge of treated sewage to South Killingholme Main Drain.	210 m south-east	290 m south-east
Scangrit Trade discharge – process water to freshwater stream/river. Discharge of process water to tributary of South Killingholme Drain.	1.0 km south-west	30 m south-west
Prax Lindsey Oil Refinery Limited Sewage discharge to freshwater stream. Discharge of treated effluent to South Killingholme Drain	220 m north	862 m north-east
Associated Petroleum Terminals (Immingham) Ltd trade effluent discharge to freshwater stream/river. Trade effluence discharge to a tributary of Haborough marsh drain, not hydrologically connected to sites.	415 m south	631 m south-east
Calor Gas Limited sewage discharge to freshwater stream. Discharge of treated effluent to Haborough marsh drain, not hydrologically connected to sites.	730 m south-east	735 m south-east

- 9.4.87 There are additionally a number of revoked discharge permits within 1 km of the Sites. Many of the discharge permits go to South Killingholme Drain, and therefore are in hydrological connection to both sites, being either upstream or downstream.

Pollution Incidents

- 9.4.88 Pollution incidents are classified by the Environment Agency on the degree of Environment Agency manpower deployed (i.e. large, small) and likely environmental impact with regard to air, water and land. Incidents are classified as category 1 (major), 2 (significant), 3 (minor) or 4 (insignificant).
- 9.4.89 The Groundsure Report indicates there have been no category 1 (major) or category 3 (minor) incidents, one category 2 incident (significant) and one category 4 (insignificant) incidents within 500 m of the Sites in the last 16 years that had the potential to affect water quality.

- 9.4.90 As reported in the Groundsure Report the principal pollution incident for water quality occurred in December 2004 and is noted as Oils and Fuel – Crude Oil.
- 9.4.91 None of the recorded incidents are considered serious enough to have affected current baseline water quality, either temporarily, or in the long-term; either due to the historical nature of the incident or the classified category. Therefore, they are not taken into account when describing the baseline conditions for the Proposed Developments.

Flood Risk

- 9.4.92 The NPPF requires the effects of all forms of flood risk to and from the Proposed Developments to be considered. A FRA has been prepared and is provided in Appendix 9A (ES Volume II). The following provides a summary of the baseline flood risk pertinent to the Sites.

VPI Site

Tidal Sources

- 9.4.93 The Flood Map for Planning (shown in Figure 9.3, ES Volume III) illustrates that the VPI Site is located within Flood Zone 3 (high risk) defined as land having a >1%/ 0.5% AEP (greater than a 1 in 100/ 1 in 200 chance in any year) of river or sea flooding. However, this map does not differentiate between the tidal and fluvial sources of risk.

Fluvial Sources – Main Rivers

- 9.4.94 The VPI Site is not considered to be at risk of flooding from fluvial main rivers. The nearest Environment Agency Main River (fluvial) is the Stallingborough North Beck Drain located approximately 5.5 km south-east of the VPI Site which has flood defences.

Fluvial Source – Ordinary Watercourses and Land Drainage Systems

- 9.4.95 South Killingholme Drain Branch 1 is located within the VPI Site, although no national mapping of the predicted flood extents is available for these watercourses. As such, the Environment Agency's Risk of Flooding from Surface Water (RoFfSW) dataset has been used as a proxy. The fluvial flood risk from Ordinary Watercourses and Land Drainage Systems is described in more detail in the FRA (Appendix 9A, ES Volume II), but to summarise, most of the watercourses are considered to have a low fluvial flood risk.

Surface Water

- 9.4.96 Overland flow results from rainfall that fails to infiltrate the surface and travels over the ground surface; this is exacerbated where the permeability of the ground is low due to the type of soil and geology (such as clayey soils), where vegetation is removed and the ground compacted by construction works, or where urban development increases the area of impermeable surfaces.
- 9.4.97 The Environment Agency's RoFfSW mapping dataset predicts that most of the VPI Site is considered to be at 'very low' risk of surface water flooding, although are small, isolated areas of the VPI Site shown to be at low, medium and high risk of surface water flooding predominantly to the south-east corner of the VPI Site. However, it is considered that these areas shown to be at risk are reflective of areas of low topography where water sits and pools during higher return period storm events.
- 9.4.98 The overall risk of surface water flooding to the Site is considered to be low. Mitigation measures are outlined in the FRA (Appendix 9A, ES Volume II).

Groundwater

- 9.4.99 Superficial deposits comprise Devensian – Diamicton Till and Tidal Flat Deposits (clay and Silt). The VPI Site is also underlain by a Principal Aquifer, associated with the Burnham Chalk Formation. There are no historical flood records for groundwater flooding within the VPI Site boundary or the wider South Killingholme area. Historic borehole records indicate a groundwater rest level of 2.74 m below ground level (bgl) within the superficial deposits and groundwater encounters at 12.80 m bgl and 18.9 m bgl within the bedrock.
- 9.4.100 As a precautionary measure the risk from groundwater flooding is considered to be moderate.

Artificial Waterbodies

- 9.4.101 Artificial flood sources include raised channels such as canals or storage features such as ponds and reservoirs. The Reservoirs Act 1975 defines a large reservoir as one that holds over 25,000 cubic metres (m³) of water, although under the Flood and Water Management Act 2010 this may be reduced to 10,000 m³ (although this provision has not yet been implemented).
- 9.4.102 The Environment Agency Long-term Flood Risk maps indicate the VPI Site is not located in an area that would flood should a reservoir failure occur.
- 9.4.103 Rosper Road Pools, an artificial flood relief reservoir, is located approximately 130 m to the east of the VPI Site, east of Rosper Road.
- 9.4.1 There are no other significant artificial water sources in proximity to the VPI Site, therefore the risk of flooding to the VPI Site from all artificial waterbodies is therefore considered to be low.

Phillips 66 Site

Tidal Sources

- 9.4.2 The Flood Map for Planning (shown in Figure 9.3, ES Volume III) illustrates that the Phillips 66 Site is located within Flood Zone 1 (low risk) defined as land having < 1000% / 0.1 % AEP (less than a 1 in 1000 chance in any year) of river or sea flooding.

Fluvial Sources - Main Rivers

- 9.4.3 The Phillips 66 Site is not considered to be at risk of flooding from fluvial main rivers. The nearest Environment Agency Main River (fluvial) is the Stallingborough North Beck Drain located approximately 5.5 km south-east of the Phillips 66 Site which has flood defenses.

Fluvial Source – Ordinary Watercourses and Land Drainage Systems

- 9.4.4 There are some small local drains adjacent to the Phillips 66 Site, although no national mapping of the predicted flood extents is available for these watercourses. As such, the Environment Agency's RoFFSW dataset has been used as a proxy. The fluvial flood risk from Ordinary Watercourses and Land Drainage Systems is described in more detail in the FRA (Appendix 9A, ES Volume II), but to summarise, most of the watercourses are considered to have a low fluvial flood risk.

Surface Water

- 9.4.5 The Environment Agency's RoFFSW mapping dataset predicts that most of the Phillips 66 Site is considered to be at 'very low' risk of surface water flooding, although there are small, isolated areas of the Phillips 66 Site shown to be at medium and high risk of surface water flooding. However, it is considered that these areas shown to be at risk are reflective of areas of low topography where water sits and pools during higher return period storm events.
- 9.4.6 The overall risk of surface water flooding to the Site is considered to be low. Mitigation measures are outlined in the FRA (Appendix 9A, ES Volume II).

Groundwater

9.4.7 Superficial deposits comprise Devensian – Diamicton Till. The Phillips 66 Site is also underlain by a Principal Aquifer, associated with the Burnham Chalk Formation. There are no historical flood records for groundwater flooding within the Phillips 66 Site boundary or the wider South Killingholme area. Two historic borehole records indicate a groundwater rest level of 7.01 m bgl and 9.5 m bgl within the boulder clay, with another recording a level of 18 m bgl within the sand bedrock.

9.4.8 As a precautionary measure the risk from groundwater flooding is considered to be moderate.

Artificial Water Features

9.4.9 The Environment Agency Long-term Flood Risk maps indicate the Phillips 66 Site is not located in an area that would flood should a reservoir failure occur.

9.4.10 With the exception of the lagoons adjacent to the Phillips 66 site there are no significant artificial water sources in proximity to the Phillips 66 Site.

9.4.11 There are no other significant artificial water sources in proximity to the Phillips 66 Site, therefore the risk of flooding to the Phillips 66 Site from all artificial waterbodies is therefore considered to be low.

9.4.12 Rosper Road Pools, an artificial flood relief reservoir, is located approximately 500 m to the east of the Phillips 66 Site, east of Rosper Road.

Future Baseline

9.4.13 In the absence of the Proposed Developments and other planned developments, there would not be any material change in baseline conditions to those recorded above, in the period to 2023/24.

9.4.14 However, through the implementation of greater and more stringent planning policy and regulatory controls, water quality and the health of the aquatic ecosystems supported by streams, rivers and lakes etc. has been improving over the past few decades. In particular, the WFD has resulted in wide ranging improvements to the UK's water environment since its implementation from 2009 and it is expected that by 2027 all waterbodies will be at Good Ecological Potential and Good Chemical Status. However, importance also depends on a wide range of attributes, many of which are limited by the size of water bodies within the study area, thus no changes in importance are anticipated.

9.4.15 Climate change is likely to result in an increase to peak river flows, peak rainfall intensity, sea level rise, and wave height and offshore wind speed, these could all result in increased flood risk to the site in the future. Full details of this future baseline are contained in Appendix 9A FRA (ES Volume II). Given that the Proposed Developments are classified as 'Essential Infrastructure' under the NPPF, the future climate change is taken into account in the assessments.

9.5 Development Design and Impact Avoidance

9.5.1 The following impact avoidance measures would either be incorporated into the design or are standard construction and operational practices. These measures have therefore been taken into account during the impact assessment in Section 9.6. Any need for additional mitigation measures as identified as a result of the impact assessment are described (where necessary) in Section 9.7.

Construction Phase

9.5.2 For the purposes of this assessment, it is assumed that the measures set out below would be required of any contractors undertaking construction work in relation to the Proposed Developments.

- 9.5.3 The following provides more detail on the range of measures that will be adopted during construction works.

Construction Environmental Management Plan

- 9.5.4 All construction works will be completed in accordance with a Construction Environmental Management Plan (CEMP). CEMPs will be prepared by each of the Principal Contractors and based on the Outline CEMP that is provided in Appendix 4A (ES Volume II).

- 9.5.5 The CEMPs will list relevant best practice guidance and all Contractors undertaking works within the Sites will comply with the relevant guidance during construction, including, but not limited to, the Environment Agency Guidance for Pollution Prevention documents (GPPs) and Pollution Prevention Guidance documents (PPGs), and IDB byelaws. An Outline CEMP is provided in Appendix 4A (ES Volume II) which includes the measures set out in this section. It is envisaged that this will be updated pursuant to a pre-commencement planning condition, thus ensuring that the necessary measures are secured through the planning permission. The CEMPs will include measures to:

- control and minimise the risk of pollution to surface waters by managing construction site runoff and the risk of chemical spillages;
- measures to control the storage, handling and disposal of potentially polluting substances during construction;
- management of flood risk during construction on-site and off-site; and
- appropriate methods and mitigation measures when undertaking works within, over, under and adjacent to water features.

Pollution Prevention Guidance

- 9.5.6 The CEMPs will align with relevant good practice guidance, including the following Guidance for Pollution Prevention (GPP) which have been released to date on the NetRegs website (NetRegs, n.d.) such as:

- GPP 1: Understanding your environmental responsibilities – good environmental practices;
- GPP 2: Above ground oil storage;
- GPP 3: Use and design of oil separators in surface water drainage systems;
- GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer;
- GPP 5: Works and maintenance in or near water;
- GPP 8: Safe storage and disposal of used oils;
- GPP 13: Vehicle washing and cleaning;
- GPP 19: Vehicles: Service and Repair;
- GPP 20: Dewatering underground ducts and chambers;
- GPP 21: Pollution Incident Response Plans;
- GPP22: Dealing with spills; and
- GPP26: Safe storage – drums and intermediate bulk containers.

- 9.5.7 While these are not regulatory guidance in England where the UK government website outlines regulatory requirements, it remains a useful resource for best practice.

- 9.5.8 Where new GPPs are yet to be published, previous Pollution Prevention Guidance (PPGs) still provide useful advice on the management of construction to avoid, minimise and reduce environmental impacts, although they should not be relied upon to provide accurate details of

the current legal and regulatory requirements and processes. Construction phase operations would be carried out in accordance with guidance contained within the following PPG:

- PPG6: Working at construction and demolition sites (Environment Agency, 2012);
- PPG7: Safe storage – the safe operation of refuelling facilities (Environment Agency, 2011); and
- PPG18: Managing fire water and major spillages (Environment Agency, 2000).

