Immingham Green Energy Terminal

Environmental Impact Assessment

Preliminary Environmental Information Report

Volume II – Main Report

Chapter 22: Major Accidents and Disasters

Associated British Ports

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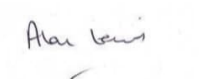
Signed		Date	20/12/2022
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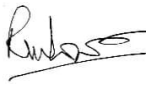
Signed		Date	20/12/2022
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22.1 Introduction

22.1.1 This chapter presents the preliminary findings of an assessment to determine the potentially adverse effects of the Project on the environment as a result of major accident and/or disaster (MA&D) scenarios which are relevant to the development. Relevant scenarios are those which could credibly arise during the construction, operation and decommissioning of the Project.

22.1.2 The potential adverse effects of the Project on the environment derive from the vulnerability of the development to relevant MA&Ds. Vulnerability is the potential for harm to occur as a result of the event, the assessment of which considers the consequences of the MA&D event scenario and the importance of the receptor. Within this assessment, effects are defined qualitatively by the nature of their consequences, size, and/or location.

22.1.3 This chapter includes a preliminary description of the measures which will be incorporated in the Project design to prevent or mitigate potential significant adverse effects of MA&D events on the environment and provides an overview of the preparedness for, and proposed response to, such emergencies.

22.1.4 The Health and Safety Executive (HSE) have established the concept of "*reasonably practicable*" as the risk-reduction goal for duty-holders established within the Health and Safety at Work Act 1974 (Ref 22-1). The mitigation measures associated with MA&D events must therefore be suitable and sufficient to reduce the risk of the event to a level that can be demonstrated to the HSE is 'as low as reasonably practicable' (ALARP).

22.1.5 In the context of Environmental Impact Assessment (EIA), the following definitions are provided within the published document "Major Accidents and Disasters in EIA: A Primer" published by the Institute of Environmental Management and Assessment (IEMA) (Ref 22-2):

a. "A major accident is an event (for instance, train derailment or major road traffic incident) that threatens immediate or delayed serious effects to human health, welfare and/or the environment and requires the use of resources beyond those of the client or its appointed representatives (e.g. contractors) to manage."

b. "A disaster is a man-made/external hazard (such as an act of terrorism) or a natural hazard (such as an earthquake) with the potential to cause an event or situation, which meets the definition of a major accident above."

22.1.6 This preliminary assessment of MA&Ds has considered the findings of a number of other key studies carried out in support of the Preliminary Environmental Information (PEI) Report, including the ongoing flood risk assessment, the identification of environmental and human health receptors in the locality of the Project, and the assessment of the vulnerability of receptors. As such, the following chapters of the PEI Report are pertinent to this assessment:

a. **Chapter 12: Marine Transport and Navigation.**

b. **Chapter 18: Water Quality, Coastal Protection, Flood Risk and Drainage.**

c. **Chapter 24: Human Health and Wellbeing.**

22.1.7 This MA&D chapter is supported by the following figures:

a. **Figure 22.1:** Major Accidents and Disasters Study Area (PEI Report, Volume III).

22.2 Approach to Assessment

Scope and Methods

22.2.1 A scoping exercise was undertaken in August 2022 to establish the methodology to be applied for the identification and assessment of MA&Ds. Currently, there is no singular approach for this type of assessment contained within the EIA Regulations, however guidance is available from sources such as IEMA (Ref 22-2).

22.2.2 The methodology used to identify credible major accidents relevant to the Project is based on an assessment of the properties of dangerous substances which could be present during the lifecycle of the Project, and the activities and operations involving these substances, from construction and operation to decommissioning and demolition.

22.2.3 The geographical location of the Project is also considered, to identify additional major accident scenarios and credible potential disaster scenarios. The Project location establishes the susceptibility of the Site to impacts such as climatic and seismic events and the vulnerability of receptors.

22.2.4 The location of the Site relative to industrial neighbours such as bulk fuel storage and chemical manufacturing facilities, can increase the risk to receptors from incidents which are referred to within the Control of Major Accident Hazards Regulations 2015 (the COMAH Regulations) (Ref 22-3) as ‘domino effects’. An example of such an event is a fire occurring at a COMAH facility which initiates an incident at a neighbouring COMAH facility. This category of scenario can include events at the Project site which can have an effect at a nearby industrial facilities and also events which are initiated at a nearby industrial facility which can reach the Project site. The assessment of MA&Ds considers the potential for these events to occur.

22.2.5 The criteria to define the level of harm to people and the environment which would constitute a MA&D is not defined within the Infrastructure Planning (EIA Regulations) 2017 (Ref 22-4). This assessment therefore considers the criteria for notification of a major accident hazard as established in the COMAH Regulations (Ref 22-3).

22.2.6 The COMAH Regulations (Ref 22-3) apply to sites in which quantities of hazardous materials are or could be present above defined thresholds. The substances stored in operational areas of the Project are expected to be present above the threshold quantities established in Annex 1 of the COMAH Regulations (Ref 22-3), and consequently this approach is considered reasonable for the preliminary assessment of MA&Ds carried out for this Project.

22.2.7 Schedule 5 of the COMAH Regulations (Ref 22-3) (now revoked) contained criteria for a major accident which would require notification to the European Commission. Following the exit of the UK from the European Union, this schedule was revoked and such notification is no longer required, however, this information can still be adopted as useful criteria to be used in the assessment of MA&Ds.

22.2.8 Criteria for a major accident includes the following based on the European Seveso III Directive on the Control of Major Accidents (Ref 22-5):

a. An injury to a person which is fatal;

b. Up to six persons are injured within the establishment and hospitalised for at least 24 hours;

c. One person outside the establishment is hospitalised for at least 24 hours;

d. A dwelling outside the establishment is damaged and is unusable as a result of the accident;

e. The evacuation or confinement of persons for more than 2 hours, where persons × hrs is at least 500;

f. The interruption of drinking water, electricity, gas or telephone services for more than 2 hours, where persons × hours is at least 1,000;

g. Damage to property in the establishment, to the value of at least €2million; or

h. Damage to property outside the establishment, to the value of at least €500,000.

22.2.9 The criteria for damage to the environment, which could be considered to represent a MA&D are also listed in Schedule 5 of the COMAH Regulations (Ref 22-3) which, although now revoked, provide useful guidance and include the following benchmarks:

a. Permanent or long-term damage to terrestrial habitats involving:

   i 0.5 hectares (ha) (equivalent to 5,000 m^2) or more of a habitat of environmental or conservation importance protected by legislation; or

   ii 10 or more hectares of more widespread habitat, including agricultural land.

b. Significant or long-term damage to freshwater and marine habitats involving:

   i 10 km or more of river or canal;

   ii 1 ha or more of a lake or pond;

   iii 2 ha or more of delta; or

   iv 2 ha or more of a coastline or open sea.

c. Significant damage to an aquifer or underground water of 1 ha or more.

22.2.10 Guidance provided by the HSE on the Pipelines Safety Regulations 1996 (Ref 22-6) defines a major accident in the context of a pipeline as:

a. A major accident would cover death or serious injury from a fire, explosion or uncontrolled emission from a pipeline. This includes both events which have escalated beyond the control of the normal operating envelope of the pipeline and those resulting from third party interference. Whether an event leads to serious danger to people will depend on factors specific to the incident. Major accidents to people can be distinguished from other accidents by the severity of the injuries, the number of casualties, or by the physical extent of the damage in areas where people may be present.

22.2.11 Guidance provided in IEMA (Ref 22-2) includes the following definition of a significant environmental effect in relation to MA&D:

a. Could include the loss of life, permanent injury and temporary or permanent destruction of an environmental receptor which cannot be restored through minor clean-up and restoration.

22.2.12 The definition aligns with that which was contained in Schedule 5 of COMAH Regulations (Ref 22-3).

22.2.13 An initial consideration of MA&D was undertaken for the Project at the Scoping Stage. The objective of the assessment at that juncture was to identify the credible potential impacts within a qualitative, high-level analysis of MA&Ds.

22.2.14 The Scoping Report (**Appendix 1.A** of PEI Report, Volume IV) recorded the findings of the scoping exercise and details the relevant legislation, policy, information, technical guidance, standards, best practice and criteria applied in the assessment, to identify and evaluate credible potential MA&D scenarios pertinent to the Project.

22.2.15 Following receipt of the Scoping Opinion (**Appendix 1.B** of PEI Report, Volume IV) as to the information to be provided in the ES, the following requirements set out in **Table 22.1** have been identified by the Planning Inspectorate, which are being taken into account as part of the ongoing MA&Ds assessment.

Table 22.1 Scoping Opinion comments on major accidents and disasters

Consultee	Summary of Response	How comments have been addressed in this chapter
PINS	The Scoping Report states that study area for the assessment of major accidents and disasters is not defined within regulatory guidance or standardised methodology, but that the study area is based on experience and judgement and includes nearby major hazard sites, pipelines other sites whose land use planning zones may encroach on any part of the Proposed Development. The ES should contain a robust justification to support the chosen study area and sensitive receptors selected for the purposes of the ES assessment, based on professional guidance such as that published by IEMA (Ref 22-2). The study area should be consulted on and agreed with relevant consultation bodies where possible. Figure 2.1 in Appendix A is stated to provide a figure showing the site boundary with respect to infrastructure and industrial sites and natural features and protected environmental sites, however this does not appear to map any major hazard sites or receptors near to the Proposed Development. A figure showing relevant receptors and potential major hazard risks should be provided in the ES.	The PEI Report incorporates a bespoke figure (**Figure 22.1**, PEI Report, Volume III) to present the study area, clearly identifying the key receptors, infrastructure and existing major accident installations. Detailed text has been included in the PEI Report to describe receptors including other COMAH installations and environmental receptors including groundwater vulnerability. A radius of 5km from the Site boundary has been used to define the study area. The Site boundary has been adjusted following the submission of the Scoping Report, however the modifications made to the boundary have been assessed to have no impact on the study area. No specific comments on the geographic extent of the study area were made by consultees during scoping, however, the PEI Report has included a more detailed description of the area within 5km of the Site which is now supported by **Figure 22.1** (PEI Report, Volume III).
	The assessment should consider the vulnerability of the Proposed Development to a potential accident or disaster and the Proposed Development's potential to cause an accident or disaster including the use of Very Large Gas Carriers (VLGCs). The ES should also provide consideration of future hazards associated with transportation and storage of CO_2. The assessment should consider how any surrounding hazardous installations may impact on the major accident hazards arising from the Proposed Development's site operation. Any assessment should include consideration of the impact on surrounding hazardous	The potential for a MA&D associated with the use of VLGC was described within the Scoping Report and has been assessed further within the PEI Report. A description of the potential hazards associated with VLGCs is included in **Sections 22.6.16** to **22.6.19** inclusive. One credible major accident scenario was identified involving a release to the marine environment, defined as Risk Event 7. This event considers the potential for an accident as a result of a loss of containment from a VLGC.

Consultee	Summary of Response	How comments have been addressed in this chapter
	installations including potential cumulative effects from multiple major accidents which the Proposed Development could become part of cumulatively. Where qualitative assessments are made the professional qualifications and experience of the assessors should be made clear in the ES.	The future use of facilities within the scope of this project to transport and/or store carbon dioxide (CO_2) has been described in the MA&D Chapter as follows: CO_2 is another bulk liquid, in addition to ammonia, that is likely to be used at the new terminal in future. Specific proposals are being developed for the import and export of liquified CO_2 from carbon capture and storage projects elsewhere, but these are at an early stage and would be subject to a separate application for development consent. There are no identified chemical incompatibilities associated with operation of facilities such as the jetty to include CO_2 operations in addition to hydrogen and ammonia transfer. There would be engineering equipment, systems and procedures to prevent these materials coming into contact such as isolation valves and vents. Consequently, no detailed treatment of CO_2 accidents is incorporated within this MA&D chapter at this juncture (see **Paragraph 22.6.14**). Potential effects to and from nearby major accident hazard pipelines and installations have been described and considered throughout, in particular, **Tables 22.2** and **22.4** and **Section 22.6.7**). The potential for a domino event to have an impact on several sites cumulatively will be assessed at the ES stage, when Quantitative Risk Assessment (QRA) and consequence modelling will be undertaken to assess hazards in more detail. A paragraph describing qualifications and experience of the author is included in **Appendix 1.D** (PEI Report, Volume IV).

