KEEPING BRITAIN TRADING

IMMINGHAM EASTERN RO-RO TERMINAL

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Associated British Ports

Immingham Eastern Ro-Ro Terminal

Environmental Statement:
Appendix 10.1: Navigational Risk Assessment

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Innovative Thinking - Sustainable Solutions

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1 Introduction

1.1 Project background

1.1.1 Associated British Ports (ABP), the Statutory Harbour Authority (SHA), owner, and operator of the Port of Immingham ('the Port') is proposing to construct a new roll-on/roll-off (Ro-Ro) facility within the Port – to be known as the Immingham Eastern Ro-Ro Terminal (IERRT). The site for the proposed new terminal lies within the eastern sector of the statutory area of the port estate.

1.1.2 The landside works for the proposed IERRT fall within the administrative boundary of North East Lincolnshire Council. Additionally, the part of the project which extends seaward, and is beyond the local authority's boundary, will take place in the bed of the Humber Estuary. This area is owned by The Crown Estate with ABP, in its capacity as the Humber Conservancy Commissioner, having the benefit of a long lease.

1.1.3 It is anticipated that the marine works for the IERRT will include a number of distinct components, which in summary will comprise:

- An open piled approach jetty from the landside leading to a linkspan with bankseat;
- Two floating pontoons with guide piles or articulated restraint arms;
- Two separate finger piers with a total of three berths – one either side of the northern most finger pier (Berths 1 and 2) and the third (Berth 3) being on the northern side of the finger pier nearest to the river bank;
- A capital dredge of the new berth pocket; and
- Disposal of dredged material and consequential ongoing maintenance dredging.

1.1.4 In order to ensure that the IERRT facility will be able to service three Ro-Ro vessels on Berths 1, 2 and 3, as noted above, it will be necessary to undertake a capital dredge of the berth pockets, deepening to 9 m below Chart Datum (CD) – with a deepening to 6 m below CD under the floating pontoons. Given that no appropriate alternative use has, as yet been identified for the dredge material, it is currently intended that the dredged material associated with the proposed development is disposed of at licensed disposal sites HU056 and HU060, as discussed in Chapters 2 and 3 of the Volume 1 of the ES ('ES') (Application Document Reference number 8.2).

1.1.5 Following the construction of the IERRT and its consequent operation, changes will inevitably arise in connection with the navigational environment which will include increased vessel activity in the area and ongoing maintenance dredging and related survey operations.

1.2 Scope of work

1.2.1 This Navigational Risk Assessment (NRA) considers the navigational consequences and impacts of the proposed IERRT development, both during its construction and consequent operation. The scope of this assessment includes the assessment of new and existing vessel activity arising as a result of the construction of the new marine infrastructure including the required, capital and maintenance dredging of a dredged pocket sufficient to accommodate Ro-Ro vessels at the three new berths at all stages of the tide.

1.2.2 The effect of the proposed development on future marine traffic is then assessed with regard to any additional hazards, embedded controls in place, and potential control/mitigation measures.

1.3 Study area

1.3.1 The study area for the NRA extends from the Humber Sea Terminal in the North to Burcom Shoal in the South, as indicated on Figure 1. This area has been selected so as to ensure that it captures marine traffic patterns and activities associated with the wider area that may impact on or be impacted by the IERRT development and consequent operation.

1.3.2 The study area, therefore, also includes the proposed dredge disposal sites (HU056 and HU060), Immingham Oil Terminal (IOT) and Immingham Outer Harbour (IOH).

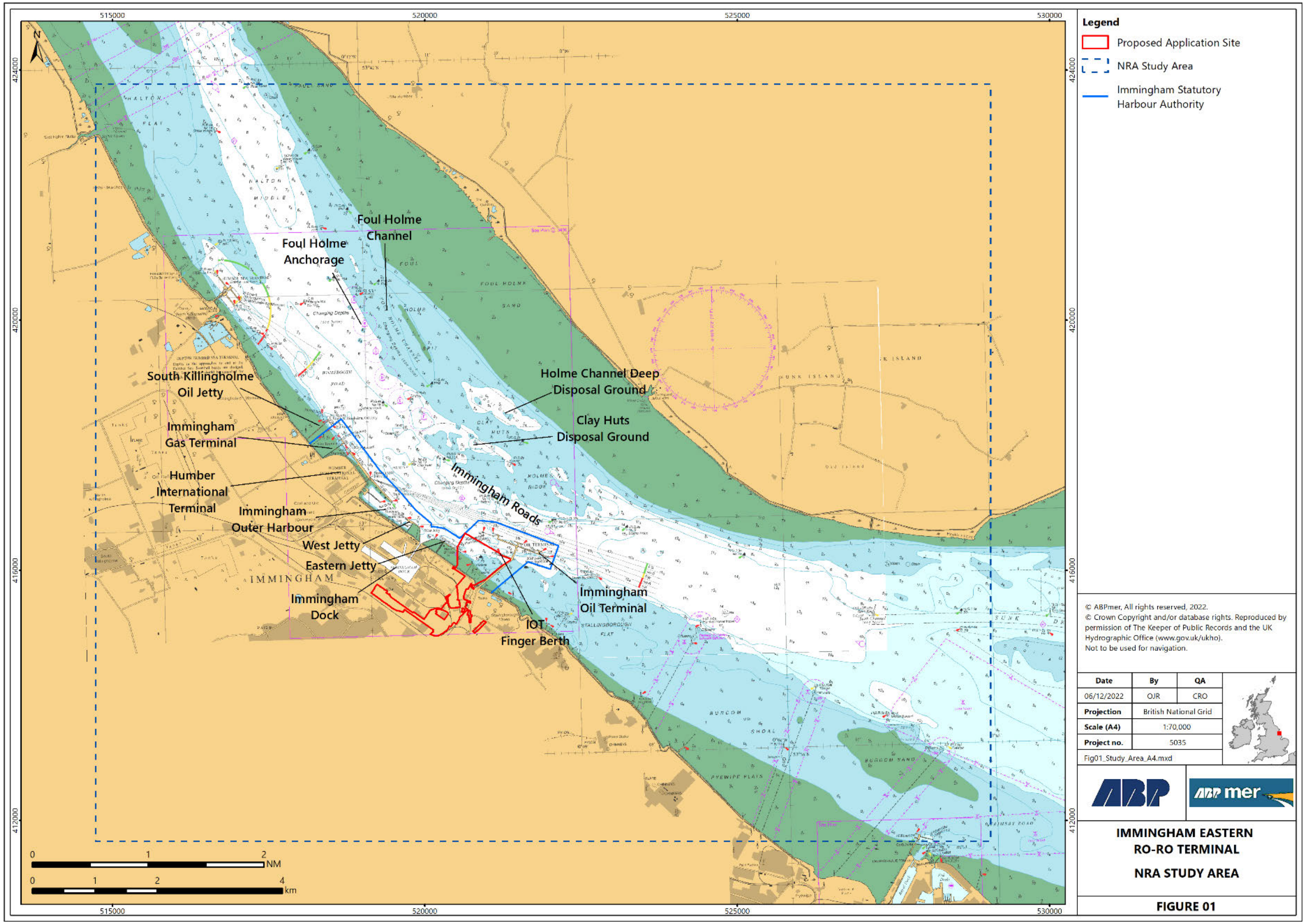

Figure 1 Study area

1.4 Legislation, policy, and guidance

Primary legislation

1.4.1 The majority of the Port's marine operations are administered by the Port of Immingham Harbour Authority which forms part of ABP as the statutory port undertaker. Separately, the Statutory Harbour Authority (SHA) which is governed by a range of national legislation has powers, exercised by the Harbour Master, to issue directions to ensure the efficient performance of navigation and its safety within the limits of the SHA. As a consequence, the ABP Harbour Master is statutorily empowered to issue directions to control movements of vessels within the Harbour Authority area (i.e., that area of water closest to the Port) in order to ensure safety whilst the SHA, i.e., the Harbour Master, regulates the safe navigation of that part of the Humber Estuary that lies beyond the limits of the Harbour Authority area – although inevitably for purely practical and operational reasons, there is a degree of overlap between the two.

Policy

1.4.2 The National Policy Statement for Ports (NPSfP) published in 2012 provides the overarching policy against which the IERRT project will be tested.

1.4.3 Paragraph 5.6.2 and 5.6.3 of the NPSfP recognises that there could be an increased risk of spills and leaks of pollutants to the water environment as a result of the infrastructure development during construction and operational activity (Department for Transport (DfT), 2012). It recommends that the Environmental Statement (ES) should describe and assess the impact on existing physical characteristics of the water environment affected by the proposed development and any impact of physical modification to these characteristics. Furthermore, the NPSfP recognises that the risks of impacts to the water environment can be reduced through careful design to facilitate adherence to good pollution control practice (DfT, 2012).

1.4.4 Sea ports and harbours provide the interface between the land, near shore and open sea. The UK Marine Policy Statement (2011) identifies, in relation to port developments and marine safety that: *"Marine plan authorities and decision makers should take into account and seek to minimise any negative impacts on shipping activity, freedom of navigation and navigational safety; and ensure that their decisions are in compliance with international maritime law",* (UK Government, 2011).

Secondary guidance

1.4.5 The UK national standard for the safe and efficient running of ports is the Department for Transport's 'Port Marine Safety Code' (DfT, 2016) and its accompanying guidance document 'A Guide to Good Practice on Port Marine Operations' on which this NRA methodology is based (DfT, 2018).

1.4.6 The following documents, which provide supplementary guidance, have also been taken into account in the preparation of this NRA insofar as they are relevant. It should be noted that the documents listed below cover a wide range of guidance advice for marine activities, not all of which are applicable to the IERRT proposals:

- International Maritime Organization (IMO) Revised Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule making process (IMO, 2018); and
- Marine Guidance Note (MGN 654) Offshore Renewable Energy Installations (OREI) safety response. Incorporating: Annex 1 Methodology for assessing marine navigational safety and emergency response risks of OREIs. Maritime and Coastguard Agency (MCA, 2021).

ALARP and Tolerability principles

1.4.7 ***ALARP*** - The Port Marine Safety Code (PMSC) defines the term 'ALARP' as being 'as low as reasonably practicable', (DfT, 2016). ALARP is an industry-wide standard, applying to both health and safety and port marine safety.

1.4.8 ***"Reasonably practicable"*** - Central to this standard is the term 'reasonably practicable'. To meet this standard, the NRA has to balance risk against the effort, time and money required to control the risk. The PMSC (2016) specifically references ALARP as an underpinning rationale for Marine Safety Management Systems (MSMS)[1] and marine risk assessments.

1.4.9 Risk assessment is based on a comprehensive and formal assessment of hazards and risks with a view, following assessment and mitigation of the more severe scenarios either to eliminating the hazards and risks or to reducing them to the lowest possible state, so far as is reasonably practicable.

1.4.10 Where a project is proposed which may alter the navigable environment, the promoter of the scheme must consult with those likely to be involved in or affected by such alterations. The overriding aim is to ensure that any consequential risk is reduced to meet the standard of as low as reasonably practicable.

[1] A system to manage the hazards and risks along with any preparations for emergencies – it should be developed after consultation, based on formal risk assessment and refer to an appropriate approach to incident investigation (DfT, 2018).

1.4.11 The Code's Guide to Good Practice (DfT, 2018) (GtGP) states that the: *"Judgement of risk should be an objective one, without being influenced by the financial position of the authority. The degree of risk in a particular activity or environment can, however, be balanced on the following terms against the time, trouble, cost, and physical difficulty of taking measures that avoid the risk. If these are so disproportionate to the risk that it would be unreasonable for the people concerned to incur them, they are not obliged to do so. The greater the risk, the more likely it is that it is reasonable to go to very substantial expense, trouble, and invention to reduce it. But if the consequences and the extent of a risk are small, insistence on great expense would not be considered reasonable",* (DfT, 2018).

1.4.12 This means that every hazard scenario needs to be assessed and, regardless as to whether that scenario produces a minor or significant hazard, it needs to be taken into account so as to ensure that the risks overall are ALARP. Greater emphasis is placed on significant risks to ensure that the more significant risk outcomes are mitigated with the aim of providing a safer environment.

1.4.13 ***Tolerability -*** Further, the concept of 'tolerability' seeks to define the point at which a risk has an unacceptable outcome (a function of frequency and consequence) when measured against key criteria. Those criteria in respect of marine safety are defined in the GtGP as:

- human life;
- the environment;
- port/port user operations; and
- port/shipping infrastructure damage (DfT, 2018).

1.4.14 When used as part of the assessment process, an appropriate authority, such as an SHA, the NRA will assist in determining whether or not analysed and assessed risks are tolerable or intolerable.

1.4.15 The GtGP states that: *"Risks may be identified which are intolerable. Measures must be taken to eliminate these so far as is practicable. This generally requires whatever is technically possible in the light of current knowledge, which the person concerned had or ought to have had at the time. The cost, time and trouble involved are not to be taken into account in deciding what measures are possible to eliminate intolerable risk Risks may be identified which are intolerable. Measures must be taken to eliminate these so far as is practicable. This generally requires whatever is technically possible in the light of current knowlede, which the person concerned had or ought to have had at the time. The cost, time and trouble involved are not to be taken into account in deciding what measures are possible to eliminate intolerable risk",* (DfT, 2018).

1.4.16 Determining whether the predicted level of risk is acceptable requires a two-part test:

- Firstly, is the risk mitigated to ALARP,
- Secondly, is the risk tolerable.

1.4.17 This means that where risks are identified and assessed as being tolerable, they can be accepted, and the associated activity may proceed once a position of ALARP has been reached. However, if the assessed risk remains above the tolerability line or position, then all relevant controls must be applied to it or else the given activity cannot take place.

2 Data Sources

2.1 Introduction

2.1.1 The following section details the origin of the data used to create the baseline information and inform this NRA.

2.2 Automatic Identification System data

2.2.1 This NRA has utilised Automatic Identification System (AIS) data for the dates 01 September 2021 to 31 August 2022. This provides a data record of 365 days for the Humber Estuary. This has been sourced from an in-house AIS database provided by Anatec Limited.

2.2.2 AIS signals are broadly classified as 'Class A' and 'Class B', where AIS-A is carried by international voyaging ships with Gross Tonnage (GT) of 300 or more tonnes, all passenger ships regardless of size, fishing vessels 15 m or more in length overall (operating within UK waters) and certain categories of workboats. The use of AIS-B is not compulsory but may be carried by other vessels, including smaller commercial craft, the fishing sector, and recreational vessels.

2.2.3 Both AIS-A and AIS-B data have been used within this study. The AIS data has been analysed and classified into the following eleven vessel categories, which are taken directly from the AIS data transmissions:

- Non-Port service craft;
- Port service craft;
- Vessels engaged in dredging or underwater operations;
- High Speed Craft;
- Military or law enforcement vessels;
- Passenger vessels;
- Cargo vessels;
- Tankers;
- Fishing;
- Recreational; and
- Unknown.

2.2.4 The 'unknown' category includes craft that are using AIS to identify their location but have not set their AIS to confirm their craft type. Typically, these are workboats (which may carry out different roles), fishing vessels and other smaller craft operating commercially. This category also includes craft that have incorrectly set their AIS transceivers or not changed the factory default settings.

2.3 Recreational activity

2.3.1 Information on recreational activity in the study area has been collated using a variety of methods. Quantitative data has been derived from AIS-B records although it is recognised that not all recreational craft carry AIS transceivers, since the use of AIS-B is not mandatory. Therefore, patterns of activity related to recreational craft have also been collected from anecdotal sources, including port staff, recreational users, and yachting guides.

2.4 Port freight and movement statistics

2.4.1 Statistics for port freight and vessel movements at major ports is recorded by the DfT. This data is collected by annual returns provided by the ports and made available online (DfT, 2021). It should be noted that collation of vessel movements at major ports was altered in 2017 by DfT. From 2018 onwards, the data sources used to estimate vessel arrivals changed. The primary source of data is now the Maritime and Coastguard Agency's CERS system, though data from ferry companies, ports and shipping agents collected by DfT is also still used. This means that that as a result the 2018 figures are not directly comparable with those for earlier years. In particular, for some ports the coverage of 'other vessels' (which includes non-cargo vessels) is notably different and not always available under the new methodology (DfT, 2021). However, this is not considered a significant issue for collating and baseline information.

2.4.2 Vessel movement statistics have been tabularised from the AIS data collected for this project.

2.5 Navigational features

2.5.1 Navigational features have been considered in this assessment and have been identified using information from UK Hydrographic Office (UKHO) Admiralty Charts 3497 and 1188. Charted information is used by mariners as part of the passage planning process and to plot progress during a passage and so contains all relevant navigational information.

2.6 Maritime incidents

2.6.1 To characterise maritime incidents occurring within the study area, available data from 01 January 2011 to 31 December 2020, has been pooled from three sources, namely:

- Royal National Lifeboat Institution (RNLI) call out data;
- Maritime Accident and Investigation Branch (MAIB); and
- Local port marine accident incident reporting database (MARNIS).

3 Navigational Baseline Information

3.1 Introduction

3.1.1 The following section presents the baseline information for commercial shipping and recreational craft in the study area. Where relevant, factors relating to the proposed marine works and the subsequent operation of the proposed development have been highlighted. The following elements are considered in the baseline:

- Statutory responsibilities and management procedures;
- MetOcean conditions;
- Visual aids to navigation;
- Vessel services;
- Vessel traffic management;
- Marine traffic analysis; and
- Marine accidents and incidents.

3.2 Statutory responsibilities and management procedures

3.2.1 The proposed development is located within the Port of Immingham's harbour authority limits. ABP, in its capacity as the Harbour Authority SHA has a set of powers, duties and responsibilities which include ensuring and maintaining safe port marine operations and the regulatory control of navigational activities.

3.2.2 Humber Estuary Services (HES) is the SHA for the harbour area of the Humber Estuary beyond the Port of Immingham's harbour limits, a role it fulfils as successor organisation to the Humber Conservancy Commissioner. HES is also the Competent Harbour Authority (CHA) under the Pilotage Act 1987 with respect to the Humber Estuary and the ABP Port of Immingham harbour area. In its capacity as CHA, HES has issued a set of Pilotage Directions identifying which vessels require a Pilot. HES also runs a Pilotage Exemption Certification (PEC) scheme for any ship's deck officer who demonstrates that he or she has the requisite skills, experience, and local knowledge to pilot the vessel within the compulsory pilotage area.

3.2.3 A Vessel Traffic Service (VTS), as described by MGN 401 (MCA, 2022), is provided for the Humber Estuary. Humber VTS maintains a vessel traffic picture through the AIS and Radar providing information on weather, vessel movements and marine safety to vessels navigating in the VTS area. All sea-going vessels are required to report to Humber VTS when entering the VTS area and at designated, charted reporting points.

3.2.4 ABP is also the Local Lighthouse Authority (LLA) for the Port of Immingham's SHA area by virtue of the Merchant Shipping Act 1995. As LLA, ABP is responsible for the provision and maintenance of Aids to Navigation (AtoN).

ABP is required to report any defects to AtoN and consult on any proposed changes, additions, or removal of AtoN with Trinity House Lighthouse Authority (THLA) as the General Lighthouse Authority for England and Wales.

3.2.5 Finally, ABP in its capacity as the Statutory Harbour Authority has committed to meeting the requirements of the PMSC. The PMSC requires that ports operate an effective MSMS which is based on a set of comprehensive and regularly updated risk assessments. The MSMS for both the Port of Immingham and HES details how the harbour authorities fulfil their statutory duties and meet the marine safety requirements prescribed by the PMSC. The MSMS is subject to annual internal audits by the ABP Group's Designated Person and external PMSC audits on a three year cyclic basis.

3.3 MetOcean conditions

3.3.1 A description of the existing MetOcean (meteorological and oceanographic) conditions at the proposed development site are provided in the following sections. These characteristics are informed by available relevant measured and modelled datasets.

Wind

3.3.2 Wind conditions at the IERRT site have been characterised using measured meteorological data from a weather station located at 53.567° N, 0.350° W, covering the period 01 January 2019 to 12 June 2021. Across the year wind directions at the site are predominantly from the south and south-west (Figure 2), with the highest wind speeds coming from the south, south-west, and the north. The annual average wind speed at the site is approximately 9.5 kts (Table 1) and the highest wind speed recorded at the site across the measurement period is 42.76 kts.

3.3.3 There is a natural seasonal variability to the winds experienced at the site, both in terms of speed and direction. For the period April to May the predominant wind direction shifts from the south-west to the east, transitioning through May back to the south-west and south for the remainder of the year. The period April to July also sees a dip in wind speeds with the monthly mean wind speed falling below 9 kts, into the 8.2-8.8 kts range. Either side of this period of lower wind speed are the two periods where wind speeds are at their highest. February and March see the average wind speed rise above 11 kts (Table 1) and in August the average wind speed again rises above 10 kts. For the remainder of the year monthly mean wind speed stays at around the annual average.

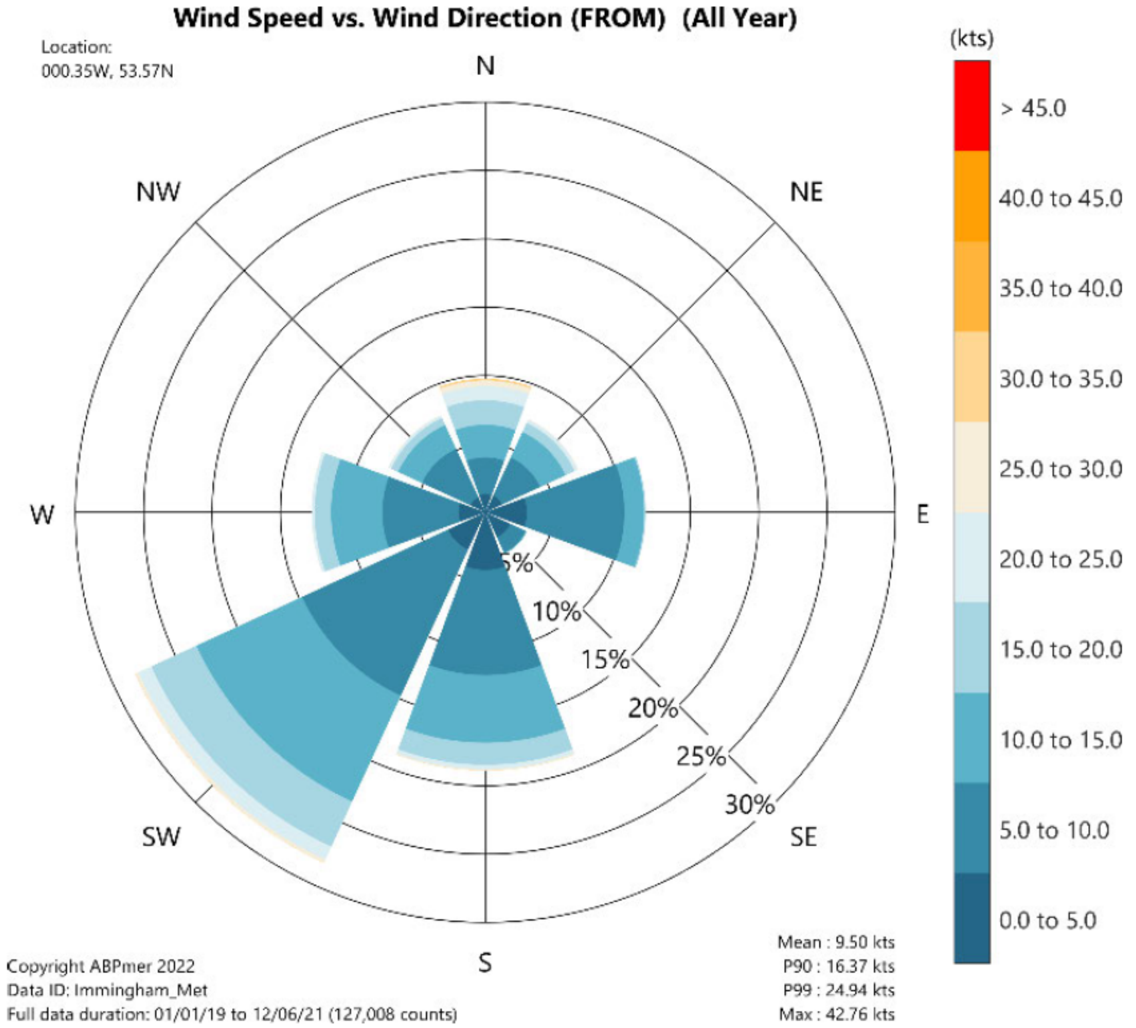

Figure 2 Wind Speed and Direction at 10 m Above Sea Level, Rose Plot

Table 1 Wind Speed Statistics

Period	Wind Speed Percentage (of Period) Occurrence					Mean Wind Speed [kts]	Max Wind Speed [kts]
	0-10 kts	10-20 kts	20-30 kts	30-40 kts	40-50 kts		
January	57.29	39.81	2.89	0.01	-	9.83	31.11
February	47	45.37	7.28	0.34	0.01	11.04	40.03
March	50.14	41.82	7.7	0.32	0.02	11.01	42.76
April	68.63	29.57	1.8	0.01	-	8.52	34.92
May	73.6	23.19	2.99	0.23	-	8.29	32.96
June	68.21	28.16	3.17	0.46	-	8.78	36.73
July	73.88	25.39	0.73	-	-	8.18	27.03
August	54.76	38.8	5.95	0.47	0.01	10.35	40.32
September	62.34	33.43	4.19	0.04	-	9.33	31.49
October	59.86	38.26	1.88	-	-	9.58	28.35
November	60.96	35.14	3.85	0.05	-	9.19	33.12
December	59.74	37.1	3.11	0.06	-	9.48	33.79
All-Year	61.15	34.78	3.9	0.17	0	9.50	42.76

Tidal levels

3.3.4 Figure 3 shows the highest water level and surge event in metres above chart datum in the past two years. The highest water level (WL) event occurred on 7 November 2021 and recorded an observed level increase of 8 m above chart datum at 07:00 which correlated with the predicted time. Of note is the fact that this exceeded the predicted level by less than 0.5 m. During this time the experienced tidal surge was minimal and averaged between 0.4 m and 0.6 m above chart datum.