9.5.9 The CEMPs and subsequent construction activity will also align with the following additional good practice guidance documents:

- British Standard BS8582 Code of practice for surface water management for development Sites (British Standards Institute (BSI), 2013a);
- British Standard BS6031:2009 Code of Practice for Earth Works (BSI, 2009);
- C741 Environmental good practice on site guide, 4th Edition (CIRIA, 2015c);
- Control of pollution from linear construction sites – Technical Guidance (CIRIA, 2006);
- C736F Containment systems for prevention of pollution (CIRIA, 2014);
- C609 Sustainable Drainage Systems, hydraulic, structural and water quality advice (CIRIA, 2004a);
- C753 The SuDS Manual (second edition) (CIRIA, 2015a);
- C624 Development and flood risk – Guidance for the construction industry (CIRIA, 2004b);
- C532 Control of water pollution from construction sites – Guidance for consultants and contractors (CIRIA, 2001);
- Environment Agency (2013) Pollution Prevention Pays in England and Wales; and
- Environment Agency (2021) Regulatory Position Statement: Temporary Water Discharges from Excavations.

9.5.10 Details on measures for securing consents and permissions from stakeholders, management of construction site runoff, management of spillage risk, management of works on waterbodies and management of flood risk will be provided within the CEMPs.

Staff Awareness/ Training

9.5.11 The contractors for each of the Proposed Developments will ensure that construction personnel are fully aware of the potential impact to water features associated with the proposed construction works and procedures to be followed in the event of an accidental pollution event occurring. This would be included in the site induction and training to be given to all personal working on the Sites, with an emphasis on procedures and guidance to reduce the risk of water pollution.

Pollution Prevention Plans

9.5.12 For each Site the Contractor will prepare a Pollution Prevention Plan to prevent, and if necessary, respond to an accidental water pollution incident. Each Pollution Prevention Plan will include:

- the implementation of an effective temporary drainage system (e.g. identification of any existing surface water drainage networks and the prevention of ingress by construction site runoff (see below for further details).
- careful storage and use of potentially polluting chemical substances (e.g. fuel, hydraulic fluids, or cementitious products) (see below for further details).

- the specific measures and added precautions to be adopted where works are being undertaken in, over, under and generally in close proximity to water features.
- spill kits will be available on site in all compounds, on mobile plant and where there are works close to water features. They will be checked regularly and topped up after use. Staff will be trained in their appropriate use.
- an Emergency Spillage Plan will be prepared and will set out the specific action that shall be taken during a pollution incident and then afterwards to ensure lessons are learned and communicated to all staff on Site. This will include how the Environment Agency and the NELIDB will be informed immediately in the unlikely event of a suspected pollution incident.
- water quality monitoring of the works (using hand held water quality meters, visual and olfactory observations, and ad hoc water sampling as necessary).

9.5.13 It is anticipated that the Pollution Prevention Plan will be prepared pursuant to a pre-commencement planning condition. Through discharging the condition, both the Environment Agency and NELIDB will be consulted.

Management of Construction Site Runoff

9.5.14 Temporary drainage facilities will be provided during the construction phase, where necessary, to ensure controlled discharge of surface water runoff. The temporary drainage system will be designed to ensure that there is appropriate storage on site to attenuate runoff but also to treat that runoff. The following describes a range of measures that can be adopted as we note that the contractor will need to constantly review on-site provision depending on the circumstances and activities that are ongoing at the time.

9.5.15 It will be a contractual requirement of the contractors to ensure that runoff from the Sites does not cause pollution or flooding. Good planning of activities can reduce the volume of construction site runoff that will be generated, but management measures will be required. Measures that will be considered for implementation for temporary drainage through the construction design and/or CEMPs include:

- installation of measures such as construction swales, geotextile silt fences, earth bunds, straw bale and sand/ gravel bag walls, and appropriately sized settlement tanks/ ponds to control the movement of construction site runoff, prevent ingress into water features and reduce sediment load;
- cut-off ditches, earth bunds, straw bale walls or geotextile silt-fences will need to be installed around excavations, exposed ground and stockpiles to prevent uncontrolled release of sediments from the Proposed Developments;
- site access points will be regularly cleaned to prevent build-up of dust and mud using options such as regular road sweepers or wheel washes;
- a valve will be installed to isolate the settlement tank/ ponds in the event of a polluted discharge to allow this to be captured in the tank/pond and then disposed of safely;
- placing arisings and temporary stockpiles at least 20m away from drainage systems and water features (on flat ground) and directing surface water away from stockpiles to prevent erosion. If areas located within Flood Zone 2 are to be utilised for the storage of construction materials, then a permit will be obtained from the Environment Agency. If present for more than two weeks, soil/earth stockpiles will be seeded to reduce risk of fine sediment running off them;
- if necessary, proprietary measures such as temporary oil interceptors, lamella clarifiers or chemical flocculation can be used to provide additional protection or enhanced treatment, where risk assessment determines they may be required; and
- all potentially polluted waters (including washdown areas, stockpiles and other areas of risk for water pollution) will have separate drainage and be tankered away from the Sites.

- 9.5.16 In addition, water quality monitoring will be undertaken along South Killingholme Drain and potentially within Rosper Road Pools. If this monitoring demonstrates unsatisfactory levels of solids or other pollutants, measures will be implemented (e.g. changes to site drainage and settlement facilities and/ or use of flocculants) to control suspended solids or other polluted discharge to watercourses.

Management of Spillage Risk

- 9.5.17 During construction the storage and use of chemical substances such as fuel, other oils or cementitious products may lead to chemical spillages that can cause water pollution and harm the aquatic environment. The contractors' CEMPs will incorporate measures reflecting the best practice guidance set out in Environment Agency and Defra documents listed in the Outline CEMP. Some of these are similar to the measures already described above for the management of site runoff, but will also include as a minimum the following:
- all chemicals will be stored in accordance with their Control of Substances Hazardous to Health (COSHH) guidelines;
 - oil/ fuel will be stored in accordance with the Control of Pollution (Oil Storage) (England) Regulations 2001. Spill kits would be provided in areas of fuel/ oil storage, on mobile plant, and in areas where there are works close to water features;
 - fuel and other chemicals are to be stored in secure locations within compounds other than when in use. They should be stored on hard standing with isolated drainage or within enclosed containers; Appropriate security measures will be implemented on the Site;
 - refuelling of mobile plant will be undertaken by trained operatives in designated areas within compound areas and on hard standing with an isolated drainage system. Certain large, less mobile plant (such as large cranes) may need to be refuelled elsewhere on the Site by mobile bowser due to their reduced mobility. In these circumstances an appropriate task specific risk assessment will need to be carried out by the Contractor.
 - an Emergency Spillage Plan will be produced for each Site, which site staff will have read and understood;
 - containment measures will be implemented, including drip trays or plant nappies on mobile/ static plant, bunding or double-skinned tanks of fuels and oils;
 - the mixing and handling of materials will be undertaken in designated areas and away from surface water drains;
 - plant and machinery will be inspected before each use to ensure they are in good working order. They shall be kept away from surface water features wherever possible and will have drip trays installed beneath oil tanks/ engines/ gearboxes and hydraulics, which will be checked and emptied regularly;
 - designated waste management areas will be provided within the compound(s);
 - concrete washout areas will be designed to ensure that there is no pathway for waste water to drain to a water feature directly or indirectly via existing land drainage, or to infiltrate to ground (e.g. repurposed skips or protected using a geotextile);
 - exposed ground and stockpiles will be protected as appropriate and practicable to prevent windblown migration of potential contaminants. Water suppression will be used if there is a risk of fugitive dust emissions (see Chapter 6: Air Quality, ES Volume I).

Wastewater Generation

- 9.5.18 A septic tank or bioreactor is likely to be used for treatment of sanitary or domestic wastewater from offices/ administration/ welfare facilities during construction. Solids from the septic tank will be emptied as required and tankered off site to a waste treatment plant or discharged to into the Anglian Water foul drain sewer on site. Clean water from the septic tank or bioreactor

will combine with other site clean water including surface water to drain off site via a local land drain.

Discharge/ Disposal of Potentially Contaminated Site Runoff/ Material

- 9.5.19 Plans for the discharge and/ or disposal of potentially contaminated water will be agreed in advance with the Environment Agency, NLC and NELIDB where appropriate, and permits obtained as required.
- 9.5.20 As already described above, all foul water from any site compound (including temporary toilets) will be either tankered away to an appropriate disposal facility by a licensed waste disposal contractor, discharged to the Anglian Water sewer on site, or treated on site in a septic tank. Any potentially contaminated water will be tested, and if it is not of a suitable quality, agreed disposal procedures will be followed. Construction drainage details will be developed in consultation with the Environment Agency.
- 9.5.21 If any suspected contaminated material is discovered during the works, it will be tested and dealt with appropriately. Pre-construction sediment contamination testing will be undertaken prior to works commencing. If material is considered to be contaminated, it will be disposed of to a licensed facility (also see Chapter 10: Geology, Hydrogeology and Land Contamination (ES Volume I)).
- 9.5.22 Any waters removed from excavations by dewatering will be discharged appropriately, subject to the relevant licenses being obtained.
- 9.5.23 Foundations and services will be designed and constructed to prevent the creation of pathways for the migration of contaminants and will be constructed of materials that are suitable for the ground conditions and designed use. For example, water supply pipes will be designed in accordance with current good practice and applicable guidance to ensure pipes are protected from potential impacts associated with contamination.
- 9.5.24 No discharges from any self-contained wheel wash and localised wheel wash will be permitted to discharge into any surface water system.
- 9.5.25 Details of all of these measures will be included in the final CEMP.

Watercourse Diversion (Proposed VPI Development)

- 9.5.26 South Killingholme Drain passes across the VPI Site. The Drain is to be diverted to the south of the proposed VPI PCC plant. The diversion construction will follow best practice guidance, including:
- excavation of the diversion channel offline and in a dry, isolated working environment, retaining 'plugs' at the upstream and downstream end until it is completed;
 - removal the downstream plug first and then the upstream plug to prevent flow 'washing' through the new channel;
 - maintaining the existing channel through diversion construction, to prevent temporary changes to flood risk;
 - only allowing water to flow through the channel once all material/equipment has been removed, and the diversion channel has been created and permanently stabilised through vegetation or other sediment stabilisation methods, to prevent mobilisation of silt and sediment;
 - stockpiling of material excavated during formation of the diversion channel away from the channel edges (minimum 20 m) or protect stockpiles, to prevent sediment run-off during rainfall or high flows; and
 - maintaining existing channel capacity through the diversion channel to prevent increased flood risk upstream or downstream.

Management of Flood Risk During Construction

- 9.5.27 Construction works undertaken adjacent to, beneath and within watercourses will comply with relevant guidance during construction, including the NPPF (Department for Communities and Local Government, 2012a) and Environment Agency GPPs and PPGs, and the requirements of the NELIDB Byelaws, particularly Byelaws 3, 6, 10 and 17 (see Section 9.2).
- 9.5.28 The CEMP will incorporate measures aimed at preventing an increase in flood risk during the construction works. Examples of measures that will be implemented in the areas of the Sites that are located in Flood Zones 2 and 3 include:
- topsoil and other construction materials will be stored outside of the 1 in 100 year floodplain extent. If areas located within Flood Zone 2 are to be utilised for the storage of construction materials, then a permit will be obtained from the Environment Agency;
 - connectivity will be maintained between the floodplain and the River Humber, with no changes in ground levels within the floodplain as far as practicable; and
 - the construction site offices and supervisors will be notified of any potential flood occurring by use of the Floodline Warnings Direct service.
- 9.5.29 The contractors for each Proposed Development will be required to produce Flood Risk Management Action Plans/ Method Statements, as part of the CEMPs, which will provide details of the response to an impending flood and include:
- a 24 hour availability and ability to mobilise staff in the event of a flood warning;
 - the removal of all plant, machinery and material capable of being mobilised in a flood for the duration of any holiday close down period;
 - details of the evacuation and site closedown procedures; and
 - arrangements for removing any potentially hazardous material and anything capable of becoming entrained in floodwaters, from the temporary works areas.
- 9.5.30 As a precaution, flood resilience measures will be incorporated into the Proposed Developments to minimise the amount of damage and reduce the recovery time in the unlikely event of the Sites becoming inundated with water. The following resilience measures will be included specific to the construction stage, subject to final design:
- adequate containment of storage areas to ensure material does not wash away and cause pollution;
 - inclusion into existing emergency response procedures; and
 - implementation of a Surface Water Management Strategy.
- 9.5.31 Further details are included within the FRA presented as Appendix 9A (ES Volume II).