Consultee	Summary of Response	How comments have been addressed in this chapter
Health & Safety Executive	According to HSE's records the proposed site is in the vicinity of a number of major accident hazard installations with Hazardous Substances Consent. Given the nature of the proposal the site will need to consider all the major hazards associated with its proposed operations including both the impact on the surrounding hazardous Installations and how these installations may impact on the major accident hazards arising from the site operation. The site would likely need to be included in a domino group of sites. Also according to our records the site is in close proximity to a major hazards pipeline operated by Cadent Gas ltd. It is noted that the EIA recognise the potential impact of these major hazard operations on to the site, but consideration also needs to be given to the impact of the site onto these sites through the lifecycle of the facility including construction.	The PEI Report MA&D chapter includes a more detailed description of industrial neighbours and the potential for domino events than was included within the Scoping Report. The potential hazards of existing operational facilities such as COMAH sites and major accident hazard pipelines have been considered in this chapter during construction, operation and future decommissioning within Risk Event 13. The ES stage will include more detailed hazard analysis such as QRA and consequence modelling which can be used to refine the assessment of potential domino effects. Assessment by HSE as part of the Hazardous Substance Consent application.
	The proposal laid out in the EIA recognises the operation of the will involve the presence of hazardous substances on, over or under land at or above set threshold quantities (Controlled Quantities) will therefore require Hazardous Substances Consent (HSC) under the Planning (Hazardous Substances) Act 1990 as amended, as set out in The Planning (Hazardous Substances) Regulations 2015 as amended (Ref 22-7). Table 21.3 of the EIA recognises that HSC would be required given the proposal involves the handling of Named Hazardous Substances or Categories of Substances at or above the controlled quantities set out in Schedule 1 of these Regulations. The proposal also recognises the site will be within the scope of Control of Major Accident Hazard Regulations 2015 and will therefore require notification to the COMAH Competent Authority prior to construction. However, what is not identified in this table is whether notification is required under the Pipelines Safety Regulations 1996 in relation to the construction and	This PEI Report MA&D chapter includes additional details on the requirement for the Project to comply with the Pipelines Safety Regulations (PSR) 1996 (Ref 22-6) which are relevant to the Project. Pipelines containing hydrogen and ammonia are within the definition of dangerous substances contained within the PSR, therefore specific controls described in PSR will apply to these. The applicability of legislation pertinent to the assessment of MA&D within discrete areas of the Project is established in **Table 22.2**. This chapter of the PEI Report includes a statement that the operator of the pipelines would fulfil all statutory requirements for compliance with PSR 1996, including the production of a Major

Consultee	Summary of Response	How comments have been addressed in this chapter
	operation of the pipelines that are proposed within the application. It is recommended that details of the proposed pipelines and whether they come within the scope of PSR are included in future consultation documentation.	Accident Prevention Document(s) (MAPD) and the appropriate emergency plans. A description of the PSR 1996 is included in **Table 22.2** and **Section 22.4.2**.
Environment Agency	The Environment Agency will have a role in regulating the site in line with COMAH and has no comments to make on the proposed assessment for planning purposes. However, we welcome the acknowledgement that the proposed development will present major accident hazards and identifies the importance of the Humber as a receptor.	This is noted.
North East Lincolnshire Council	Thank you for the opportunity to comment on the submitted EIA Scoping report provided by the Applicant. On the whole NELC are content with the scope of the proposed EIA, responses from internal consultees are provided at the bottom of this letter. NELC would like to highlight the importance of fully understanding and considering the extent of any Hazardous Zones associated with the development and the land use planning implications of such zones. This should be through consultation with the Health and Safety Executive.	The HSE is a statutory consultee during the planning process and this consultation is expected to incorporate a detailed discussion with the Applicant around the land use planning consultation zones in the area of the Project. The Project site is within the consultation distances of a number of major hazard sites and pipelines, therefore this will be a key factor to be taken into account during the EIA for the Project and through consultation with the HSE.

Legislation, Policy and Guidance

22.2.16 **Table 22.2** presents the legislation which applies to the facilities included within the Project. The duty holder for these facilities may include operators other than the Applicant. N/A denotes the legislation is not applicable.

22.2.17 There are a considerable number of best practice guidance documents and engineering design standards applicable to the assessment of MA&Ds for the Project. Two key standards have been selected as indicative examples for preventing a loss of containment and assessment of the significance of a release to the environment should a loss occur.

Table 22.2 Relevant Legislation, Policy and Best Practice Regarding MA&D

Legislation/Policy/Guidance	Consideration within the PEI Report
The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (Ref 22-4)	
The Infrastructure Planning (EIA) Regulations 2017 require that the effects of a project, where these are likely to have a significant effect on the environment, are taken into account in the decision-making process for that project. These regulations indicate the process and requirements for the provision of adequate environmental information to enable the EIA process.	Regulation 5 - Environmental Impact Assessment (EIA) process Paragraph 4 The effects to be identified, described and assessed under paragraph (2) include, where relevant, the expected significant effects arising from the vulnerability of the proposed development to major accidents or disasters that are relevant to that development. This chapter of the PEI Report contains a description of the potential types of risk events identified as being relevant to the Project which could result in a MA&D. The IEMA guidance (Ref 22-2) defines a risk event as an identified, unplanned event, which is considered relevant to the development and has the potential to result in a major accident and/or disaster, subject to assessment of its potential to result in a significant adverse effect on an environmental receptor. A significant effect is defined as one which could include the loss of life, permanent injury and temporary or permanent destruction of an environmental receptor which cannot be restored through minor clean-up and restoration. The nature of the Project is such that there are a number of potential risk events inherent to the substances present on Site, however, the Project is required to demonstrate to the regulatory authorities that risks have been reduced to levels that are as low as reasonably practicable (ALARP) prior to the start of operational activities. This chapter therefore presents the assessment to identify risk events, categorise their significance and summarise the control and mitigation measures to reduce risk, for the purposes of the EIA process.

Legislation/Policy/Guidance	Consideration within the PEI Report
The Control of Major Accident Hazards (COMAH) Regulations 2015 (Ref 22-3)	
The COMAH Regulations 2015 (as amended) implement the Seveso III Directive and are applicable to the operators of establishments which store quantities of dangerous substances equal to or in excess of the qualifying quantities listed in Schedule 1 of the Regulations. The COMAH Regulations require that operators take all necessary measures to prevent major accidents involving dangerous substances and are enforced by the Competent Authority comprising the Health and Safety Executive (HSE) and Environment Agency (EA) acting in cooperation.	Part 2 General Duties of Operators The inventory of substances at the Project would be in excess of the qualifying quantities listed in Schedule 1 of the COMAH Regulations, therefore this legislation is applicable to the Project. Regulation 5(1) Every operator must take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment. Notifications Regulation 6(1) Within a reasonable period of time prior to the start of construction of a new establishment the operator must send to the competent authority a notification containing the information set out in Regulation 6. This PEI Report contains a high-level identification of credible major accidents and disasters which will be considered as part of the ongoing programme of work to be carried out by the operator (the person in control of operations at the COMAH establishment) to demonstrate that risks associated with the Project are reduced to a level as low as reasonably practicable (ALARP), as required by the COMAH Regulations.
Land Use Planning Public Safety Advice (HSE) (Ref 22-25)	
HSE is a statutory consultee for planning applications around major hazard sites and pipelines and on applications for hazardous substances consent. HSE's advice is aimed at mitigating the effects of a major accident on the population around a major hazard site The HSE is a statutory consultee for developments which are subject to COMAH Regulations, such as this Project. Part of the consultation process will involve a review by the HSE of the site location relative to existing installations (includes COMAH sites, major accident hazard pipelines). These existing installations will have defined consultation zones. The HSE's consultation zones are categorised as either 'Inner', 'Middle' or 'Outer' and a separate category is applied for the safeguarding zones associated with explosive hazards. Within these zones, the HSE's decision making criteria are based on the type of development which is proposed within the zone, the vulnerability of those	The information contained within this chapter of the PEI Report will form part of the information and assessments undertaken by Air Products to be considered by the HSE during the statutory consultation process. Information from this Project will be considered by the HSE alongside the existing consultation zones associated with existing installations within the area. The outcome from the consultation will inform the ongoing development of the Project.

Legislation/Policy/Guidance	Consideration within the PEI Report
likely to be present within those developments and the societal tolerance of the associated risk. HSE's advice will usually depend upon: • The consultation zone within which the proposed development is located. The Inner Zone closest to the major hazard where risks and hazards are greatest and restrictions on development are strictest, the Middle Zone and the Outer Zone. The zones are normally determined by a detailed assessment of the risks and/or hazards of the installation which takes into account the quantity of hazardous substances for which hazardous substances consent is held and the details of storage and/or processing, the hazard range and consequences of major accidents involving the hazardous substances that could be present. • The "sensitivity level" of the proposed development derived from HSE's categorisation of development types. There are 4 broad sensitivity levels: level 1 – based on the normal working population; level 2 – based on the general public at home and involved in normal activities; level 3 – based on vulnerable members of the public; and level 4 – large examples of level 3 and very large outdoor developments. Other rules may apply in more complex cases, for example where the project is located in more than one zone or there is more than one hazard or development type.	
The Environmental Permitting (England and Wales) Regulations (EPR) 2016 Regulations (Ref 22-24)	
Installations which carry out one or more defined prescribed activities such as chemical manufacturing are subject to the Environmental Permitting Regulations (EPR), therefore these Regulations will apply to the Project. EPR requires operators to supply detailed information to the Regulator in the form of a Permit Application and only when fully determined, is operation allowed to commence.	The MA&D chapter of the PEI Report includes the preliminary identification of major accidents and disasters with environmental impacts. This information is summarised in **Tables 22.2** and **22.3**.

Legislation/Policy/Guidance	Consideration within the PEI Report
Operators of sites regulated by EPR are required to take the measures necessary to prevent incidents and accidents.	
The Planning (Hazardous Substances) Regulations 2015 (Ref 22-6)	
The Planning (Hazardous Substances) Regulations 2015 apply to facilities which would like to hold quantities of hazardous substances at or above defined limits within the Regulations. These facilities must obtain a Hazardous Substance Consent (HSC). Applications for HSC are made to the hazardous substance authority (usually the local planning authority and in this case, is Northeast Lincolnshire Council (NELC)). The HSE is a statutory consultee for HSC applications. These Regulations amend planning procedures in relation to sites where hazardous substances are held and to land near those sites. This consent process regulates the storage and use of hazardous substances and enables breaches of control, which may present serious risks, to be dealt with quickly and effectively. However, even after measures have been taken to prevent major accidents, there will remain the residual risk of an accident which cannot entirely be eliminated. Hazardous Substances Consent ensures that this residual risk to people in the vicinity or to the environment is taken into account before a hazardous substance is allowed to be present in a controlled quantity. The extent of this risk will depend upon where and how a hazardous substance is present, and the nature of existing and prospective uses of the application site and its surroundings.	Part 3 Hazardous Substances Consent Procedures Regulation 5(1) Subject to paragraph (2) and regulation 23 (application of the Act to hazardous substances authorities), an application for hazardous substances consent must: (d) include details of: (i) the location of the land to which the application relates; (ii) the person in control of the land to which the application relates; (iii) each hazardous substance for which consent is sought (“relevant substance”), including the maximum quantity of each relevant substance proposed to be present; (iv) the main activities carried out or proposed to be carried out on the land to which the application relates; (v) how and where each relevant substance is to be kept and used; (vi) how each relevant substance is proposed to be transported to and from the land to which the application relates; (vii) the vicinity of the land to which the application relates, where such details are relevant to the risks or consequences of a major accident; and (viii) the measures taken or proposed to be taken to limit the consequences of a major accident. The information listed in 5(d) parts (i) to (vi) is contained within **Chapter 2: The Project**. Parts (vii) and (viii) are included in this chapter, specifically **Figure 22.1** (PEI Report, Volume III) and **Section 22.7** respectively. The inventory of substances stored within the landside infrastructure areas of the Project would be in excess of the qualifying quantities listed in Schedule 1 of the Hazardous Substances Regulations, and therefore this legislation is applicable. The PEI Report therefore contains information which is expected to be included within the application for HSC to the Local Planning Authority.
Health and Safety at Work etc. Act 1974 (HSWA) and Regulations made thereunder (Ref 22-6)	