3.3.5 In terms of a surge event, the highest surge event was recorded on 8 January 2021, and recorded the highest level above chart datum of 1.5 m at 02:30.

Figure 3 Tidal Levels

3.3.6 Figure 4 shows the current maximum water level that has been recorded at Immingham which occurred on 5 December 2013 at 19:00 hours with an observed level increase of 9 m above chart datum. The level was recorded during a tidal storm surge which caused extensive flooding to Immingham Dock as well other areas along the northeast coast.

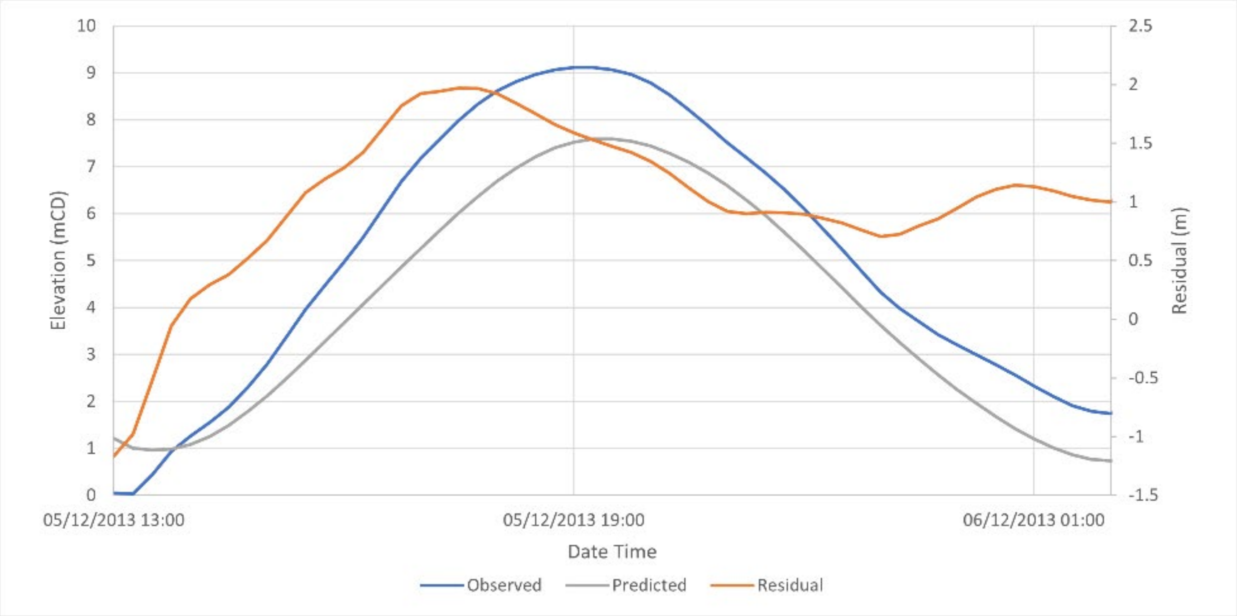

Figure 4 Maximum Recorded Water Level

Waves

3.3.7 Measured data from an AWAC bed frame deployment in the vicinity of the proposed site, displayed at Figure 5, shows that the wave regime at the site is dominated by waves approaching from the northwest and southeast coincident with the longest fetch lengths at the site. Waves with significant wave height (Hs) of above 0.7 m are observed from both of these main approach directions, with a peak Hs value during the deployment period, of 0.84 m.

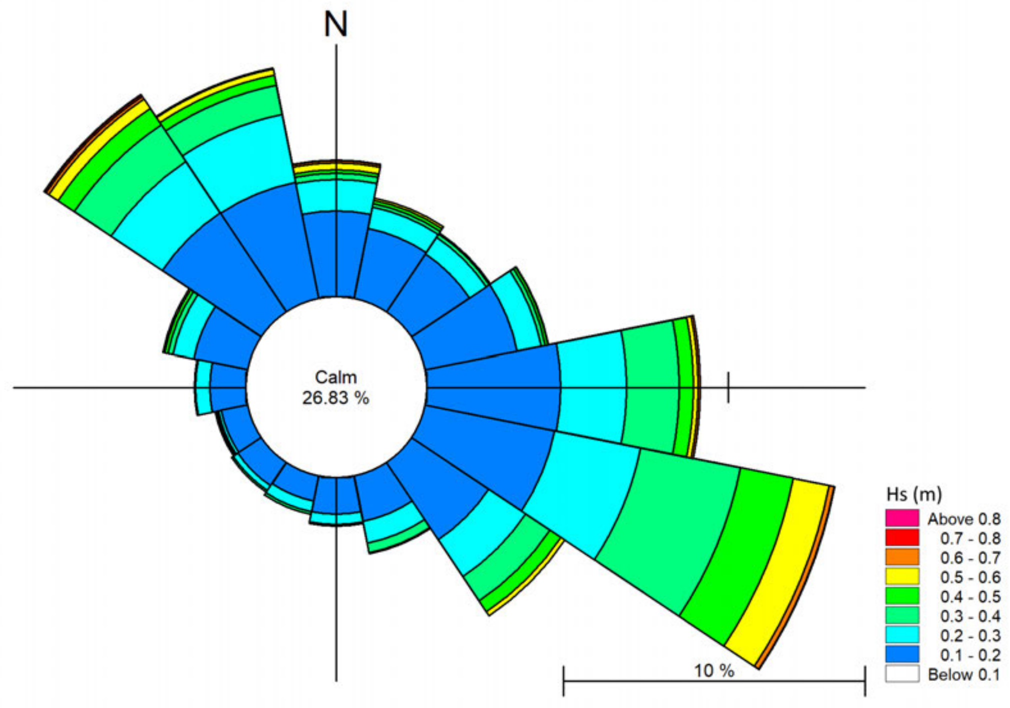

Figure 5 Wave rose at the proposed site

3.4 Visual aids to navigation

3.4.1 Visual aids to navigation within the study area conform to the standards of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA).

3.4.2 Lateral marks and a directional light are used to denote the navigable sections of the estuary, the main navigable channel, and the smaller channels. Directional lights are positioned on the Immingham Bulk Terminal and Humber Sea Terminal to assist navigation within the main channel for vessels transiting near Immingham.

3.4.3 Numerous additional AtoN are present at those facilities close to the IERRT development site which include lights identifying the terminals and jetties at the Port of Immingham.

3.5 Vessel services

3.5.1 Pilotage in the Humber Estuary and the Port of Immingham is provided by Humber Estuary Services. The ABP 'Pilotage Directions for ships to be navigated within the Humber pilotage area' (ABP, 2016) defines the Humber Pilotage Area and the requirements for compulsory pilotage within it. The directions also lay down regulations under which PECs are issued and administered in the area.

3.5.2 Vessels subject to compulsory pilotage within the compulsory pilotage area include:

- All vessels greater than 60 m length;
- Any vessel less than 60 m carrying a bulk cargo of dangerous substances as defined and categorised in the Dangerous Substances in Harbour Areas Regulations (1987); and
- All vessels over 100 m moving between tidal estuary berths which includes the moving of mooring lines.

3.5.3 Towage is provided by a number of service providers, the main companies being SMS towage and Svitzer who offer a range of tugs with different bollard pull capacities. The vessel's size, type and draught dictate the minimum tugs that are required. Of particular note for the study area, all tankers visiting IOT up to 150,000 Deadweight Tonnage (DWT) and gas tankers over 20,000 DWT require two tugs from the Sunk Spit buoy, North of Grimsby (as shown on Admiralty Chart 3497) for the passage to the berth. Tankers up to 50,000 DWT require three tugs for berthing, four tugs are required for berthing tankers between 50,000 and 150,000 DWT, and five for any vessels greater than 150,000 DWT.

3.5.4 Vessels visiting the IOT Finger Pier will be accompanied by a smaller harbour tug, owned, and operated by Briggs Marine, which is on standby at the pier. Laden crude oil tankers in excess of 100,000 DWT which are visiting the IOT are required to berth with two mooring advisors, who are not pilots but who form part of the IOT team, to assist with berthing.

3.6 Vessel traffic management

3.6.1 A VTS is in operation for the area designated Humber VTS. This service provides AIS coverage throughout the VTS area and radar tracking within a large portion of the VTS area. Communications are provided over three Very High Frequency (VHF) radio channels which consist of:

- VHF channel 14 is the main operational working channel for the Humber approaches through to the meridian of longitude passing through the No.4A Clee Ness light float;
- VHF channel 12 is the main operational channel for the middle Humber up estuary of the meridian of longitude which passes through the No.4A Clee Ness light float to the Humber bridge; and
- VHF channel 15 is the main operational channel for the upper Humber inland of the Humber bridge and includes those areas of the River Ouse and River Trent.

3.6.2 In addition, every 2-hours the VTS service broadcasts information to mariners regarding the weather, tidal information, and navigational warnings.

3.7 Marine traffic analysis

3.7.1 Figure 6 through to Figure 16 identify commercial vessel movements in the study area and the proposed development. Figure 17 provides recreational information from the Royal Yachting Association (RYA).

Commercial navigation

3.7.2 It can be seen in Figure 7, Figure 8, Figure 9 and Figure 13 that the proposed development area is utilised by port service craft (tugs, pilot boats, line handling vessels etc.), vessels engaged in dredging or underwater operations, high speed craft, and tankers, respectively.

3.7.3 Figure 18 provides the cumulative AIS data for average vessel density per week which shows that in the immediate vicinity of the IERRT development there is an average of between 10.1 to 15.0 vessels per week that access the Finger Pier berths of the IOT. This provides an overall assessment of the potential impacts of vessel movements near the IERRT development (the use of the IOT is further considered in paragraph 3.7.13).

3.7.4 Figure 6 shows non-port service craft which includes but is not limited to tugs, workboats, and line handling vessels. Approximately five vessels used for line handling and tug work are extensively employed in support of tanker berthing operations on the IOT, Immingham Gas Terminal and South Killingholme Oil Jetty. Smaller coastal tankers and bunker barges using the Finger Pier berths of the IOT are required to use small, AIS equipped, workboats in a pushing capacity during mooring operations. These vessels are usually berthed on a floating pontoon on the east side of the jetty, opposite the Finger Pier or within Immingham Dock during inclement weather.

3.7.5 Other workboats which are extensively used in support of tanker operations include two line handling vessels and one support vessel that is used for safety boat work, which are equipped with AIS. These vessels may be berthed at the pontoon or on one of the two buoys adjacent to the IOT. The western buoy currently falls within the development area and will require removal or relocation.

3.7.6 If there is sufficient clearance, then workboats may make use of the Barge Passage which allows small vessels to move under the IOT trunk way/approach jetty to provide quick access to the Finger Pier berths. Alternatively vessels can transit around the outer berths to reach the Finger Pier. Workboats frequently travel up the river from the IOT to provide line handling services at the South Killingholme Oil Jetty and Immingham Gas Terminal. This results in workboats, including those without AIS fitted, passing close to the various berths west of the IOT and the entrance to Immingham Dock.

3.7.7 The AIS vessel category port service craft is shown in Figure 7. This data set includes but is not limited to tugs, pilot boats, and line handling vessels. As such, a substantial proportion of vessel movements are likely to be in the vicinity of various port berthing locations. Line handling vessels are employed in support of berthing operations throughout the study area. The larger harbour tugs provide support to vessels throughout the estuary and at the majority of the berths. This is supported by the data contained within Table 2 and Table 3 which show that port service craft make up 36.8% of vessel movements within the study area and 24.7% of the transits between IOT and the Eastern Jetty, respectively. As these movements are in support of reducing risk for vessels berthing and departing their presence in the development areas are not of particular concern due to their size and manoeuvrability.

3.7.8 Dredging or underwater operation vessels, as shown in Figure 8, operate frequently in the vicinity of the Port of Immingham. These include survey vessels which, due to the nature of their business, proceed back and forth across parallel points within their area of operation. This creates the appearance when observing AIS data that the traffic density is very high whilst this may not in fact be the case. In this instance, it is clear that a survey has taken place in the development area meaning that the actual vessel density is low. This activity is not of significant concern in this assessment as surveys of the area can be deconflicted without impacting navigational safety.

3.7.9 Figure 9 shows the movements of 'High speed craft'. This category consists mostly of vessels that have a wind farm support role, carrying contractors and engineers out to the wind farms near the entrance of the Humber. It can be seen that they do not pass into the development area, and given their size and manoeuvrability, are not of significant concern in this vessel traffic analysis.

3.7.10 Figure 10 shows relatively infrequent transits within the study area for military and law enforcement vessels. The main area of operation can be seen along the Foul Holme channel to Holme Ridge, well clear of the proposed development.

3.7.11 As shown in Figure 11 there are a significant amount of passenger vessel transits. This essentially comprises of ferries that operate out of Hull and South Killingholme (though at South Killingholme this is associated with driver accompanied freight on Ro-Ro vessels). The passenger vessel transits can be seen to be in close proximity to the IOT as the vessels make their way to the Humber Sea Terminal, thereby identifying traffic on the approach to the study area. Both Hull and South Killingholme, however, are sufficiently distant from the development site and as such, are not a cause of significant concern for the proposed IERRT development within the context of this vessel traffic analysis.

3.7.12 There are a small number of transits that seem to show passenger vessels within Immingham Dock. It should be noted, however, that some of the ferry providers operate unaccompanied Ro-Ro freight services which may actually be classed as cargo rather than passenger vessel transits if there are less than 12 passengers onboard.

3.7.13 Figure 12 denotes the movements of cargo vessels. It can be noted from the AIS data that cargo vessels arrive and depart from Immingham Docks, the IOH, the bulk terminal and international terminals. Table 2 identifies that cargo vessels represent 41% of the vessels in the study area.

3.7.14 Tankers account for a significant number of vessel movements within the study area, as shown by Figure 13. These vessels regularly operate throughout the Spurn Head to Immingham section of the Humber, with further traffic heading up river. Tankers regularly utilise the South Killingholme Oil Jetty, Immingham Gas Terminal, Immingham Outer Harbour Berths, the Western and Eastern Jetty and the IOT. Larger tankers use the IOT's three outer berths, while smaller coastal product tankers and bunker barges use the four berths of IOT's Finger Pier. Table 2 identifies that tankers account for 21% of the vessel in the study area.

3.7.15 Figure 14 displays relatively infrequent transits by fishing vessels. The main area of operation is further downstream to the east. Fishing vessels are not considered to present any significant concern for this vessel traffic analysis.

3.7.16 Vessels berthing at the Finger Pier are only allowed to do so when the tide is flooding, and will manoeuvre ahead, stemming the tide as they berth. The navigable water to the west of the Finger Pier is currently used by departing coastal tankers to turn as they manoeuvre astern off the berth, a manoeuvre which is also conducted on flooding tides. The smaller size of the coastal tankers means that they do not take a long time to load (typically less than 12 hours). This relatively quick turnaround results in the coastal tankers on the Finger Pier accounting for a high percentage of the IOT's vessel movements.

3.7.17 It is worth also noting that there are three small bunker barges operating within the river. These bunker barges load cargoes at the Finger Pier before transiting to various locations around the river in order to refuel ships. Bunker barges are categorized as tankers within AIS datasets, and their movements account for the majority of tanker traffic in areas not generally frequented by tankers, such as Immingham Dock.

3.7.18 Figure 16 denotes AIS tracked movements of vessels whose status is unknown or may have multiple roles, as is the case with certain workboats. Due to the nature of this data, it is difficult to analyse the nature or intent of the movements seen, however the vast majority of the vessel tracks within the study area fall outside the marine development site and its immediate vicinity. One such interpretation of the data in the vicinity of the development can reasonably deduce that there is occasional utilisation of the Barge Passage at the IOT, this activity (although somewhat infrequent) will need to be deconflicted with other vessel movements during the construction and operational phases of the development.