Operation Phase

- 9.5.32 The following section describes the mitigation measures that are embedded in the design or that will be required by other regulatory processes that the Proposed Developments will need to comply with.

Environmental Permitting

- 9.5.33 The operational phase of the Proposed Developments will require the storage, transport, handling and use of hydrocarbons and chemicals. The operation of the Proposed Developments to undertake the primary function of removing CO₂ from release to the atmosphere will involve the use of chemicals and potentially polluting substances, and in some cases the discharge of treated waste pollutants to surface water receptors. The primary operation of the Proposed Developments will also require an increase in the water usage over the existing case.

- 9.5.34 Throughout their lifetime, the Proposed Developments will be regulated by the Environment Agency through Environmental Permits, which will include conditions relating to the discharge limits and concentrations of potentially polluting substances in line with the Environmental Permitting Regulations (EPR). There will also be conditions related to the handling, storage and use of diesel and other chemicals, including emergency procedures in line with the use of the EPR and Best Available Techniques (BAT).
- 9.5.35 The wider Phillips 66 and VPI sites currently incorporate treatment and pollution prevention measures within their operating procedures to comply with existing Environmental Permits and the EPR. These procedures and treatment will be extended to the Proposed Developments, and in some cases new procedures will be developed. These measures will be in place during operation to prevent pollution during plant operation in accordance with the permit.
- 9.5.36 A number of the impact avoidance measures employed during the construction phase will remain for the operation phases of the Proposed Developments (where relevant), and will be maintained through the site operator's Environmental Management System (EMS), for example:
- plans to deal with accidental pollution and any necessary equipment (e.g. spillage kits) will be held on site and all site personnel will be trained in their use, for example the plan will incorporate details on how to appropriately deal with accidental spillages to ensure they are not drained to any surface water system;
 - containment measures will be implemented, including bunding or double-skinned tanks for fuels and oils; all chemicals would be stored in accordance with their COSHH guideline; and
 - interceptors will be incorporated into the drainage system to prevent oils from entering the surface water drainage system or local waterbodies.
- 9.5.37 Further details relating to the operational drainage networks for each of the Proposed Developments are detailed in the following sections.
- 9.5.38 The potential for impact avoidance associated with the discharge of chemicals, that is amine and sulphate, associated with the operation are considered in detail in the sections below. The potential effects and mitigation for the additional water usage is also discussed later in the chapter.

Site Drainage

- 9.5.39 Conceptual drainage philosophies outlining how surface water will be managed for each Proposed Development are provided in Appendix 9C, and are summarised in the following sections. It is anticipated that the details set out in the conceptual drainage philosophies will be developed through detailed design subject to a pre-commencement planning condition.
- 9.5.40 Where surface water drainage to a land drain is proposed during operation of the Proposed Developments the NELIDB will be consulted regarding consenting requirements.

Phillips 66 Site

- 9.5.41 For the Phillips 66 Site, the conceptual drainage strategy proposes to provide surface water drainage for all equipment and areas installed as part of the Proposed Phillips 66 Development.
- 9.5.42 The new drainage system will consider the following categories of discharges:
- non-process drainage streams (e.g. rainwater runoff from non-process areas, sanitary wastewater);
 - process drainage streams (including intentional drainage from process vessels, and accidental overflows and spillages);

- closed process drains (including accidental leaks and spillages); and
- firewater.

9.5.43 Each drainage system for the above drainage categories will be capable of collecting and handling the design flows from the specific sources.

9.5.44 All areas containing potentially hazardous substances that may be harmful in the water environment, will be isolated from other drainage streams through appropriate bunding/kerbing.

Surface Water Drainage

9.5.45 The surface water drainage, which will drain areas that are outside of potentially contaminated areas will include:

- a new surface water drainage network will be created to drain paved areas, building roofs/ rain shelters, roads, parking areas, process areas and truck movement areas;
- the new surface water drainage network will tie into the Humber Refinery's existing surface water sewer (SWS) drainage system;
- attenuation will be provided within the existing Humber Refinery holding ponds (subject to sizing assessment);
- the surface water will feed into the existing Phillips 66 Surface Water system Tilting Plate Interceptor, which overflows to the holding pond prior to the final outfall.
- if surface water is contaminated, this can be pumped to the Humber Refinery Effluent Treatment Plant (ETP), which also treats potentially contaminated drain routes, for treatment prior to discharge;
- surface water will discharge from the ETP via an existing outfall covered by the site environmental permit to South Killingholme Drain;
- the new surface water drainage will be sized in line with a 1 in 100 year Average Recurrence Interval (ARI) storm event incorporating 30% climate change allowance; and
- appropriate filtration/ separation devices, such as silt traps and oil interceptors, will be installed where appropriate – details to be confirmed in the detailed drainage design and approved in accordance with a planning condition.

9.5.46 The drainage system will connect into the existing Phillips 66 drainage systems, a block flow diagram of the drainage system is shown in Plate 9.2.

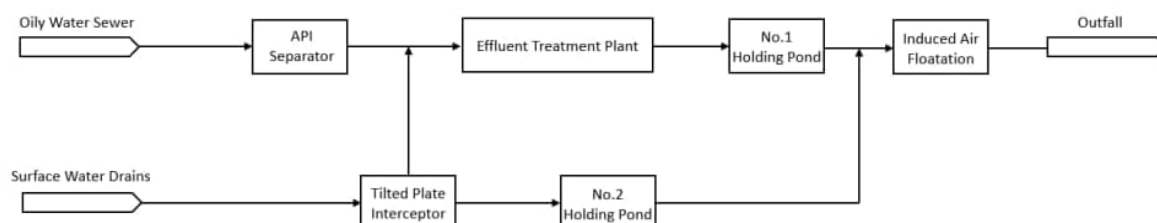


Plate 9.2 – Phillips 66 Drainage Stream Block Flow Diagram

Foul Water Drainage

9.5.47 New foul water drains may not be required for the Proposed Phillips 66 Development.

9.5.48 Foul water generated from the Proposed Phillips 66 Development from occupied buildings (toilets, sinks, showers etc.) is segregated from other drainage systems and will be routed either to the Anglian Main Foul Water Sewer, as per the other existing buildings on the refinery site, or will utilise a new septic tank/ cesspit. The design flow and discharge criteria for any

new foul water load will be confirmed based on anticipated occupancy levels, shift patterns and an estimated water usage per person. The final drainage commitments will be subject to permitting.

Process Area Drainage Systems

9.5.49 The Phillips 66 process area drainage systems, which includes potentially hazardous chemical substances, will be segregated from surface and foul drainage systems and will include a number of different drainage measures as follows:

- Oily Water Sewer (OWS) will route potentially oil contaminated surface water to the existing OWS network, which is attenuated in the existing holding ponds and treated by the ETP prior to discharge;
- process drainage systems can include bunded/ kerbed areas and blind sumps as needed to allow testing of contents prior to discharge into the OWS;
- bunded areas will be sized based on the larger of 110% of the maximum liquid inventory of the largest single equipment item, or one day of rainfall at the Phillips 66 Site assuming the maximum rainfall rate;
- sumps will be sized for one week's worth of average rainfall;
- bunds/ kerbed areas/ sumps and any associated drainage channels/ pipework will be constructed from materials which are compatible with the full range of chemical substances which they could credibly encounter;
- if contamination levels in the sump are above the acceptable levels for the ETP, the contents of the sump will be pumped out by a specialist waste management contractor and taken off-site for appropriate treatment and disposal; and
- laboratory drainage will operate a type specific sample waste collection system using drums/ containers for disposal of contaminated lab waste and will not be discharged from the Site.

9.5.50 Process area drainage water will be directed via the above drainage systems to the ETP, where it will be treated prior to discharge to South Killingholme Drain as per the current refinery effluent discharge.

9.5.51 It is anticipated that the provision of a detailed Process Water Drainage Strategy will be provided pursuant to a planning condition, and that the Environment Agency and NELIDB will be consulted during a reserved matters application. The Environment Agency will also be consulted as part of the permitting process dealing with effluent discharges from the Proposed Developments.

9.5.52 Process areas without the risk of contamination (i.e. with equipment that does not require frequent maintenance or prone to leakage) will be drained to surface water drains. Procedures will be maintained to ensure no contamination is allowed into these drains through working practice and the use of temporary bunding or spill kits.

Contaminated Fire Water

9.5.53 The fire protection system for the Phillips 66 Site will utilise the existing fire protection system, and may require expansion of the existing firewater ring. The new firefighting system will mainly consist of hydrants, monitors and systems, portable fire extinguishers, water sprays system and gaseous extinguishment systems where required. Existing site fire pumps and water tanks have adequate capacity to supply the FCC plant.

9.5.54 In the event of a fire, the surface water drainage system will be closed to prevent contaminated water being released through surface water drains into South Killingholme Drain. Fire water will be contained within the Phillips 66 Site within bunds and sumps and either disposed off-site in accordance with waste management legislation (if contaminated) or treated and discharged to surface water in accordance with the Environmental Permit, if the water quality

is acceptable for surface water discharge (and subject to agreement with the Environment Agency and/ or the NELIDB). This strategy will prevent pollution of surface water receptors.

Solvent Closed Drains System

- 9.5.55 The solvent system on the PCC plant and the solvent storage and thermal reclaimer areas are provided with a closed drain system to minimise amine losses during maintenance activities.
- 9.5.56 During full drain down of the systems and areas the major equipment items containing lean/ rich amine will discharge to the amine storage tanks or the absorber/ stripper closed drains drum.
- 9.5.57 Liquid will enter the closed drains system which connect to an underground closed drains network and terminate at the closed drains drum. The absorber/ stripper closed drains drum will be provided with a pump to enable recovered solvent to be routed to the storage tanks.
- 9.5.58 All bleed valves, pump drains etc. associated with equipment containing lean or rich solvent shall be routed via underground drainage lines to the absorber/ stripper closed drains drum. This approach enables isolations to be proven visually and minimises amine losses. The system has been designed to prevent amine from being routed to the ETP as far as possible. Any low concentrations of amine that is routed to the ETP will be treated, and water to be discharged will be tested to ensure compliance with the discharge permit.

Wet Gas Scrubber – Sulphate Discharge

- 9.5.59 The bottom section of the Wet Gas Scrubber will comprise an absorber tower which will use caustic to remove the SO₂ from the flue gas. SO₂ will react with the caustic forming sulphur salts that will dissolve in the recirculating liquid, whereas the particulates and aerosols will become suspended within the liquid.
- 9.5.60 A purge stream will be drawn off from the Wet Gas Scrubber into a Purge Treatment Unit to ensure that the recirculating liquid does not accumulate suspended solids and dissolved compounds which have been removed from the flue gas. The Purge Treatment Unit will include a clarifier which will enable the separation (through sedimentation) of solids, promoted by the addition of coagulant and flocculant. The resulting wet solids will be discharged into dewatering bins below the clarifier, which will hold a membrane to allow the content of the bins to dewater. Liquid drained from the dewatering bins will be collected in a sump and then returned to the clarifier. The dewatered solids will be collected for disposal off-site via a licensed waste contractor.
- 9.5.61 The liquid level in the clarifier will be maintained, with overflow liquids being routed to a Sulphite Oxidation Tank. The liquid from the de-watering process will contain ammonia and sulphites from the SCR process and the Wet Gas Scrubber respectively. The Sulphite Oxidation Tank will allow the sulphites present in the liquid to oxidise to sulphates, thereby reducing the Chemical Oxygen Demand (COD) of the liquid effluent. The contents of the Sulphite Oxidation tank will be recirculated and caustic will be dosed into the recirculation loop for pH control, which will mitigate any potential for odour to occur. A blower will introduce air bubbles into the contents of the Sulphite Oxidation Tank to aid the oxidation. The Sulphite Oxidation tank discharges liquid effluent which will be discharged with the existing site effluent.
- 9.5.62 Initial calculations indicate that the concentration of sulphates to be discharged, following the dilution with the existing Phillips 66 Humber Refinery site discharge, may be up to around 1,800 mg/l. Water quality and flow monitoring along South Killingholme Drain and Rosper Road Pools is to be undertaken to inform water quality calculations to confirm the potential discharge concentration (see Section 9.7).
- 9.5.63 Treatment options to reduce the concentration of sulphate in the discharge have been investigated to reduce (mitigate) water quality impacts, and as set out in Section 9.7, a desulphurisation additive (deSO_x) can be used to reduce this concentration by around 50% (e.g. deSO_x).