Legislation/Policy/Guidance	Consideration within the PEI Report
The HSWA is the primary legislative instrument covering workplace health and safety in Great Britain. The HSWA establishes the obligations to ensure, so far as is reasonably practicable (SFAIRP), that persons are not exposed to risks to their health and safety. The HSE, along with local authorities, are responsible for enforcing the HSWA.	Preliminary – Article 1 The provisions of this Part shall have effect with a view to— (a) Securing the health, safety and welfare of persons at work. (b) Protecting persons other than persons at work against risks to health or safety arising out of or in connection with the activities of persons at work. (c) Controlling the keeping and use of explosive or highly flammable or otherwise dangerous substances, and generally preventing the unlawful acquisition, possession and use of such substances. This chapter of the PEI Report contains a high level description of the mitigation measures proposed to manage the reasonably foreseeable identified risks to health and safety of persons working at the Project Site, in neighbouring facilities and other persons which may be affected by these operations. The mitigation measures described in this chapter include the primary containment systems for dangerous substances, such as hydrogen and ammonia, and the security systems to prevent unauthorised access to operational areas where they are present.
The Pipelines Safety Regulations (PSR) 1996 (Ref 22-6)	
The PSR, made under the Health and Safety at Work etc Act 1974, do not cover the environmental aspects of accidents arising from pipelines. However, the Regulations, by ensuring that a pipeline is designed, constructed and operated safely, provide a means of securing pipeline integrity, thereby reducing risks to the environment. It is important that effects on the environment are considered at all stages in the life cycle of a pipeline. The PSR require operators of major accident hazard (MAH) pipelines to ensure that they are designed (and subsequently modified) so that they are safe to operate within the range of operating conditions to which they will be subjected. Safety systems such as emergency isolation and pressure relief valves will be provided to secure safe operation. Specific emergency plans are required for the pipelines and a Major Accident Prevention Document (MAPD) is to be	This Project would include installation of pipelines connecting the two operational process areas and these areas to the jetty, crossing land which is not owned and under the control of the Applicant and therefore the PSR will apply. These pipelines would transport hydrogen and ammonia, consequently, these are categorised as MAH pipelines within the PSR. A further pipeline would transport nitrogen between the East and West Sites. Gaseous nitrogen is not classified as a dangerous fluid in accordance with regulation 18(2) and Schedule 2 of the PSR, therefore is not categorised as a MAH pipeline. This chapter of the PEI Report establishes the principles to be adopted by the Project to comply with these Regulations, including identification and management of the risks associated with their operation.

Legislation/Policy/Guidance	Consideration within the PEI Report
produced, describing the hazards and safety management systems associated with management of risk. Operators are required to notify the HSE in advance of construction of a MAH pipeline and operations commencing.	
Construction (Design and Management) (CDM) 2015 Regulations (Ref 22-8)	
The CDM Regulations place specific duties on those undertaking defined roles during construction activities, such as clients, designers and contractors. These duties are to ensure health and safety is managed throughout the life of a construction project.	The CDM Regulations apply specific requirements for the management of health and safety during construction projects. This chapter of the PEI Report includes certain general overarching principles of how the Project will comply with CDM, to manage risks which have the potential to be a major accident, such as the development of a Construction Environmental Management Plan (CEMP).
The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002 (Ref 22-9)	
DSEAR set out the minimum requirements for the protection of workers from fire and explosion risks related to dangerous substances and potentially explosive atmospheres. These Regulations apply to employers at workplaces in Great Britain where a dangerous substance such as hydrogen is present or could be present. For COMAH Installations such as the Project, DSEAR is enforced by the HSE. Compliance with DSEAR requires employers to assess and control risks and ensure safety measures are in place before beginning work activities. Areas where an explosive atmosphere may be present must be identified, and can include tank vents, around flanged connections in pipework and many others. New equipment supplied for use in places where an explosive atmosphere may occur must meet the requirements established by DSEAR to prevent a source of ignition becoming active and available, thus increasing the risk of fire and/ or explosion.	The substances which would be present at the Project Site include hydrogen, ammonia and natural gas which are categorised in these regulations as dangerous, therefore the DSEAR is applicable. Mitigation measures to reduce the risk of MA&D events such as fire, explosion and toxic gas release include activities carried out for the purposes of DSEAR compliance. These activities would be undertaken throughout the lifecycle of the Project, from an early stage in the engineering design process where explosive atmospheres would be identified, and equipment (mechanical and electrical) would be specified appropriately. DSEAR compliance during construction includes assessments for the safe use of diesel which is classified as a flammable fluid within mobile plant. During Project operation and maintenance activities, detailed risk assessments would be completed, documented and regularly updated to reflect any changes made on site. These risk assessments would demonstrate a robust basis of safety for operation of the site as required by DSEAR.

Legislation/Policy/Guidance	Consideration within the PEI Report
The Chemical and Downstream Oil Industries Forum (CDOIF) Guideline on Environmental Risk Tolerability for COMAH Establishments (Ref 22-10)	
The COMAH Competent Authority recognizes the CDOIF Guideline on Risk Tolerability at COMAH Establishments as providing an appropriate methodology to Operators completing their Safety Reports. These reports must include an assessment of the environmental consequences (extent, severity and duration) of potential accidents, to determine whether the effects might constitute a Major Accident to the Environment (MATTE). The CDOIF guideline methodology includes a structured approach to assessing environmental risks following major accidents, taking into consideration the extent (the area / distance), the severity (the degree of harm within the area of impact), and duration (the recovery period) of the event. The levels of harm to the environment which would be categorised as serious depends on the type of receptor, therefore this methodology includes threshold harm levels specific to categories of receptor e.g., groundwater and soils. Risk is evaluated taking into consideration the severity and duration of the event, and a category of MATTE can be concluded. These risk categories are A (lowest) to D (highest). Risks identified as being below category A are termed 'sub-MATTE' and can be screened out of further assessment. For each MATTE event identified, the CDOIF guidance presents frequency limits to identify events which can be categorised as 'intolerable' or 'broadly acceptable'. Where risks are classed as intolerable, Operators must take additional measures to reduce risk.	Operators of COMAH sites such as the Project recognise the CDOIF methodology as providing best practice for environmental risk assessment (ERA). An ERA is typically undertaken following or alongside the engineering design process prior to operation, to support the development of the COMAH Safety Report. However, this methodology is focused on oil and chemicals/hazardous liquids and not industrial gases processes and was not developed in consultation with the industrial gases industry, so will need be used with caution in this context. The measures to prevent and mitigate the consequences of MA&Ds include undertaking an ERA to support COMAH compliance and demonstrate that all measures necessary have been taken to prevent major accident hazards. The output of the ERA provides guidance to operators on the suitability of their installed systems such as bunding and containment, to prevent an accidental release reaching the environment. Consequently, a robust ERA employing the CDOIF methodology is listed as a mitigation measure in **Section 22.7**.
British Standard (BS) 61508 (Ref 22-11) **/ 61511** (Ref 22-12) **Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems**	
Functional safety is a term used to describe engineering assessments and systems to reduce the risk to people and the	Operators of COMAH sites such as the Project recognise these standards as providing best practice in the engineering design of process facilities and the specification of SIS Safety Instrumented Functions and

Legislation/Policy/Guidance	Consideration within the PEI Report
environment from process operations via the use of automatic protection functions. COMAH Installations typically employ functional safety within Safety Instrumented Systems (SIS), which provide control functions for process operations. SIS incorporate devices such as automatic high pressure and low pressure trips, the purpose of which is to return a process operation to a safe condition if a deviation occurs, without the need to an operator in a control room to take action. SIS incorporate computer controlled functions to monitor process conditions and are connected to devices such as valves, which open or close automatically in response to a computer signal. The reliability of SIS is important to the safe operation of the Project's process facilities. The means of demonstrating an appropriate level of reliability can be achieved is established in a series of standards developed by the International Electrotechnical Commission (IEC) and published by the British Standards Institution (BS). BS 61508 is a basic functional safety standard applicable to all industries and BS 61511 is specific guidance for the process industries as well as implementing Safety Instrumented Functions and safety lifecycle process in accordance with IEC61511. These guidance documents are recognised by the Competent Authority as representing best practice for functional safety.	safety lifecycle process in accordance with IEC 61511, which are important to prevent a loss of containment occurring from process systems which could lead to an accident. These standards are a key mitigation measure in the prevention of a number of risk events, such as fire, explosion and toxic release which are noted in **Section 22.7**.

22.2.18 **Table 22.3** presents the legislation which applies to the facilities included within the Project. The duty holder for these facilities may include operators other than the Applicant. N/A denotes the legislation is not applicable.

22.2.19 An application for Hazardous Substances Consent will be submitted to NELC shortly.

22.2.20 Formal notification to the HSE would be required prior to Project construction for compliance with the COMAH and PSR. An additional notification is required prior to operation.

Table 22.3 Applicability of Legislation to Project Facilities and Areas

Project Facility/ Area	COMAH Regulations	Hazardous Substances Consent	Pipelines Safety Regulations	DML MMO
Ships in Transit	N/A	N/A	N/A	Applicable in English waters
Ships in Port	N/A	N/A	N/A	Applicable
Pipelines on Jetty Trestle	N/A	N/A	Applicable	Applicable
Terrestrial Pipelines (Connecting Process Facilities to Jetty)	N/A	N/A	Applicable	N/A
Process Facilities (inc. Hydrogen and Ammonia Storage)	Applicable	Applicable	N/A	N/A

22.2.21 A key aspect of the COMAH Regulations and Hazardous Substances Consent Regulations is the control of certain types of new development, such as the Project, in order to maintain adequate separation from residential areas, buildings and areas of public use around major hazards when the development increases the risk or consequences of a major accident. Any new development should not significantly worsen the situation should a major accident occur. The HSE is a statutory consultee during the planning and Hazardous Substance Consent process and is responsible for advising whether the risks associated with a new development such as the Project are at an acceptable level. This decision making process includes the use of criteria referred to as 'Consultation Distances' which are zones (often referred to as land use planning zones) established by the HSE around major accident hazard sites and pipelines for planning control.

22.2.22 The HSE's Consultation zones are categorised as either 'Inner', 'Middle' or 'Outer' and a separate category is applied for the safeguarding zones associated with explosive hazards. Within these zones, the HSE's decision making criteria are based on the type of development which is proposed within the zone, the vulnerability of those likely to be present and the societal tolerance of the associated risk. The Inner Zone is closest to the major hazard where risks and hazards are greatest and restrictions on development are strictest. A full description of these zones is found at HSE: Land Use Planning (Ref 22-25). The operator will still need to ensure that the overall risk of a major accident is reduced to as low as reasonably practicable.

22.2.23 The methodology used by HSE when providing land use planning advice is based on the following principles:

a. The risk considered is the residual risk which remains after all reasonably practicable preventative measures have been taken to ensure compliance

with the requirements of the Health and Safety at Work etc. Act 1974 and its relevant statutory provisions.

b. Where it is beneficial to do so, advice takes account of risk as well as hazard, that is the likelihood of an accident as well as its consequences.

c. Account is taken of the size and nature of the proposed development, the inherent vulnerability of the exposed population and the ease of evacuation or other emergency procedures for the type of development proposed. Some categories of development (e.g. schools and hospitals) are regarded as more sensitive than others (e.g. light industrial), and advice is weighed accordingly.

d. Consideration is given to the risk of serious injury, including that of fatality, attaching weight to the risk where a proposed development might result in a large number of casualties in the event of an accident.