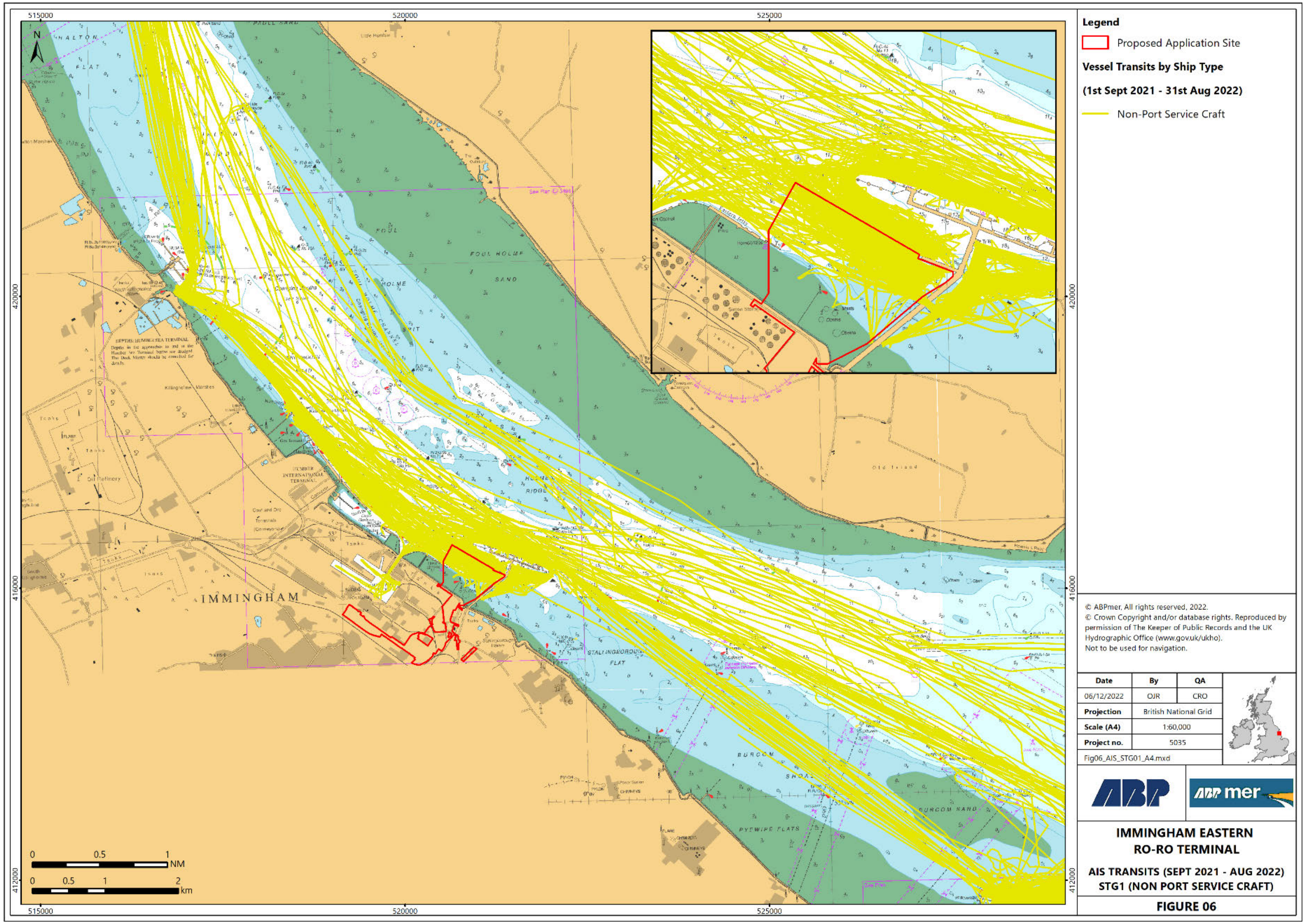

Figure 6 Vessel transits – Non-Port Service Craft

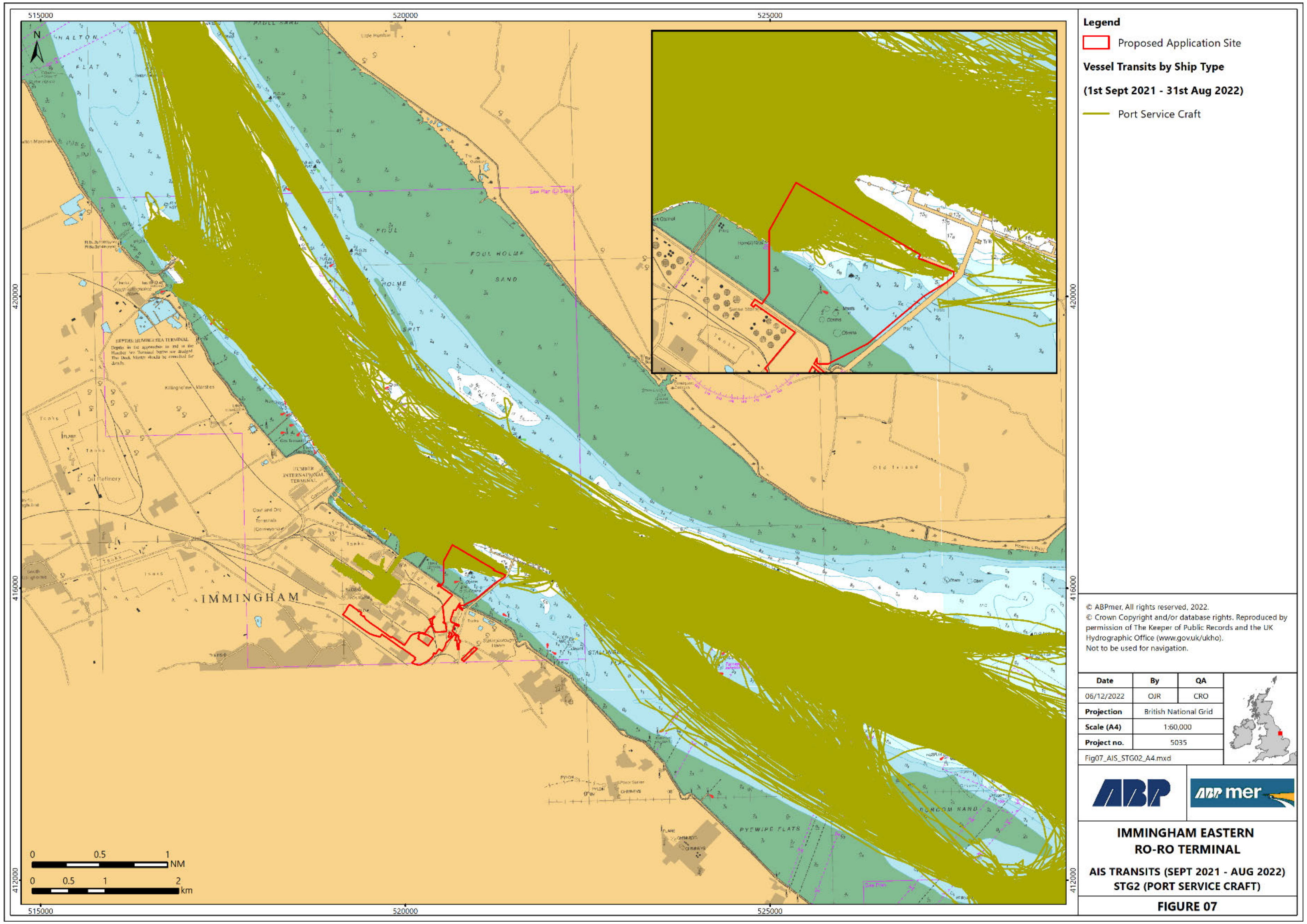

Figure 7 Vessel transits – Port service craft

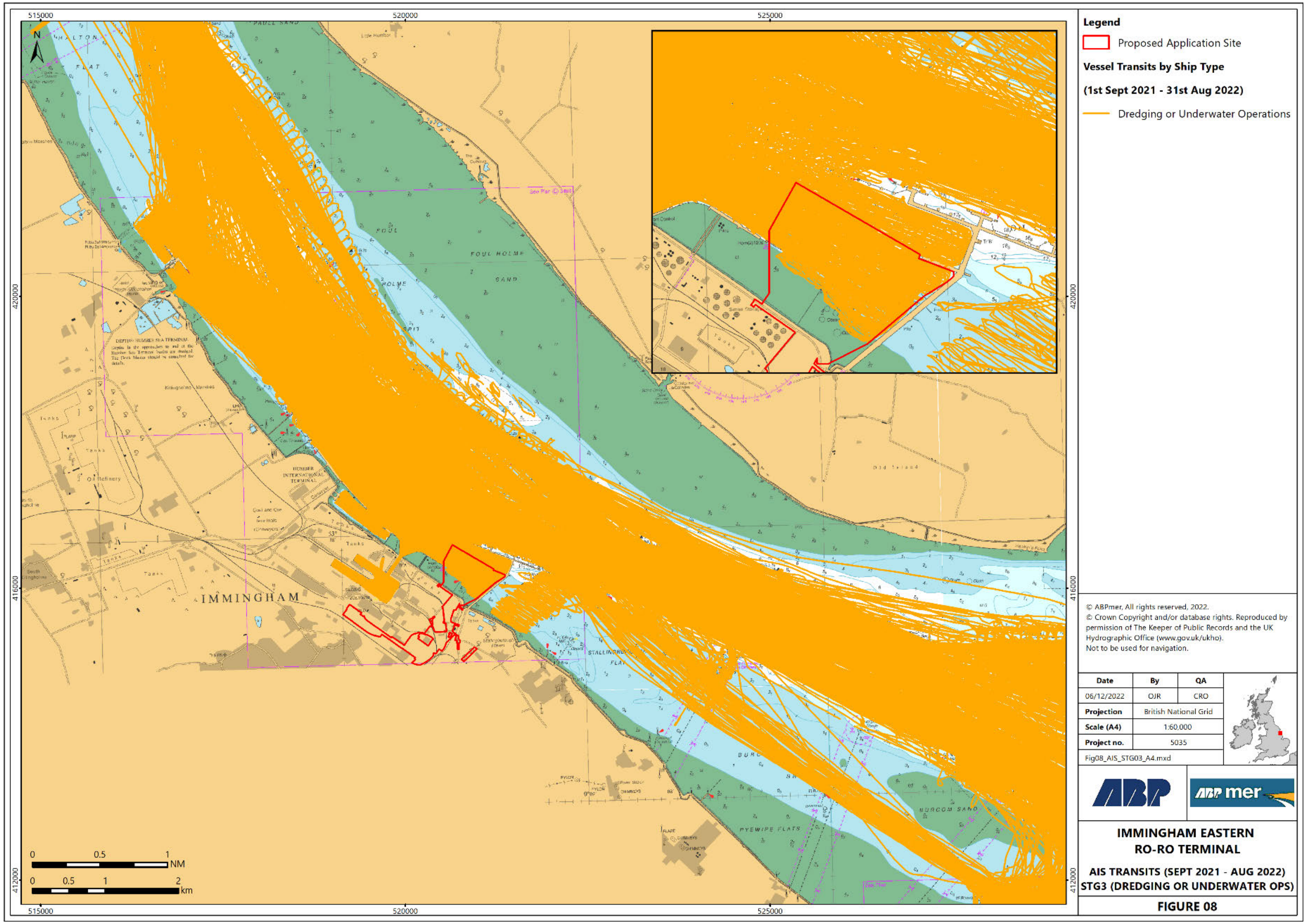

Figure 8 Vessel transits – Dredging or underwater operations

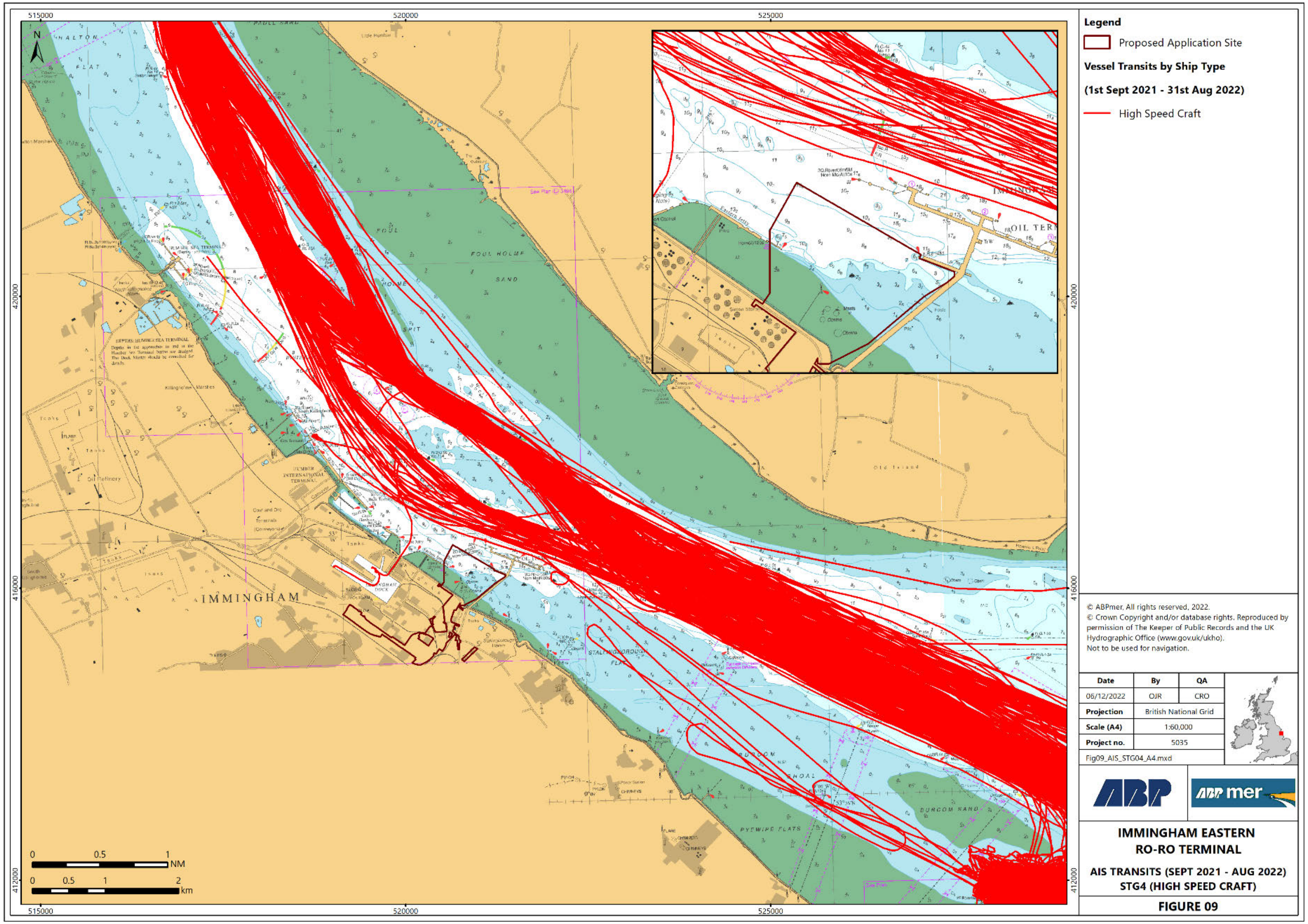

Figure 9 Vessel transits – High speed craft

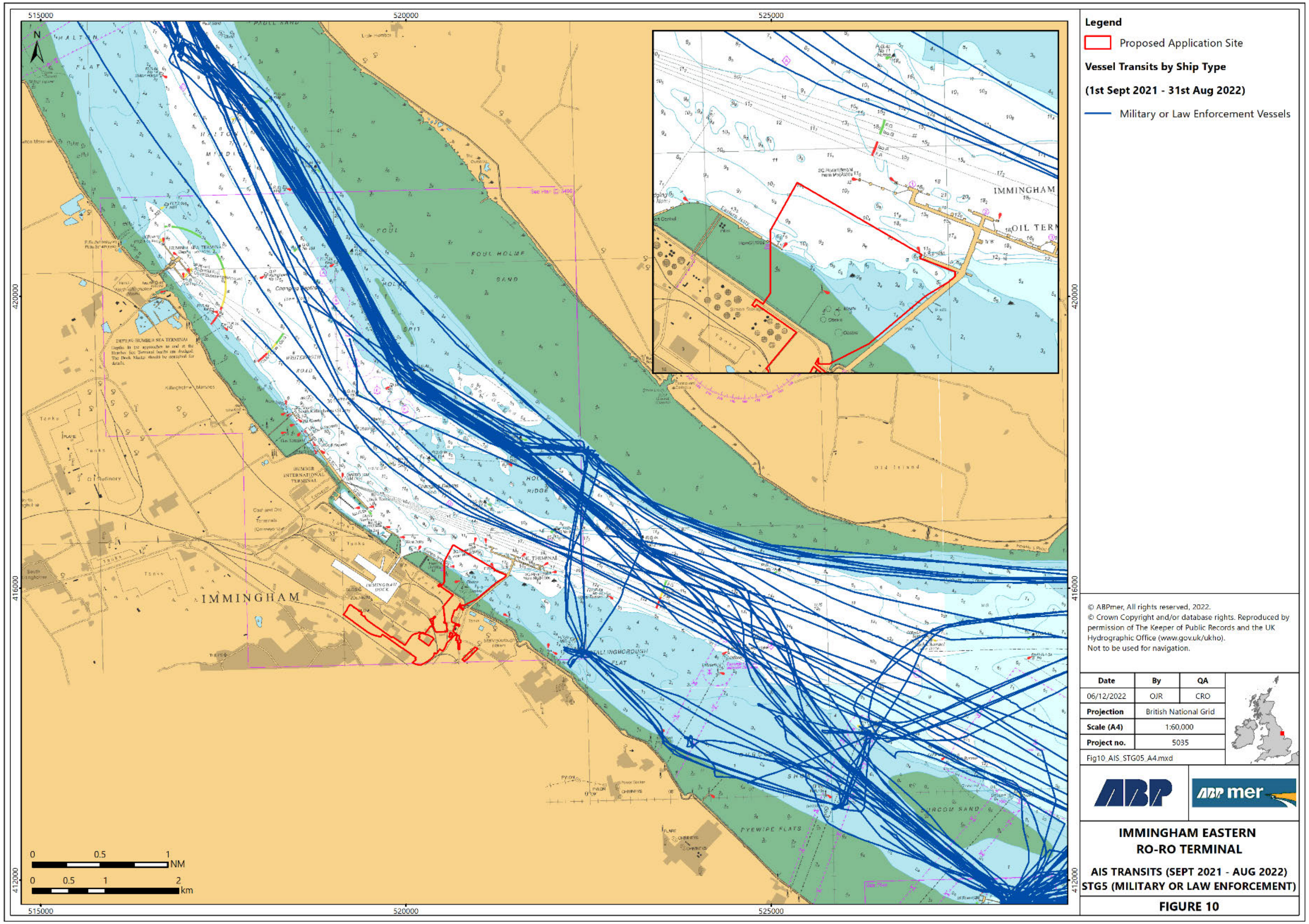

Figure 10 Vessel transits – Military or Law Enforcement Vessels

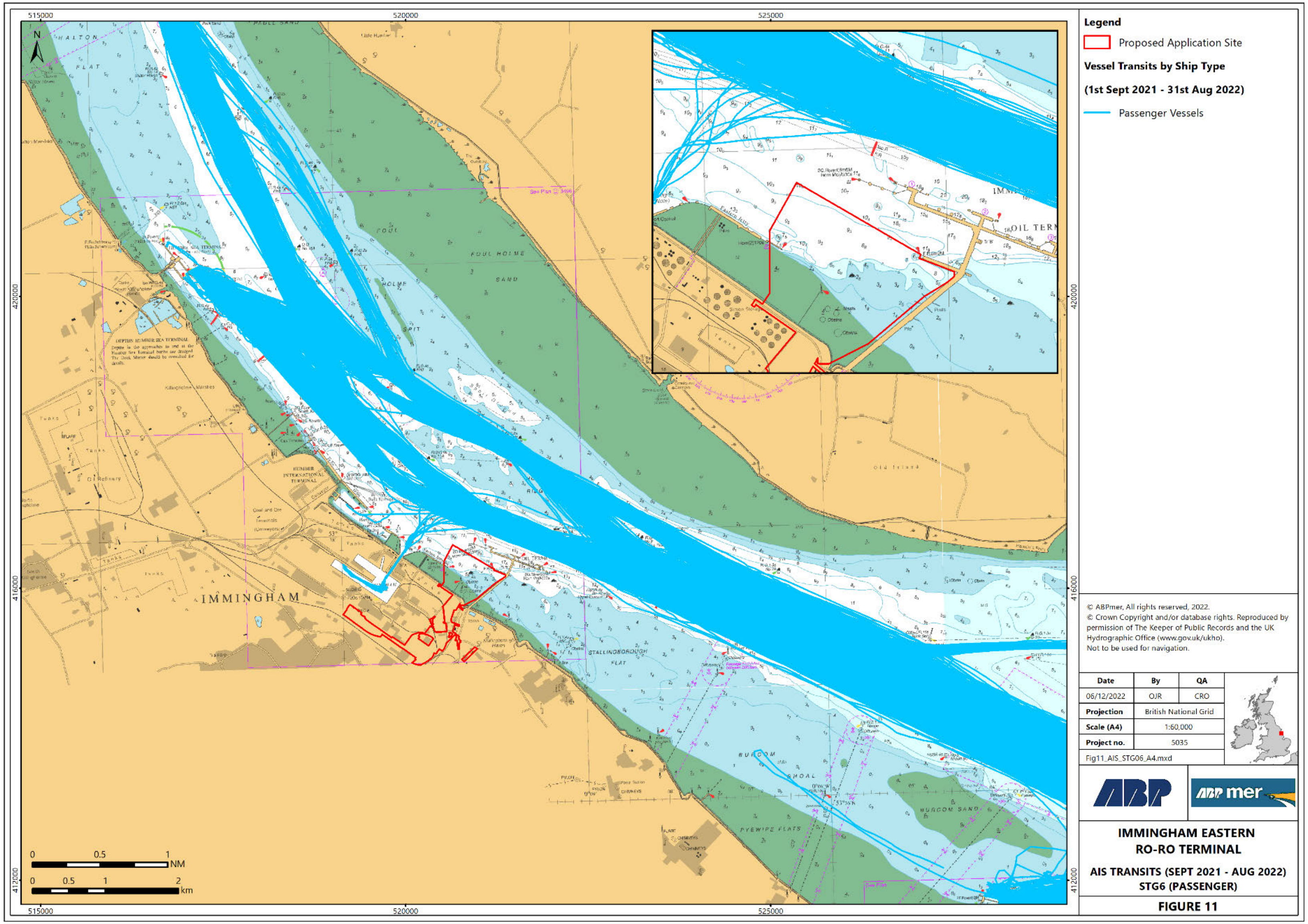

Figure 11 Vessel transits – Passenger

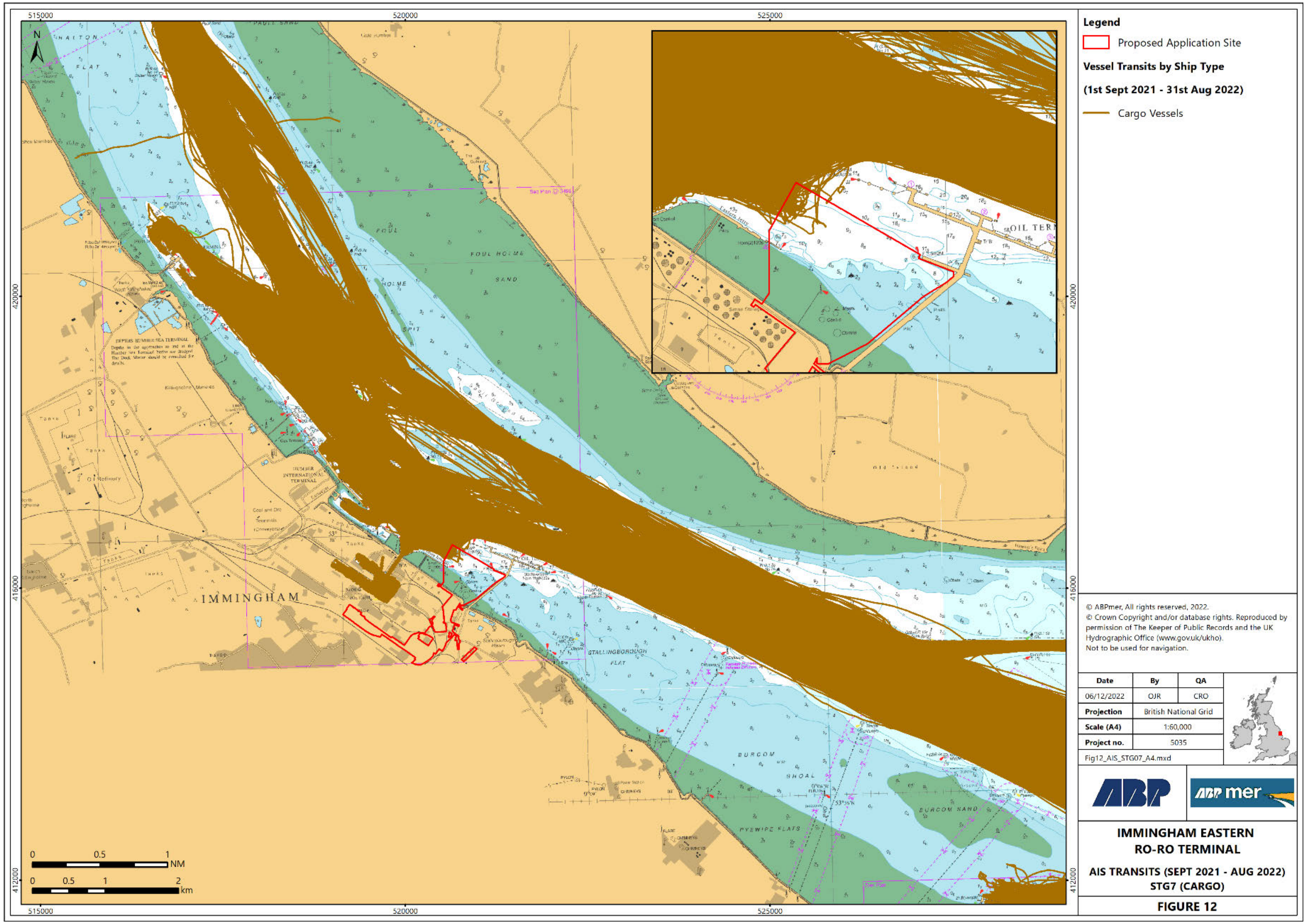

Figure 12 Vessel transits – Cargo

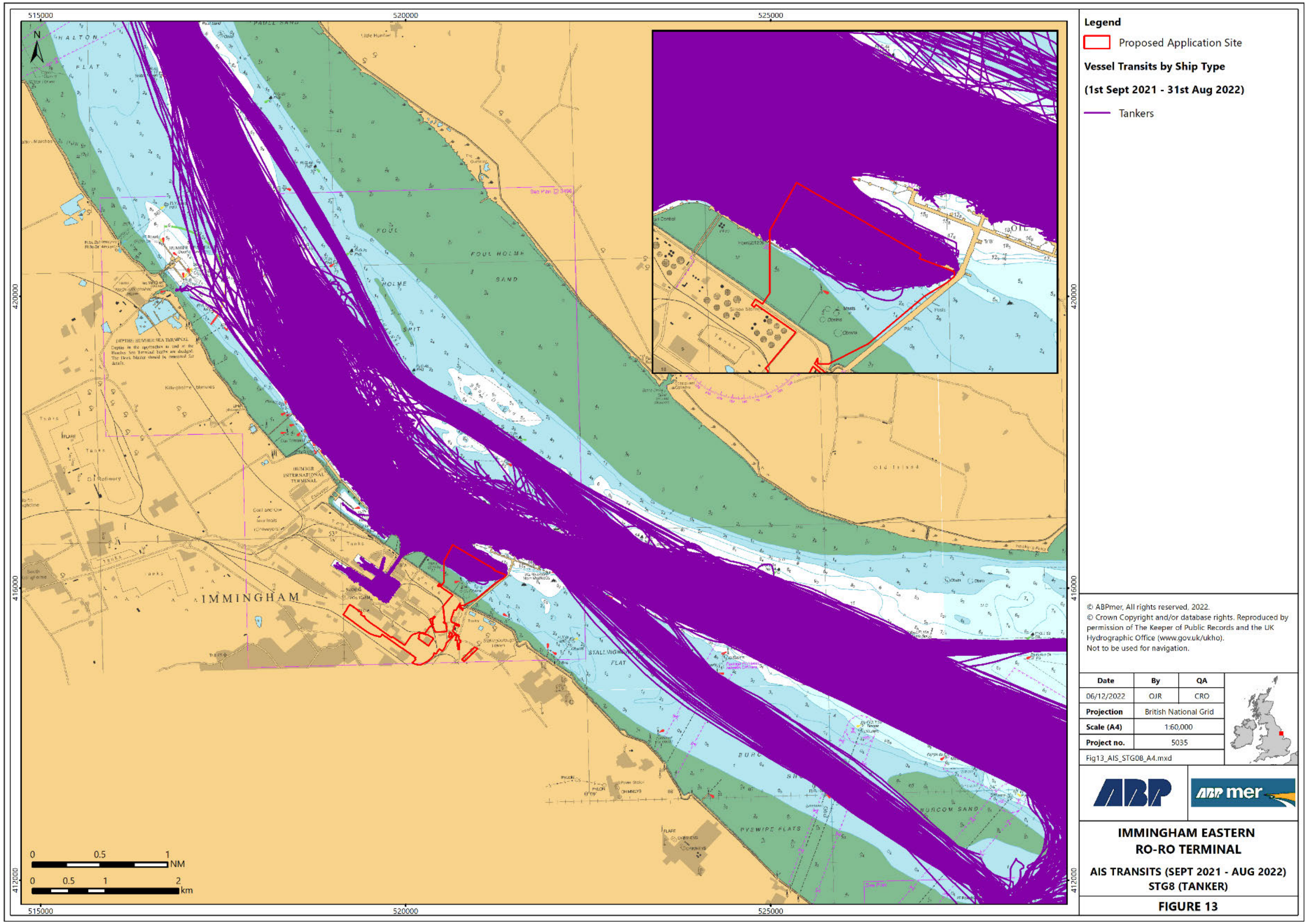

Figure 13 Vessel transits – Tankers

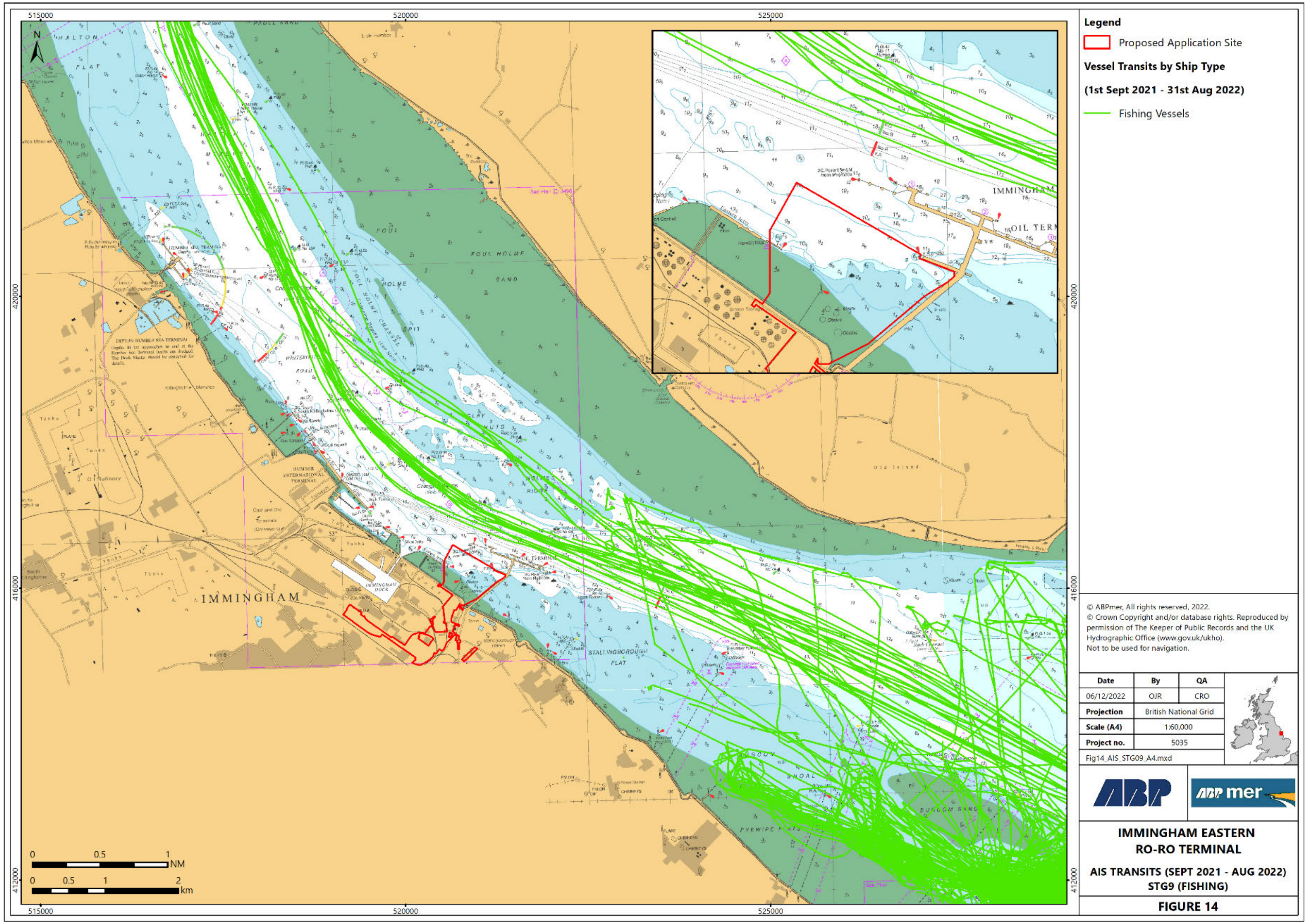

Figure 14 Vessel transits – Fishing

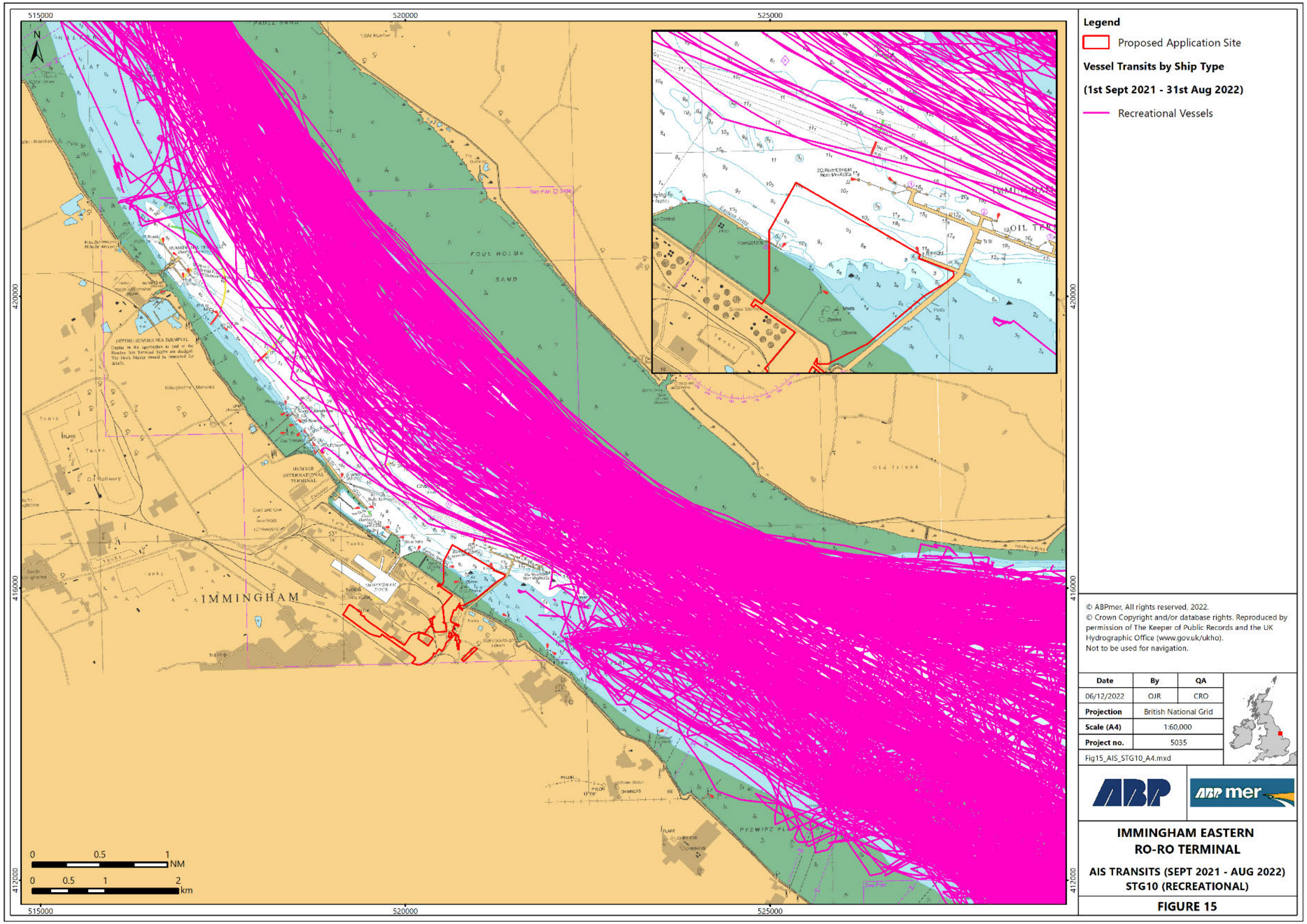

Figure 15 Vessel transits – Recreational

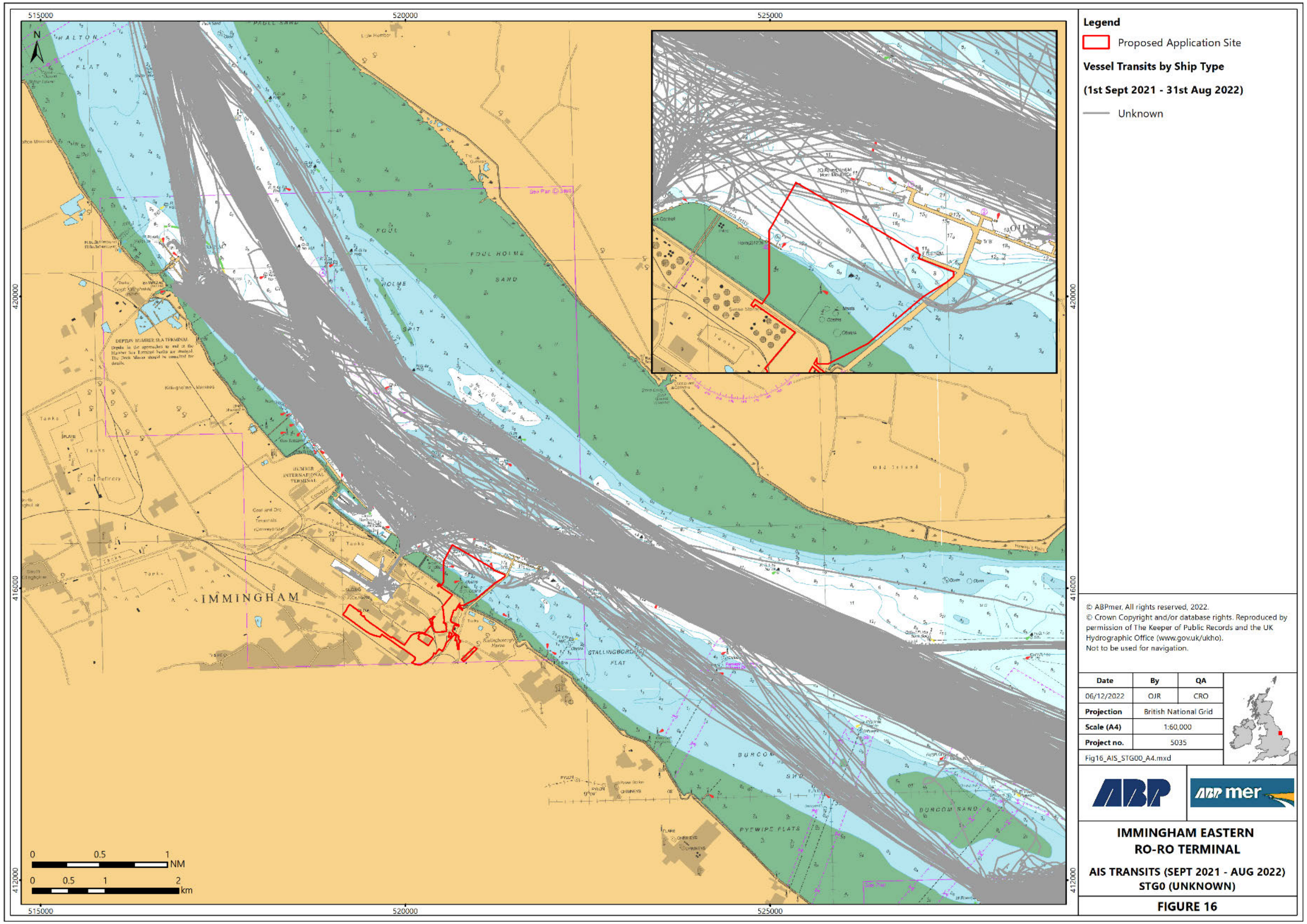

Figure 16 Vessel transits – Unknown

3.7.19 Table 2 shows a count of the AIS transits by vessel type through the study area as per the data provided by Anatec for dates 1 September 2021 to 31 August 2022, which is representative of 365 days of data.

3.7.20 Within the study area, the most prevalent vessel types are:
- Cargo vessels at 41%;
- Tankers at 21%; and
- Port service craft at 20%

3.7.21 All other vessel types each represent 5% or less of the vessel traffic.

Table 2 Transits in the Study area

Vessel Type	Transit Count	Percentage
Non-Port Service Craft	2,063	2%
Port Service Craft	23,697	20%
Dredging or Underwater Operations	4,136	3%
High Speed Craft	6,228	5%
Military or Law Enforcement	74	1%
Passenger	3,480	3%
Cargo	48,593	41%
Tanker	25,100	21%
Fishing	1,078	1%
Recreational	1,282	1%
Unknown	2,851	2%
Total	118,583	100%

3.7.22 Table 3 presents the vessel transits crossing a transect between the western extent of the IOT infrastructure and the eastern extent of the Eastern Jetty, the transect line is shown on Figure 18.

3.7.23 For the area in close proximity to the proposed IERRT marine infrastructure, Table 3 shows that the majority of transits are from tankers with 1,279 movements. Given the location of the transect, it is likely that all of these transits are to/from the IOT Finger Pier. Other notable transits are from port and non-port service craft which are likely to be associated with IOT berthing operations, and the tug berths on the eastern jetty.

Table 3 Transits between IOT and Eastern Jetty

Vessel Type	Transit Count	Percentage
Non-Port Service Craft	175	10%
Port Service Craft	291	16%
Dredging or Underwater Operations	75	4%
Cargo	2	<1%
Tanker	1,279	70%
Unknown	10	<1%
Total	1,832	100.0%

3.7.24 Table 4 gives an indication of the general Humber traffic including vessels that continue past Immingham and up to other ports such as Hull and Goole.

Table 4 Transits between IOT and Stone Creek

Vessel Type	Transit Count	Percentage
Non-Port Service Craft	152	2%
Port Service Craft	4,852	20%
Dredging or Underwater Operations	543	2%
High Speed Craft	270	1%
Military or Law Enforcement	30	<1%
Passenger	1,435	6%
Cargo	12,956	52%
Tanker	3,525	14%
Fishing	18	<1%
Recreational	360	1%
Unknown	565	2%
Total	24,706	100%

DfT vessel counts

3.7.25 The Humber Estuary is one of the busiest waterways in the UK. The estuary handles around 40 thousand commercial shipping movements a year, bound for 27 principal docks, jetties, which include CLdN Killingholme, South Killingholme, and estuary locations including anchorages). The major Humber ports of Hull, Goole, and Grimsby/Immingham account for the majority of cargo handled on the Humber Estuary, namely 9.2 million tonnes, 1.0 million tonnes and 45.6 million tonnes of cargo respectively in 2017 (DfT, 2021).