VPI Site

9.5.64 Surface water discharge from the developed part of the VPI Site currently discharges to the South Killingholme Drain via a separating pond and tidal flap gate near Rosper Road. The undeveloped part of the VPI Site has no existing formal surface drainage system.

9.5.65 Drainage from the Proposed VPI Development will include:

- storm water drain – rainwater from non-contaminated areas (e.g. building roofs and parking areas), clean/ non-contaminated water from bunded and kerbed areas with controlled outlets, treated effluent meeting the requirements for environmental discharge, and fire fighting water from fire fighting in non-segregated areas;
- waste water oily drain – rain water from paved areas subject to contamination, washdown and fire fighting water, minor equipment drains and instrumentation drains; and
- amine drain - rainfall from areas potentially contaminated by amines.

Surface Water Drainage

9.5.66 The surface water drainage system elements are described below:

- surface water is proposed to discharge to South Killingholme Drain at a new outfall to South Killingholme Drain Branch 1 immediately upstream of Rosper Road via a holding/ pond and class 1 oil separator.
- surface water will be collected by a network of surface water ditches, which will be designed for a 1 in 10 year return period storm event, with larger rainfall events stored above ground;
- all rainwater collected from the Proposed VPI Development will discharge via the balancing/ holding pond to the South Killingholme Drain. The pond will be a two stage design for attenuation with a first stage designed for commonly occurring storm events and drain via gravity outfall. A second stage shall be accessed via a weir and shall hold the additional water volumes to a 1 in 100 year storm event with pumped discharge;
- surface water discharged from the Proposed VPI Development will be restricted to the greenfield runoff rate, via the holding/ balancing lagoon (with an estimated storage volume in the range of 2,995 m³ for a 1 in 100 year event with a 30% allowance for climate change);
- other SuDS techniques such as swales, permeable paving and soakaways, to attenuate flow from the VPI Site and maximise infiltration (where appropriate), may be considered at the detailed design stage; and
- tank bunds and areas of potentially significant contamination (kerbed areas) shall be connected to the surface water ditches through a valved outlet. The valve shall be normally closed. Following periods of rainfall, the collected water shall be tested to verify it is contaminated. Non-contaminated effluent shall be discharged to the surface water ditches while contaminated effluent shall be removed by vacuum truck for off-site treatment/disposal.

Foul Water Drainage

9.5.67 The existing site foul water drainage (from washrooms, kitchens etc.) is collected and discharged via a grease interceptor before entry to the foul drainage system. The foul effluents will then drain to an existing local package biological treatment plant, with the final treated effluent discharging to the VPI Site's surface water drainage system and ultimately the South Killingholme Drain. Accumulated settled solids shall periodically be removed by vacuum truck for off-site disposal for a suitably qualified waste management contractor.

9.5.68 The Proposed VPI Development makes no provision for new sanitary systems; additional staffing are currently expected to utilise the existing facilities, and therefore no new foul

drainage is anticipated. The existing facility discharges has capacity for the additional staffing, however with more regular maintenance or potentially replacement with a higher capacity system.

Potentially Contaminated Runoff

- 9.5.69 Water that is likely to be polluted by hydrocarbon products will be collected in paved and kerbs areas and will drain to internal catch basins at low points of paving. These areas will be connected by gravity sewer to automatically closing oil separators before discharging (if uncontaminated) to the storm water drain system or balancing holding pond prior to discharge to South Killingholme Drain.
- 9.5.70 Runoff from areas which are potentially contaminated with hazardous chemical substances, will be segregated from surface and foul drainage systems. Potentially contaminated areas include areas around pumps, compressors and transformers. The treatment will include a number of different drainage measures as follows:
- tank bunds and areas of potentially significant contamination will be kerbed/ bunded and connected to the surface water ditches through a valved outlet. The collected water shall be tested to verify contamination, with non-contaminated discharges to the surface water ditches, while any contaminated effluent shall be removed for off-site treatment/ disposal for a suitably qualified waste management contractor; and
 - potentially contaminated surface water, likely to be polluted by hydrocarbon products, will be collected to automatically closing oil separators before discharging to the storm water drainage system or balancing/ holding pond.

Amine drain

- 9.5.71 Amine will not enter the storm water system. In areas where amine contamination is possible, the area will drain to a sump tank where it may be tested before pumped discharge to storm water drain or tanker for off-site treatment/disposal. This will include areas below the air coolers.
- 9.5.72 Concrete surfacing and kerbs will be provided below areas where amine contamination is expected. Holding tanks and water sampling facilities will be provided to collect water potentially contaminated by amine. Samples indicating the presence of amine concentrations above those permitted for environmental discharge will be disposed to treatment plant via tanker truck, and the source of the amine leakage will be located and resolved. Non-contaminated discharges will be pumped to the storm water drain.

Contaminated Fire Water

- 9.5.73 In the event of a fire, the surface water drainage system will be closed to prevent contaminated water being released through surface water drains. Fire water will be contained on the VPI Site within the kerbed and bunded areas, or within the balancing pond which will be closed. Contaminated fire water will be captured and disposed off-site in accordance with waste management legislation (if contaminated) or treated and discharged to surface water (South Killingholme Drain) in accordance with an Environmental Permit, if the water quality is acceptable for surface water discharge (and subject to agreement with the Environment Agency and/ or the NELIDB). This strategy will prevent pollution of surface water features.

Watercourse Diversion (VPI Site)

- 9.5.74 South Killingholme Drain Branch 1 is required to be diverted as part of the VPI development. It will be diverted along the boundary of the VPI Site during the construction phase. The final design details of the realignment are not confirmed, however the preliminary design incorporates diverting the drain along the southern boundary of the VPI Site in a combination of an open channel, with a culverted section. This will involve making the channel slightly longer, however maintaining a similar slope, cross-section and depth. This can be achieved within the space allowed within the layout of the Proposed VPI Development for the diversion,

however there are some challenges associated with the easement corridor, therefore a culverted section has been incorporated.

9.5.75 The diversion construction will follow best practice guidance, including:

- the diverted drain will tie into the existing channel near the western boundary where the watercourse emerges from under the Network Rail railway and the eastern end before a culvert under Rosper Road;
- the design will maintain existing channel capacity through the diversion channel to prevent increased flood risk upstream or downstream;
- the diversion will be, as far as practicable, undertaken on a 'like for like' basis in terms of cross-section, bank vegetation, substrate and habitats, to ensure there is no long-term deterioration in the water features habitat value and character (although opportunities for enhancement can be considered during detailed design).

9.5.76 The dimensions and plan of the channel are given below:

- Existing open drain through VPI site has a length of 558 m;
- New channel a total length of 618 m including:
 - Extension of the railway culvert along the south-western boundary by a length of approximately 163 m where it will terminate in a headwall;
 - 455 m of open channel formed with constant fall (i.e. approximately 80 m less than current);
 - Approximately 30 m of scour protection on the lower part of the diversion to provide protection from new VPI outfall.
 - The channel will provide additional storage volume (15.4%) than that of the existing channel

9.5.77 The diversion will be subject to consent from the NELIDB and Environment Agency.

Additional Water Demands

9.5.78 Water demand within both the Phillips 66 and VPI Proposed Developments has been reduced as far as practicable. This has been achieved through utilising air cooling for the majority of operations for both sites.

9.5.79 The requirement of additional water demands could not be entirely avoided through the mitigation measures, with additional water required for cooling of the CO₂ condenser. This will result in an additional 10% water demand for both the Phillips 66 and VPI Proposed Developments over the existing case. This is proposed to be sourced from Anglian Water and there are no plans to abstract from groundwater or apply for any new abstraction licence. This will reduce the strain on the existing groundwater unit which is at the abstraction capacity.

Flood Risk During Operation

9.5.80 Flood resilience measures will be incorporated into the Proposed Developments during the design phase to minimise the amount of damage and reduce the recovery time in the unlikely event of the Sites becoming inundated with water. These measures are adopted at the construction phase and remain in-situ over the operational lifetime of the Proposed Developments. The following resilience measures will be included, subject to final design:

- if technically feasible, critical equipment will be raised 300 mm above the expected extreme 0.1% AEP climate change scenario flood depth of 6.3 mAOD (for the year 2115), in line with the NLC SFRA (2022);
- adequate containment of storage areas to ensure material does not wash away and cause pollution;

- flood proofing including the use of flood resistant building materials, use of water resistant coatings, use of galvanised and stainless steel fixings and raising electrical sockets and switches;
- inclusion into the VPI and Phillips 66 emergency response procedures the recommendation of at least one Flood Warden for the Proposed Developments (if not already sufficiently covered by the existing emergency response plans for the Refinery and CHP Plant); and
- implementation of appropriate surface water management systems (see the Drainage Strategies in Appendix 9C).

9.5.81 Further details are included within the FRA presented as Appendix 9A (ES Volume II).

Decommissioning Phase

9.5.82 The Proposed Developments would be subject to decommissioning under the conditions of the Environmental Permit including conditions relating to chemical/ polluting material handling, storage and use and emergency procedures in line with BAT. A detailed Decommissioning Environmental Management Plan (DEMP) would be prepared for each of the Proposed Developments to identify required measures to prevent pollution during this phase of the Proposed Developments, based on the detailed decommissioning plan. It is assumed that this will be in accordance with site procedure for decommissioning and best practice, and in compliance with all existing permitting and regulatory requirements

9.5.83 The impact avoidance measures for decommissioning would be similar to those identified above for the construction phase. As above, measures would be in place to prevent pollution in accordance with the permit.

9.6 Likely Impacts and Effects of the Proposed Developments

9.6.1 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 (existing or future, as appropriate), and effects are determined in accordance with the identified methodology. As described earlier, where relevant the effects of the Proposed Developments are described compared to future baselines without the Proposed Developments.

9.6.2 The Proposed Developments have the potential to cause adverse effects to the water environment during construction, operation and decommissioning phases. Potential effects are described below.

Summary of Receptor Importance

9.6.3 Only surface watercourses in close proximity (hydraulic connectivity) to the Sites and with the significant potential to be affected by the Proposed Developments have been considered further within this impact assessment.

9.6.4 This assessment considers the following resources/ receptors:

- surface water receptors in terms of water quality and hydromorphology (South Killingholme Drain, local land drains and ditches, Rosper Road Pools and Humber Estuary); and
- other offsite receptors in terms of flood risk.

9.6.5 A summary of the importance of the receptors are presented in Table 9.12.

Table 9.12: Summary of importance/ sensitivity (value of the receptors)

Resource/ Receptor	Location	Importance of Receptor	Justification
South Killingholme Drain (inc. South Killingholme Drain Branch 1)	Within VPI Site and adjacent to Phillips 66 Site	Low importance for water quality Low importance for hydromorphology	The watercourses are local, relatively small with a flow regime dominated by surface water and effluent discharges from large industrial sites and tide locking effects from the estuary. Although detailed in the Digital River Network, has low aquatic fauna and flora biodiversity and no known protected species, and no economic or social uses other than for the conveyance of effluent/surface water runoff. Substantial modification and artificial cross-section, with limited ecological importance.
Local land drains and ditches	Various locations adjacent to Proposed Developments	Low importance for water quality Low importance for hydromorphology	These surface water features are not detailed in the Digital River Network and are agricultural drainage ditches. Likely artificial in cross-sector and laterally.
Humber Estuary	Approximately 3 km downstream of the Proposed Developments	Very High importance for water quality High importance for hydromorphology	The Lower Humber is considered to be a water resource receptor of very high importance with respect to water quality as a WFD water body and Ramsar, SPA, SAC and SSSI. The WFD water body is classified as heavily modified, however conforms closely to natural state.
Rosper Road Pools	130 m east of VPI and 500 m East of Phillips 66	Medium importance for water quality	The Rosper Road Pools are artificial flood storage ponds. However, they are also a LWS and therefore has medium importance in terms of water quality. The pools are artificial and therefore not applicable for hydromorphology.
Other off site receptors	Industrial areas surrounding site	Medium importance for flood risk	The surrounding land use around the Proposed Developments are industrial areas therefore less vulnerable in terms of all forms of flood risk.

Construction Phase

9.6.6 This section contains an assessment of the potential effects on the water environment receptors as a result of the construction phase of the Proposed Developments. The following impacts have been assessed:

- contaminated surface runoff and spillage of chemical pollutants on water quality;
- suspended sediments in site runoff/ resuspension of suspended sediments;
- temporary changes to morphology due to diversions and in channel works; and
- temporary changes to flood risk due to construction activities.