22.2.24 The Project is within the consultation distances of a number of major hazard sites and pipelines; therefore this will be a key factor to be taken into account during the Project design and planning. An application for hazardous substances consent has been submitted to NELC in connection with the hydrogen production facility.

22.2.25 The land use planning zones are likely to impact the seven residential properties located on the west side of Queens Road which are included within the Site boundary. Once the hydrogen production facility on the West Site is fully operational, it is likely that these properties will fall within or close to the Inner Zone associated with the operational Project. Further design work and consultation with the HSE are being undertaken relating to the consultation zones for the Project.

22.2.26 It is currently anticipated that the continued residential use of those properties is unlikely to be compatible with the operation of the hydrogen production facility on the West Site and will need to cease. Discussions have commenced with the owners and occupiers with a view to negotiating their acquisition. Where it is not possible to acquire those properties through negotiation, acquisition powers for these properties will be sought through the DCO.

22.2.27 As defined in **Chapter 2: The Project**, a number of businesses are also present in the same area on the west side of Queens Road. It is likely that the ongoing operation of those businesses will be compatible with the operation of the hydrogen production facility. As part of HSE advice on the hazardous substance consent application, the HSE will determine if there are relevant impacts on these businesses. Whilst it is possible that powers to compulsorily acquire the properties or undertake appropriate works may be sought as part of the DCO, this is currently considered unlikely.

Limitations and Assumptions

22.2.28 This preliminary assessment has identified the credible, worst-case Risk Events relevant to the Project. The risk of these events is required to be reduced to a level demonstrated to be ALARP by the design and operation of the facilities. At this stage in the Project design the facilities have not yet been fully specified, therefore standard industry approaches to managing risk which are typically

adopted at COMAH installations will be assumed. These are covered in detail in **Table 22.5**

22.2.29 The assessment has been based on the hazardous substances expected to be present on site during the construction and operational phases. The quantities of these substances are likely to vary during the Project's development, as the terrestrial phases of the green hydrogen production facility is expanded and built out, although the means of storage and transport would not be expected to vary.

22.2.30 The findings of this preliminary assessment may be subject to change as the design of the Project is developed and refined further through the assessment and consultation processes, and as further research and investigative surveys are completed to fully understand its potential effects. Further assessments will be reported in the ES.

Study Area

22.2.31 The extent of the study area for the assessment of MA&Ds is not defined within regulatory guidance or standardised methodology, therefore an area defined by a radius of 5km from the Site boundary has been applied. The extent of this study area is based on experience and professional judgement, taking into consideration the proximity of the Project to protected environmental receptors such as the Humber Estuary, industrial sites which include the Humberside cluster of COMAH installations and MAH pipelines, and the residential area of Immingham. These receptors are all within a 5km radius of the Project Site. Expanding the study area to a wider radius such as 10km would not be expected to introduce new categories of receptor or more sensitive receptors to the assessment.

22.2.32 The study area is shown in **Figure 22.1** (PEI Report, Volume III) and identifies nearby major hazard sites, pipelines, and other sites whose land use planning zones may encroach on any part of the Project.

22.2.33 There have been minor changes to the Project boundary and therefore the study area for MA&D since the publication of the Scoping Report (**Appendix 1.A** of PEI Report Volume IV). These changes have made no appreciable impact on the study area or the assessment of MA&D.

22.3 Summary of Assessment Methodology

22.3.1 The assessment of MA&Ds undertaken within this PEI Report involves the following steps, which are the same as outlined within the Scoping Report. The assessment steps are summarised as follows:

a. Collation and review of baseline information pertaining to the hazardous properties of the substances (and their consequences) which are expected to be present during the construction and operation of the Project. The hazardous properties of the substances is informed by their classification in accordance with the Classification, Labelling and Packaging (CLP) Regulations (Ref 22-1813).

b. Identification of hazards and threats based on the concept design work completed to date and in accordance with industry standard approaches to hazard identification.

c. The determination of the study area and assessment of the Project's location in relation to the sensitivity of the environment and the potential for natural disasters, such as meteorological hazards, seismic events and climate change impacts was initially considered within the Scoping Report.

d. The conclusions of this scoping assessment were that certain natural disasters would not be credible MA&D scenarios; however this has been reassessed within the PEI Report. The meteorological hazards assessed include the following:

- Flooding following heavy rainfall events (including fluvial, surface water, groundwater, river and sewer flooding).
- Storms and high wind speeds.
- Drought, heatwave and extreme humidity.
- Extreme cold and snow conditions.
- Lightning and electrical storms.
- Reduced visibility, such as severe fog.

e. An assessment of the potential impacts to and from neighbouring industrial facilities, which includes sites regulated by the COMAH Regulations (Ref 22-3) and PSR (Ref 22-6) i.e. the consideration of the local cluster of industrial sites.

f. Screening of hazards and threats, including the likely significant effects.

g. Assessment of the potential magnitude of impacts that result from credible scenarios, to identify those which may be significant and within the criteria benchmark for a MA&D. The output is a schedule of Risk Events, for which mitigation measures are to be considered.

h. For credible MA&D scenarios, measures to prevent, minimise and/or mitigate risk are outlined in this preliminary assessment and will be further defined, so far as is possible in the ES. Embedded mitigation measures include engineering design by using industry standards, procedural controls and maintenance, fire and gas detection, fire protection and others.

i. Following consideration of the outlined mitigation measures, the residual risks are identified, and a conclusion reached on the tolerability and significance of the residual risks to determine if risks have been reduced to ALARP.

22.3.2 The conclusions of the MA&Ds chapter are a qualitative assessment of the significance of identified foreseeable credible events and the residual risks after mitigation measures are taken into account. Risk management will be part of an ongoing process throughout the lifecycle of the Project and a requirement for compliance with applicable legislation including COMAH, Environmental Permitting, Hazardous Substances and PSR, for example:

a. Operators of COMAH installations are required to demonstrate within a Safety Report that the risks associated with the facility have been comprehensively assessed and a conclusion has been reached on the tolerability of risk, including the sufficiency of measures to ensure risk is

reduced to ALARP. It is a regulatory requirement that all measures necessary must be taken to reduce risk at COMAH installations and Safety Reports must be updated and resubmitted to the Competent Authority, comprising of the HSE and EA for review every five years.

b. Installations which carry out one or more defined prescribed activities are subject to the Environmental Permitting Regulations (EPR), which will apply to the Project. This legislation requires operators to supply detailed information to the Regulator in the form of a Permit Application and only when fully determined and the relevant environmental permit granted, is operation allowed to commence. Compliance with EPR requires operators to regularly submit information and data such as emissions monitoring results to the Regulator to confirm the Site is operating within permitted limits (as set out in the environmental permit).

c. The Hazardous Substances Regulations require operators to assess the inventory of defined hazardous substances which could be present at the Site against controlled quantities. If the inventory exceeds the controlled quantities, operators are required to obtain a Hazardous Substances Consent. An application is made to the Hazardous Substance Authority (normally the local planning authority) which is responsible for enforcement. The application must include a description of substances, operations and the identification of the hazards associated with the Site and relevant safety information. For the Project, an application for the Hazardous Substances Consent for the Project is being submitted to North East Lincolnshire Council (NELC) shortly.

d. Compliance with PSR requires operators to operate in accordance with a defined Safety Management System (SMS) for the pipeline(s) which includes the production of a Major Accident Prevention Document (MAPD). This document must be developed during design to incorporate means to demonstrate that the risks of identified hazards have been evaluated and appropriately managed via means such as inspection. PSR requires performance standards to be established and safety information regularly audited.

22.4 Baseline Conditions

Overview

22.4.1 The current baseline environment for the consideration of MA&Ds has been established through a review of existing information sources. Within the study area shown in **Figure 22.1** (PEI Report, Volume III), industrial facilities are present which are regulated as major accident hazard establishments through the COMAH Regulations (Ref 22-3), as well as major accident hazard pipelines regulated in accordance with the PSR (Ref 22-6). These installations and their corresponding hazards are therefore important factors under consideration as part of the ongoing development of the Project design, in discussion with key stakeholders such as the regulatory authorities, including the HSE and EA.

Existing Baseline - Infrastructure and Industrial Sites

22.4.2 The industrial area of Immingham contains a number of upper tier COMAH sites which are regulated in accordance with the COMAH Regulations (Ref 22-3). The numbering of sites [#] corresponds to the location as identified within **Figure 22.1** (PEI Report, Volume III):

a. [1] The Humber Refinery operated by Phillips 66 is located approximately 4 km in a westerly direction from the Project Site and processes crude oil to produce gasoline, diesel and aviation fuels as primary products.

b. [2] The Lindsay Oil Refinery operated by Prax Ltd is located approximately 5 km in a westerly direction from the Project Site and undertakes similar operations to the Humber Refinery.

c. [3] The Humber LPG Terminal and underground gas storage caverns also operated by Phillips 66 Ltd, located approximately 4 km from the Project Site in a westerly direction.

d. [4] Immingham Docks operated by ABP which comprises a number of discrete operational areas, some of which are COMAH Installations. These facilities store commodities including bulk fuels and fertilizer and include:

   i [4a] Immingham Oil Terminal operated by Associated Petroleum Terminals (APT), directly adjacent to the Project Site.

   ii Exolum Immingham Limited (formerly Inter Terminals Ltd) located 1.5 km (east terminal [4b]) and 2 km (west terminal [4c]) in a westerly direction from the Project Site.

e. [5] Tronox Pigment UK Ltd operate a chemical manufacturing facility located approximately 1 km south-east of the Project Site.

f. [6] Air Products operate a facility for the manufacture and storage of industrial gases including oxygen and nitrogen which is located approximately 1.5 km from the Project Site in an easterly direction.

g. [7] BOC operate a facility for specialty gas manufacturing and storage operations, located approximately 2 km south-east of the Project Site.

h. [8] The South Humber Bank Power Station owned by EP UK Ltd which is a combined cycle gas turbine (CCGT) facility supplied by a high pressure gas pipeline, located approximately 2.5 km south-east of the Project Site.

i. [9] Synthomer Ltd operate a chemical manufacturing facility, producing substances such as adhesives and coatings. Location is approximately 2.5 km south-east the Project Site.

22.4.3 The major accident hazard pipelines located in the study area are used to transport gas and petroleum products. These include a high-pressure gas pipeline operated by National Grid located approximately 4 km from the Site, in a south-easterly direction, routed to the South Humber Bank Power Station [8]. National Grid also operate 400 kV overhead electrical power distribution systems in the vicinity of the Site boundary.

22.4.4 There are no major airports located within the vicinity of the Project, the closest airport being Humberside which is located approximately 12 km in a south-

westerly direction. This airport is used for short haul chartered and scheduled flights, including helicopter flights to offshore installations in the southern North Sea. The flight path for these services and other routes crosses the industrial area of Immingham and the Humber Estuary.

22.4.5 In addition to the major accident hazard sites and pipelines, the baseline area consists of critical road, rail and seaport infrastructure and is an important industrial area within the UK. The Port of Immingham [4] currently handles thousands of ship movements per year, including the import of significant quantities of liquid and gaseous fuels. The Port of Immingham is located directly adjacent to the Project, and comprises loading and offloading jetties, bulk storage tanks for hydrocarbon liquids and fertiliser storage. Subterranean caverns [3] for the storage of liquefied petroleum gas (LPG) are located approximately 3.5 km in a westerly direction from the Project.

Existing Baseline – Natural Features and Protected Environmental Sites

22.4.6 The potentially credible disaster scenarios relevant to the Project are largely dependent on the existing natural features and proximity of protected environmental sites/receptors.

22.4.7 The UK experiences very low levels of seismic activity and there are no significant seismic events recorded by the British Geological Survey (BGS) for the Humberside region at the nearest seismic monitoring location which is sited approximately 10 km south of Humberside Airport.

22.4.8 The Humber Estuary [10] is classified as a Special Protection Area and is a designated Ramsar Site. The estuary is directly adjacent to the Project and contains areas which are designated as Special Areas of Conservation (SAC) and Sites of Special Scientific Interest (SSSI). The wetland areas of the estuary support internationally important numbers of waterfowl in the winter, including golden plovers, and hosts the second largest colony of grey seals in the UK. An incident which has an impact on these receptors could satisfy the criteria for a disaster, and therefore requires consideration.