Recreational navigation

3.7.26 The Humber Estuary has approximately 1,000 permanent berths and 120 visitors' berths for recreational craft. The majority of recreational activity occurs during the summer months and predominantly on the weekend. There are no recreational facilities at the Port of Immingham. Table 2 shows a count of the AIS transits for recreational craft which is *circa* 1% of the traffic total.

3.7.27 Established recreational vessel destinations in the Humber Estuary include Hull Marina which has accommodation for 310 boats and 20 visitors, Goole Boathouse which offers 140 moorings and South Ferriby marina which provides accommodation for 100 boats plus 20 visiting vessels. In addition, there are various creeks around the estuary providing further capacity through anchorages and moorings, including; Tetney Haven (Humber Mouth Yacht Club), Stone Creek, Hessle Haven and, Barrow Haven. Additionally, the yacht havens of Brough and Winteringham (Humber Yawl Club) provide limited mooring for small vessels (HES, 2022).

3.7.28 Figure 15 shows the recreational transits through the area from AIS data. Whilst considering this, it must be noted that a proportion of recreational vessels do not use AIS. Figure 17 presents information from the RYA and provides a density grid of recreational use for the study area.

Traffic density

3.7.29 Vessel traffic density has been mapped for the study area through the use of AIS data. Figure 18 identifies that the density of traffic in the approaches to Immingham (within the main estuary, for vessels transiting to and from sea) reaches 15.1 to 50 transits per week. The most intensely used part of the study area is the lock entrance and passage into Immingham enclosed dock, which demonstrates average density of over 100 transits per week.

3.7.30 Off the IOT main berths, the intensity of vessel transits reaches 15.1 to 50 transits per week. The most significant quantity of vessel traffic closest to the site of the proposed IERRT development is 2 to 5 transits per week, which is associated with vessel movements on and off the IOT Finger Pier and through the Barge Passage.

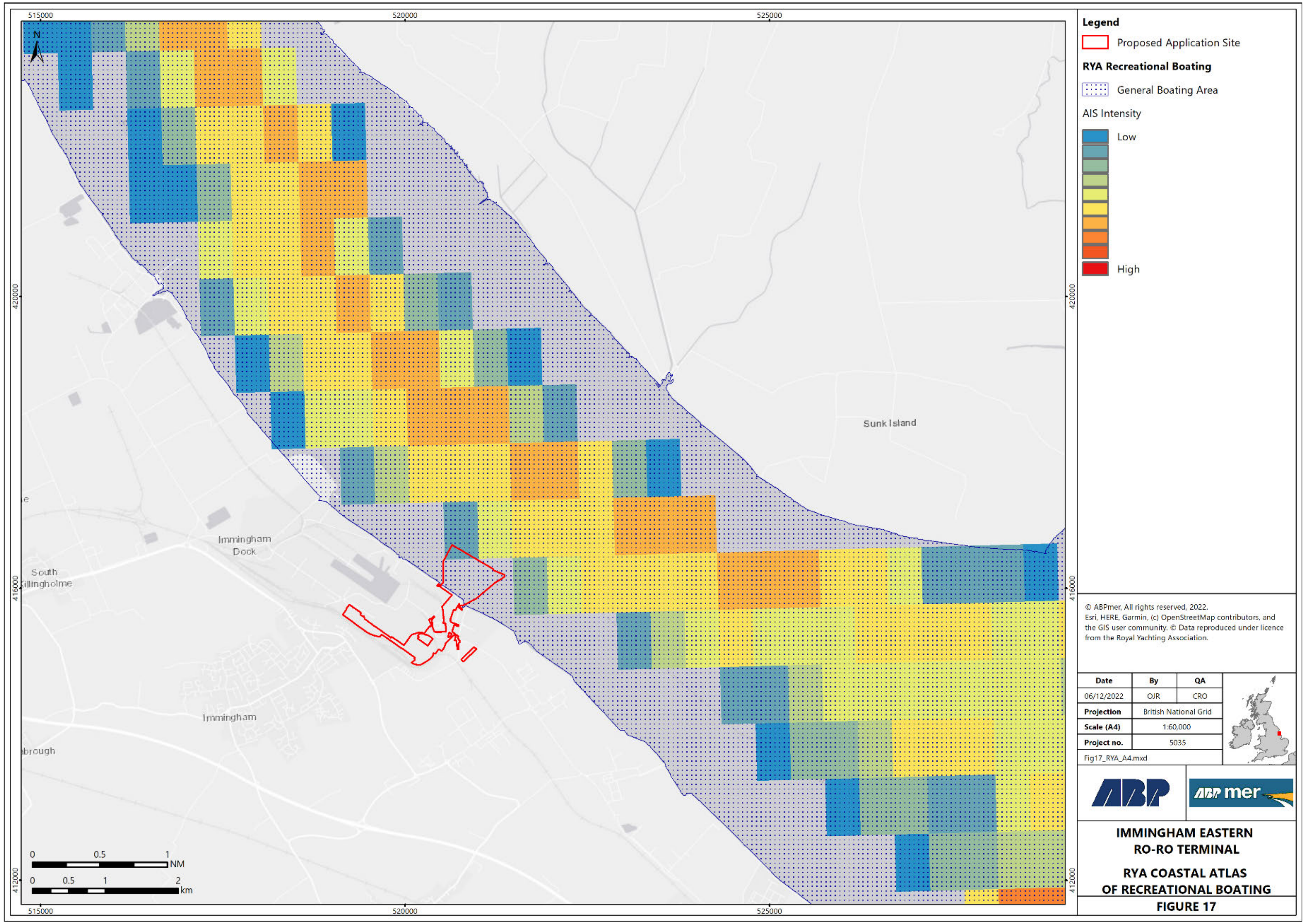

Figure 17 RYA coastal atlas of recreational boating

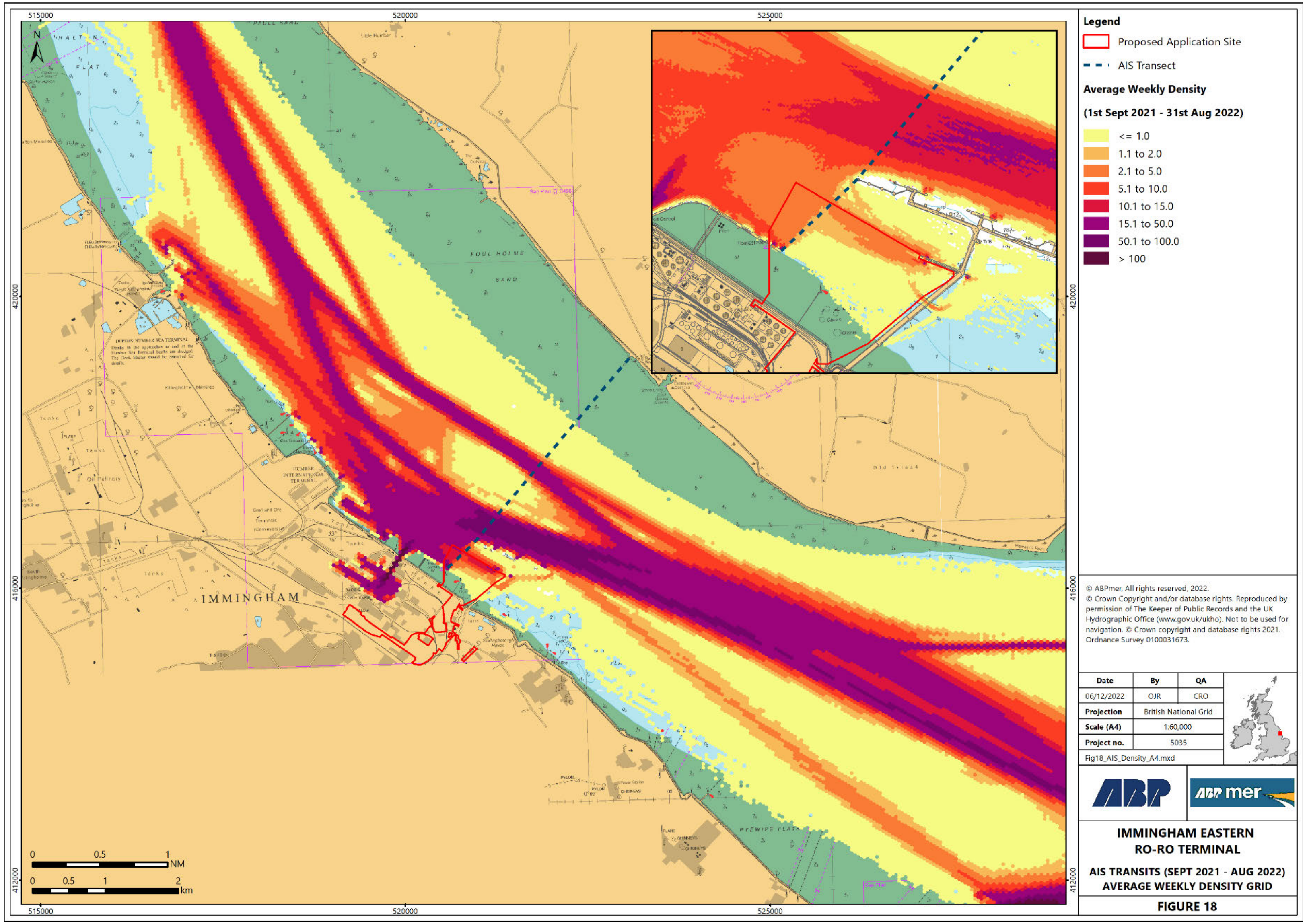

Figure 18 AIS vessel density per week

3.8 Marine accidents and incidents

3.8.1 The MARNIS harbour authority database, the MAIB national dataset and the RNLI national dataset hold the details of all reported marine safety incidents and other occurrences which have potential significance to navigational safety. These datasets have been used to identify accidents/incidents for the whole study area from 2011 and 2020 inclusive. This data is presented in Table 5 – Table 7.

3.8.2 Table 5 which presents MARNIS incident records, indicates that there were 1,834 incidents recorded during the 10 year data period. This equates to an annual frequency of 183.4 incidents across the whole study area. The most frequent incident type was 'Equipment failure (vessel)' with a total frequency of 778. These events are generally reported to Humber VTS by the pilots and PEC holders and relate to any equipment including, navigational equipment and communications.

3.8.3 The next most common accidents/incident category was 'Impact with Structure' which is predominantly reported at dock infrastructure. The majority of these accidents/incidents have minor consequences. These location of MARNIS accident/incident reports are displayed at Figure 19.