9.6.7 Contaminated material exposed or disturbed during the construction works has the potential to affect surface water or groundwater, this is discussed in Chapter 10: Geology, Hydrogeology and Land Contamination.

Contaminated Surface Runoff and Spillage of Chemical Pollutants

- 9.6.8 During construction, there is an elevated risk that runoff will contain chemicals from leaks and accidental spillage of construction materials and potential chemical pollutants used on the Sites. These may migrate to nearby surface water features directly or indirectly. Leaks, spills and runoff from washout facilities (washing of tools, plant and equipment), storage and use of various liquids and soluble solids, stored aggregates, contaminated road surfaces, and fuel storage and handling all have the potential to result in pollution of water resources. Inappropriate disposal of waste materials associated with the construction phase also has the potential to enter surface water. However, with the measures set out in Section 9.5 (including the implementation of a CEMP), the likelihood of a large chemical spillage occurring is low. Taking this into account, and based on the information available to date, the anticipated potential effects on different water attributes are described below under a heading for each receptor.

South Killingholme Drain

- 9.6.9 Potential contamination impacts on the water quality and WFD status of the South Killingholme Drain (low importance), including South Killingholme Drain Branch 1, are assessed as possible short-term, direct but highly localised and temporary change in water quality.
- 9.6.10 With the implementation of the impact avoidance and risk management measures, the risk to these watercourses can be effectively managed and the Proposed Developments would be unlikely to have any measurable effect on them. Overall, a negligible adverse impact is proposed on a medium importance water feature resulting in a **negligible (not significant)** effect.

Local Drains Adjacent to the Sites

- 9.6.11 Potential contamination impacts on the water quality and WFD status of local land drains (low importance) adjacent to the Site are assessed as possible direct (overland flow), short-term, but highly localised and temporary change in water quality.
- 9.6.12 However, with the implementation of the impact avoidance and risk management measures, and whilst effects might be experienced in the localised area, these would be unlikely to have any measurable effect on the water features.
- 9.6.13 Overall, a minor adverse change is proposed on low importance water features resulting in a **negligible (not significant)** effect.

Rosper Road Pools

- 9.6.14 Potential contamination impacts and effects on the water quality of the Rosper Road Pools (medium importance), are assessed as likely short-term, indirect (as the hydrological connection is via the South Killingholme Drain) and localised and temporary change in water quality.
- 9.6.15 However, with the implementation of the implementation of the impact avoidance and risk management measures, these would be unlikely to have any measurable effect on the waterbodies. Overall, a negligible impact is proposed on a medium importance water feature resulting in a **negligible (not significant)** effect.

Humber Estuary

- 9.6.16 Given the distance from the Sites, the indirect nature of any impact via the periodically tide locked South Killingholme Drain etc., and the dilution potential in the Humber Estuary, potential impacts from construction site runoff and chemical spillage risks during construction are assessed as a short-term and very localised. Any impact would most likely be significantly diluted by the time that any contamination reached the estuary, within which further dilution and dissipation would occur.

- 9.6.17 Whilst temporary changes might be experienced in the localised area, no change on the quality of the river and WFD status will be experienced with the implementation of the impact avoidance and risk management measures described in Section 9.5 above. Overall, a negligible adverse impact is predicted, which on a very high important water features, results in a **negligible (not significant)** effect.

Suspended Sediments in Site Runoff/ Re-suspension of Sediments in Watercourses

- 9.6.18 The movement and storage of construction and waste materials to and from the Sites, unstable exposed soils, excavated materials, in channel works, and from other construction activities, has the potential to give rise to suspended solids that could become entrained in surface water run-off from the Sites following rainfall. This creates a potential risk of increased sediment loads being discharged into the nearby surface water. High sediment input has the potential to affect waterbodies by increasing turbidity, reducing dissolved oxygen (DO) levels and reducing light penetration. There could also be toxic effects caused by inorganic and organic compounds associated with re-suspended sediment. Indirect effects could include impacts on invertebrates and fish communities, and destruction of feeding areas, refuges and both breeding and spawning grounds.
- 9.6.19 With the measures set out in Section 9.5, including the implementation of a CEMP, the likelihood of this occurring will be low. Taking this into account, the following effects on different attributes are described below.

South Killingholme Drain

- 9.6.20 Potential contamination impacts on the water quality and WFD status of the South Killingholme Drain (low importance), including South Killingholme Drain Branch 1, are assessed as possible short-term, direct but resulting in a temporary change in water quality only. The construction of the diversion of South Killingholme Drain (VPI Site), without mitigation measures, could result in a large input of sediment to the watercourses.
- 9.6.21 Whilst changes might be experienced in the localised area, only a minor adverse impact (not significant) is predicted with **no effect** on WFD status, with the implementation of the impact avoidance and risk management measures described in Section 9.5 above.

Local Land Drains Adjacent to the Sites

- 9.6.22 Potential contamination impacts on the water quality and WFD status of local land drains (low importance) adjacent to the Sites are assessed as possible direct (overland flow), short-term, but highly localised with only temporary change in water quality.
- 9.6.23 Whilst changes might be experienced in the localised area, a minor adverse impact is predicted and no change to WFD status with the implementation of the impact avoidance and risk management measures described in Section 9.5 above.
- 9.6.24 Overall, a minor adverse impact on a medium important water feature will result in a **negligible adverse (not significant)** effect.

Rosper Road Pools

- 9.6.25 Potential contamination impacts on the water quality of the Rosper Road Pools (medium importance) are assessed as possible short-term, indirect with only temporary change in water quality expected. The construction of the diversion of South Killingholme Drain (VPI Site), without mitigation measures, could result in a significant input of sediment to the watercourses, which could settle within the Pools and impact on habitat or require removal.
- 9.6.26 However, with the implementation of impact avoidance and risk management measures, the change is considered to be minor adverse once implementing the mitigation measures and construction methodologies. Despite the mitigation measures, some fine sediment may still

reach the Pools, although this is not expected to be a significant amount to result in a large effect on water quality, habitats or overall capacity.

- 9.6.27 A minor adverse impact is predicted, which on a medium importance water feature, will result in a **minor adverse (not significant)** effect.

Humber Estuary

- 9.6.28 Water in the Humber Estuary is turbid with periodic high levels of suspended sediment, which with the high dilution and dispersion potential, means that this water feature is less sensitive to elevated levels of fine sediments in construction site runoff. In addition, the flow pathway to the estuary is not direct, but via other watercourses that will result in further dilution and dispersion of fine sediment, and under low, quiescent flows, potentially when the watercourse is tide locked, settlement. However, at a water body level the Environment Agency has set mitigation measures under the WFD for this water body that include the strategic management of sediment, a reduction in the impact of dredging, sediment re-suspension and manage disturbance.
- 9.6.29 Given the distance from the Sites and indirect nature of the impact, there are possible short-term, temporary and very localised changes in water quality, as sediment would be readily dispersed and diluted. Given this and the higher suspended sediment levels experienced in the baseline for the estuary, and the minor increases in suspended sediment likely to result from the Proposed Developments, only a negligible impact is predicted. On a water feature of very high importance, this results in a **negligible adverse (not significant)** effect.

Temporary Changes to Morphology Due to Diversion and In Channel Works (VPI Development)

- 9.6.30 The Proposed VPI Development incorporates a channel diversion of South Killingholme Drain Branch 1, and the provision of a new outfall. New crossings of the diverted section of South Killingholme Drain Branch 1 will also be required for the Proposed VPI Development comprising up to four temporary vehicle crossings during construction and a permanent CO₂ pipeline and pedestrian access crossing during operation.
- 9.6.31 The Proposed VPI Development also includes the creation of a new access into the VPI Site from Rosper Road which will require a permanent new crossing over South Killingholme Drain adjacent to Rosper Road.
- 9.6.32 The Proposed Phillips 66 Development's CO₂ pipeline to the north-east of the railway line will cross also South Killingholme Drain Branch 1 but will not require in-channel works.

South Killingholme Drain (including Branch 1)

- 9.6.33 The temporary crossings of South Killingholme Drain Branch 1 during construction of the Proposed VPI Development will result in temporary, short-term effects to the drain. The permanent crossings of South Killingholme Drain as part of the Proposed VPI Development will result in permanent, long term effects, but the crossings will be designed appropriately, in consultation with NELIDB.
- 9.6.34 The diversion of South Killingholme Drain Branch 1 (low importance) associated with the Proposed VPI Development will be permanent, however this effect will be localised, as the diversion will tie into the existing watercourse points within the VPI Site boundary.
- 9.6.35 The potential effects associated with the Proposed VPI Development on the South Killingholme Drain associated with in-channel works is assessed as minor adverse magnitude with the implementation of the construction methodology and implementation of avoidance and risk management measures described in Section 9.5 above.
- 9.6.36 Overall, a minor adverse impact on a low importance water feature will result in a **minor adverse (not significant)** effect from the Proposed VPI Development.

- 9.6.37 The Proposed Phillips 66 Development's CO₂ pipeline crossing over South Killingholme Drain Branch 1 will have **no effect** on the channel.

Temporary Changes to Flood Risk Due to Construction Activities

- 9.6.38 The construction of temporary construction laydown areas, parking areas, and other areas of hardstanding have the potential to increase surface water runoff and result in increases in flood risk to offsite receptors. In channel works, including the proposed diversion of South Killingholme Drain, have the potential to alter flow pathways resulting in changes to flood risk in the local area.
- 9.6.39 With the measures set out in Section 9.5, the construction of the drainage prior to development and the implementation of the diversion methodology, the effects are likely to be low.
- 9.6.40 The changes to flood risk associated with the Proposed VPI Development are assessed as a localised and temporary change in flood risk. The existing flood risk associated with the VPI Site, aside from tidal flood risk, is low, with minor watercourse and overland flow confined to the banks of the South Killingholme Drain.
- 9.6.41 The changes to flood risk associated with the Phillips 66 Site are assessed as a localised and temporary change in flood risk. The existing flood risk associated with the Phillips 66 Site is low.
- 9.6.42 Whilst changes might be experienced in the localised area, there is no anticipated construction effects to flood risk beyond the VPI Site and Phillips 66 Site boundaries, and therefore no significant effect to off-site receptors with the implementation of the impact avoidance measures described in Section 9.5 above.
- 9.6.43 The significance of this effect is therefore considered to be **minor adverse (not significant)**.

Operation Phase

- 9.6.44 The Proposed Developments will utilise the land drainage ditches and South Killingholme Drain adjacent to the Sites for surface water drainage and will utilise South Killingholme Drain for process water discharges. The Phillips 66 Site drainage will use the existing connection via the existing ETP at the Humber Refinery to South Killingholme Drain. The VPI Site will utilise an existing connection to South Killingholme Drain.
- 9.6.45 This section contains an assessment of the potential effects to the water environment receptors as a result of the operation phase of the Proposed Developments. The following impacts have been assessed:
- water quality impacts from contaminated surface water and spills, leakages or overflows of process water, foul drainage and firewater;
 - water quality sulphate impacts from routine process discharges (Phillips 66 Development only).
 - increased water demand;
 - changes to morphology due to the diversion of South Killingholme Drain (VPI Site only); and
 - changes to flood risk from differences in the rate/volume of runoff or flow pathways.

Water Quality Impacts from Contaminated Surface Water and Spills, Leakages or Overflows of Process Water, Foul Drainage and Firewater

- 9.6.46 High level conceptual drainage philosophies have been developed for the Proposed Developments, as summarised in Section 9.5.
- 9.6.47 There are a number of potentially contaminated sources of water within the Proposed Developments during operation, associated:

- contaminated and sediment laden surface water from non-process areas;
 - leakage from wastewater drainage networks;
 - oily or slightly contaminated process water entering the watercourses;
 - firewater entering the watercourses; and
 - contaminated process water entering the watercourses due to accidental release or overflow, including amine.
- 9.6.48 The potential impacts associated with operational process discharges are considered separately in the next section.
- 9.6.49 The effects associated with contamination of surface water from non-process areas (with sediments, fuels etc.) are considered to be low, as any potentially polluting substances will be stored inside buildings or suitably bunded areas as set out below. Implementation of the measures as described in Section 9.5 will ensure the risk of contamination of site runoff will be low.
- 9.6.50 The potential impacts associated with wastewater drainage networks are considered to be low, as these are separate systems, will involve treatment and there is no potential leakage pathway to the surface water drainage network.
- 9.6.51 Firewater and significantly contaminated process water from the closed process systems will be contained and either treated within the sites or tankered off site for treatment, and therefore the potential for leakage prior to treatment or off-site disposal is considered to be low.
- 9.6.52 For both sites, the amine drain and other areas of high potential contamination incorporate measures to control and isolate contamination through sumps or kerbs and bunds. These kerbed / bunded areas will be tested for contamination and disposed for off-site treatment if contamination is present. This should prevent issues such as leakage of amine or other accidentally discharges from entering the stormwater drainage networks, and being discharged to the environment. Therefore, the potential for highly contaminated water to be released to surface water receptors is low.