22.4.9 The bedrock groundwater within the Site boundary is designated as a principal aquifer via the BGS and EA classification system. This designation corresponds with the most important type of groundwater which supports drinking water supplies and ecosystems. Potential impacts to groundwater are considered within the assessment of Risk Events.

22.4.10 The Humber Estuary is tidal and situated on low-lying land, therefore at risk of tidal flooding. Significant investment has been made in flood defences for this area; however continued efforts are required to combat the potential impacts of climate change. Currently, the flood risk level defined by the EA in the area of the Project is Low to Medium from rivers and the sea, therefore the potential impact of flooding on the Project is considered in this assessment.

22.4.11 Climate change resilience is being incorporated in the design of the Project as necessary. The expectations of the COMAH Competent Authority (being the HSE and the EA) are that operators will include an assessment to identify and assess Major Accidents to the Environment (MATTE) within their Safety Report for the Project. MATTE could include those initiated by climate change consequences,

e.g.: rising river levels. The assessment of MATTEs will contain information on how natural events could directly or indirectly cause a MATTE. Best practice for the methodology to carry out this assessment is provided within the CDOIF Guidance, described in **Table 22.2**.

22.4.12 There are no World Heritage Sites, Scheduled Monuments, Grade I and II listed buildings, conservation areas, registered parks and gardens, registered battlefields, or protected wreck sites within the 2km study area for designated heritage assets. A detailed assessment of heritage sites is contained in **Chapters 14: Historic Environment (Terrestrial) and Chapter 15: Historic Environment (Marine)** of the PEI Report.

Existing Baseline – Human Health and Safety

22.4.13 Immingham is the nearest town to the Project and has a population of around 11,728, located approximately 1.5 km in a south-westerly direction. The conurbations of Grimsby (southeast) and Hull (north-west) have populations of around 86,105 and 287,705 respectively.

22.4.14 The closest residential premises to the Project are located on the west side of Queens Road within the western side of the Site and these are listed in **Chapter 2: The Project.** A large number of residential properties are also located approximately 500m to the west of the Site boundary on the eastern edge of the town of Immingham.

22.4.15 Population and human health receptors include persons present on site during construction and operation as well as the greater external population. Persons present on neighbouring industrial facilities have also been taken into consideration. Off-site sensitive receptors include vulnerable locations such as hospitals, care homes and schools, of which there are a number within the town of Immingham but none closer than 3.5km from the Site. The nearest such sensitive receptor is the Immingham Day Nursery [11].

Future Baseline - Infrastructure and Industrial Sites

22.4.16 The future baseline of the area may include potential new developments located in and around the areas of Immingham, North and South Killinghome and Stallingborough. The Immingham Eastern Ro-Ro Terminal (IERRT) is a development currently going through a separate Development Consent Order (DCO) process and is associated with the development of the Port of Immingham. This facility would primarily service commercial cargo, with some use by passengers (members of the public) and involve construction and operation of marine and landside infrastructure. Further details are contained within **Chapter 25: Cumulative and In-Combination Effects.**

22.4.17 The nature of the area around Immingham provides an attractive location for major projects and therefore the additional industrial developments could be brought forward in future.

22.5 Project Design and Impact Avoidance

22.5.1 The following impact avoidance measures will either be specific measures incorporated into the Project design or are standard construction or operational

measures, typically included within similar industrial developments and it can be assumed that these will be incorporated into the Project. These measures have therefore been taken into account during the impact assessment process described in this chapter.

Design

22.5.2 During the Project design process, a number of philosophies with regard to process safety and safeguarding, isolation, emergency shutdown, and if required, depressurisation will be developed. The Project design process will also involve reviews of the layout and give due consideration both to the on-Site facilities design as well as the off-Site receptors. A design hazard management plan will be prepared, and a number of hazard identification (HAZID), Hazard and Operability (HAZOP) and other risk assessments have been and will continue to be carried out during the design process. This is a standard approach to the engineering design of industrial facilities which has been used for decades in the processing industries worldwide. The objective of these assessments is to identify, prevent or minimise hazardous scenarios through appropriate design during the Front End Engineering Design (FEED) studies which are to be progressed. Major accident assessments and technical studies will be undertaken over the course of the design development as required. A Major Accident Prevention Plan (MAPP) for the Site will be prepared to support the notification to the HSE of the green hydrogen production facility (the Associated Development) as a COMAH installation and a MAPD will also be developed for the pipelines.

22.5.3 CDM regulations (Ref 22-8) will be followed as required throughout the design phase.

Construction

22.5.4 Formal risk assessments to identify potential hazards during construction (HAZCON) are typically carried out prior to completion of the design phase for process facilities such as the Project. This study is similar to formal process safety studies such as HAZID and HAZOP, in that it is a structured review based on guidewords, employing a multi-disciplinary team of specialists led by an experienced facilitator.

22.5.5 The use of suitably experienced contractors, risk assessments, working method statements, operating procedures and personnel training minimise the risk of accidental scenarios occurring during construction of the Project.

22.5.6 An Outline Construction Environmental Management Plan (CEMP) would be prepared to set out how construction activities would be managed and controlled in compliance with accredited health and safety and environmental management systems, relevant legislation and environmental permits, consents and licences. An Outline CEMP will be produced in support of the Application and will set out the key measures to be employed during construction of the Proposed Development to control and minimise impacts on the environment. A Requirement of the DCO would ensure that the contractor's CEMP must be in accordance with the principles set out in the Outline CEMP.

Operation

22.5.7 As outlined previously, Hazardous Substances Consent issued by the local authority, a COMAH Safety Report and pipelines MAPD approved by the HSE, and an Environmental Permit issued by the EA would be required for the operation of the Project facilities. These consents and documents require a number of stipulations and requirements to be fulfilled to the satisfaction of the regulators, including the use of appropriate control and monitoring procedures, risk assessments, management systems and control measures to minimise the risk of accidents occurring and to minimise the effects of any such accidents on off-site receptors as well as the operational workforce. The Environmental Permit would require the approach to managing accidents and emergencies to be in accordance with the use of Best Available Techniques (BAT).

Decommissioning of the hydrogen production facility

22.5.8 Similarly with construction and operation, formal process safety studies and risk assessments would be carried out to identify potential hazards prior to decommissioning and demolition of the hydrogen production facility. These studies would be carried out in accordance with industry best practice such as HAZDEM. These studies typically employ a team of specialists to identify potential hazards, consider the associated risks and specify the appropriate mitigation and control measures required. As explained in **Chapter 2: The Project**, the jetty, which comprises the Nationally Significant Infrastructure Project (NSIP), would not be decommissioned, as it would become part of the port infrastructure and would be maintained and refurbished as necessary in accordance with this status.

22.6 Potential Impacts and Effects

22.6.1 This section describes the hazardous properties of the substances which would be present on site during the lifecycle of the Project and potentially hazardous activities which have the potential to be a credible major accident scenario.

Construction

22.6.2 The potentially harmful substances which would be present during the construction phase include liquid cement and diesel fuel oil.

22.6.3 Cement and mixed liquid concrete is classified as an irritant to skin as contact can cause alkali burns. This substance can harm the eyes and the respiratory system via inhalation of dust and if cement or wet concrete enters drains or watercourses, there is the potential to cause harm to the environment via an increase in the pH of water.

22.6.4 Diesel is likely be used within mobile power generators, construction plant and construction vehicles, even if it is possible that some of the construction plant and vehicles will use alternative power sources. This substance is classified as a flammable liquid and harmful to the aquatic environment. A release which is ignited could cause harm to people via exposure to thermal radiation in a fire, or if unignited, diesel can cause harm to people if inhaled, ingested or exposed to skin. A release of diesel to the environment such as the Humber could result in harm to flora and fauna.

22.6.5 Construction work can include potentially hazardous activities such as working near to overhead power supplies or buried services such as power cables and gas transmission mains. Accidents have occurred historically due to contact with high voltage (HV) electricity supplies, the collapse of excavations and structures during construction which have resulted in fatal injuries to workers on Site.

Operation

22.6.6 When operational, the terminal would receive consignments of liquefied refrigerated ammonia delivered via ship to the offloading jetty, where it would be transferred for storage in tanks onshore prior to use. Hydrogen gas would then be produced by the dissociation of ammonia within process operations using the hydrogen production units described in **Chapter 2: The Project**. The hydrogen gas would then be cooled and liquefied prior to filling into bulk road tankers for delivery to end users.

22.6.7 Utility services supporting hydrogen production operations would include compressed air, nitrogen, natural gas (used as a source of energy, at least in the initial stages of the Project) and electrical power supplies. Cooling water would also be used, which would be circulated in a closed loop through the process with a purge stream to maintain water quality. Process wastewater would be treated on Site prior to discharge to the local sewerage system. Water would also be stored for the purposes of firefighting. Small quantities of substances such as biocides and scale inhibitor would be used to treat water on Site for use in the process, and while these substances can be categorised as dangerous to humans and the environment, the quantities used on Site are expected to be small.

22.6.8 Refrigerated anhydrous ammonia is classified as a flammable gas and if released can form explosive mixtures in air if in confined spaces , ammonia does not sustain combustion. Ammonia is toxic if inhaled and causes severe skin burns, eye damage and respiratory irritation and can be damaging to flora and fauna .

22.6.9 Ammonia is toxic to the environment if released to water and is incompatible with certain substances, such as oxidants e.g. sodium hypochlorite (bleach), which reacts with ammonia to release chlorine gas. No ammonia incompatible substances would be present in significant quantities on Site.

22.6.10 The most common cause of injuries to people associated with ammonia are as a result of gas inhalation. Serious incidents involving ammonia are rare events, when considering the very large number of operating hours of facilities handling ammonia in continual industrial processes. If they do occur, extensive investigations are carried out to identify lessons which can be learned to improve safety within industrial usage. Examples of such incidents include the ammonia release at a Petronas facility in Malaysia (Ref 22-14) and the Medicine Hat facility in Canada (Ref 22-15).

22.6.11 Hydrogen is an extremely flammable gas, with a wide flammable range (4% to 77% by volume) and can form explosive mixtures in air. The hazardous properties of hydrogen are well understood by industrial operators and there is a substantial body of safety regulation and industry guidance associated with the equipment used to store and use this material. An example of an incident

involving a release of hydrogen is the explosion at a chemical manufacturing facility in Illinois in 2019 (Ref 22-16).

22.6.12 Natural gas used as a source of fuel for the hydrogen production units is classified as extremely flammable and can form explosive mixtures in air. The consequences of a loss of containment of natural gas would be substantially similar to hydrogen, however the quantity of hydrogen would be substantially greater than natural gas, if a release were to occur. Legislative controls and engineering standards for equipment and pipework design and other mitigation measures to reduce risk are very closely aligned with those for hydrogen and consequently this assessment focuses on hydrogen as the primary flammable gas.

22.6.13 When in operation, the jetty and associated facilities may be used to import and export CO_2 as a bulk liquid from carbon capture and storage installations. This system would be subject to a separate application for consent with corresponding assessment of MA&D, and therefore are not included within this assessment.

22.6.14 Small quantities of substances such as mineral and synthetic lubricating and hydraulic oils would be used for equipment on Site with moving parts, such as pumps and compressors. These fluids are not generally categorised as hazardous, and are of low flammability but are combustible in the event of a fire and may cause harm to the environment if released to water. The quantity of these materials is, however, expected to be small and would typically be stored in containers not exceeding 1,000 litres capacity as well as water treatment chemicals including small qualities of acid, hypochlorite and biocides which would be stored in bunded containers.

22.6.15 Process operations would include hazardous activities by virtue of the dangerous substances present on Site. A robust safety management system (SMS) is a requirement of the COMAH Regulations and would be in place prior to operation to ensure operational risks are reduced to ALARP.