3.8.4 Table 6 which presents MAIB incident records identifies that there were 153 incidents reported to the MAIB between 2011 and 2020. This equates to an average annual frequency of 15.3 incidents reported to the MAIB. Ports and vessel operators are required to report certain incidents to the MAIB. These tend to be incidents which are more serious in nature or had the potential to be more serious. Some ports and marine facilities will also choose to report incidents which are not classed as 'MAIB-reportable'. The most frequently reported incident type was 'Impact with Structure' which occurred 59 times over the 10-year period. The next most frequently reported category was 'Equipment failure (vessel)' followed by 'Person in distress' with a total of 28 and 22 reports respectively. There are some incidents which are duplicated across the three datasets. It should be noted that it has not been possible to remove duplicates definitively. This means that the true total incident rates will be less frequent than stated in this report, as some incidents classified as 'MAIB – optional report' have also been reported to the MAIB. For this reason, all datasets have been treated individually within this NRA. The location of MAIB accident/incident reports are shown at Figure 21.

3.8.5 Table 7, which presents RNLI incident records, indicates that there were 70 marine accidents/incidents in the study area during the 10-year period which were attended by the RNLI. It should be noted that none of these incidents occurred within the proposed development area, with only 10 of the records being located within the Port of Immingham's SHA. For the RNLI dataset, the most frequent type of incident was 'Equipment failure (vessel)' and 'Grounding' which both occurred with an annual frequency of 2.2. The following most common accidents/incidents are categorised as 'Other nautical safety'. These accident/incident reports are displayed at Figure 20.

Table 5 MARNIS Accident Incident for the study area 2011 to 2020

Incident Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	%
Collision ship - ship	2	5	3	2	4	3	4	3	5	1	**32**	**1.7**
Equipment failure (port)	3	7	3	10	9	3	16	7	3	3	**64**	**3.5**
Equipment failure (vessel)	52	72	84	84	88	77	132	81	45	63	**778**	**42.4**
Event Management	0	0	0	0	0	0	4	4	1	0	**9**	**0.5**
Fire/Explosion	3	1	3	2	3	2	4	0	0	2	**20**	**1.1**
Grounding	3	0	1	2	5	6	4	6	0	1	**28**	**1.5**
Heaving Lines	0	0	0	0	0	0	0	9	16	9	**34**	**1.9**
Impact with Structure	66	66	77	47	36	30	55	30	22	23	**452**	**24.6**
Other nautical safety	0	0	0	24	23	31	63	43	34	22	**240**	**13.1**
Other nautical safety hazard	11	25	28	0	0	0	0	0	0	0	**64**	**3.5**
Pilot boarding arrangements	0	0	0	0	0	0	0	0	0	1	**1**	**0.1**
Ranging	4	3	5	20	11	14	8	5	2	0	**72**	**3.9**
Sinking and capsizing	0	0	0	0	0	0	0	0	1	0	**1**	**0.1**
Striking with Floating Object	2	1	0	3	1	0	1	0	3	0	**11**	**0.6**
Striking with ship (moored)	3	6	5	4	0	3	4	0	2	1	**28**	**1.5**
Total	**149**	**186**	**209**	**198**	**180**	**169**	**295**	**188**	**134**	**126**	**1,834**	**100.0**

Table 6 MAIB Accident Incident for the study area 2011 to 2020

Incident Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	%
Collision	1	1	1	2	0	2	2	1	3	0	**13**	**8.5**
Equipment failure (vessel)	1	0	3	0	2	4	4	5	1	8	**28**	**18.3**
Fire/Explosion	1	0	1	1	3	0	1	0	1	2	**10**	**6.5**
Grounding	1	1	0	0	2	6	2	2	0	1	**15**	**9.8**
Impact with structure	3	1	3	4	12	9	8	5	6	8	**59**	**38.6**
Other nautical safety	0	0	0	0	0	1	0	0	1	3	**5**	**3.3**
Person in distress	0	1	4	0	1	3	1	3	5	4	**22**	**14.4**
Person(s) in the water	0	0	0	0	0	0	0	0	1	0	**1**	**0.7**
Total	**7**	**4**	**12**	**7**	**20**	**25**	**18**	**16**	**18**	**26**	**153**	**100.0**

Table 7 RNLI Accident Incident for the study area 2011 to 2020

Incident Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	%
Collision	0	0	0	0	0	2	0	0	0	0	**2**	**2.9**
Equipment failure (vessel)	5	1	4	1	2	3	1	1	4	0	**22**	**31.4**
Fire/Explosion	0	1	0	0	0	0	0	0	0	0	**1**	**1.4**
Grounding	3	0	9	4	0	3	1	2	0	0	**22**	**31.4**
Other nautical safety	1	2	0	1	0	1	2	3	5	2	**17**	**24.3**
Person in distress	1	0	0	0	1	0	0	2	0	1	**5**	**7.1**
Person(s) in the water	1	0	0	0	0	0	0	0	0	0	**1**	**1.4**
Total	**11**	**4**	**13**	**6**	**3**	**9**	**4**	**8**	**9**	**3**	**70**	**100.0**

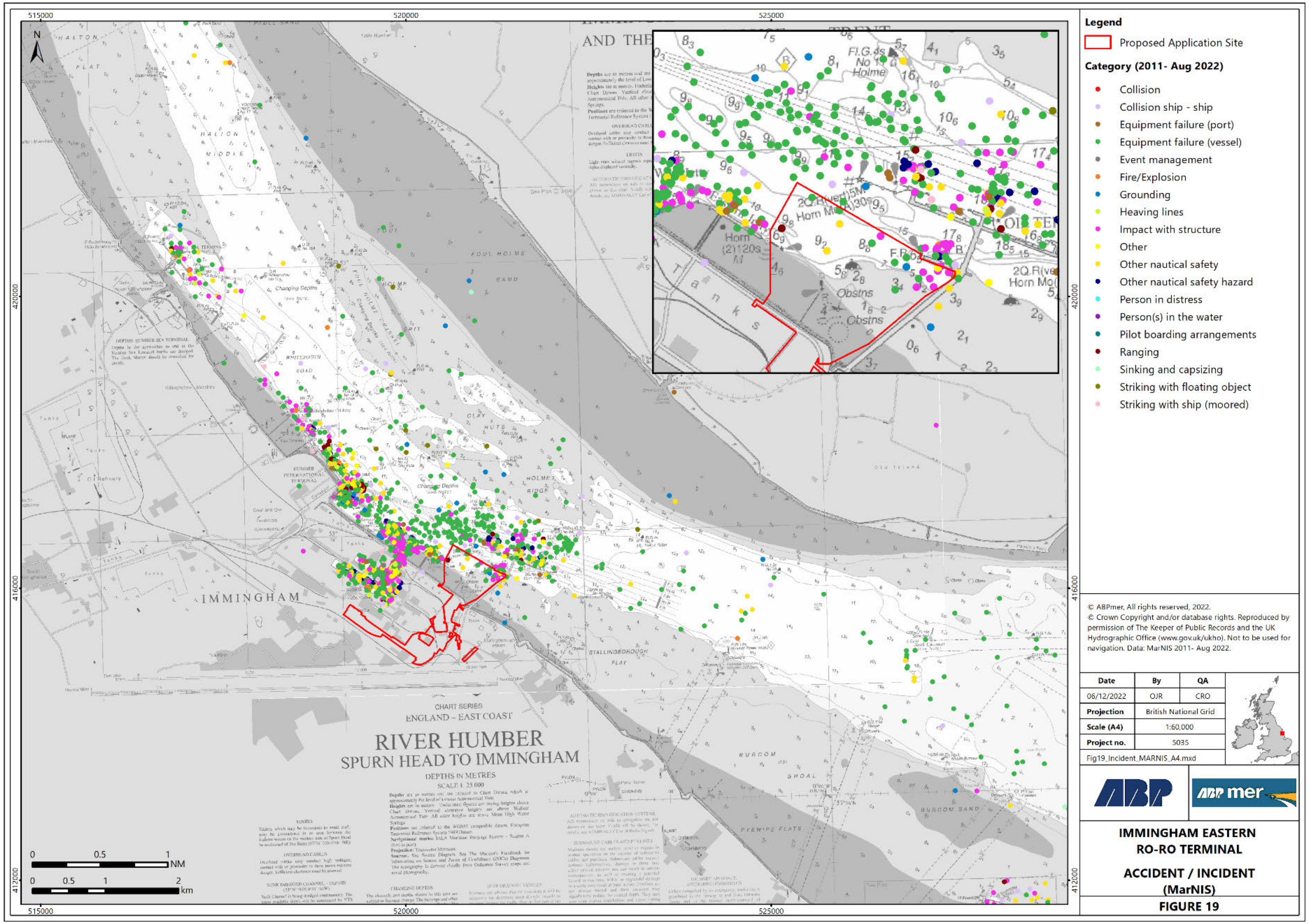

Figure 19 MARNIS accident/incident reports

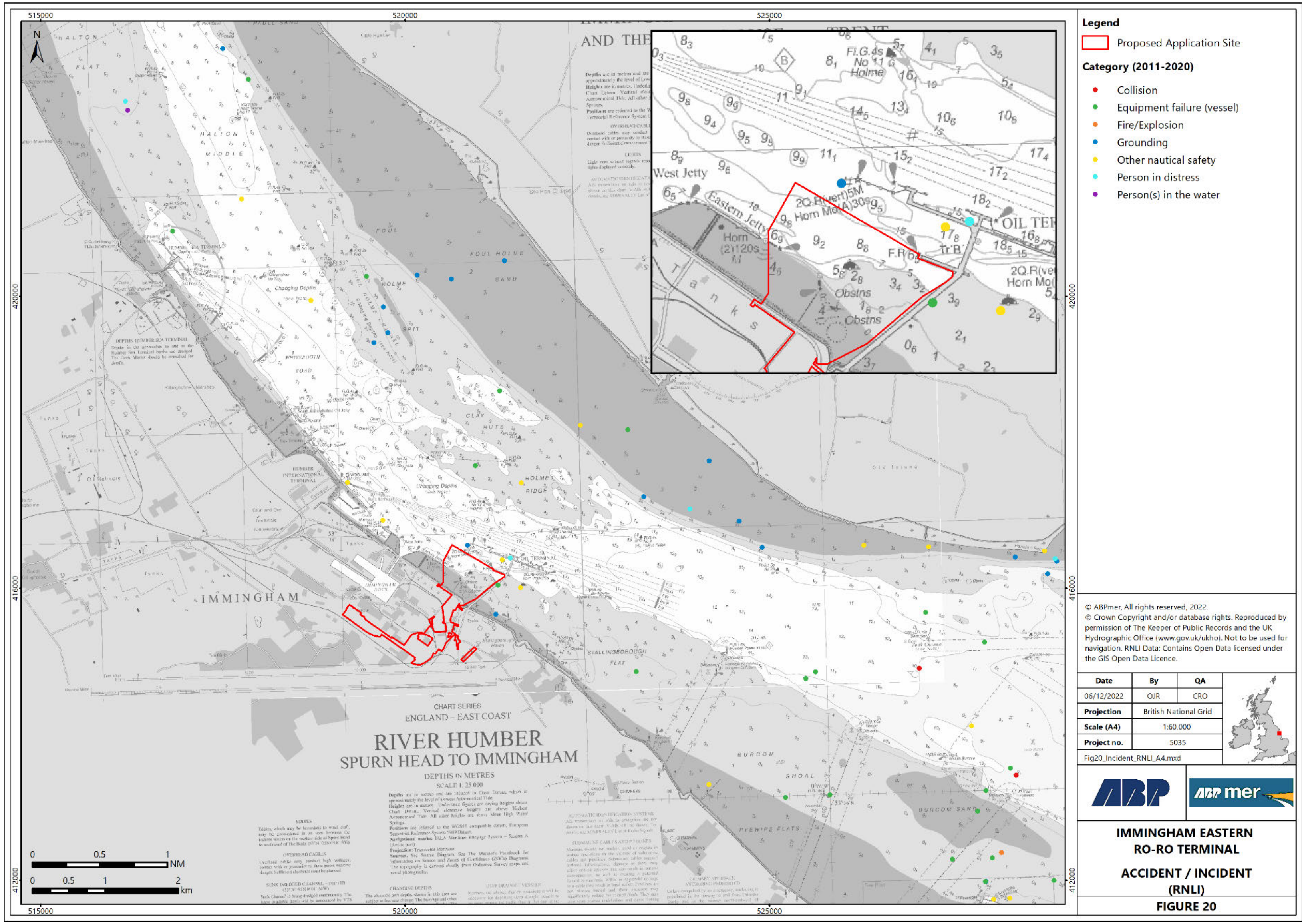

Figure 20 RNLI accident/incident reports

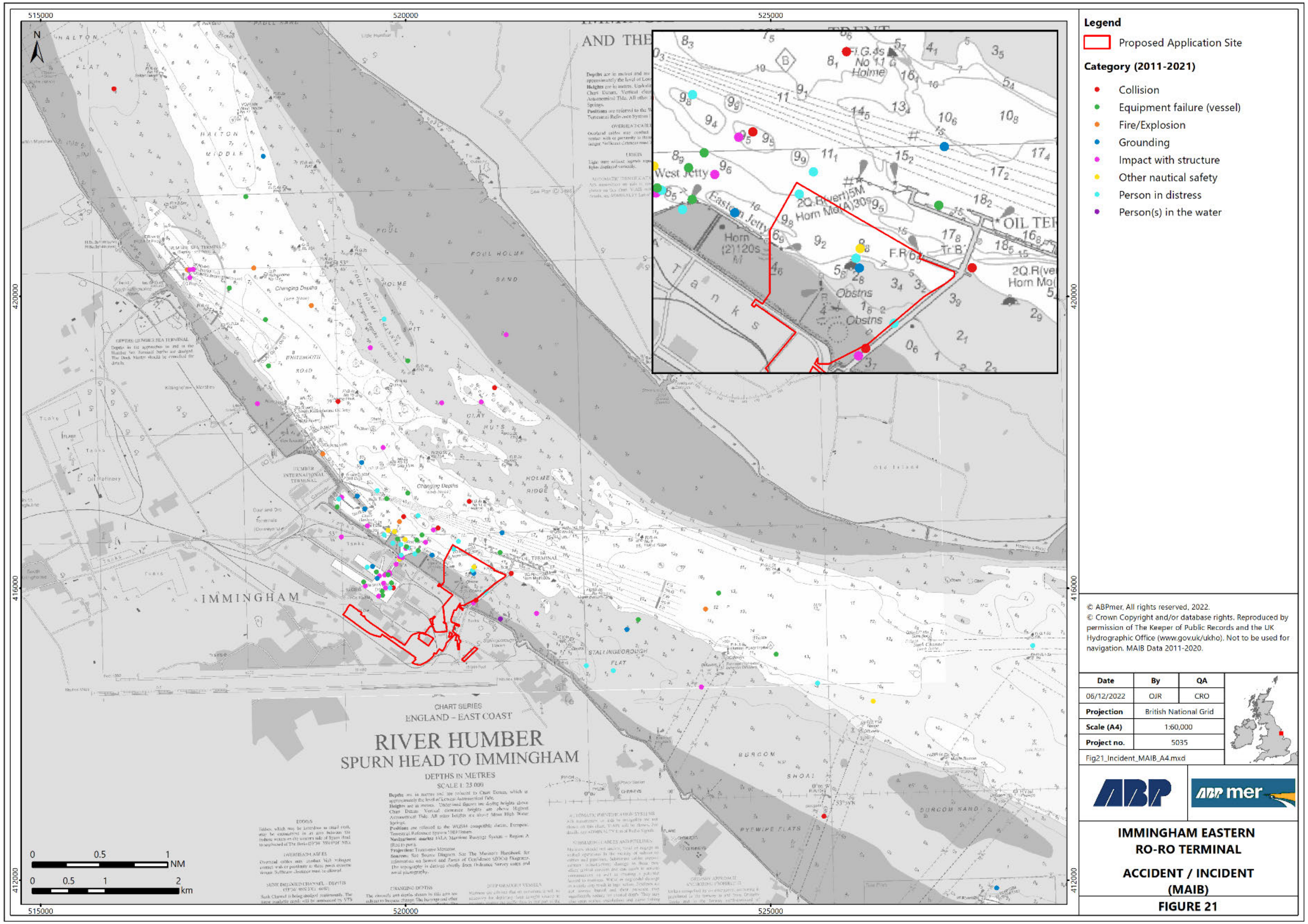

Figure 21 MAIB accident/incident reports

4 Marine Development

4.1 Introduction

4.1.1 The specifications of the marine infrastructure associated with the proposed development, how it will be constructed, and its operational purpose is described in detail in Chapters 2 and 3 of Volume 1 of the ES for the IERRT project (Application Document Reference Number 8.2). This section of the NRA repeats the relevant parts of the description of the marine works associated with the proposed development to assist the reader.

4.2 Marine works

Marine infrastructure

4.2.1 An open piled approach jetty with abutments will be constructed to provide access for vehicles and wheeled cargo between the shore and the berthing infrastructure. The approach jetty will rise from ground level on the landside and cross over the existing sea defence wall and pipelines. It will then extend from the shore across the intertidal area to the pontoons and berthing infrastructure in a roughly north eastern direction. To span the sea defence and pipelines, two abutment structures consisting of six piles each, with a maximum diameter of 1,422 mm, and a short bridge section will be constructed. The approach jetty itself will be approximately 290 m in length, 10 m in width (though wider, approximately 11 m at the positions of the piles), and 12 m above chart datum (CD). The deck will be supported by a maximum of 46 piles with a maximum diameter of 1,422 mm. A series of multi piled and two piled transverse rigid frames and a concrete deck will be used to form the jetty. The spans between each set of piled frames will be around 12.5 m, though this may increase if detailed design reveals that fewer piles can be used.

4.2.2 The jetty will terminate at a bankseat consisting of six piles which will form the foundation for the linkspan bridge – see below. A roadway, a separate footway, utilities including cable management for the shore power systems, power and lighting, and environmental screens to minimise bird disturbance during operation (see the Nature Conservation and Marine Ecology chapter (Chapter 9) of this ES for further details) will be constructed on the surface of the approach jetty.

4.2.3 A linkspan bridge carrying a roadway, a separate footway, lighting, utilities, and environmental screens will be located on the approach jetty's bankseat with its free end resting upon the edge of the innermost floating pontoon. The linkspan will extend in a generally northerly direction acting as a link between the approach jetty and the floating pontoons allowing vehicles and cargo to embark and disembark. The linkspan will be approximately 90 m in length and 10 m wide. Its length has been optimised to ensure that vehicular accessibility from the approach jetty to the berthed Ro-Ro vessels via the two floating pontoons, as noted below, can be maintained at all states of the tide.

4.2.4 wo floating pontoons will be located centrally in relation to a finger pier (see below) so as to be able to receive the loading and unloading ramps of berthed Ro-Ro vessels. Each floating pontoon will be constructed from steel and/or concrete and equipped with lighting, power and a small crew shelter. The area of the pontoons will be approximately 40 m x 90 m. They will be linked together by a short linking bridge approximately 20 m in length. Both will have an overall depth up to 9.35 m and will provide the resting point for the moored vessels' stern ramp and the linkspan bridges. Each pontoon will be secured in place by two reinforced concrete restraint dolphins of approximate dimensions 12 m x 8 m. These will ensure the pontoons can range up and down freely with the tide. The restraint dolphins will each be supported on six piles plus a guiding pile.

4.2.5 Positioned perpendicular to each floating pontoon and extending away in a north westerly direction, two open piled finger piers with concrete decks will be constructed against which the Ro-Ro vessels will berth. Each finger pier will be approximately 270 m in length, 6 m in width (though wider, approximately 13 m at the positions of the piles), and 12 m above CD and will consist of up to 54 piles with a maximum diameter of 1,422 mm. Each pier will include navigation markers, lighting, shore power infrastructure, cable management and connections for berthed vessels and water bunkering facilities.

4.2.6 The northern finger pier will be constructed with berthing faces (lined with fender panels and equipped with mooring infrastructure such as fixed bollards and/or quick-release hooks) on both its northern and southern elevations. The southern finger pier will be constructed with a berthing face to its northern elevation only (it will also be lined with fender panels and equipped with mooring infrastructure such as fixed bollards and/or quick-release hooks). As a consequence, vessels will be able to berth on either side of the northernmost pier (i.e., providing two berths) and one vessel will be able to berth on the northern side of the southernmost pier (i.e., providing one berth) – three berths in total.

4.2.7 The final element of the marine infrastructure is the possible inclusion of vessel impact protection measures to provide protection in the unlikely event of an errant vessel contacting the IOT trunk way. The impact protection structure will be installed, if required, adjacent to the IOT trunk way to the south of the IOT Finger Pier. It will be approximately 160 m in length, consisting of a concrete beam supported by up to 20 piles. The outward face will be provided with fendering units and panels to protect the structure from vessel impacts.

Capital dredging

4.2.8 The proposed development will require a capital dredge of the new berthing area to ensure accessibility and safe mooring for vessels at all states of the tide. The maximum spatial extent of the dredge is estimated at being in the order of 70,000 m², dredged into existing bathymetry which varies across the area between 1.1 m above CD to 9 m below CD. The berthing area will have

1 in 4 side slopes, optimised so as to ensure its stability. It will be dredged to a depth of 9 m below CD, with an allowance for the general tolerances of the dredging equipment. The area beneath the floating pontoons will be dredged to 6 m below CD. The majority of the berth pocket does not require any deepening as it is already below the required depth for the IERRT (i.e., 9 m below CD). Furthermore, over most of the area that does require dredging, only a relatively small amount of deepening is required. Therefore, in real terms the dredge represents a maximum deepening of 6.2 m over a small area, with an average lowering of 2.35 m.

4.2.9 It is estimated that a maximum of 190,000 m³ of material in total will be removed as a result of the dredge. This is estimated to consist of approximately 40,000 m³ of boulder clay, alongside 150,000 m³ of sand/silt (alluvium) *in situ*.

Disposal of dredge material

4.2.10 The dredge material is proposed to be disposed of at sea within licensed disposal sites within the Humber Estuary. The disposal site HU056 (Holme Channel) will be used to dispose of unerodable clay material, and HU060 (Clay Huts) will be used to dispose of sand/silt (alluvium) material. This is based on the proximity of those sites to the proposed IERRT development, and their suitability and capacity to receive the dredged material.

4.3 Construction

Capital dredging

4.3.1 The final capital dredge methodology will be determined in collaboration with the dredging contractor. It is currently anticipated, however, that the majority or all of the material will be removed with a tug assisted backhoe dredger, the size of which will need to be determined by the specialist dredging contractor. Some material may also be removed by trailer suction hopper dredger (TSHD) depending on the sediment conditions and the availability of TSHD dredgers. It is estimated that between two to five split bottom barges will be used for the capital dredging and disposal, although the exact configuration and number of barges will be confirmed by the specialist dredging contractor.

Marine infrastructure

4.3.2 Where sufficient water depth allows, the piling for the marine infrastructure will be from a crane barge or jack up utilising a crawler crane, a vibratory hammer (PVE 38M or equivalent as required) and percussive piling hammer (such as BSP CG300). The piles will be transported to the jetty area by flat top barges and lifted with the barge mounted crane into a piling gate located on the edge of the barge. The piling gate supports the pile during the pile driving process to ensure it maintains position. The vibro hammer will then be placed onto the top of the pile using the crane and the pile will be vibrated through the softer ground layers.

4.3.3 Once the pile has reached the level of refusal and can no longer be advanced through the ground the vibro hammer will be removed and placed on the barge using the crane. The percussive hammer will then be lifted by the crane onto the top of the pile. This percussive hammer will strike the pile head, incrementally advancing the pile into the harder ground levels until final pile toe level is achieved. Where barge access cannot be achieved due to shallow water depths, a land-based crane positioned on completed sections of the jetty will be used. The piling equipment and process will be the same as described above.

4.3.4 Following pile installation, pre-cast pile caps will be added to receive pre-cast concrete boxes which will be lifted and lowered with a crane. The boxes will be filled with in situ concrete to stitch the piles and boxes together. For the piers and approach jetty, once a pair of boxes have cured at each end of a span, pre-stressed pre-cast concrete beams will be placed to span the boxes and stitched together with another *in situ* concrete pour. The concrete will be supplied by either a concrete wagon or an onsite batching facility.