Phillips 66 Site

- 9.6.53 The Proposed Phillips 66 Development has potential for contaminated process water from various operations to be accidentally discharged or to overflow to the surface water discharge and be discharged to the surface water receptors. This includes hydrocarbons, chemicals and amine. There are mitigation measures that will be incorporated into the drainage networks to prevent discharge, through isolation, testing and treatment. Water from the process area bunds are tested prior to discharge to the process water drainage system, which is then treated via the ETP. Following treatment within the ETP, the discharge is subject to the monitoring and testing requirements applicable to the Humber Refinery effluent discharge to ensure compliance with the discharge permit conditions. The Humber Refinery is an existing industrial site with an established effluent discharge and baseline conditions.
- 9.6.54 Firewater will be contained within bunds and through the onsite surface water sewer. Storage is available within the holding ponds, which will prevent firewater from escaping offsite. This water will be tested for contamination and either removed for offsite disposal or discharged following treatment.
- 9.6.55 Leakage from the foul water drainage system is unlikely, as this is a separate drainage network which is isolated from the surface water drainage, and there is no connection to the surface water receptors.
- 9.6.56 There is the potential for minor spills of oils and sediment entering the surface water drainage network from car parking and other hardstanding areas. However, the surface water drainage network incorporates bunds and kerbs and can be pumped to the ETP for treatment if

required. Any discharge to South Killingholme Drain will comply with the existing discharge consent.

VPI Site

- 9.6.57 The Proposed VPI Development has potential for contaminated process water from various operations to be accidentally discharged or to overflow to the surface water discharge and be discharged to the surface water receptors. This includes hydrocarbons, chemicals and amine.
- 9.6.58 There is a separate amine collection system which is isolated from the surface water network and discharged off site. Testing will be incorporated to prevent amine contaminated water from entering the surface water drainage network to be discharged to the receiving environment.
- 9.6.59 The VPI Development has the potential to produce oily water pollution on site, which could theoretically enter the surface water drainage network. The drainage incorporates automatic oil separators and this is discharged off site. Firewater and other potentially polluted water is isolated and collected and prevented from entering the surface water network.
- 9.6.60 Leakage from the wastewater drainage system is unlikely, as this is a separate drainage network with no pathways to the surface water drainage network.
- 9.6.61 There is the potential for minor spills of oils and sediment entering the surface water drainage network from car parking and other hardstanding areas. However, the surface water drainage network incorporates automatic oil separators and filters, and therefore the majority of this will be isolated.

Local Land Drains Adjacent to the Sites

- 9.6.62 Potential operation contamination impacts and effects on the water quality and WFD status of local land drains (low importance) are considered unlikely to occur, as the drainage network will prevent runoff from entering these water bodies, and there are no potential discharges to these receptors. The potential effect is evaluated to be of negligible magnitude above the existing case, with the implementation of the drainage network and treatment, and comply with existing consents and requirements. Therefore, the potential impact to these water bodies is **negligible (not significant)** or less.

South Killingholme Drain and South Killingholme Drain Branch

- 9.6.63 Potential operation contamination impacts and effects on the water quality and WFD status of the South Killingholme Drain and South Killingholme Drain Branch 1 (low importance) are assessed as a localised and temporary change in water quality.
- 9.6.64 With the implementation of the implementation of the impact avoidance measures, these would be unlikely to have any measurable effect on the water bodies. The significance of this effect is therefore considered to be **negligible (not significant)**.

Rosper Road Pools

- 9.6.65 Potential operation contamination impacts and effects on the water quality of the Rosper Road Pools (medium importance), are assessed as localised and temporary change in water quality.
- 9.6.66 With the implementation of impact avoidance measures, these would be unlikely to have any measurable effect on Rosper Road Pools. The significance of this effect is therefore considered to be **negligible (not significant)**.

Humber Estuary

- 9.6.67 Pollution from runoff of contaminated surface water from the Proposed Developments entering a watercourse will cause little change to the Humber Lower (very high importance) given the indirect nature of the effect and due to the level of dilution in the water body. The potential effect is assessed as negligible once implementing the mitigation measures including the drainage philosophies (see Appendix 9C).

- 9.6.68 The significance of this effect is therefore considered to be **negligible (not significant)**.

Water Quality Impacts Associated with Sulphate Discharge (Phillips 66 Site)

- 9.6.69 The Proposed Phillips 66 Development will result in an elevated discharge of sulphate via the existing process discharge outfall from the Humber Refinery into South Killingholme Drain. The removal of sulphate (using the Wet Gas Scrubber) is required as part of the flue gas pre-treatment process to enable the CO₂ removal process for the FCC to work. The operation of the Wet Gas Scrubber will result in an increased discharge of sulphate from the Humber Refinery above the existing baseline levels.
- 9.6.70 The current discharge from the Humber Refinery has an average concentration of 290 mg/l, and up to 350 mg/l. The Proposed Phillips 66 Development will result in an additional sulphate discharge which may have a resulting total effluent concentration of up to around 1,800 mg/l. There is unlikely to be significant dilution from the natural catchment of South Killingholme Drain (including Branch 1) under normal conditions, however the concentration will dilute along South Killingholme Drain downstream of the existing VPI Immingham CHP Plant discharge. The calculation of the sulphate concentrations at the discharge point and along South Killingholme Drain will be refined following flow and water quality monitoring of South Killingholme Drain (see Section 9.7).
- 9.6.71 Sulphate is not assessed as a contaminant under the WFD for either freshwater or marine water. Sulphate is not included in the indicative list of polluting substances in Annex II to the Industrial Emissions Directive (2010/75/EU). However, the Environment Agency have an Environmental Quality Standard (EQS) of 400 mg/l for freshwaters (there is no EQS in place for estuaries and coastal waters). It is not certain whether the freshwater EQS applies to South Killingholme Drain given that the lower reaches appear to experience tidal ingress (see paragraph 9.4.63 above).
- 9.6.72 The Report to Inform HRA (submitted with the Proposed Phillips 66 Development planning application alongside this ES) includes a review of the literature available on ecotoxicity of sulphate to aquatic organisms and potential effects on aquatic ecosystems, the review demonstrated that there is no certainty regarding the effect levels of sulphate will have to aquatic organisms, including fish and macroinvertebrates. The review concluded that a level of ~1,000 mg/l of sulphate would be an appropriate maximum allowable concentration to protect aquatic life.
- 9.6.73 Treatment options to reduce the sulphate concentration have been investigated and a reduction of around 50% is achievable using deSO_x additive. However there is no suitable technology to cost effectively reduce the sulphate further (see Section 9.7).

South Killingholme Drain and South Killingholme Drain Branch

- 9.6.74 The current water quality data for South Killingholme Drain a few hundred metres upstream of the outfall location to the Humber Estuary (i.e. NGR TA 1860 1702) indicates that current sulphate concentrations are an average of 473 mg/l (Wood, 2022); this is likely due to the existing process discharges as well as possible saline intrusion within the lower part of the watercourse from the Humber Estuary. The additional sulphate discharge to South Killingholme Drain from the Proposed Phillips 66 Development is likely to result in the concentrations within the drain increasing significantly, although the effluent discharge will be diluted with surface water runoff in the receiving environment and by discharges from VPI Immingham (i.e. the existing CHP Plant and the Proposed VPI Development).
- 9.6.75 The increase in sulphate discharge (without mitigation) will result in a measurable decrease in chemical quality of South Killingholme Drain, although it is noted that this drain is already impacted by effluent discharges, tide locking flow conditions, and has low biodiversity (see Section 9.4). Overall, it is predicted that the sulphate discharge will result in a medium adverse magnitude of impact.

- 9.6.76 Given that South Killingholme Drain is of low importance in terms of water quality, given that the watercourse is heavily modified and acts largely as an effluent channel, this will result in a **minor adverse effect (not significant)**.

Rosper Road Pools

- 9.6.77 The is no direct discharge from the Phillips 66 Development to the Rosper Road Pools. South Killingholme Drain discharges to the Rosper Road Pools across a control weir only when the drainage system is tide locked and there is high flow within the drain. Therefore, there would not be regular routine operational discharge into the Pools, as the weir is not believed to be overtopped on all high tides but requires tide locking conditions to coincide with high levels of rainfall (although the regularity of weir overtopping is not monitored by the Internal Drainage Board).
- 9.6.78 The discharge from South Killingholme Drain to Rosper Road Pools is downstream of the VPI Immingham CHP Plant (and Proposed VPI Development) discharge. Initial estimates suggest that this additional discharge may dilute the concentration of sulphate by around 40% to around 1,000 mg/l at the point where the discharge could enter Rosper Road Pools. However, additional water quality and flow monitoring will be undertaken to confirm the dilution potential and inform the degree with which any additional treatment may be required. Therefore, despite the predicted high sulphate level at the point of discharge, it is unlikely that water entering Rosper Road Pools when the system is tide locked would be at the same concentration as that discharged.
- 9.6.79 There does remains a risk that on occasion, water containing an elevated sulphate level would enter the Rosper Road Pools. There is no known baseline water quality data for Rosper Road Pools, therefore the effect of the elevated sulphate levels on the water quality within the pools is not known. As such based on the available data and a precautionary approach, it is considered that the additional sulphate discharge (without mitigation) may result in a measurable reduction in the water quality of Rosper Road Pools, but this will depend on the frequency of weir overtopping, the volume of ingress, the sulphate concentration of that inward flow, and the quality of water already within the pools (i.e. if of a lower sulphate concentration the volume of water would likely buffer any rise in overall sulphate level across the pools)..
- 9.6.80 Overall, a medium adverse magnitude of impact is predicted (given that the effect has the potential to result in a long term change in water quality). For the water environment assessment, Rosper Road Pools are considered a receptor of medium importance, given that it is a local wildlife site. Therefore, in terms of water quality, excluding additional treatment options or mitigation that may be considered, the significance of effect is conservatively assessed as **moderate adverse (significant)**. The ecological impact of the impact of sulphate on the Pools is considered in Chapter 13: Ecology (ES Volume I).

Humber Estuary

- 9.6.81 Sulphate concentrations in sea water are as high as 2,700 mg/L (Meays & Nordin, 2013), however this may be reduced within the estuarine setting.
- 9.6.82 Sulphate concentrations within South Killingholme Drain at the point of discharge to the Humber Estuary are currently estimated to be in the order of magnitude of 1,000 mg/l following dilution from the VPI Immingham CHP Plant (to be confirmed following additional monitoring). This will be significantly diluted further within the Humber Estuary and is likely to be similar concentration of sulphate to the estuary. Therefore, this will result in a negligible change in sulphate concentration within the Humber Estuary. Thus, the magnitude of change is also assessed as negligible. Thus, the significance of this effect is considered to be **negligible (not significant)**.

Increased Water Demand for VPI and Phillips 66 Site

- 9.6.83 The Phillips 66 and VPI Site requires an additional water supply, which is approximately 10% of the existing usage. This will be sourced from Anglian Water rather than from the

groundwater unit. As noted in the Environment Agency's scoping response, the Catchment Abstraction Management Strategy that covers the South Humber Bank states that the groundwater unit balance shows more water has been abstracted based on recent amounts than the amount available, and the Environment Agency will not grant further consumptive licences. Due to this a new licence to abstract water is not being considered. Discussions are ongoing with Anglian Water.

- 9.6.84 Due to the fact that the additional water will be sourced from Anglian Water, there will be no impact to the groundwater unit or effects to the base flow to the surface water receptors. As such the effects associated with this to the surface water receptors is negligible.

Morphological Changes Associated with Drain Diversion, crossing and new outfall (VPI Site)

- 9.6.85 The proposed diversion of South Killingholme Drain Branch 1 (low importance) has the potential to result in a permanent loss of riparian zone, substrate and habitats along the drain. Although the channel is of low morphological value, due to historic realignment and artificial cross-sections, there still remains some potential for habitats within the channel. A WFD screening and scoping assessment has been undertaken and is presented in Appendix 9B (ES Volume II), which states the physical characteristics of the channel, potential effects and mitigation.
- 9.6.86 This assessment is based on the channel being designed suitable and as far as practicable like-for-like to the existing case, as well as the implementation of avoidance measures described in Section 9.5 above.
- 9.6.87 Overall, a negligible impact on a medium important water feature will result in a **negligible (not significant)** effect from the Proposed VPI Development.