Jetty and Marine Operations

22.6.16 The vessels used to deliver refrigerated ammonia would be VLGCs. In order to assess a worst case and particularly in relation to the climate change considerations (see **Chapter 19: Climate Change**), it is assumed that the VLGCs, would initially be powered by marine fuel oil (MFO) which is a liquid hydrocarbon mixture similar to diesel fuel. If released, MFO is toxic to the aquatic environment, it is classified as a flammable liquid and vapour and is harmful to people. In the longer term, it is anticipated that the existing VLGC fleet for ammonia imports would be replaced by a fleet powered by sustainable low carbon fuels. Over the long term, a similar transition can be expected across the marine fleet, to include similar vessels in the carbon capture sector which are expected to use the new terminal.

22.6.17 VLGC vessels would contain ballast water which provides stability. This water can be contaminated with biological material such as pathogens native to the water of the country of origin of the delivery vessel. The vessel would also contain grey water from washing and black water from toilet facilities. If released to the Humber, these waste waters could be harmful to the environment.

22.6.18 Jetty loading/offloading systems typically contain hydraulic oils, which are synthetic, non-flammable fluids. If released to water, these could potentially cause harm by forming a film on the surface which inhibits oxygen transfer. The quantities of hydraulic fluids present in the systems would be small and any release would be considered trivial and an accidental release would be unlikely to reach the criteria for a potential major accident to the environment. Control of pollution during the operational phase of the Project is covered further in **Chapter 17: Marine Water and Sediment Quality** and **Chapter 18: Water Quality, Coastal Protection, Flood Risk and Drainage**.

22.6.19 The operational activities carried out at the jetty and the VLGC would, in relation the green hydrogen production facility, primarily be offloading of refrigerated ammonia. This would be undertaken in a substantially similar manner to the loading and offloading of hazardous gases undertaken for many years at the Port of Immingham, in accordance with established safety procedures.

Demolition of the hydrogen production facility

22.6.20 The hazards associated with activities carried out during demolition are substantially the same as construction, however, as the process equipment and pipework have contained dangerous substances, additional safety precautions are required. These include gas purging, venting and cleaning processes and catalyst removal to ensure no hazardous substances remain prior to dismantling and demolition.

22.6.21 **Table 22.4** presents the results of the assessment of the hazardous properties of substances and activities, geographic location of the Project and the baseline study area, to identify credible MA&Ds scenarios, termed Risk Events. Further analysis of risk events will be undertaken to support the COMAH Safety Report and relevant Safety Case(s).

Table 22.4 Identification of Major Accident & Disaster Categories

Ref.	Hazard Category	Impact/Receptor	Credible MA&D
Construction Activities Credible hazard categories associated with construction activities include accidental damage to existing service infrastructure such as electrical power, gas and oil pipelines. Consequences of such incidents generally depend on the extent of contact made and proximity of people and sensitive receptors.			
1	Release of Raw Materials used in Construction Activities A release of construction materials e.g. liquid concrete, diesel (used for power generation). Potential for minor harm to people if exposed to liquid cement, and/or diesel. Potential for minor harm if substances released to environment (due to quantities likely to be released).	Potential minor impact to human health (on-site workers) and environmental receptors on Site.	No

Ref.	Hazard Category	Impact/Receptor	Credible MA&D
2	Construction Activities – Electrical Systems Strike Impact with overhead electrical transmission system e.g. crane impact on high voltage (HV) electrical cable or underground cable strike during excavation. Potential for harm to people including fatal injuries. Potential interruption to local electrical power supplies.	Potential significant impact to human health on Site. Interruption to local power supplies.	Yes Risk Event 1
3	Construction Activities – Underground Gas Main/UXO Strike Impact with underground gas main during excavation activities. Potential for unexploded ordnance (UXO) on the Project Site. Potential for a significant release of gas leading to fire and/or explosion, with harm to people including potential for fatal injuries. Potential explosion in event of UXO strike. Potential interruption to local gas supplies.	Potential significant impact to human health on-Site and off-Site. Interruption to local gas supplies.	Yes Risk Event 2
4	Construction Activities – General/Other Incident during construction e.g. structural collapse of building(s), excavation collapse, collisions from construction vehicles. Potential for significant harm to people on-site (construction workers) including potential for fatal injuries.	Potential significant impact to human health on-Site.	Yes Risk Event 3
Operational Activities (Commissioning and Commercial Operation) Credible hazard categories associated with process equipment failure, malfunction, accidental damage, vehicular impact, disturbance etc., resulting in the loss of containment of hazardous substances. The consequences depend on the type and quantity of substance released, which are considered below as fire/ explosion/toxic release/environmental harm.			

Ref.	Hazard Category	Impact/Receptor	Credible MA&D
5	Fire Significant loss of containment of ammonia, hydrogen or natural gas which immediately finds a source of ignition. Potential for harm to people. Potential for harm to the environment via release of contaminated firewater. Potential for damage to assets including buildings. Potential for domino effect, escalation to other areas on-site and off-site including nearby COMAH installations.	Potential significant impact at: Human health – on-Site & off-Site populations. Environment - Humber Estuary	Yes Risk Event 4
6	Explosion /Energy release Significant loss of containment of ammonia, hydrogen or natural gas which accumulates, and ignition is delayed, resulting in an explosion. Impact depends on release point and level of congestion within process structures on-Site. Potential for harm to people. Potential for damage to assets e.g. overhead power transmission systems, with subsequent loss of power to neighbours. Potential for domino effect, escalation to other areas on-Site and off-Site including nearby COMAH installations.	Potential significant impact at: Human health – on-Site and off-Site populations. Environment - Humber Estuary	Yes Risk Event 5
7	Toxic (Ammonia) Release Significant loss of containment of ammonia gas from onshore facilities. Consequences include potential for significant harm to people exposed to high concentrations of ammonia gas. Rainout and/or dissolution in air to form ammonium hydroxide therefore potential for harm to the environment. Emergency services may issue shelter in place orders for neighbours until incident has been resolved.	Potential significant impact at: Human health – on-Site and off-Site populations. Environment - Humber Estuary, soil and groundwater.	Yes Risk Event 6

Ref.	Hazard Category	Impact/Receptor	Credible MA&D
8	Asphyxiant (Nitrogen) Release Significant loss of containment of nitrogen gas from onshore facilities. If released into a confined area on-site where people are present, there is the potential for a release of nitrogen to result in harm via asphyxiation. If released to an open area, this gas would disperse, and concentrations would reduce to level which would not cause harm. In all scenarios, the concentration off-Site at receptors would not be sufficient to cause harm to people or the environment. Design and operational measures provide high integrity containment systems and measures for safe disposal of nitrogen, therefore not considered a credible MA&D scenario.	Potential significant impact at: Human health – on-Site.	No
9	Release of Substances into the Marine environment Scenarios include an accidental loss of containment of marine fuel oil or black grey/ballast water from marine transport. Incidents involving ammonia vessels at sea and during berthing could cause a loss of containment for example via accidental impact with other vessels or port infrastructure. A release of flammable substances could result in a fire if ignited, causing harm to people and the environment. A release of ammonia could have a significant impact on people onboard the vessel and at the port. Potential for harm to flora and fauna located at the Humber Estuary. The substances present on board vessels associated with the Project have potential for harm to the water environment if released, via an increase in Chemical and or Biological Oxygen Demand (COD/BOD) levels.	Potential significant impact at: Human health (fire which affects persons on board vessel and/or at jetty). Environment - Humber Estuary.	Yes Risk Event 7

Ref.	Hazard Category	Impact/Receptor	Credible MA&D
10	Loss of Containment of Transported Dangerous Goods (by road) Collisions/accidents involving road tankers containing hydrogen causing loss of containment, potential subsequent fire and/or explosion. Potential for significant harm to people in the vicinity of the incident who are exposed to high levels of thermal radiation and/ or explosion overpressures. Potential for damage to property located near to incident. Emergency services may close roads and potential to interrupt power and water supplies in the event of damage to infrastructure.	Potential significant impact at: Human health population (off-Site).	Yes Risk Event 8
Decommissioning Activities Credible hazard categories associated with decommissioning activities include accidental damage to existing service infrastructure such as electrical power, gas and oil pipelines.			
11	Decommissioning Activities – Dismantling Vessels and Pipework Incident occurring during decommissioning e.g. dismantling pipework and vessels using equipment which could generate a spark such as electrical grinders and saws. If systems have not been fully de-inventoried or isolated i.e. still contain flammable material there is the potential for fire and/or explosion causing harm to people on-Site. Causes include operator errors or lapses, failure in safety management systems. Failure to isolate electrical supplies prior to work on site could also result in harm to workers e.g. electrocution, arc flash injury.	Potential significant impact to human health on-Site.	Yes Risk Event 9
Disasters Credible disaster categories include intentional malicious damage to assets and infrastructure (e.g. vandalism) and potential impacts of adverse weather including future climate change effects. Consequences of such incidents generally depend on the extent of the harm caused, the proximity of people and sensitive receptors.			

Ref.	Hazard Category	Impact/Receptor	Credible MA&D
12	Malicious Damage/Conflict/Arson Various scenarios resulting in loss of containment of hazardous substances such as malicious damage to process storage tanks or pipework including Theft/malicious damage /terrorist threat - external interference - (damage to the pipelines/power supplies) Consequences are considered above - see fire/explosion/toxic release scenarios.	Potential significant impact at: Human health – on-Site and off-Site populations. Environment - Humber Estuary.	Yes (as fire/ explosion/toxic release). Considered in Risk Events 4, 5, 6
13	Domino Event Various scenarios such as fire and/or explosion at a neighbouring facility, such as the nearby oil storage terminal, high pressure gas pipeline or others which has an impact at the Project Site. This category of Risk Event also includes incidents initiated at the Project Site which could potentially escalate and have an impact at facilities within the local industrial cluster. The potential impacts to and from the Project can include loss of containment via thermal radiation related failure mechanisms or accidental impact damage from projectiles generated during an explosion.	Potential significant impact at: Human health – on-Site and off-Site populations. Environment - Humber Estuary.	Yes (as fire/ explosion/toxic release) Considered in Risk Events 4, 5, 6
14	Seismic Event/Landslide A seismic event such as an earthquake could cause structural damage to process equipment, pipework, infrastructure and buildings causing loss of containment. Consequences considered above in Risk Events 4, 5, 6.	Potential significant impact at: Human health – on-Site and off-Site populations. Environment - Humber Estuary.	No (however if one did occur could results in fire/ explosion/toxic release and the plant and equipment will be designed for the appropriate seismic zone).

Ref.	Hazard Category	Impact/Receptor	Credible MA&D
15	Storms/Flooding/Climate Change/storm surge Potential for pluvial and fluvial flooding which reaches the Project Site and overwhelms drainage systems. A major flooding event has potential to cause asset damage leading to loss of containment of dangerous substances. The consequences of such a loss of containment are considered above. Lightning strike during a storm has potential to cause ignition of highly flammable gas if this were to occur while material was being vented directly to atmosphere. This would however be a very infrequent operation.	Potential significant impact at: Human health – on-Site and off-Site populations. Environment - Humber Estuary	Yes Risk Event 10

22.6.22 The potential initiating causes and impacts from the MA&D scenarios identified in **Table 22.4** are considered in further detail within **Table 22.5**.

22.7 Mitigation Measures

22.7.1 Project objective (d) is to minimise adverse impacts on the environment and safeguard the health and safety and amenity of local residents. The mitigation measures described in this section contribute to delivering this objective.

22.7.2 The Associated Development is being developed to produce green hydrogen to replace fossil fuels and natural gas, for use in the UK's transport sector, where other sources of renewable energy cannot be used.

22.7.3 Hydrogen is highly flammable, and therefore the potential for Risk Events such as those identified in **Table 22.4** cannot be entirely eliminated. Risks must therefore be carefully controlled, and the risk reduced to ALARP via mitigation measures, as required by the COMAH Regulations (Ref 22-3). Production of hydrogen from non-hydrocarbon sources would employ ammonia, which is a commonly used industrial substance. Ammonia is a toxic material and there are associated risks with its use, however, these risks would be managed by applying safety and environmental control measures.