4.3.5 The pontoons and linkspans will be fabricated off-site and floated and craned into place, respectively.

Construction vessels and plant

4.3.6 As noted above, the dredging operation is expected to consist of a tug assisted backhoe dredger and two to five split bottom barges. The exact configuration will be determined by the specialist dredging contractor once appointed. A TSHD might also be deployed depending on plant availability and at the discretion of the dredging contractor.

4.3.7 The piling and construction activities are likely to be undertaken by up to four jack-up/floating crane barges (known as 'marine spreads') supported by up to five flat top barges to supply the marine spreads with piles, precast concrete elements, and other equipment and materials as necessary. The jack-up/floating crane barges and flat top barges will be supported by up to two tugs or multicats in order to service the marine spreads with materials and equipment and to position the jack-ups and floating crane barges in the right location in order to execute the works.

4.3.8 A further dedicated safety vessel will be deployed to patrol the waters adjacent to the barges with a view to being on hand and assisting should any emergencies arise. The multicats/tugs and safety vessel will also act as the crew transfer vessels to take personnel to and from the location of the marine works.

Material delivery

4.3.9 As much of the construction materials as possible will be delivered to site by sea for the marine works. The steel piles and related construction materials will be delivered to a common user berth in the Inner Dock at the Port of Immingham and unloaded onto the quay. Piles and related construction materials will then be loaded onto a barge and transported to the required location within the marine works area. Some marine construction materials will also be delivered to site via road transport.

4.4 Construction-Operation

4.4.1 The construction programme will be taken forward on the basis of one of two principal scenarios. The first scenario – which is the preferred option – is to construct all of the marine and landside infrastructure at the same time. Under this scenario, it is envisaged that construction works will start in early 2024 and will then be complete by mid-2025. Capital dredging works would necessarily be undertaken 24 hours a day, 7 days a week, and would take around 80 days in early to mid-2024. It is estimated that piling works would be undertaken for approximately 24 weeks in total. These would be scheduled to commence in early 2024 on the northern (outer) finger pier.

4.4.2 The second and alternative construction programme scenario would involve a sequenced construction period. Under this scenario, construction of the northern finger pier would commence in early 2024, as well as construction of the North, Central and South Storage Areas. The northern finger pier, with two berths, would then be complete along with the approach jetty and become operational around mid-2025. Following this, and at the same time as operation of the northern finger pier, the innermost southern finger pier (accommodating the third berth) would be constructed at the same time as the construction of the West Storage Area. Under this scenario, the southern finger would be completed in late 2026 when the third berth would become operational.

4.4.3 The timing of the capital dredging works outlined above for the first construction scenario will not be changed under the second scenario as this will still be undertaken in a single stage in early to mid-2024. Under the second scenario piling works for the northern finger pier, approach jetty, and pontoons would be scheduled to be carried out for the approximate 24-week period starting in early 2024, followed by a second approximate 13-week period in mid-2025 to construct the southern finger pier.

4.4.4 Furthermore, piling and construction activities associated with the southernmost pier will not be undertaken at the same time as maintenance dredging and disposal during operation of the northernmost pier (i.e., piling and construction will pause whilst any maintenance dredging and disposal activities are being undertaken).

4.5 Operation

4.5.1 The IERRT will operate 24 hours a day, seven days a week, closing for Christmas Day. It is envisaged that – having regard to the current nature of existing ro-ro activities that occur on the Humber – it will generally be the case that three vessels will be handled at the IERRT per day, one per berth, with the vessels likely to arrive in the morning and depart in the evening.

4.5.2 The berthing facilities have been designed to handle vessels with a length overall (LOA) of 240 m, a breadth of 35 m, and a draught of up to 8 m. Tug vessels will help to manoeuvre vessels onto the berth when required. Ship to shore power will also be made available and used where practicable. This will enable berthed vessels to connect to the port electricity grid allowing them to shut down the onboard power generation units while at berth.

4.5.3 During the operation of the IERRT development, maintenance dredging will be required in the same way as currently occurs elsewhere at the Port of Immingham, and at ports generally. The estimated annual maintenance dredge volume (120,000 m^3) will not be removed in a single maintenance dredge campaign. Maintenance dredge campaigns will be undertaken throughout the year during operation of the IERRT (with smaller volumes of material removed) as required to maintain safe access to the berths. The actual requirements for the level and frequency of potential future maintenance dredging of the Ro-Ro berth will be dependent on a number of commercial factors (including vessel type, size and berthing requirements). Based on the predicted rates of infill from the numerical modelling and the level of maintenance afforded to other berths at the Port of Immingham, it is anticipated that a maintenance dredge campaign within the IERRT berths may be required around three to four times per year (although, as noted above, this will be dependent on a range of factors).

4.5.4 The maintenance dredge arisings will be transported by barge to the Clay Huts (HU060) licensed marine disposal site within the Humber Estuary as per current operations under the existing maintenance dredge licence that exists for the Port of Immingham (L/2014/00429/1).

5 Future Baseline

5.1 Tonnage and vessel numbers

5.1.1 Shipping volumes bear a direct relationship to the global economic market. As markets react to the changing financial situation, shipping lines respond with services to move goods and people. The future growth and development of ports and shipping on a global scale level is inherently linked to trade patterns and the economic climate and is reactive to changing economic circumstances. Economic growth and increases in world trade results in higher levels of shipping and growth of port operations. Conversely, economic slowdown and recession result in lower levels of global trade and of shipping. Ultimately, economy is a function of people and as global and local populations continue to rise, the economy is expected to grow to facilitate this.

5.1.2 The timeframe for the future baseline has been set at at 50 years although the IERRT infrastructure will in fact continue to be used beyond the engineering design standard of 50 years. In practical reality, the IERRT marine infrastructure will become an integral part of the port's infrastructure, being maintained and renewed over the ensuing years as appropriate and as is already the case with similar infrastructure within the Port.

5.1.3 In establishing a future baseline for this timeframe, however, global and local contexts have had to have been taken into account so as to be able to anticipate changes caused for example, in shipping trends or by estuary constraints etc. Thus, potential changes in shipping can be assessed by reviewing vessel trends at ports on the Humber and then placing the resulting data in the context of national shipping trends. The final stage is then to review the data results in the wider context of the global change in the economy by considering population change both locally and internationally. The future baseline can also be anticipated by considering if any local (estuary) geomorphological constraints prevent maximum vessel size increasing above a certain threshold.

5.1.4 Table 8 reflects changes that have occurred over the past 50 years in a local context. It indicates that the peak of maritime trade on the Humber Estuary was in 2019 with a total of 78.3 million tonnes. This is over double (2.36 times) the freight tonnage movements that were recorded in 1970. This increase in trade rate closely correlates with the increase in global population over this time from 3.7 billion to 7.8 billion at a rate of 2.1 times.

5.1.5 The data in Table 9 demonstrates all UK port freight in ten-year increments and as annual statistics since 2016. The trend seen is a far more gradual increase in trade for the whole of the UK. Furthermore, this data suggests that the national peak for trade via shipping was some 15-20 years earlier than the historic peak experienced on the Humber Estuary as displayed in Table 8. It should also be noted that Northern Ireland data was incorporated from 1980, however from 2017, a change in the coverage of smaller ports was made (i.e. smaller port reporting now not included) reducing the total observed in this data set.

5.1.6 considers the change in the number of ship arrivals at principal ports in the Humber Estuary since 1995. The data in this table shows a peak occurring around the mid-2010s reducing slightly prior to the change of coverage observed in 2017. Of particular interest is the data for Grimsby and Immingham, which shows that over the past 27 years the highest number of vessel arrivals in a calendar year was just under 9,000 recorded in 2015.

5.1.7 Table 11 considers 10 years of annually occurring data for Tankers and Ro-Ro vessels arrivals at UK ports.

5.1.8 Table 8 shows a relatively stable tonnage level between 2010 and 2020 with values ranging between 76 to 78 million tonnes (with the exception of 2020, which was affected by COVID impacts, but still recorded 72 million tonnes). Table 11 identifies over the same time period, a reducing trend in vessel numbers from 11,467 in 2010 to 9,522 in 2020. This is a 17% decrease in shipping arrivals over the past 10 years, compared to a relatively stable tonnage volume. This indicates that vessels must be transporting more tonnage per vessel move, which can be assumed to be an increase in carrying efficiency and/or an increase in vessel size. This suggests that less frequent but larger vessels are becoming more commonplace as time goes on which tracks with other international shipping indicators.

5.1.9 Table 9 shows a similar trend, with tonnage level gradually reducing from 573 million tonnes in 2010 to 439 million tonnes in 2020. Table 11 identifies over the same time period, a reducing trend in vessel numbers from 144,206 in 2010 to 99,684 in 2020. This is a 31% decrease in Tanker and Ro-Ro traffic in the past 10 years, compared to a 23.4% decrease in tonnage handled by UK ports.

5.1.10 In considering these tables and their most recent data, a number of geopolitical and international considerations must be taken into account, most particularly, the impacts of the COVID-19 pandemic and the European Union transition period. If tonnage handled by the Humber Estuary remains relatively stable, as it has over the last 10 years, with ship size increasing gradually, it is likely that vessel movement totals will continue gradually to reduce. That said, the physical features of the Estuary may limit further ship size increase and it is suggested that vessel totals will plateau (if tonnages remain at current levels).

Table 8 Humber Estuary freight tonnage (millions of) traffic by port

Ports	Ten Yearly					Annual				
	1970	1980	1990	2000	2010	2016	2017	2018	2019	2020
Goole	2.2	1.4	1.7	2.7	1.9	1.4	1.4	1.5	1.2	1
Grimsby and Immingham	23.7	22.2	39.4	52.5	54	54.4	54	55.6	51.2	45.6
Hull	7.2	3.8	6.8	10.7	9.2	10.2	9.8	9.8	9.2	9.2
River Trent	0	2.3	3.2	2.5	1.4	1.3	1.1	1.1	1,0	1
Rivers Hull and Humber	0	4.1	7.6	9	10	10.2	9.9	10.1	10.7	10.5
Dutch River Wharf	0	0	0	0.01	0	0	0	0	0	0
River Ouse	0	0.5	1	0.3	0.2	0.2	0.2	0.2	0.1	0.1
Total Tonnage	**33.1**	**34.3**	**34.3**	**59.7**	**77.7**	**76.7**	**77.7**	**76.4**	**78.3**	**72.4**

Source: Port and domestic waterborne freight statistics. (DfT, 2021)

Table 9 All UK port freight tonnage (millions of) traffic by direction

Direction	Ten Yearly					Annual				
	1970	1980	1990	2000	2010	2016	2017	2018	2019	2020
Inwards	257	223	278	316	313	303	301	310	312	279
Outwards	113	201	214	257	199	181	181	173	170	160
All	**370**	**424**	**492**	**573**	**512**	**484**	**482**	**483**	**482**	**439**

Table 10 Humber Estuary major port ship arrivals

Ports	Five Yearly					Annual				
	1995*	2000	2005	2010	2015	2016	2017	2018	2019	2020
Goole	1,317	1,342	1,282	932	655	717	718	725	617	533
Grimsby and Immingham	6,949	7,030	8,720	7,923	8,959	8,548	7,912	7,197	7,126	6,511
Hull	4,379	3,821	3,632	2,612	2,719	2,568	2,760	3,217	3,081	2,478
Total	**12,645**	**12,193**	**13,634**	**11,467**	**12,333**	**11,833**	**11,390**	**11,139**	**10,824**	**9,522**
* Earliest year available in the data record										

Source: Port and domestic waterborne freight statistics. (DfT, 2021)

Table 11 UK Port arrivals by vessel type

Type	2010	2013	2014	2015	2016	2017	2017	2018	2019	2020
Tankers	21,192	19,216	17,501	18,838	18,060	16,914	15,403	15,448	15,031	12,950
Ro-Ro	70,096	63,065	64,019	64,029	62,307	61,572	57,842	57,792	57,231	47,829
Total	**144,206**	**138,331**	**141,435**	**140,339**	**136,217**	**134,123**	**120,637**	**120,445**	**117,518**	**99,684**

Source: Port and domestic waterborne freight statistics. (DfT, 2021)

5.2 Future baseline without scheme

5.2.1 The global population is modelled to increase from 7.95 billion in 2022 to 10.5 billion in 2072 based on the current average cumulative population increase of ~1-2% per annum. This growth is considerably less than the growth seen in the past 50 years (~2.1%) and as result global economies are not expected to grow by the same factor as they did in the latter half of the 20th century (DfT, 2021). It is reasonable to assume that a growth in the economy will likely lead to a greater tonnage of freight moving through the Humber Estuary. A conservative metric for determining a potential future baseline has been adopted by projecting from 2019 at 1% cumulative growth in tonnage as shown in Table 12.

Table 12 Future baseline for 1% Growth

Year	Grimsby and Immingham Tonnage (mil)	UK Total Tonnage (mil)	Grimsby and Immingham arrivals
2019	51.2	482.0	7,126
2022	52.8	496.6	7,342
2030	57.2	537.8	7,950
2040	63.2	594.0	8,782
2050	69.8	656.2	9,701
2060	77.1	724.8	10,716
2070	85.1	800.6	11,837
2072	86.8	816.7	12,075

5.2.2 Establishing a future baseline requires assumptions to be made. Alternative methods could include extrapolating the existing data or utilising an accepted economic change value such as a long-term government bond. In this instance the recent effects of leaving the European Union and the COVID-19 pandemic have provided a system-wide affect.

5.3 IERRT scheme traffic

5.3.1 Once operational, the IERRT development will lead to increased vessel traffic during both the construction phase and the operation phase of the development.

5.3.2 The construction of the marine infrastructure will generate marine works traffic for a period of approximately one and half years (for single stage construction) or approximately three years (for a sequenced construction scenario). This marine traffic will include work boats, barges, tugs, and other works craft. It is estimated that for the capital works, up to 5 split bottom barges will be used to transport material to the disposal site. During the construction phase, up to four floating jack-up barges with associated small tugs will be used. In addition, a safe/crew transfer vessel will be present throughout. Other than the transit of vessels to/from the site, the construction activity for the marine works will be contained within the IERRT redline application boundary.

5.3.3 The operational phase will see an increase in Ro-Ro vessel arrivals for this location on the Humber of three vessels a day. Two of these vessels however, already utilise other port facilities on the Humber Estuary on a daily basis. – meaning daily, an additional six vessel movements. This equates to a total of 2,190 additional movements per year. In addition, these vessels may on occasion require tugs (at an estimate of two tugs for a vessel using the outer finger berth, representing four additional tug movements per day) or 1,460 additional movements per year. There will also be an increase in line handling/mooring vessels as required.

5.3.4 In addition, based on estimated volumes of material from maintenance dredging, an estimated total annual maintenance dredge volume of 120,000 m^3, with an assumed split over 4 dredge campaigns, gives four volumes of 30,000 m^3 annually. Each campaign will require 32 hopper loads, giving a total dredge time per campaign of 144 hours total. Within this period, dredger and hopper would be moored on site for 4 hours, then the hopper would transit to and from the disposal site over 0.5 hours, with the cycle repeating until the end. In terms of vessel movements, for one campaign, 32 hopper loads equate to 64 movements, an additional increase of 256 movements per year.

5.3.5 Table 2 details the transits in the study area, with data from 01 September 2021 to 31 August 2022, which is representative of 365 days of data. From this table, 118,583 transits are recorded passing a transect line from the IOT to Stone Creek (a line across the estuary used to gauge vessel transits). Taking this as the baseline for annual vessel movements, the future with the IERRT scheme operational has been assessed in terms of percentage increase. This is presented in Table 13 and represents a total increase of 3.3%. This is within the capacity of the Humber Estuary as demonstrated by previous peaks noted in Table 10 above.

Table 13 Future baseline with scheme

Future baseline			
Dredger	**Ro-Ro**	**Tug**	**Total**
Additional Annual Transits			
256	2,190	1,460	3,906
Percentage increase over the baseline (118,583: measured 01 September 2021 to 31 August 2022)			
0.22	1.85	1.23	3.29

6 NRA Methodology

6.1 Introduction

6.1.1 The International Maritime Organization (IMO) Guidelines for Formal Safety Assessment (FSA) for the use in the IMO rule making process defines a hazard as: *"A potential to threaten human life, health, property or the environment"*, (IMO, 2018). This statement identifies the potential event that has an undesirable outcome on four defined receptors. The potential for a hazard to be realised can be combined with an estimated (or known) consequence and frequency. This combination is termed 'risk'. Risk is a measure of the frequency and consequence of a particular hazard. The methodology applied within this NRA evaluates and records the risk by utilising a matrix approach using the four receptors of people, planet (i.e., environment), port (i.e., business and reputation), and property (i.e., damages).

6.1.2 This NRA has been undertaken to determine the risk to marine and navigation associated with the proposed development (as described in Section 4). To do so, the potential hazards of the proposed IERRT development have been assessed in the context of the potential impacts that may arise during:

- Construction: construction of the southern and northern finger piers, including capital dredging and installation of infrastructure;
- Construction and Operation: construction of the southern finger pier whilst operating the northern finger (with two berths); and
- Operation: change to the study area's vessel movements including any maintenance dredging.

6.1.3 The methodology applied for carrying out this NRA follows and complies with the guidance from the PMSC 'A Guide to Good Practice on Port Marine Operations' (DfT, 2018). Additionally, considerations from MGN 654, Annex 1 'Methodology for assessing marine navigational safety and emergency response risks of OREIs' (MCA, 2021) and the underpinning IMO FSA (IMO, 2018) have been taken into account for guidance on the hazard categorisation and analysis stages. The following identifies the steps required for carrying out marine hazard identification and the risk analysis process:

1. Identification of hazard (listing of potential marine hazard scenarios, describing hazard descriptions and outcomes).
2. Risk analysis (determination of frequency and consequence for each hazard scenario).
3. Risk assessment and control options (consideration of existing (embedded) mitigation measures, which either reduce the outcome frequency or control the severity or both; and potential risk controls, which are not currently in place, but could be used to further reduce or eliminate risk).
4. Cost-benefit assessment (an evaluation of the time, cost, and physical difficulty of taking the measures identified to avoid or reduce the risk).

5. Recommendations for decision-making (final decisions in determining risk made by the Duty Holder).

6.1.4 The following sections identify the outcome from the above steps, carried out within this NRA. Section 9 describes and expands on the discussion of the Hazard Logs (Annexes 0, B, and C) which forms the interpretation of the NRA.

6.2 Stage 1: Hazard identification

6.2.1 When considering the introduction of new, or alterations to, port infrastructure, a collective process is required to identify new or altered hazards created by new trade or by the changes likely to arise in connection with marine operations. An incident may occur if new or altered port infrastructure and its associated trade has not been evaluated and all risks managed as far as reasonably practicable.

6.2.2 ABP, as the Harbour Authority, manages changes to port development and the introduction of new trade through risk-based evaluation and established risk controls, with the application of appropriate additional risk mitigation measures in accordance with the PMSC (DfT, 2016) and the GtGP (DfT, 2018). This forms the basis of the risk assessment methodology.

6.2.3 Within the process of hazard identification and risk assessment, ABP take fully into account the relationships between the Statutory harbour Authority, the port authority, terminal operators, and relevant vessel operators. The GtGP recommends that: *“structured meetings need to be held during this process involving relevant marine practitioners at all levels”,* (DfT, 2018). Port users need to be invited to take part in these meetings, including groups such as Pilots and Pilotage Exemption Certificate (PEC) holders, commercial operators, tug operators, crew and other regulators and agencies. This stage of the process is termed the ‘Hazard Identification’ (HAZID) and may take the form of one or more sequenced meetings. Broad hazard categories are used to group different hazard scenarios. These hazard categories are taken from Annex H of MGN 654 ‘Methodology for Assessing the Marine Navigational Safety and Emergency Response Risks of Offshore Renewable Energy Installations’ (MCA, 2021) and are reproduced in Table 14 below.

6.2.4 In the case of this NRA exercise, the identified hazard categories have been considered and those not applicable to the development have been scoped out with the rationale for doing so explained (Table 19). Hence, only scoped in categories have been taken forward to the NRA.

6.2.5 The use of expert judgment is an important aspect of the HAZID. In applying expert judgment, different experts may be involved in a particular NRA. It is unlikely that the experts' opinions will be in agreement. It might even be the case that the experts have strong disagreements on specific issues. However, it is the goal of each HAZID to reach a position of consensus. If this is not possible, the degree to which opinions differ needs to be considered.

6.2.6 This stage also highlights the potential outcomes and consequences if each of the identified hazards were to occur. This process follows the GtGP as a useful way to consider hazard scenarios the 'most likely' and the 'worst credible' outcomes.

6.2.7 The GtGP states: *"This approach provides a more realistic and thorough assessment of risk, which reflects reality, in that relatively very few incidents result in the worst credible outcome. On a 5 x 5 risk matrix used by many organisations, these incidents score highly for consequence, but this is tempered by a low score on the frequency axis"*, (DfT, 2018).

6.2.8 The output of this stage is the initial listing for a Hazard Log, listing hazards caused or changed by new or altered port infrastructure.

Table 14 Hazard category definitions as defined in Annex H of MGN 654

Category	Description
Accidents to personnel	Accidents to personnel are defined as those accidents which cause harm to any person on board the vessel e.g. crew, passengers, stevedores, who do not arise as a result of one of the other accident categories. Essentially, it refers to accidents to individuals, though this does not preclude multiple human casualties as a result of the same hazard, and typically includes harm caused by the movement of the vessel when underway, slips, trips, falls, electrocution, confined space accidents, food poisoning incidents, etc.
Accidents to the general public	Accidents to the general public are defined as those accidents which lead to injury, death, or loss of property amongst the population ashore resulting from one of the other ship accident categories.
Allision	Defined as a violent contact between a vessel and a fixed structure.
Capsizing	The overturning of a vessel after attaining negative stability.
Collision	Collision is defined as a vessel striking, or being struck by, another vessel, regardless of whether either vessel is under way, anchored or moored; but excludes hitting underwater wrecks.
Contact	Contact is defined as a vessel striking, or being struck by, an external object that is not another vessel or the sea bottom. Sometimes referred to as impact.
Explosion	An explosion is defined as an uncontrolled release of energy which causes a pressure discontinuity or blast wave.
Fire	Fire is defined as the uncontrolled process of combustion characterised by heat or smoke or flame or any combination of these.
Flooding	Flooding is defined as sea water, or water ballast, entering a space, from which it should be excluded, in such a quantity that there is a possibility of loss of stability leading to capsizing or sinking of the vessel.
Foundering	To sink below the surface of the water.

Category	Description
Grounding	Grounding is defined as the ship coming to rest on, or riding across underwater features or objects, but where the vessel can be freed from the obstruction by lightening and/or assistance from another vessel (e.g. tug) or by floating off on the next tide.
Hazardous substance accidents	Hazardous substance accidents are defined as any substance which - if generated as a result of a fire, accidental release, human error, failure of process equipment, loss of containment, or overheating of electrical equipment - can cause impairment of the health and/or functioning of people or damage to the vessel. These materials may be toxic or flammable gases, vapours, liquids, dusts, or solid substances.
Loss of hull integrity	Loss of Hull Integrity is defined as the consequence of certain initiating events that result in damage to the external hull, or to internal structure and sub-division, such that any compartment or space within the hull is opened to the sea or to any other compartment or space.
Machinery related accidents	Machinery related accidents are defined as any failure of equipment, plant and associated systems which prevents, or could prevent if circumstances dictate, the ship from manoeuvring or being propelled or controlling its stability.
Payload related accidents	Payload related accidents include loss of stability due to cargo shifting and damage to the vessel's structure resulting from the method employed for loading or discharging the cargo. This category does not include incidents which can be categorised as Hazardous Substances, Fires, Explosions, Loss of Hull Integrity, Flooding accidents etc.
Stranding	Stranding is defined as being a greater hazard than grounding and is defined as the ship becoming fixed on an underwater feature or object such that the vessel cannot readily be moved by lightening, floating off, or with assistance from other vessels (e.g. tugs).

6.3 Stage 2: Risk analysis

6.3.1 The GtGP states that: *"Hazards need to be prioritised. A method which combines an assessment of the likelihood of a hazardous incident and its potential consequences should be used. This is likely to be a matter of judgement best taken by those with professional responsibility for managing the harbour*", (DfT, 2018).