Changes in Flood Risk to Off-site Receptors

- 9.6.88 Surface water discharge will be restricted to greenfield runoff rates from the VPI Site and to the existing consent limit for the Phillips 66 Site. These will discharge to South Killingholme Drain, via existing surface water drainage networks. Therefore effects on the land drain will be **negligible (not significant)**.
- 9.6.89 Although the detailed drainage design will not be completed until the detailed design stage, drainage systems will be designed so as not to increase flood risk. These measures allow the design criterion of no flooding during a 1 in a 100 year (1.0% AEP) plus climate change storm to be achieved. A high level drainage strategy has been developed for the each of the Sites and is summarised in Section 9.5.
- 9.6.90 For outline design purposes the 1% AEP, critical storm rainfall event with a 25% climate change allowance has been used to size surface water drainage for the VPI Site. This ensures that ponding of the VPI Site due to exceedance of drainage network flow capacity is unlikely to occur during the design life of development.
- 9.6.91 The detailed drainage design will consider the risk posed by any flooding up to and beyond the 1% (1 in 100 year) flood event. Any flooding will be diverted away from critical infrastructure or access routes and retained on the Sites wherever possible.
- 9.6.92 Other SuDS techniques such as swales, permeable paving and soakaways may be considered at the detailed design stage.
- 9.6.93 The FRA for the Proposed Developments, included within Appendix 9A (ES Volume II), concludes that development of the Sites will not increase the risk of flooding from fluvial, tidal, groundwater or overland flow sources.
- 9.6.94 Flood risk to the Proposed Development Sites and staff are contained in the FRA (Appendix 9A, ES Volume II).

Decommissioning Phase

- 9.6.95 Decommissioning of the Proposed Developments will be undertaken in accordance with the Environmental Permits. This will include decommissioning of all potentially polluting plant and equipment so that it does not pose an unacceptable risk of contamination.
- 9.6.96 It is assumed that all underground infrastructures will remain in-situ; however, all connection and access points will be sealed or grouted to ensure disconnection.
- 9.6.97 On this basis, decommissioning effects are expected to be limited to watercourses in close proximity to the Sites and will be the same as construction effects, as discussed above.

9.7 Mitigation and Enhancement Measures

Construction Phase

- 9.7.1 Mitigation of adverse effects on the water environment during the construction phase will be achieved principally through embedded measures identified in Section 9.5, notably the adoption of CEMPs for each of the Sites.
- 9.7.2 A water quality monitoring programme will be set out within the final CEMPs. These will need to be further developed by the Principal Contractors in consultation with the NELIDB, the Environment Agency (due to works potentially impacting flow in a Main River and WFD waterbodies), and the LLFA (due to works potentially impacting flow in an Ordinary Watercourse) during the process of obtaining Environmental Permits/ Consents/ Licences for works affecting, or for temporary discharges to, waterbodies during the construction period.
- 9.7.3 The programme will be expected to include a combination of daily observations and monitoring using a calibrated, handheld water quality probe through the upstream and downstream reaches of water features hydrologically-connected to the Sites. It is expected that water quality sampling will be undertaken on a periodic as well as ad-hoc basis, dependent upon circumstances/ activities onsite. Monitoring and sampling will be undertaken prior to the commencement of construction as to allow a sufficient baseline data.

Operation Phase

- 9.7.4 Mitigation of adverse effects on the water environment and flood risk during the operational phase will be achieved principally through embedded measures identified in Section 9.5, notably the drainage strategies and the flood and pollution mitigation strategies. This section also sets out embedded mitigation measure assumptions that have been included within this assessment.
- 9.7.5 There is only one additional mitigation measure recommended, which is treatment of the Proposed Phillips 66 Development sulphate discharge from the Wet Gas Scrubber, incorporating a monitoring strategy and assessment.

Sulphate Treatment and Monitoring (Proposed Phillips 66 Development)

- 9.7.6 Due to the potential medium adverse impacts identified associated with the Proposed Phillips 66 Development Wet Gas Scrubber sulphate discharge on South Killingholme Drain and Rosper Road Pools, that may result in minor and moderate adverse effects respectively, the sulphate concentration in the effluent discharge will be reduced through treatment, unless further assessments can confirm that the sulphate concentrations will have no significant effect on the receiving water environment (Rosper Road Pools).
- 9.7.7 Phillips 66 has carried out an assessment of sulphate removal methods and technologies that could be feasible at the Proposed Phillips 66 Development. The methods investigated include:
- membrane technology;

- ion exchange technology;
 - chemical precipitation; and
 - biological removal.
- 9.7.8 Due to the high sulphate and / or total dissolved solids concentration in the effluent leaving the Wet Gas Scrubber, the majority of these methods are not technically feasible. The only option that currently is feasible is the chemical precipitation of sulphate (using deSOx additive) from the flue gas. This will reduce the effluent sulphate concentration from the Proposed Phillips 66 Development by around 50%, but beyond this no viable option for sulphate treatment has been identified.
- 9.7.9 To inform the final assessment of the potential effects of the Proposed Phillips 66 Development's sulphate discharge, a monitoring strategy and dilution assessment will be undertaken prior to the final design of the Proposed Phillips 66 Development, which will include:
- water quality monitoring for sulphate and other relevant physico-chemical parameters in the receiving environment including South Killingholme Drain, Rosper Road Pools and (where safe to do and access permitting) the Humber Estuary;
 - flow and water level monitoring of South Killingholme Drain; and
 - an assessment of potential dilution of sulphate within the South Killingholme Drain and Rosper Road Pools under various flow and tidal conditions.
- 9.7.10 This monitoring will provide greater certainty regarding the predicted effects of elevated sulphate discharge and required mitigation.
- 9.7.11 It is assumed based on the available data that application of the additional mitigation of sulphate precipitation to reduce the sulphate concentration at the Proposed Phillips 66 Development discharge to South Killingholme Drain, will result in a sulphate concentration of below 1,000 mg/l at the discharge point, with additional dilution within the South Killingholme Drain prior to Rosper Road Pools.

Flood and Pollution Mitigation Strategies

- 9.7.12 The need for a number of mitigation strategies will be assessed during the design process for the Proposed Developments and included if required to ensure the safety of each Site is maintained in the event of an extreme flood, or the effects are managed in the event of a significant pollution event. These strategies include:
- flood emergency response plans – flood emergency response plans form part of existing emergency response plans for the Humber Refinery and the VPI Immingham CHP Plant, and these will be updated as required to incorporate the Proposed Developments including details of -
 - flood risk measures, including evacuation and shut down procedures, and
 - pollution control measures, including setting out how the risk of large emergency and pollution incidents will be managed during the operation of the Proposed Developments; and
 - providing flood resistance and resilience measures into the design of the buildings (i.e. minimum floor levels) and designing for failure, maintenance and capacity exceedance of the surface water drainage network. More details are provided in the FRA (Appendix 9A, ES Volume II).

Embedded Mitigation Measure Assumptions

- 9.7.13 The assessment has assumed that the watercourse diversion will be designed to ensure no increase in flood risk, and additionally will replace the existing channel in a like-for-like basis with similar banks, bed material and slope, and will be designed by a suitably qualified person

with hydromorphological and flood risk experience. This assumption has been embedded within the assessment. There are potential opportunities to provide improvements over the existing case, however this has not been assessed.

- 9.7.14 The drainage designs will be finalised prior to construction, and will be designed to ensure that the effects are not significant.
- 9.7.15 New water supply will be sourced through Anglian Water rather than utilising groundwater.
- 9.7.16 It is assumed that the need for long term water quality monitoring will be set out and agreed with the Environment Agency through the environmental permitting process and thus no details of what this may involve are described here.

Decommissioning Phase

- 9.7.17 Mitigation of adverse impacts on the water environment during the decommissioning construction phase will, as with the construction phase, be achieved principally through embedded measures identified in Section 9.5, notably the adoption of a Decommissioning Environmental Management Plan (DEMP) for each of the Proposed Developments.
- 9.7.18 The diverted South Killingholme Drain will remain in-situ beyond the decommissioning phase.

9.8 Residual Effects and Conclusions

- 9.8.1 As for the 'before mitigation' effects reported in Section 9.6, residual effects associated with the Proposed Phillips 66 Development and the Proposed VPI Development will be assessed separately as well as together to provide transparency and clarity to the planning process.
- 9.8.2 A summary of residual effects on water resources and flood risk and their significance is provided in Table 9.13.
- 9.8.3 This chapter assesses potential impacts from the Proposed Developments on the quality and quantity of surface waterbodies, and the effects of these potential changes on key receptors (or attributes). Water features that could potentially be affected include local land drains (located adjacent to the Sites boundaries), South Killingholme Drain (South Killingholme Drain Branch 1), the Humber Lower (Humber Estuary) and the Rosper Road Pools. A summary of the impact assessment findings is provided in Table 9.13.
- 9.8.4 The standard impact avoidance measures proposed would reduce the risk of many impacts occurring during the construction, operational and decommissioning phases. These include implementation of Environment Agency GPPNs, PPGs, construction staff awareness and training, implementation of pollution plans and the appropriate discharge/ disposal of site runoff.
- 9.8.5 The assessment has identified the 'worst-case scenario', such as significant pollution events, which have a low probability of occurrence due to the procedures and measures that would be put in place.
- 9.8.6 Adverse residual effects on the key receptors have predominantly been assessed as minor adverse to negligible and therefore not significant, except for the proposed Wet Gas Scrubber sulphate discharge associated with the Proposed Phillips 66 Development, which is discussed in the following subsection.
- 9.8.7 Aside from the sulphate removal (e.g. deSOx), no mitigation measures additional to those described within Section 9.5 have been identified. Therefore all other residual effects remain as described in Section 9.6. It is acknowledged that even with the implementation of impact avoidance measures, there is still a very limited potential for some residual risk to the water environment associated with the construction, operation and decommissioning of the Proposed Developments.

- 9.8.8 The FRA (Appendix 9A, ES Volume II) concludes that development of the Sites would not increase the risk of flooding from tidal, fluvial, groundwater, overland flow, drainage infrastructure or artificial watercourse sources.

Water Quality Impacts Associated with Sulphate Discharge (Proposed Phillips 66 Development)

- 9.8.9 The application of the desulphurisation measures (deSO_x) as set out in Section 9.7 will reduce the concentration of sulphate discharged from the Proposed Phillips 66 Development by around 50%. This will reduce the maximum total effluent concentration from around 1,800 mg/l to below 1,000 mg/l. This will dilute further along South Killingholme Drain downstream of the existing VPI Immingham CHP Plant (and Proposed VPI Development) discharge.
- 9.8.10 As noted in Section 9.6, sulphate is not assessed as a contaminant under the WFD nor is it included in the indicative list of polluting substances in Annex II to the Industrial Emissions Directive (2010/75/EU). A literature review to inform HRA (AECOM, 2023) concluded that a level of ~1,000 mg/L of sulphate would be an appropriate maximum allowable concentration to protect aquatic life.
- 9.8.11 The effect of this discharge to South Killingholme Drain would be a measurable decrease in the chemical quality of South Killingholme Drain. The deSO_x treatment will reduce the sulphate concentration by around 50% which should be sufficient to ensure that the sulphate concentration in the effluent is around or less than 1,000 mg/l, but conservatively it is predicted that the sulphate discharge will result in a medium adverse magnitude of impact. Given that South Killingholme Drain is of low importance in terms of water quality, given that the watercourse is heavily modified and acts largely as an effluent channel, this will result in a **minor adverse effect (not significant)**.
- 9.8.12 Rosper Road Pools are downstream of the existing VPI Immingham CHP Plant (and Proposed VPI Development) discharge, which is predicted to provide dilution of sulphate in the refinery effluent of around 40%. Therefore, with the proposed 50% reduction in sulphate through treatment in the effluent discharged from the refinery, the residual concentration of sulphate in water that may spill under certain conditions into the Rosper Road Pools would be expected to be lower than the appropriate maximum concentration to protect aquatic life (i.e. 1,000 mg/l). The dilution may be higher given that flows to Rosper Road Pools only occurs during tide locked and high flow events. However, additional water quality, flow and level monitoring is recommended to confirm the dilution potential and function of the control weir into the pools. Overall, although there will still may be a measurable decrease in the chemical quality, it is considered unlikely to impact on integrity of Rosper Road Pools. As such, it is considered that incorporating a reduction of 50% through desulphurisation to mitigate the impact, the additional sulphate discharge may result in a minor adverse magnitude of impact. This would result in a **minor adverse (not significant)** significance of effect.