22.7.4 The mitigation measures associated with preventing a loss of containment for gaseous substances are substantially similar for ammonia, hydrogen and natural gas.

22.7.5 The mitigation measures associated with the identified credible MA&D scenarios for the Project are presented in **Table 22.5**. This is not intended to be an exhaustive list and presents typical measures to illustrate the controls which will be considered in further detail within the ES (including how they will be secured) and the engineering development of the Project design.

Table 22.5 Assessment of Major Accident & Disaster Risk Event Scenarios

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
1	**Contact with high voltage (HV) electricity (overhead or underground)**	Contact with overhead electrical transmission system e.g. crane impact on HV electrical cable or underground cable strike during excavation. Contact with overhead HV electricity cables can occur via accidental contact with the jib of construction cranes. Similarly, during excavation, contact of an excavator bucket with underground electrical cable.	Potential for harm to construction workers including fatal injuries. Potential interruption to local electrical power supplies.	Project notifications would be communicated to utility service providers, including National Grid and others. This service ensures up-to-date information is available on the location of above and below ground electrical cables on drawings/maps. Locations confirmed by use of specialist tools to detect underground cables and pipes. During the construction phase of the Project, activities which would be carried out in proximity to HV electrical distribution networks would be carefully controlled via risk assessments. Appropriate techniques including hand-dig would be used as required by these risk assessments. Protective measures and safety signage would be used to alert personnel to overhead and below ground electrical hazards. Only suitably qualified and experienced personnel (SQEP) would operate equipment such as cranes and excavators.	**Yes**

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
2	**Contact with underground gas main or UXO**	Potential for unexploded ordnance (UXO) on Site and gas transmission infrastructure. Impact with gas main/UXO during excavation activities causing a release of gas and fire/or explosion.	Potential for harm to construction workers including fatal injuries. Potential for harm to people off-Site via thermal radiation/explosion projectiles. Potential interruption to gas supplies used for power generation and to local industry and residents.	Measures as Risk Event 1 for underground services such as gas mains. Project would work with UK Gas Transmission services to ensure work is carried out safely where gas infrastructure has been identified as present. An UXO survey would be completed for the Site and any remedial activities safety complete prior to construction commencing.	**Yes**
3	**Construction incident – structural collapse, collision**	Incident such as structural collapse of building(s) and/ or process structures caused by inadequate design, accidental impact from vehicle, malicious interference etc. Excavation collapse caused by inadequate supports. Collisions with vehicles, such as	Potential for significant harm to construction workers including fatal injuries.	The engineering design of the Project, in particular, civil and structural engineering would be carried out in accordance with all applicable legislative requirements and industry standards. Groundworks to ensure site stability would be carried out as part of the Project development. Equipment and vehicles used during construction would be carefully selected and appropriate temporary construction access installed. Security controls would be in place throughout construction including guards	**Yes**

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
		overturning or when reversing.		and CCTV to prevent unauthorized access to Site.	
4	**Fire**	Significant loss of containment of ammonia, hydrogen or natural gas caused by accidental damage or failure of containment systems. Fire could also be initiated via malicious damage/conflict/arson. Potential for fire at a neighbouring major hazard installation to escalate to site via domino effect. Also, potential for fire at Project Site to have an impact on neighbouring sites. Storm events such as flooding could initiate a loss of containment via damage to assets. Lightning strike could ignite flammable gas/vapour released	Potential for significant harm to people on-Site, including fatal injuries and harm to people off-Site via thermal radiation. Potential for domino effect, escalation to other areas on-Site and off-Site including COMAH installations. Escalation of the fire to other installations at the Port of Immingham could initiate emergency plans at those sites causing a significant disruption to critical facilities, along with potential harm to persons on those sites and damage to their assets. Potential for direct harm to the environment from thermal radiation such	Measures included in design to reduce the potential for a loss of containment include the following: - Engineering design of the facility by experienced, qualified personnel. - The specification, construction and installation of equipment and pipework to industry codes and standards. - Plant design and plant layout to keep hazardous substances as far as is practical from off site receptors - Engineering design risk assessments and Quantified Risk Assessment (QRA) carried out to demonstrate ALARP as required by the COMAH Regulations (Ref 22-3). - DOMINO discussions with neighbouring COMAH facilities - Use of fully welded connections rather than flanged connections for gaseous systems. Flange guards are to be fitted as necessary where welding is not practical.	**Yes**

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
		from vent stack or relief valve. Gas which immediately finds a source of ignition will result in flash or jet fire depending on pressure.	as impact on flora and fauna near to Site. Also, harm to the environment via release of contaminated firewater to environmental receptors including the Humber Estuary. Emergency services are likely to advise local residents to close doors and windows and remain indoors for the duration of the event.	- The Pressure Systems Safety Regulations 2000 (PSSR) (Ref 22-17) apply to equipment and pipework at the Site. Compliance with PSSR requires detailed scheduled inspection and testing to prevent a loss of containment. - Certification of equipment by notified bodies prior to use which demonstrate “fit for purpose” equipment. - Control systems to be installed to continuously monitor process parameters including pressure and temperature. - Safety instrumented systems would be designed, operated and maintained in accordance with guidance documents BS 61508/11 (Ref 22-11, 22-12) which is recognised as providing best practice. - Fire and gas detection and alarm systems would be in operation. - Passive and active fire suppression systems would be employed subject to risk assessments.	

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
				- A flare system would be used for safe disposal of flammable gas in the event of a process upset. - All process areas of Site would be subject to hazardous area classification, to determine where mechanical and electrical equipment is to be certified in accordance with the A Appareils destinés à être utilisés en ATmosphères EXplosives (ATEX) Directive (Ref 22-18), to reduce the risk of an active source of ignition. This would be carried out as part of the programme of compliance with the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) (Ref 22-9) at the Project. DSEAR implements both EU ATEX directives, the 'equipment directive' (Ref 22-18) and the 'workplace directive' (Ref 22-19) into UK Legislation. Currently, no changes are planned to these Regulations as a result of the UK leaving the EU. - Anhydrous ammonia would be stored and handled as a liquid in a cold/refrigerated condition. This is inherently safer than storing, handling, and transporting as a compressed gas	

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
				at ambient temperature and high pressure. The management and operational controls to reduce the potential for a loss of containment include the following: - Operation and management of the facility by experienced, qualified personnel. - Security systems to be deployed including cyber security - - Operability risk assessments carried out during design phase. - A Safety Management System (SMS) would be developed and in place prior to operation, incorporating Management of Change (MoC) procedures. - Planned preventative maintenance systems to prevent equipment defects and failures. - Inspection regimes to detect corrosion and other defects. - Emergency planning and response procedures including regular live tests. - A risk assessment in accordance with DSEAR (Ref 22-08) would be	

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
				produced prior to operation including Hazardous Area Drawings. These drawing define areas where electrical and mechanical equipment is to be appropriately certified in accordance with the ATEX Directives (Ref 22-18, 22-19).	
5	**Explosion/Energy release**	Significant loss of containment of ammonia, hydrogen or natural gas caused by accidental damage or failure of containment systems. Explosion could also be initiated via malicious damage/conflict/arson. Potential for incident at a neighbouring major hazard installation to escalate to Site via domino effect and vice versa. If released gas accumulates and ignition is delayed, an explosion could occur.	Potential for significant harm to people on-Site, including fatal injuries and harm to people off-Site via explosion overpressure. Potential for damage off-Site such as broken glass, impact from projectiles. Potential for damage to critical assets e.g. overhead power transmission systems. Potential for domino effect, escalation to other areas on-Site and off-Site including COMAH installations.	The design and operating mitigation measures are the same as those defined for Risk Event 4, which is a major fire. Principally, these measures involve preventing a loss of containment by applying industry standards and best practice to the engineering design of the facilities which would be subject to rigorous safety assessments. These measures are a fundamental requirement for legislative compliance, without which the facility would not be permitted to operate.	**Yes**

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
		Degree of impact depends on release point and level of congestion within process structures on-Site.			
6	**Release of toxic gas**	Significant loss of containment of ammonia gas from onshore facilities caused by accidental damage, failure of containment systems or malicious damage. Potential for incident at a neighbouring major hazard installation to escalate to and from site via domino effect. Material could be released as gas or rainout and/or dissolution in air to form ammonium hydroxide.	Potential for significant harm to people on-Site, including fatal injuries and harm to people off-Site via contact with ammonia. Emergency services are likely to advise local residents to close doors and windows and remain indoors for the duration of the event. Significant interruption to operations at Immingham Port and other key locations. Potential for harm to the environment if material released to Humber Estuary.	The principal design and operating mitigation measures are be as those defined for Risk Event 4. In addition to these measures, a specific toxic gas detection system would be installed, with a corresponding emergency alarm and procedures. This would allow an early intervention by operators in the event of an accidental loss of containment of ammonia.	**Yes**

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
7	**Release to marine environment**	Scenarios involving a direct release of harmful material to the Humber Estuary include: An accidental release of marine fuel oil or black/grey/ballast water from marine transport. Accidental damage to ammonia vessels such as during berthing causing loss of containment.	Potential for significant harm to persons on board vessels, at jetties or other locations close to vessels. A release of flammable substances such as fuel oil leading to potential for fire if ignited, resulting in harm to people and the environment. If not ignited, material could form a plume on water restricting oxygen supplies to the marine environment. All substances listed have potential for harm to the water environment if material(s) released, via increase in Chemical and or Biological Oxygen Demand (COD/BOD) levels.	Measures included in design to reduce the potential for a loss of containment to the marine environment include the following: - The fuel systems onboard ships would be designed to the appropriate maritime engineering standards. These would include the technical integrity of the fuel storage systems, leakage detection and spill containment. - Fuel leaks would be readily detected by devices such as flow and pressure indicators and isolated (using isolation valves etc.) to minimise the loss of material to secondary containment. - Onshore facilities at the port are to be used for the treatment and disposal of ballast/grey/black water. This material would not be discharged to the Humber Estuary. - The design and operation of the VLGC would incorporate safety features, primarily the robust design of the ship and cargo tanks, which typically incorporate a double-hull construction. - Lloyds Register publish a list of standards to be adopted for the ammonia transport ships, contained in	**Yes**

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
				'The Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquefied Gases in Bulk', published July 2022 (Ref 22-20). - Control systems including Emergency Shutdown (ESD) systems, would be designed, and installed according to engineering design standards, such as those published by International Electrotechnical Commission (IEC). These systems minimise the potential for human error and mitigate the consequences, should an error be made, by a fast, safe shutdown of the transfer systems. - In the event of a fire onboard vessels or at the jetty, a safe haven would be constructed to allow people in the area to reach a place of safety. This is typically onshore at the base of the jetty. The management and operational controls to reduce the potential for a loss of containment include the following: - An oil spillage plan would be produced prior to operation as required by the International Convention for the Prevention of Pollution from Ships	

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
				(MARPOL) Annex 1, Regulations for the Prevention of Pollution by Oil, Regulation 26 (Ref 22-21) The MARPOL convention is enacted in the UK via The Merchant Shipping (Prevention of Oil Pollution) Regulations 2019 (Ref 22-22). - A Navigation Risk Assessment (NRA) to be developed in consultation with stakeholders including the Port operator. Prior to operation, an ERA would be produced for the Project which will use best practice such as the CDOIF methodology described in **Table 22.2**. This assessment would determine the sufficiency of protection measures in the event of a scenario such as a release to the marine environment and conclude if risks are within the tolerable category.	
8	**Release during road transport off-site**	Collisions/accidents involving road tankers containing hydrogen causing loss of containment, leading to fire and/or explosion.	Potential for significant harm to persons within and near to vehicle including potential fatalities. Significant interruption to road traffic, requiring	The design, construction, operation, maintenance and repair of road vehicles for the transport of hydrogen would be in accordance with The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (Ref 22-23).and ADR.	**Yes**