6.3.2 Subject matter experts and local port users in attendance at the HAZID workshop(s) contribute to the formation of the hazard scenario with descriptive and tailored 'worst credible' and 'most likely' events which are then assessed against four receptors, namely:

- People (human life/personal injury);
- Planet (environment);
- Port (reputation/business/amenity loss); and
- Property (port and shipping infrastructure damage).

6.3.3 Risk ranking is determined through a count culmination of outcome categories in a risk tally ranking system. For each hazard scenario eight outcomes are determined. This is comprised of four outcomes from the 'worst credible' description and four outcomes from the 'most likely' description for each receptor. These outcomes are identified from the frequency and consequence criteria and determined by attendees at the HAZID. The outcome categories are assigned through the matrix shown in Figure 23 and these categories are used to calculate risk as above. Figure 22 shows the discussion flow per hazard scenario used in the NRA process.

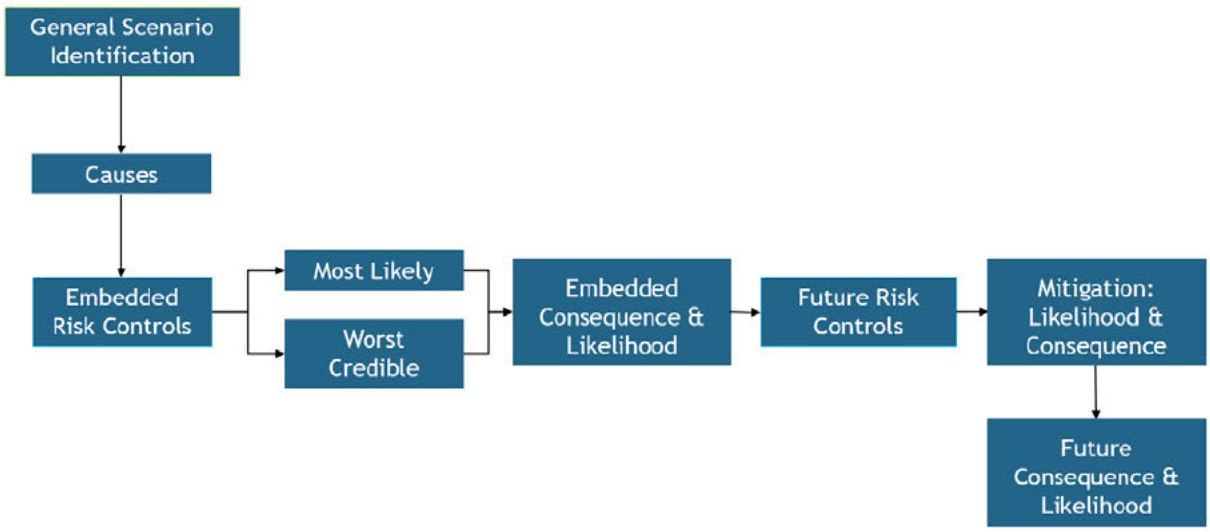

Figure 22 HAZID Discussion Flow chart

Consequence descriptors

6.3.4 The consequence descriptors (as defined within ABP's Marine Safety Management System's consequence categories) are used to inform the assignment of values to the hazard scenarios within the Hazard Log. The associated descriptions detailed below in Table 15 to ensure that outcomes are applied consistently in contemplation of the severity of the consequence should it actually occur.

Table 15 Consequence Descriptors

Descriptor	Consequence
Consequence Descriptors: People	
No injury	Negligible (1)
Minor injury(s)	Minor (2)
Serious injury(s) (MAIB/RIDDOR reportable injury)	Moderate (3)
Single fatality	Major (4)
Multiple fatalities	Extreme (5)
Consequence Descriptors: Property	
Negligible (£0 - £10,000)	Negligible (1)
Minor (£10,000 - £750,000)	Minor (2)
Moderate (£750,000 - £4M)	Moderate (3)
Serious (£4M - £8M)	Major (4)

Descriptor	Consequence
Major (> £8M)	Extreme (5)
Consequence Descriptors: Planet	
None (No incident - or a potential incident/near miss)	Negligible (1)
No Measurable Impact (An incident or event occurred, but no discernible environmental impact - Tier 1 but no pollution control measures needed)	Minor (2)
Minor (Incident results in pollution with limited/local impact - Tier 1, Harbour Authority pollution control measures deployed)	Moderate (3)
Significant (Has the potential to cause significant damage and impact - Tier 2, pollution control measures from external organisations required)	Major (4)
Major (Potential to cause catastrophic and/or widespread damage - Tier 3, requires major external assistance)	Extreme (5)
Consequence Descriptors: Port	
None	Negligible (1)
Minor (Little local publicity. Minor damage to reputation. Minor loss of revenue, £0 - £750,000)	Minor (2)
Moderate (Negative local publicity. Moderate damage to reputation. Moderate loss of revenue, £750,000 - £4M)	Moderate (3)
Serious (Negative national publicity. Serious damage to reputation. Serious loss of revenue, £4M - £8M)	Major (4)
Major (Negative national and international publicity. Major damage to reputation. Major loss of revenue, > £8 M)	Extreme (5)

Frequency descriptors

6.3.5 The frequency descriptors are used to inform the assignment of values to the hazard scenarios within the Hazard Log. The associated descriptors detailed in Table 16 ensure that values are applied consistently in contemplation of the frequency of the scenario should it come to fruition.

Table 16 Frequency Descriptors

Descriptor	Frequency
The impact of the hazard is realised but should <u>very rarely</u> occur (within the lifetime of the entity)	Rare (1)
The impact of the hazard <u>might</u> occur but is unlikely (within the lifetime of the entity)	Unlikely (2)
The impact of the hazard <u>could</u> very well occur, *but it also may not* (within the lifetime of the entity)	Possible (3)
It is <u>quite likely</u> that the impact of the hazard will occur (within the lifetime of the entity)	Likely (4)
The impact of the hazard <u>will</u> occur (within lifetime of entity)	Almost Certain (5)

Risk evaluation

6.3.6 The risk classification associated with each of the hazard scenarios is then assessed to a pre-defined scale shown in Table 17. In the context of marine safety, it must be remembered that the overriding objective identified in the PMSC is to reduce risk to a point which is 'as low as reasonably practicable' (ALARP).

Table 17 Risk classification

Classification	Outcome
Very High Risk	Very High
Significant Risk	Significant
Medium Risk	Medium
Low Risk	Low
No Practicable Risk	No Practicable Risk

6.3.7 Any identified control which contributes to reducing risk is considered, irrespective of the initial risk outcome. For example, a hazard scenario with a baseline or existing risk score of moderate or low would still be taken forward for risk reduction to satisfy the requirement of the 'as low as reasonably practicable' principle. The associated five-by-five risk Matrix is provided at Figure 23.

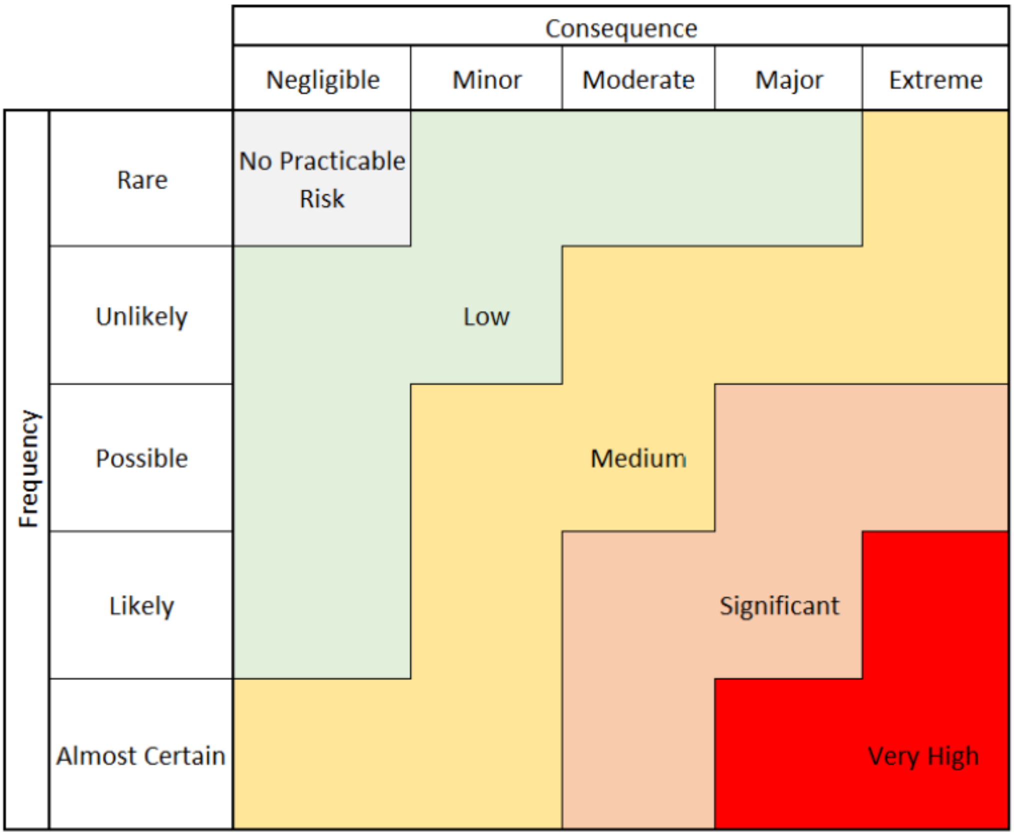

Figure 23 Five-by-Five Risk Matrix

6.3.8 When using this risk matrix in combination with the consequence and frequency descriptors (Table 15 and Table 16), the outcome for the receptors of people, planet, port, and property is reached. This outcome is compared with risk tolerability. Any intolerable risk is unacceptable unless sufficient control measures are able to be identified so as to reduce consequence and frequency to a position that is tolerable and ALARP.

6.3.9 Stage 1 and Stage 2 are completed once the required level of information has been gathered from the HAZID workshop process.

6.4 Stage 3: Risk assessment and control options

6.4.1 Following Hazard Identification and Risk Analysis the NRA process is then able to consider Risk Assessment and Applied Control options. Risk Assessment necessarily includes a review of existing (embedded) controls as well as potential controls identified. This step allows a broader view of controls, some of which may not have been considered at each of the HAZID workshops. It is likely that additional controls are identified, which if applied could further reduce the outcome of the risk if applied.

6.4.2 In doing so there is a hierarchy of risk control principles as advised in the GtGP. These are:

- *“Eliminate risks – by avoiding a hazardous procedure or substituting a less dangerous one;*
- *Combat risks – by taking protective measures to prevent risk;*
- *Minimise risk – by suitable systems of working. If a range of procedures is available, the relative costs need to be weighed against the degree of control provided, both in the short and long term”*.

(DfT, 2018)

6.4.3 As a result of this additional consideration and feedback, new causes, risk control measures, future mitigations (or changes to existing risk control measures) may also be identified which could trigger an increase or a decrease in hazard scenario risk.

6.4.4 The overall risk exposure of the organisation is considered during this stage with future applicable controls reducing risk to tolerable and ALARP. The outcome from this stage of the process is recorded in the Risk Assessment.

6.5 Stage 4: Cost benefit analysis, ALARP and tolerability

6.5.1 The aim of the risk associated with marine operations in harbours is to reduce it to ALARP. The degree of risk for each hazard scenario can be balanced on the following terms against the time, effort, cost, and physical difficulty of taking measures that avoid the risk. The GtGP states that: *“If any of these are so disproportionate to the risk that it would be unreasonable for the people concerned to incur them, they are not obliged to do so. The greater the risk, the more likely it is that it is reasonable to go to very substantial expense, trouble, and invention to reduce it. But if the consequences and the extent of a* *risk are small, insistence on great expense would not be considered reasonable",* (DfT, 2018).

6.5.2 An organisation that requires an NRA to determine if an activity can or cannot go ahead, needs to define its position on tolerability. Without this known state of risk acceptance, hazard scenarios (and their associated risk) cannot be determined as tolerable or intolerable. Tolerability must be approached from the perspective of the previously defined receptors of people, planet, port, and property. This is because organisations will have different perspectives on each of the receptors and it is highly unlikely that a risk matrix will be so proportionately balanced that (as an example) the acceptable risk to people (life) aligns with an acceptable risk to property (damage).

6.5.3 Tolerability, therefore, is a requirement of any risk assessment and must be determined by those accountable within the organisation concerned. Specifically, in the case of NRAs the GtGP states that : *"Risks may be identified which are intolerable. Measures must be taken to eliminate these so far as is practicable. This generally requires whatever is technically possible in the light of current knowledge, which the person concerned had or ought to have had at the time. The cost, time and trouble involved are not to be taken into account in deciding what measures are possible to eliminate intolerable risk",* (DfT, 2018).

6.5.4 The purpose of the Cost Benefit Analysis process ensures all risks to an ALARP state. If a risk is intolerable, it is imperative that controls are applied until the risk is both ALARP and tolerable. If, however, the risk is neither ALARP nor tolerable then the given organisation, in this case ABP, will need to review design and operational parameters before re-assessing.

6.6 Stage 5: Decision making process

6.6.1 As part of the Cost Benefit Analysis the Risk Assessment and Control Options are presented to those who have the appropriate authority to authorise or reject the proposed further applicable controls. This forms the final step of the assessment process. The aim of the previous stage is to reduce risks to ALARP through the addition of further applicable controls.

6.6.2 If risks returned from the Cost Benefit Analysis are both ALARP and tolerable, then the decision-making process automatically recommends that the activity can be approved from a risk-based perspective. If a case occurs where all controls and mitigation measures are applied, and a risk is still intolerable then the organisation cannot proceed with the associated activity.

7 Hazard Identification Workshops

7.1.1 In order to provide an assessment of navigational risk during the construction, construction and operation, and operational stages of the IERRT project, three hazard identification workshops with a variety of stakeholders were held.

7.1.2 The first workshop was held on 29 October 2021 over Microsoft Teams involving key stakeholders from ABP. This was arranged to inform the Preliminary Environmental Information Report (PEIR).

7.1.3 The second workshop took place on 7 April 2022 and was held at the Port of Immingham which was timed to follow publication of the PEIR (January 2022). This workshop focused on collecting hazard information and analysis of the risks identified as part of the first HAZID workshop. It also facilitated a wider stakeholder group to add risks that may have not been considered by the first workshop.

7.1.4 Following the second HAZID workshop it became apparent that a third workshop would be required for three principal reasons:

- ABP wanted to be able to take into account the opinions of all stakeholders that were likely to be directly impacted by the proposed development and as such, a wider stakeholder group was invited.
- Feedback and correspondence from the first workshop identified that some stakeholders had questions related to the methodology of the risk analysis. ABP acted on this feedback and modified the method specifically to remove the calculation that occurred in the background to rank and categorise risks in lieu of a qualitative based ranking system.
- ABP also wanted to consider the possibility that an overlap of construction and operation could occur during the project. This possibility required risks to be considered and assessed over the specific period of construction and operation occurring simultaneously.

7.1.5 The third HAZID workshop took place over two days (16 - 17 August 2022) in person with a wider stakeholder group and was followed by two consultation periods. The first consultation period (18 - 30 August 2022) enabled the risks that had not been fully discussed at the workshop to be commented on by all stakeholders whilst the second consultation period (2 - 16 September 2022) was designed to give time to allow all stakeholders to confirm that their comments had been correctly recorded in the Hazard Log. The resultant risk assessments are contained in Annexes 0 to C. Attendees from each HAZID workshop are detailed in Table 18 and correspondence regarding the HAZID from consultees is summarised in Chapter 10 of this ES.

7.1.6 During all the HAZID workshops, presentations were given by ABP, ABPmer and HR Wallingford that included the available baseline data, methodology, and risk table descriptors for frequency and consequence. Additionally, the HAZID 3 workshop contained a presentation which described the overall revised scheme and a presentation on the construction phase plan and application process. Following these presentations, on both days of the HAZID workshop, discussions took place with a view to identifying potential hazards associated with the proposed development as it had evolved.

7.1.7 The overall aim of the workshops was to identify the navigational safety concerns likely to be created by the IERRT project and to provide an analysis of the risks. In each workshop a qualitative approach was taken with stakeholders providing subject matter expertise. This included anecdotal information regarding marine use within the study area. Following discussion of the hazards and their causes, current, and suitable further risk control measures were then discussed with a view to reducing any risks associated with the proposed development.

7.1.8 HAZID workshop 3 which was scheduled for two days concluded with two-thirds of the Hazard Scenarios having been discussed. To ensure all the risk assessments were completed with an allowance for review by the stakeholders i.e., the port users who participated in the Workshops, the following course of action was agreed with attendees at the beginning of this third workshop. In brief, it was agreed that the most significant hazard scenarios carrying the larger risk levels would be addressed in person at the workshop and any hazard scenarios that were not covered, would be analysed during a seven working day consultation period following the workshop and presented back to the stakeholders for review and comment. This ensured that all risk assessments were covered, with allowance for stakeholders to review and raise any comment on the whole assessment set.

7.1.9 The attendees and people consulted for the hazard identification workshops are shown in Table 18. A summary of correspondence from the HAZID process is available in Chapter 10 of this ES.

Table 18 Hazard Identification Workshop Attendees

Attendee	Organisation/ Role
Workshop 1: 29 October 2021	
Gary Wilson	ABP – Humber, Head of Marine
Mark Collier	ABP – Immingham Dock Master
Ben Brown	ABP – Humber Assistant Pilotage Operations Manager
Tom Jeynes	ABP – Sustainable Development Manager
Adam Fitzpatrick	ABPmer – Senior Maritime Consultant
Harry Aitchison	ABPmer – Maritime Consultant
Workshop 2: 7 April 2022	
Tom Jeynes	ABP – Sustainable Development Manager
Mark Collier	ABP – Immingham Dock Master
Ian Cousins	ABP – VLS Pilot
Andrew Firman	ABP – Harbour Master
Neal Keena	APT – Marine Superintendent
Ed Rogers	NASH – Consultant representing APT
John Vinje	Stena Line

Attendee	Organisation/ Role
Hiddo de Boer	Stena Line
Michael van der Zwan	Stena Line
Jesper Nielsen	DFDS – Head of Ferry Operations
Roy Kersey	DFDS
Phil Pannett	CLdN
Trevor Auld	ABPmer – Associate Marine Consultant
Timothy Aldridge	ABPmer – Senior Maritime Consultant
Adam Fitzpatrick	ABPmer – Senior Maritime Consultant
Workshop 3: 16-17 August 2022	
Alan Redfern	APT
Mark Collier	ABP – Immingham Dock Master
Matt Dearnley	APT – Terminal Manager
Neal Keena	APT – Marine Superintendent
Nigel Bassett	NASH – Consultant representing APT
Mike Parr	HR Wallingford – Vessel Simulation Consultant
Jesper Nielsen	DFDS – Head of Ferry Operations
Tom Jeynes	ABP – Sustainable Development Manager
Rob Herbert	ABP – Head of Construction Delivery
Timothy Aldridge	ABPmer – Senior Maritime Consultant
Ian Cousins	ABP – VLS Pilot
Andrew Firman	ABP – Harbour Master
Edward Rogers	NASH – Consultant representing APT
Tom Johnson	Exolum
Dean Boon	Exolum
Graham Bishop	Bishop Marine Consulting – representing DFDS
Rob Follon	Stena Line
Phil Bailey	Svitzer
Antony Renton Jones	Svitzer
Wagt Richard	Stena Line
Nick Allen	Rix – Director
Nikki Jessop	Rix
Oliver Peat	ABP – Project Development Manager
Tomasz Kolesnik	James Fisher Everard
Harry Aitchison	ABPmer – Maritime Consultant
Peter van de Wardt	Stena Line
Claire Grange	DFDS

7.1.10 The post-workshop review period provided the stakeholders with the opportunity to comment on the hazard scenarios that had not been covered and apply their risk scoring. This was then taken forward to inform the Hazard Log as part of the risk analysis process.

7.1.11 Of particular note, during the risk analysis process the resultant risk assessments used a recording rationale of the 'on-balance most risk averse position' as provided by the stakeholders. Where two or more stakeholders had disagreement on a risk level, the higher of the two positions was taken if they were adjacent and the middle of two differing positions was taken if they were not adjacent. For example, if 'Likely' and 'Unlikely' were provided as responses, a outcome of 'Possible' was taken forward. If a position of 'Likely' and 'Possible' was returned, then the outcome was recorded as 'Likely'.

7.1.12 Following the second round of consultation for the Hazard Log, a project team risk assessment workshop was held by ABPmer on 04 October 2022 to consider the stakeholder correspondence and whether any significant changes to risk outcomes were required. The outcome of this workshop noted was that none of the risk outcomes were so drastically misrepresented to an extent that required alteration.

7.1.13 Then, following this, on the 06 October 2022 a Cost-Benefit Analysis and Tolerability workshop was held with ABP, the SHA and ABPmer in attendance, to determine which of the further applicable controls should become applied controls. The other function of this meeting was to ensure that the controls applied reduced the risk outcomes to such an extent that they were both tolerable and ALARP.

7.1.14 The following day – on 07 October 2022 – ABP's IERRT Project Manager presented the findings of the previous day's meeting to the ABP Steering Committee (SteerCo) chaired by a Duty Holder representative with a view to briefing SteerCo on the risk assessment outcomes. This meeting had two purposes:

- To consider ABP's position on risk tolerability with respect to the four assessment receptors (people planet, property, port); and
- To consider if the identified 'further applicable (risk) controls' had reduced the hazard scenario to a level considered to be ALARP.

7.1.15 The ABP Project team and an ABPmer representative then presented the likelihood and consequence tables, the tolerability limits, the NRA methodology and the Hazard Logs to the ABP Harbour Authority Safety Board (HASB) for approval by the 'Duty Holder'.

7.1.16 The meeting of the HASB was held on Monday 12 December 2022 and formally approved the descriptors for the criteria shown in the likelihood and consequence tables (Table 15 and Table 16), the tolerability as detailed in each of the four criteria (receptors; people, planet, port, and property – see Figures 26 to 29) and the risk assessments in Annexes A, B and C of this NRA.

8 Hazard Scenarios

8.1 Introduction

8.1.1 The following section identifies the hazard scenarios identified from the risk assessment process.

8.2 Hazard categories scoped out

8.2.1 One hazard category was scoped out as detailed in Table 19 along with the rationale for doing so.

Table 19 Scoped out Hazard categories

Hazard Category	Rationale
Accidents to the general public	The facility will be constructed and then operated from within an exclusion zone and is not accessible by the general public from the sea or landside.

8.3 Hazard scenarios

8.3.1 From the hazard categories scoped into the NRA, the following specific hazard scenarios were identified in consultation with stakeholders at the three HAZID workshops. As noted above, the hazard scenarios are split into construction, construction/operation, and operation in Table 20 to Table 22.

8.3.2 The hazard scenarios identified below in Table 20 to Table 22 have each been considered according to their 'Most Likely' and 'Worst Credible' outcomes. This provides the option to consider very serious outcomes which could credibly occur (i.e., worst credible), together with outcomes that are potentially less serious but could occur on a more frequent basis (i.e., most likely). The full descriptions and evaluations for each hazard scenario are presented as a Hazard Log, in table format, in Annexes 0, B, and C for the construction, construction-operation and, operational periods respectively.

8.3.3 The assessment of risk is based upon the descriptions of the 'Most Likely' and 'Worst Credible' to determine the outcome in respect of effect to people (human life), property, planet (the environment), and port business. This approach follows the best practice guidance from the PMSC GtGP (DfT, 2018).

Table 20 Construction hazards

Assessment	Hazard Category	Hazard Scenario
C.1	Accidents to personnel	Person overboard during dredge/construction works
C.2	Allision	Dredger/construction vessel impact with IOT infrastructure
C.3	Allision	Commercial vessel with marine works
C.4	Collision	Two craft associated with the marine works
C.5	Collision/Allision	Commercial vessel enters construction area
C.6	Collision	Dredger collision with vessel at ‘F’ anchorage when disposing of dredge material
C.7	Grounding	Dredger grounding whilst engaged in operations
C.8	Hazardous substance accidents	Hazardous chemical spill from construction vessel
C.9	Other (Mooring)	Vessel mooring failure
C.10	Other (Cranage)	Component dropped during construction
C.11	Other (Swamping)	Workboat takes on water from excessive wash
C.12	Other (Payload related accident)	Incorrect payload distribution affects stability

Table 21 Construction and Operational hazards

Assessment	Hazard Category	Hazard Scenario
CO.1	Collision	Craft associated with the marine works with a Ro-Ro Vessel
CO.2	Other (Mooring)	Ro-Ro mooring failure in vicinity of marine works on IERRT
CO.3	Other (Cranage)	Component dropped during construction preventing Ro-Ro Operations
CO.4	Other (Swamping)	Workboat takes on water from excessive wash from Ro-Ro
CO.5	Allision	Ro-Ro contact with IERRT infrastructure
CO.6	Other (Mooring)	Flat top barge breaks free of mooring
CO.7	Allision	Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2 with a tanker berthed on eastern jetty.