Table 9.13: Summary of effects

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
Construction	Contaminated surface runoff impacting on water quality (VPI and Phillips 66 Sites)	Local Land Drains – Negligible (not significant) South Killingholme Drain (Low) – Negligible (not significant) Rosper Road Pools – Negligible Humber Estuary – Negligible (not significant)	Construction works would be carried out in accordance with CEMP and environmental good practice on site.	Local Land Drains – Negligible (not significant) South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant) Humber Estuary – Negligible (not significant).	Short term, reversible
	Suspended sediments in site runoff entering watercourses or resuspension of sediment within watercourses resulting in water quality impacts and impacting habitats (water quality and morphology) (VPI and Phillips 66 Sites)	Local Land Drains – Negligible (not significant) South Killingholme Drain – Minor adverse (not significant) Rosper Road Pools – Minor adverse (not significant) Humber Estuary – Negligible (not significant)	Construction works would be carried out in accordance with CEMP and environmental good practice on site.	Local Land Drains – Negligible (not significant) South Killingholme Drain – Minor adverse (not significant) Rosper Road Pools – Minor adverse (not significant) Humber Estuary – Negligible (not significant)	Short term, reversible
	Temporary changes to morphology and loss of habitat due to diversions and in channel works (VPI only)	NELIDB watercourses – Negligible (not significant)	Construction works would be carried out in accordance with CEMP and environmental good practice on site.	NELIDB watercourses – Negligible (not significant)	Short term, reversible
	Temporary changes to localised flood risk due to construction laydown areas and temporary diversion (Phillips 66 and VPI Sites)	Off-site receptors – Negligible (not significant)	Construction works would be carried out in accordance with CEMP and environmental good practice on site.	Off-site receptors – Negligible (not significant)	Short term, reversible

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
			Incorporation of construction attenuation to suitable return period. In channel works ensuring flood passage provided.		
Operation	Contaminated and sediment laden water flows from surface runoff entering the watercourses.	South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant) Humber Estuary – Negligible (not significant)	Implementation of drainage philosophies, water treatment and compliance with permits and consents.	South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant) Humber Estuary – Negligible (not significant)	Short term, reversible
	Foul water effluent entering watercourses	South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant) Humber Estuary – Negligible (not significant)	Implementation of drainage philosophies, water treatment and compliance with permits and consents.	South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant) Humber Estuary – Negligible (not significant)	Short term, reversible
	Contaminated laden process water flows from spills, overflows and accidental discharges entering the watercourses.	Local Land Drains – Negligible (not significant) South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant) Humber Estuary – Negligible (not significant)	Implementation of drainage philosophies, water treatment and compliance with permits and consents.	Local Land Drains – Negligible (not significant) South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant) Humber Estuary – Negligible (not significant)	Short term, reversible
	Operational discharge of sulphate to watercourses (Phillips 66 only)	South Killingholme Drain – Minor adverse (not significant)	Desulphurisation (deSOx) to reduce sulphate concentration	South Killingholme Drain – Minor adverse (not significant)	Long term, reversible

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
		Rosper Road Pools – Moderate adverse (significant) Humber Estuary – Negligible (not significant)	of Wet Gas Scrubber effluent Monitoring and further assessment	Rosper Road Pools – Minor adverse (not significant) Humber Estuary – Negligible (not significant)	
	Additional water demand abstractions	South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant) Humber Estuary – Negligible (not significant)	Additional water to be sourced from Anglian Water, no new abstractions from groundwater or surface water	South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant) Humber Estuary – Negligible (not significant)	
	Permanent morphological changes and habitat effects - South Killingholme Drain (VPI only)	NELIDB watercourses – Negligible (not significant)	Design of the diversion channel with hydromorphological input on like for like basis, incorporating similar cross-section, bed and banks.	NELIDB watercourses – Negligible (not significant)	Long term, irreversible
	Permanent changes to localised flood risk due to increased hardstanding and channel diversion	Off-site receptors – Negligible (not significant)	Attenuation to greenfield runoff rates and implementation of site drainage plan. Design of diversion channel to prevent increases in flooding.	Off-site receptors – Negligible (not significant)	Long term, irreversible
De-commissioning	Contaminated surface runoff impacting on water quality	Local Land Drains – Negligible (not significant) South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant)	Decommissioning works would be carried out in accordance with DEMP and environmental good practice on site.	Local Land Drains – Negligible (not significant) South Killingholme Drain – Negligible (not significant) Rosper Road Pools – Negligible (not significant)	Short term, reversible

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
		Humber Estuary – Minor adverse (not significant)		Humber Estuary – Minor adverse (not significant)	
	Suspended sediments in site runoff entering watercourses or resuspension of sediment within watercourses resulting in water quality impacts and impacting habitats (water quality and morphology)	Local Land Drains – Negligible (not significant) South Killingholme Drain – Minor adverse (not significant) Rosper Road Pools – Minor adverse (not significant) Lower Humber – Minor adverse (not significant)	Decommissioning works would be carried out in accordance with DEMP and environmental good practice on site.	Local Land Drains – Negligible (not significant) South Killingholme Drain – Minor adverse (not significant) Rosper Road Pools – Minor adverse (not significant) Lower Humber – Minor adverse (not significant)	Short term, reversible

9.9 References

British Standards Institute (1990). BS 5908 Code of practice for fire precautions in the chemical and allied industries. London: British Standards Institution.

British Standards Institute (2009). BS6031:2009 Code of Practice for Earth Works. London: British Standards Institute.

British Standards Institute (2013a). BS8582 Code of Practice for Surface Water Management of Development Sites. London: British Standards Institute.

British Standards Institute (2013b). BS 10175: 2011+A2:2017 Investigation of Potentially Contaminated Sites – Code of Practice. London: British Standards Institute.

CEH (n.d.). National River Flow Archive [Online]. Available at: <http://nrfa.ceh.ac.uk/>

CIRIA (2001). C532 Control of water pollution from construction sites –Guidance for consultants and contractors. London: CIRIA.

CIRIA (2004a). C609 Sustainable Drainage Systems, hydraulic, structural and water quality advice. London: CIRIA.

CIRIA (2004b) C624 Development and flood risk – Guidance for the construction industry.

CIRIA (2006). C648 Control of water pollution from linear construction projects, technical guidance. London: CIRIA.

CIRIA (2014). C736F Containment systems for prevention of pollution

CIRIA (2015a). C753 The SuDS Manual. London: CIRIA. [Online]. Available at: <https://www.ciria.org/ItemDetail?iProductCode=C753&Category=BOOK&WebsiteKey=3f18c87a-d62b-4eca-8ef4-9b09309c1c91v>

CIRIA (2015b). C744 Coastal and marine environmental site guide (second edition). London: CIRIA.

CIRIA (2015c). C741 Environmental good practice on site guide (fourth edition). London: CIRIA

Cranfield University (n.d.). Soilscapes [Online]. Available at: <http://www.landis.org.uk/soilscapes>

Department for Communities and Local Government (2012a). National Planning Policy Framework. London. The Stationery Office.

Department for Communities and Local Government (2012b). National Planning Practice Guidance. London. The Stationery Office.

Department for Communities and Local Government (2014). Flood Risk and Coastal Change. London: The Stationery Office.

Department of Energy and Climate Change (2011a). The Overarching NPS for Energy (EN-1). London: The Stationery Office.

Department of Energy and Climate Change (2011b) National Policy Statement for Fossil Fuel Electricity Generating Infrastructure (EN-2). Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37047/1939-nps-for-fossil-fuel-en2.pdf

Defra (2011b). Future Water: The Government's Water Strategy for England. London: The Stationery Office.

Defra (2015). Sustainable Drainage Systems: non-statutory technical standards. London: The Stationery Office.

- Defra (2018). A Green Future: Our 25 Year Plan to Improve the Environment. London: The Stationery Office.
- Defra (n.d.). Multi-Agency Geographic Information for the Countryside (MAGiC) [Online]. Available at: <http://www.magic.gov.uk/>
- Department for Transport (2019). TAG unit A3 Environmental Impact Appraisal [Online]. Available at: <https://www.gov.uk/government/publications/webtag-tag-unit-a3-environmental-impact-appraisal-december-2015>;
- Environment Agency (1998a) River Geomorphology: a practical guide. Bristol: Environment Agency.
- Environment Agency (1998b). Geomorphological approaches to river management. Project record W5A/i661/1. Bristol: Environment Agency.
- Environment Agency (2000) PPG18: Control of Spillages and Fire Fighting Runoff.
- Environment Agency (2001). Pollution Prevention Guidance [Online]. Available at: <https://www.gov.uk/government/collections/pollutionprevention-guidance-ppg>
- Environment Agency, (2004). CLR 11 Model Procedures for the Management of Land Contamination. Bristol: Environment Agency.
- Environment Agency (2010). GPLC1 Guiding Principles for Land Contamination in Assessing Risks to Controlled Waters [Online]. Available at: <https://webarchive.nationalarchives.gov.uk/20140328173027/http://cdn.environment-agency.gov.uk/geho1109brgy-e-e.pdf>
- Environment Agency (2011). Pollution Prevention Guidance. Safe storage – the safe operation of refuelling facilities: PPG7.
- Environment Agency (2012) PPG6: Working at Construction and Demolition Sites.
- Environment Agency (2013) Pollution Prevention Pays in England and Wales.
- Environment Agency (2015). Humber River Basin District River Basin Management Plan. Part 1. Updated 2015 Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718328/Humber_RBD_Part_1_river_basin_management_plan.pdf
- Environment Agency (2016). Discharges to surface water and groundwater: environmental permits [Online]. Available at: <https://www.gov.uk/guidance/discharges-to-surface-water-and-groundwaterenvironmental-permits>.
- Environment Agency (2021) Regulatory Position Statement: Temporary Water Discharges from Excavations.
- Environment Agency (n.d.a). Catchment Data Explorer [Online]. Available at: <http://environment.data.gov.uk/catchment-planning/>
- Environment Agency (n.d.b). Flood Risk Maps for Planning [Online]. Available at: <https://flood-map-for-planning.service.gov.uk/>
- Environment Agency (n.d.c). Water quality data archive website [Online]. Available at: <https://environment.data.gov.uk/water-quality/view/landing>
- Environment Agency (n.d.d). Find a bathing water [Online]. Available at: <https://environment.data.gov.uk/bwq/profiles/>
- European Commission (2016) Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/

Management Systems in the Chemical Sector [Online]. Available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC103096/jrc103096_cww_bref_10_2016.pdf

Humber Estuary Services (n.d.). Estuary History. Available at: https://www.humber.com/Estuary_Information/Marine_Information/Estuary_History/. Accessed 26/01/2023.

Highways Agency (2006a). Design Manual for Roads and Bridges HD 103/06, Vegetated Drainage Systems for Highway Runoff. Birmingham: Highways Agency.

Highways Agency (2006b). Design Manual for Roads and Bridges HD 33/16, Surface and Subsurface Drainage Systems for Highways. Birmingham: Highways Agency.

Highways England (2019). Design Manual for Roads and Bridges LA113 Road Drainage and the Water Environment. Birmingham: Highways England.

Highways England (2020) Design Manual for Roads and Bridges L104 Environmental Assessment and Monitoring. Birmingham: Highways England.

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

Met Office (n.d.). Climate averages data [Online]. Available at: <http://www.metoffice.gov.uk/public/weather/forecast>

National Rivers Authority (1992). Humber Estuary: A Report from the Humber Estuary Committee of the National Rivers Authority. Available at: <http://www.environmentdata.org/archive/ealit:3122/OBJ/20000049.pdf>

National Library of Scotland (n.d.). Map Images, Historic Map Layers, OS 25 Inch, 1892-1914. Available at: <https://maps.nls.uk/geo/explore/#zoom=16.5&lat=53.63395&lon=-0.22239&layers=168&b=1>

North East Lindsey Internal Drainage Board (2019). North East Lindsey Internal Drainage Board Bylaws. Available at: <https://witham3idb.gov.uk/wp-content/uploads/2019/12/NORTH-EAST-LINDSEY.pdf>

North Lincolnshire Council (2022). North and North East Lincolnshire Strategic Flood Risk Assessment. Available at: <https://m.northlincs.gov.uk/public/localplan/evidence/SFRA%202022.pdf>

Wood Group UK Limited (2022). Phillips 66 – Humber Refinery – Environmental permit improvement conditions IC28 and IC29. Environmental Risk Assessment.