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
			intervention by emergency services.	Vehicles containing hydrogen would be driven by specialist drivers only. Training and management of these drivers would be in accordance with this legislation and supported by advice from a dangerous goods safety advisor.	
9	**Decommissioning Activities – Dismantling Vessels and Pipework**	An incident occurring during decommissioning such as dismantling pipework where vessels have not been fully de-inventoried or isolated (still contain flammable material). Potential for fire and/or explosion. Failure to isolate services such as electrical cabling during these activities could also result in harm to human health, such as electrocution.	Potential for significant harm to persons on-Site carrying out activities, including potentially fatal injuries. Due to quantities involved which would be less than normal operation, no impact would be expected off-Site.	At the end of the operational life of the Project, there are a number of factors which must be considered to safely carry out the decontamination, decommissioning and disposal of process equipment and pipework which has contained the dangerous substances. These include ensuring systems are 'gas-free' via the removal of the inventory, venting systems to atmosphere and ensuring they are sufficiently clean so no remaining gas can be detected. Comprehensive plans for decommissioning safety and environmental management would be developed prior to work commencing, to risk assess tasks and produce method statements for the work. This would be required as part of the COMAH Safety Report. All decommissioning work to be controlled via permit to work systems.	**Yes**

Risk Event	Risk Event Description	Summary Description of Risk Event	Risks and Consequences before Mitigation	Mitigation Measures	Mitigated to ALARP?
				Isolation procedures such as 'Lock-out/Tag-Out' are standard industrial practice for the isolation of electrical systems on process and manufacturing sites.	
10	**Storms / Flooding / Climate Change**	Potential for pluvial and fluvial flooding to cause asset damage leading to loss of containment of substances, consequences considered above within Risk Events 4, 5 and 6. Lightning strike during storm has potential to cause ignition of highly flammable gas. Potential for the frequency and severity of consequences of storm events could increase as a result of climate change.	Potential for significant harm to persons on Site in the event of a loss of containment via fire/ explosion/toxic release. Potential for harm to people off-Site in the event of a major release. Potential harm to the environment e.g. via release of contaminated flood water.	Flood risk assessments will be carried out to inform the addition of flood protection measures, if required. Climate change resilience is a consideration under the COMAH Regulations (Ref 22-3) e.g. flooding as a consequence of climate change is considered as an initiating event for a major accident hazard. Design and construction of drainage systems in accordance with civil engineering codes and standards to withstand storm events. Engineering design of jetty and other systems to allow for potential increase in tidal range and potential climate change impacts.	**Yes**

22.8 Preliminary Assessment of Residual Effects

Construction

22.8.1 The potential risk events during Project construction activities have been identified and assessed in **Tables 22.4** and **22.5**. Where risks cannot be eliminated, they would be reduced to ALARP and the residual risks associated with construction hazards managed via the controls listed in **Table 22.5**. The controls and mitigation measures are primarily compliance with the CDM Regulations (Ref 22-8) and the development and use of a comprehensive CEMP.

22.8.2 A COMAH Pre-Construction Safety Report would be submitted for review by the competent authority prior to Project construction. The purpose of this report is to demonstrate to the competent authority that all measures necessary to reduce risk have been taken.

Operation

22.8.3 The presence of toxic and flammable gases during Project operation means that their associated hazards cannot be entirely eliminated, but must be managed to reduce risks to ALARP, in accordance with the HSE's requirements under the COMAH Regulations (Ref 22-3). Risk reduction and mitigation would be via compliance with all applicable UK legislation and the adoption of UK and worldwide industry standards and best practice used for the design of process equipment.

22.8.4 Continuous monitoring would observe operational conditions such as temperature and pressure, with routine inspection and planned preventive maintenance carried out on all assets to ensure the plant operates safely and efficiently.

22.8.5 All personnel associated with the operation of the Project facilities would be subject to the highest standards of training and competency assurance, including process operators, vessel and jetty personnel and road tanker drivers.

22.8.6 The proposed operation of the Site and the on and off site emergency plans would be subject to rigorous appraisal by the COMAH competent authority and other stakeholders. The operator of the facility would be required to notify the competent authority prior to operation and submit the Safety Report for review. The competent authority would authorise Site operations through review/assessment of the COMAH Safety Report.

22.8.7 When operational, the Site would form part of a COMAH cluster. The purpose of these groups is to share information and provide a cooperative, collaborative forum for operators of COMAH sites. The information shared includes the hazards which are present on each site and emergency response plans. Humberside is one of the main clusters in the UK, with sites working together to share information with local residents and people working near the sites as well as with the competent authority and local authorities.

Decommissioning of the hydrogen production facility

22.8.8 Process substances present at the facility are primarily flammable gases, therefore risks would be reduced to ALARP during decommissioning via controls such as the use of equipment including electrical tools. Prior to dismantling equipment and pipework, the contents would be safely vented to ensure no flammable or toxic materials remain and portable gas detectors would be used to confirm a 'gas-free' status prior to commencement of work.

22.9 Summary of Preliminary Assessment

22.9.1 The purpose of this PEI Report chapter is to present a high level assessment to identify and describe the potential, credible MA&D scenarios which could be pertinent to the Project, which is defined within **Chapter 2: The Project** and comprises a jetty in the Humber Estuary to import and export liquid bulk products and a landside facility to convert ammonia to hydrogen which will be liquified and transported off site for use.

22.9.2 A total of 15 potential hazardous scenarios were initially identified, of which ten (10) were considered credible and therefore termed Risk Events, requiring further assessment. These Risk Events include incidents such as fire and/or explosion caused by a major loss of containment of flammable and toxic gases.

22.9.3 Potential Risk Events have been identified during construction, operation and decommissioning phases of the Project.

22.9.4 The consequences of Risk Events identified are primarily harm caused to people present on-Site. This is as a result of any exposure to thermal radiation generated by fire, exposure to explosion overpressure, impact with missiles such as glass fragments and exposure to toxic ammonia gas. The harm caused by these events can include the potential for fatal injuries, corresponding to the criteria for a MA&D established in **Paragraph 22.2.7**.

22.9.5 There are potentially harmful consequences to the environment as a result of the identified Risk Events. These include direct harm from thermal radiation to flora and fauna in and around the Humber Estuary caused by a major fire. A release of harmful substances such as MFO from vessels transporting ammonia to Site could also cause harm which could potentially correspond to the criteria established in **Paragraph 22.2.7**, which is long term damage to 0.5 ha of the river.

22.9.6 The Project would produce a flammable gas from a toxic gas transported by sea and so it is not possible to eliminate risks entirely. Risk must therefore be reduced by a comprehensive safety and environmental protection programme implemented via engineering design, operational measures and management to achieve a level ALARP, as required by the COMAH Regulations (Ref 22-3).

22.9.7 The Project would comply with all relevant safety and environmental legislation for the management of risks on industrial facilities, from the design and construction phase, through operation and eventual decommissioning.

22.9.8 Further analysis of the level of potential harm to people and the environment, and more detailed information on the mitigation and control measures associated with

the Project will be available as the design progresses and will be included within the ES.

22.10 References

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Ref 22-4 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 SI 572.

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Ref 22-7 HMSO (2015). The Planning (Hazardous Substances) Regulations 2015.

Ref 22-8 HMSO (2015). The Construction (Design and Management) Regulations 2015.

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Ref 22-16 Chemical and Engineering News (2019). Hydrogen blast led to deaths at US silicones plant.

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Ref 22-22 HMSO (2019). The Merchant Shipping (Prevention of Oil Pollution) Regulations.

Ref 22-23 HMSO (2009). The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009.

Ref 22-24 HMSO (2016). The Environmental Permitting Regulations (2016).

Ref 22-25 Health and Safety Executive (HSE). HSE’s Land Use Planning Methodology (https://www.hse.gov.uk/landuseplanning/methodology.htm).

22.11 Abbreviations and Glossary of Terms

Table 22.5 Glossary and Abbreviations

Term	Acronym	Meaning
As Low as Reasonably Practicable	ALARP	Term used by UK Regulatory Authorities and throughout industry to denote that risk is reduced to a level which is a low as practically achievable with existing technology.
Atmosphere Explosive	ATEX	EU Directive on the protection of people from explosive / flammable atmospheres and the selection of equipment to be used in such areas.
Best Available Technology	BAT	BAT assessments are used to establish evidence-based means to prevent pollution and achieve environmental permit conditions for industrial installations.
Biochemical Oxygen Demand	BOD	A parameter for determining the degree of contamination of water related to the amount of oxygen used by microorganisms to breakdown organic substances.
British Geological Survey	BGS	Industry organisation publishing geological information including groundwater designations.
Chemical and Downstream Oil Industries Forum	CDOIF	Industry organisation publishing guidance on best practice for the chemical and downstream oil industries aimed at delivering health, safety and environmental improvements.
Chemical Oxygen Demand	COD	A parameter for determining the degree of contamination of water related to the amount of oxygen required to breakdown organic substances chemically.
Construction, Design and Management Regulations	CDM	UK Regulations for control of construction activities.
Classification, Labelling and Packaging Regulations	CLP	UK Regulations for control of substances which implement harmonized means of classification into hazards, and the appropriate labelling and packaging corresponding to these hazards.
Control of Substances Hazardous to Health Regulations	COMAH	UK Regulations for managing risk from major accident hazard installations.

Term	Acronym	Meaning
Dangerous Substances and Explosive Atmospheres Regulations	DSEAR	UK Regulations for control of dangerous and flammable substances which implements the EU ATEX Directive
Environmental Risk Assessment	ERA	A structured assessment to determine the risk to environmental receptors following a release of harmful substances.
Front End Engineering Design	FEED	An early stage in the engineering design process for projects, following proof of concept but prior to detailed engineering commencing.
Hazards of Construction Hazards of Demolition Hazard Identification Hazard and Operability	HAZCON HAZDEM HAZID HAZOP	Formal process safety assessments used to identify and assess potential hazards at defined stages in engineering design and operation of a facility.
Health and Safety Executive	HSE	UK Health and Safety Regulator and statutory consultee
Hazardous Substances Consent	HSC	UK Regulations for installations storing and/or using dangerous substances which is regulated by Local Authorities for planning purposes.
High Voltage	HV	High voltage electricity is typically categorised as above 1 kV, a level which would be harmful and potentially fatal to people.
Immingham, Eastern Roll-on, Roll-off Terminal	IERRT	A proposed development currently going through the planning stages near to the Project Site.
International Electrotechnical Commission	IEC	Organization which publishes international standards for all electrical, electronic and related technologies.
Institute of Environmental Management and Administration	IEMA	Industry organisation publishing environmental guidance including EIA.
Major Accident to the Environment	MATTE	A term used within the COMAH Regulations to define incidents to the environment which are assessed to have a specific level of harm and frequency of occurrence.
Major Accident Prevention Document	MAPD	A ‘Safety Case’ prepared by operators of major hazard pipelines to demonstrate that the risk is being appropriately managed.

Term	Acronym	Meaning
Marine Fuel Oil	MFO	Specific grade of hydrocarbon fuel used on ships / vessels.
Management of Change	MOC	A system of procedures for controlling changes made to industrial facilities, to ensure there are no adverse safety or environmental implications of the change.
Pipelines Safety Regulations	PSR	UK Regulations for major accident hazard pipelines such as those containing hydrogen which are not fully contained within a facility.
Quantitative Risk Assessment	QRA	A detailed study of risk, applying values of frequency and severity to a hazard to obtain a value of risk level.
So Far as Is Reasonably Practicable	SFAIRP	Risk is reduced to a level which is as low as can be practically achieved with existing technology but is balanced with economic availability.
Safety Instrumented System	SIS	Instrumented control functions for process operations such as automatic trips.
Safety Management System	SMS	A series of policies and procedures developed and implemented by Operators of major accident hazard pipelines and COMAH Installations to deliver an appropriate standard of safety.
Suitably Qualified and Experienced Personnel	SQEP	A term used within UK industries to ensure only appropriately competent personnel are allowed to work where safety is very important, such as drivers of vehicles transporting hydrogen.
Unexploded Ordnance	UXO	Bombs which have been dropped or discarded during military activities which may explode if disturbed. Surveys are used to detect these prior to construction and safely dispose of material which is found.
Very Large Gas Carriers	VLGC	Large ships/vessels used to transport liquefied gases.