Table 22 Operational hazards

Assessment	Hazard Category	Hazard Scenario
O.1	Allision	Vessel proceeding to/from Immingham Eastern Ro-Ro with tanker moored at IOT Finger Pier
O.2	Allision	Tanker manoeuvring on/off IOT Finger Pier (flood tide)
O.3	Allision	Barge manoeuvring on/off IOT Finger Pier (flood tide)
O.4	Allision	Ro-Ro allision with IOT trunk way
O.5	Allision	Ro-Ro contact with IERRT infrastructure
O.6	Collision	Ro-Ro on passage to/from Immingham Eastern Ro-Ro Terminal with another vessel
O.7	Grounding	Ro-Ro manoeuvring to south-western berth
O.8	Other (Mooring)	Ro-Ro vessel breaks free of moorings
O.9	Allision	Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2-3 with a tanker berthed on eastern jetty.

9 NRA Discussion

9.1 Introduction

9.1.1 This section provides a commentary on the navigational risk assessments contained within the Hazard Logs provided at Annexes 0, B and C. Section 9.2 provides details of the causes which were part of the risk analysis discussions during the HAZID workshops. Section 9.3 discusses the common embedded risk controls – namely those controls that are already active and used by the Port of Immingham, HES, and marine operations in the study area. These include elements from wider guidance/policy as well as measures intrinsic to the Port.

9.1.2 Section 9.4 contains the risk assessment outcomes as discussed at the HAZID workshops. These were informed by subject matter expertise and are a function of the need to consider the causes, controls, and hazards for the 'most likely' and 'worst credible' scenarios.

9.1.3 Following the embedded risk outcome scores, Section 9.5 addresses the further applicable controls discussed in the HAZID workshops. These further applicable controls are either controls that are not currently implemented as the proposed development does not yet exist, or they are increases/additions to controls that currently exist but will be applied to the development. An example of the latter category would be the wearing of Personal Protective Equipment (PPE). In the context of PPE, it is commonplace to wear items such as life jackets whilst operating in and around the water (this would be an embedded control). The use of additional PPE, however, such as thermal protection to prevent exposure would be a specific control identified for this scheme.

9.1.4 Section 9.6 details further applicable controls and considers the level of mitigation they might provide as discussed in the HAZID Workshops. The framework used to describe mitigation is qualitative and seeks to provide a mechanism/common language by which the effectiveness of a given control is described through subject matter expertise and opinion.

9.1.5 Following the HAZID workshop two rounds of stakeholder correspondence took place. The first round of correspondence was to complete the HAZID process, and the second round was to confirm that comments captured throughout the process were aligned with what was said. The Second round of stakeholder correspondence subsequent to the HAZID workshops was not incorporated into the second row of raw data (Further Applicable Controls and Potential Risk Consequence/Frequency) to preserve the discussions held during the third HAZID workshop. However, all correspondence received prior to 4 October 2022 was considered as part of the Applied Controls, Cost-Benefit Analysis and Risk Assessment.

9.1.6 Section 9.7 outlines ABP's tolerability for this proposed development against the four hazard receptors of people, port, property, and planet. This information, together with determining if each risk is ALARP, has been used to determine the overall outcome of each risk assessment.

9.1.7 Section 9.8 displays the risk outcomes with the applied controls. Where there are differences from the potential risk outcomes, Section 9.9 explains the rationale for the selected controls and the risk assessment overall outcome.

9.2 Hazard scenario causes

9.2.1 The possible causes leading to each of the identified hazard scenarios have been considered, both individually and in combination. Table 23 presents a compiled list of causes from the 28 hazard scenarios and the frequency of these causes within the hazards identified in the third HAZID workshop. Annexes 0, B and C list these against each risk.

Table 23 Hazard Scenario Causes

Causes	Count
Human Error - Various	28
Adverse weather conditions	25
Vessel breakdown or malfunction	19
Inadequate procedures in place onboard vessel	19
Excessive vessel speed	17
Restricted visibility	16
Communication failure - Personnel	16
Incorrect assessment of tidal flow	16
Poor situational awareness	15
Manoeuvre misjudged	14
Interaction with passing vessel	14
Inadequate bridge resource management	13
Inadequate number/type tugs	11
Communication failure - Operational/procedural	10
Failure to comply with Towage guidelines	9
Inadequate training/competence - Others	7
Ship/Tug/Launch failure	7
Risk Assessment, Incomplete/not reviewed	7
High traffic density	7
Failure to follow passage plan	7
Failure to comply with safe systems of work	7
Construction and Operation occurring concurrently	6
COLREGs - failure to comply	6
Failure of berth mooring systems	6
AIS failure/ lack of AIS	4
Loss of vessels stability (due to other than loss of watertight integrity)	4
Failure to follow onboard vessel procedures	4
Towing equipment failure	3
Tidal flow	3
Anchors not cleared	3
Notice to Mariners failure to observe	3
Communication failure - equipment	2

Causes	Count
Tugs - inadequate number/type ordered or supplied	2
Lifting equipment failure	2
Limited area for manoeuvring	2
Inadequate maintenance/inspection	2
Aid to Navigation - failure (out of position/unlit)	2
Navigation equipment failure	2
Port Equipment (inc. craft) mechanical breakdown/ system malfunction	2
Communication failure - Operational/procedural	1
Adverse tide /current	1
Bridge resource management -inadequate	1
Byelaws/harbour directions/local regulations - failure to comply	1
Inadequate dredging	1
Inadequate hydrographic surveying	1
Traffic density - high	1
Inadequate procedures shoreside	1
Marine works vessel operating in close proximity to Ro-Ro berthing	1
Vessel obstructing fairway / Traffic Separation Scheme	1
VTS Radar failure - equipment or display	1
VTS/LPS instructions - failure to comply	1

9.2.2 The next stage of the process considers these causes in the context of embedded controls, which might be applicable to prevent the hazard scenario from occurring.

9.3 Embedded risk controls

9.3.1 During the HAZID workshops each hazard scenario was considered in the context of embedded risk controls (and causes). It should be noted that embedded risk controls relate to processes, practices and available safety resources that are in existence prior to the project development or are incorporated into the current design for the proposed development. These might include for example, international regulations (such as the International Regulations for Preventing Collisions at Sea (COLREGS)), training of personnel (such as the International Standards of Training, Certification and Watchkeeping for Seafarers (STCW)), or Marine Pollution response (Oil spill contingency plans).

9.3.2 Table 24 to Table 26 present the embedded risk controls, as previously defined, for construction, construction operation and operation (respectively) along with an occurrence count.

Table 24 Construction - Embedded risk controls

Embedded Risk Control	Count
Vessel Traffic Services	11
Communications equipment	11
Oil spill contingency plans	8
Port Facility Emergency Plan	8
Towage, available and appropriate	5

Embedded Risk Control	Count
Passage planning	4
Notices to mariners	4
Local Port Service	4
Byelaws	4
AIS/Radar coverage	4
Aids to navigation - provision and maintenance of	4
International COLREGs 1972 (as amended)	4
Vessel safety management system (ISM code)	3
Safety/Support Vessel	3
Accurate tidal measurements	2
Harbour Authority requirements	2
Emergency services equipment - shore side	2
Training of port marine/operations personnel	2
Vessel maintenance	2
Adequate berth fendering	1
Availability of latest hydrographic information	1
CCTV coverage	1
Emergency plan exercises	1
Fatigue and Health monitoring	1
General directions	1
Harbour/Dock Masters powers (inc. special directions)	1
Personal Locator Beacon	1
Ship personnel - training	1
Standing Orders/SOPs	1
Tidal information - accurate	1
Unusual vessels - specific risk assessments	1
Vessel speed	1

Table 25 Construction-Operation - Embedded risk controls

Embedded Risk Control	Count
Vessel Traffic Services	7
Towage, available and appropriate	5
Port Facility Emergency Plan	3
Harbour Authority requirements	3
Oil spill contingency plans	3
Communications equipment	3
Safety/Support Boat	2
Vessel propulsion redundancies	2
Passage planning	2
Monitoring of met ocean conditions	2
Local Port Service	2
Byelaws	2
Aids to navigation, Provision, and maintenance of	2
Adequate berth fendering	2
Additional lines/increase mooring	2
Accurate tidal measurements	1
Arrival/Departure, advance notice of	1

Embedded Risk Control	Count
Availability of latest hydrographic information	1
Berthing procedures	1
Communications - traffic broadcast	1
Design criteria	1
Mooring analysis	1
Towage guidelines	1
Vessel safety management system (ISM code)	1
Vessel simulation study	1

Table 26 Operation - Embedded risk controls

Embedded Risk Control	Count
Towage, available and appropriate	8
Harbour Authority requirements	7
Vessel Traffic Services	7
Towage guidelines	6
Monitoring of met ocean conditions	5
Oil spill contingency plans	4
Passage planning	4
Adequate berth fendering	3
Aids to navigation, Provision and maintenance of	3
Anchors cleared and ready for use	3
Communications equipment	3
Local Port Service	3
Port Facility Emergency Plan	3
Training of port marine/operations personnel	3
Vessel propulsion redundancies	3
Accurate tidal measurements	2
Availability of latest hydrographic information	2
Berthing procedures	2
Arrival/Departure, advance notice of	1
Byelaws	1
Communications - traffic broadcast	1
Design criteria	1
Hydrographic Survey	1
International COLREGs 1972 (as amended)	1
Joint emergency drills with VTS and Port staff	1
Mooring analysis	1
Vessel simulation study	1
Weather limits	1

9.4 Risk analysis: Embedded risk ranking

9.4.1 Table 27 shows the risk outcomes for the embedded hazard scenarios as discussed in the HAZID workshops. The risks are ranked within their respective groups from most severe to least severe based on the greatest number per highest risk outcome category. Risks have been considered within their respective groups to avoid any issue with respect to timeframe - noting that the duration of operation will exceed the duration of construction.

Table 27 Hazard scenarios ranked by Embedded Risk

Risk No.	Hazard Category	Hazard Scenario	WC ML	Embedded Risk Outcomes			
Construction				People	Property	Planet	Port Rep
C.1	Accidents to personnel	Person overboard during dredge/construction works	WC	Significant	Low	Low	Medium
			ML	Medium	Low	Low	Medium
C.3	Allision	Commercial vessel with marine works	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Medium	Medium
C.2	Allision	Dredger/construction vessel impact with IOT infrastructure	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Low	Medium
C.4	Collision	Two craft associated with the marine works	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Low	Medium
C.6	Collision	Dredger collision with vessel at 'F' anchorage when disposing of dredge material	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Low	Medium
C.5	Collision/ Allision	Commercial vessel enters construction area	WC	Medium	Medium	Low	Medium
			ML	Medium	Medium	Low	Medium
C.9	Other (Mooring)	Vessel mooring failure	WC	Low	Medium	Low	Medium
			ML	Medium	Medium	Medium	Medium
C.10	Other (Cranage)	Component dropped during construction	WC	Medium	Medium	Medium	Medium
			ML	Low	Medium	Low	Medium
C.11	Other (Swamping)	Workboat takes on water from excessive wash	WC	Medium	Low	Low	Medium
			ML	Medium	Medium	Medium	Medium
C.12	Other (Payload accident)	Incorrect payload distribution affects stability	WC	Medium	Medium	Medium	Medium
			ML	Low	Low	Low	Medium
C.7	Grounding	Dredger grounding whilst engaged in operations	WC	Medium	Medium	Low	Medium
			ML	Low	Low	Low	Medium
C.8	Hazardous substance accidents	Hazardous chemical spill from construction vessel	WC	Medium	Low	Medium	Low
			ML	Low	Low	Medium	Low
Construction and Operation				People	Property	Planet	Port Rep
CO.4	Other (Swamping)	Workboat takes on water from excessive wash from Ro-Ro	WC	Significant	Significant	Medium	Significant
			ML	Medium	Low	Low	Medium
CO.6	Other (Mooring)	Flat top barge breaks free of mooring	WC	Medium	Significant	Significant	Significant
			ML	Low	Low	Low	Low
CO.7	Allision	Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2 with a tanker berthed on eastern jetty	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Significant	Significant

Risk No.	Hazard Category	Hazard Scenario	WC ML	Embedded Risk Outcomes			
CO.5	Allision	Ro-Ro contact with IERRT infrastructure	WC	Medium	Significant	Medium	Significant
			ML	Medium	Medium	Low	Medium
CO.2	Other (Mooring)	Ro-Ro mooring failure in vicinity of marine works on IERRT	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Medium	Medium
CO.1	Collision	Craft associated with the marine works with a Ro-Ro Vessel	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Low	Medium
CO.3	Other (Cranage)	Component dropped during construction preventing Ro-Ro Operations	WC	Medium	Medium	Low	Medium
			ML	Low	Low	Low	Medium
Operation				People	Property	Planet	Port Rep
O.4	Allision	Ro-Ro allision with IOT trunk way	WC	Significant	Significant	Significant	Significant
			ML	Significant	Significant	Significant	Significant
O.2	Allision	Tanker manoeuvring on/off IOT Finger Pier (flood tide)	WC	Significant	Significant	Significant	Significant
			ML	Low	Significant	Low	Medium
O.3	Allision	Barge manoeuvring on/off IOT Finger Pier (flood tide)	WC	Significant	Significant	Significant	Significant
			ML	Medium	Medium	Medium	Medium
O.1	Allision	Vessel proceeding to/from Immingham Eastern Ro-Ro with tanker moored at IOT Finger Pier	WC	Medium	Medium	Medium	Medium
			ML	Medium	Significant	Significant	Significant
O.9	Allision	Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2-3 with a tanker berthed on eastern jetty.	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Significant	Significant
O.8	Other (Mooring)	Ro-Ro vessel breaks free of moorings	WC	Medium	Medium	NPR	Medium
			ML	Medium	Medium	Medium	Medium
O.6	Collision	Ro-Ro on passage to/from Immingham Eastern Ro-Ro Terminal with another vessel	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Low	Low
O.7	Grounding	Ro-Ro manoeuvring to south-western berth	WC	Low	Medium	Low	Low
			ML	Medium	Medium	Low	Medium
O.5	Allision	Ro-Ro contact with IERRT infrastructure	WC	Low	Medium	Low	Medium
			ML	Low	Low	Low	Medium

9.5 Further applicable controls

9.5.1 Table 28 to Table 30 are divided into Construction, Construction-Operation and Operation to assist in analysing the count of further applicable controls suggested. A further applicable control with a higher count identifies that it has been selected a number of times and, therefore, has a greater cumulative use across the hazard scenarios. This should not be interpreted as a measure of the control's significance in reducing frequency and/or consequence outcomes.

9.5.2 It must be noted that the proposed further applicable controls have been treated as raw data from the participants of the third HAZID workshop. That is to say that opinions such as the level of perceived mitigation has been drawn from stakeholder comments within the workshop.

Table 28 Construction - Further Applicable risk controls

Control	Frequency
Marking construction area (exclusion zone)	5
Adaptive procedures	4
Guard (support) vessel	3
Designated safety craft	1
Incident Reporting - Dropped component	1
IOT trunk way protection	1
Loading/Unloading Plan	1
Personnel management during tanker berthing	1
Suitable PPE for construction personnel	1
Tidal restrictions	1

Table 29 Construction-Operation - Further Applicable risk controls

Control	Frequency
Additional measures to ensure separation of marine works from Ro-Ro vessels proceeding to or departing IERRT	2
Berthing criteria specific to operation-construction	2
Special Instructions issued to Ro-Ro not to berth unless area is clear of marine works craft	2
Additional pilotage training/ familiarisation	1
Additional storm bollards	1
Additional training to PEC and Pilots on manoeuvring during the operation-construction phase	1
Berth specific weather parameters	1
Charted safety area, berthing procedures	1
During operation and construction ensure a safety boat/ tug is available to assist whilst a Ro-Ro is manoeuvring in close proximity	1
Hooks with load monitoring	1
Incident Reporting - Dropped component	1

Table 30 Operation – Further Applicable risk controls

Control	Frequency
Berthing criteria	5
Moving finger pier	3
Additional pilotage training/ familiarisation	2
Charted safety area, berthing procedures	2
Tidal limitations/ weather restrictions	2
Additional storm bollards	1
Additional Training	1
Additional tug provisions	1
Berth specific weather parameters	1
Hooks with load monitoring	1
Impact protection	1
Increase size of dredge pocket	1
Increased use of tugs	1
Marking safe water with AtoN	1

Discussion of potential risk controls

9.5.3 The following section outlines the context in which the further applicable controls were discussed within the HAZID workshops. In most instances the further applicable controls are considered to be controls relevant to the proposed development that are not yet in effect. This can either mean that the control is completely new or that the control has to be amended specifically for the purpose of the proposed development, i.e., the IERRT. A small number of the further applicable controls identified in the HAZID workshops have been discounted as they replicated or mirrored an existing embedded control. In order to preserve the information gathered from the HAZID workshops these controls have been included in the Hazard Logs , with comments made regarding their application as part of the risk assessment and cost benefit analysis stages.

9.5.4 Controls that are not currently deployed, but would be used in association with particular activities, have been identified as further applicable controls. For example, the further applicable control ‘Guard (Support) Vessel’ is often used in association with marine construction activities but is not currently present at the proposed development site whilst construction is not yet occurring. In many examples from the HAZID workshops, the inclusion of a guard/support vessel was considered as a further applicable control and the mitigation it provided was considered to impact the potential risk outcome.

9.5.5 The following list provides a commentary on the purpose and application of each identified further applicable control and the perceived level of mitigation for either frequency or consequence. Figure 23 shows whether a control mitigates the frequency or consequence (or both) of the hazardous event occurring.

9.5.6 If a control is considered to reduce the frequency of a hazardous event occurring, it is considered as a preventative or as having a preventative mitigation impact. Similarly, a control that is considered only to impact the consequence after the hazardous event occurs is considered to be a reactive control. In the event that a further applicable control is considered to affect both the frequency and consequence of a hazardous event, then this control is considered to be 'detective'. Consequently, detective controls will have mitigation impacts for both frequency and consequence. This relationship is depicted in Figure 24.

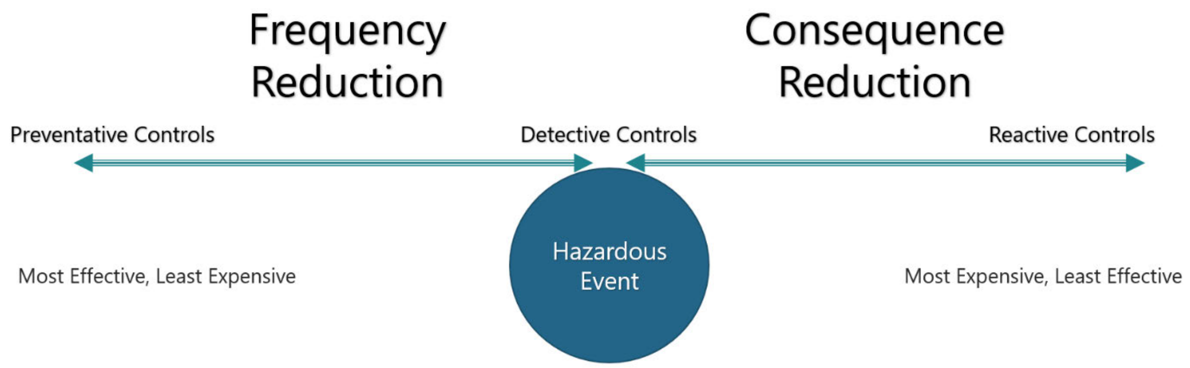

Figure 24 Mitigation diagram

9.5.7 Whilst considering mitigation and its potential impacts in a qualitative perspective, it is important to establish a framework or common language that can be referenced so as to aid future discussions during the risk assessment and cost-benefit analysis stages. To facilitate this, Figure 25 presents the guidance used in the HAZID workshop to evaluate control effect. It is important to note that the suggested percentages are provided as a descriptive guide to describe the level of perceived mitigation.

Perceived Control Mitigation Impacts	
0%	No Effect
~5%	Minute
~10%	Slight
~20%	Fair
~30%	Considerable
+50%	Very Substantial

Figure 25 Perceived Control Mitigation Impacts

9.5.8 The following presents a summary list of further applicable controls with a description of each. The controls have been split into construction, construction/operation and operation and are mentioned once only. In instances where a control has been applied to multiple hazards the commentary identifies to which risk assessments the control was applied together with whether it reduces frequency and/or consequence:

Construction

- **Marking construction area (exclusion zone)** – this further applicable control was considered as potential mitigation for Risks C2-5 and C11. The control is perceived to provide slight mitigation to hazard categories of allision and collision during the construction of the proposed development as this further applicable control is considered likely to reduce the frequency of the hazardous event occurring and is assessed to be a preventative control.

- **Adaptive procedures** – this further applicable control was identified for Risks C3, and C5-7, during the third HAZID workshop. Specifically, the control relates to additional training of PECs, Pilots and Dredge Vessel operators to assist in familiarisation and adaptation to the proposed new layout of the port. This control was considered to provide very substantial mitigation to the frequency of the hazardous event occurring and therefore assessed as a preventative control.

- **Guard (support) vessel** – this further applicable control was identified for Risks C3, C5 and C9. The exact specification of the guard/support vessel was not identified. It was suggested during the third HAZID workshop, that depending on circumstance, it could be a tug or other local service craft as appropriate. The potential mitigation for this control was considered to be fair in the reduction of frequency of the associated hazardous events occurring, thus making it a potential preventative control.

- **Designated safety craft** – this control specifically considers a vessel being available and specifically designated for safety, in particular to respond to a 'Man Over-Board' recovery situation. This control was considered to be a considerable reactive control as the mitigation would occur following the hazardous event of a person falling overboard.

- **Incident Reporting - Dropped component** – this control considered establishing a specific routine for reporting incidents related to components being dropped in the water to ensure that VTS is made aware without delay. This control was considered to be a preventative control with the frequency mitigation being fair for preventing a vessel colliding with the dropped object.

- **IOT trunk way protection** – this further applicable control considered protection of the IOT trunk way (approach jetty) during the construction period, to help prevent an errant vessel from making contact with marine infrastructure. It was also suggested that the control would reduce the impact damage of a vessel hitting the IOT trunk way if the hazardous event was to occur and thus it would reduce consequence. This control is therefore detective as it is considered to have very substantial mitigation effect on both frequency and consequence.

- **Loading/Unloading Plan** – this further applicable control discussed at the third HAZID workshop specifically considers the implementation of a vessel stability plan to ensure stability is maintained during loading and unloading operations. This control was perceived to provide considerable mitigation to the frequency of the hazard scenario; therefore, it has been considered as a preventative control.

- **Personnel management during tanker berthing** – this control was discussed in the context of an errant tanker colliding with a Jack-Up Barge/Barge during construction. The discussion was in contemplation of mitigating the consequence for people being injured as a result of this hazardous scenario occurring. Specifically, the management of personnel is intended to address the proximity at which people are standing/working to the area of potential danger if there is an errant tanker (likely reported via other control mechanisms such as VTS or through VHF communication). This control was considered to provide fair mitigation to the potential injuries to personnel by moving them from the point of greatest danger in the event of an incident, thus making it a reactive control.

- **Suitable PPE for construction personnel** – this control specifically considers additional checks that could be conducted by HES. In the third HAZID workshop it was also discussed that additional PPE could be worn to prevent the impacts of exposure if a person was to fall overboard during construction. This was considered as a very substantial reactive control as the mitigation would occur following the hazardous event of a person falling overboard.

- **Tidal restrictions** – this control was specifically considered for periods during construction and related to the potential implementation of tidal restrictions depending on the specific vessel involved. The associated hazard scenario considers a dredger/construction vessel making contact with the IOT infrastructure to which this control was thought to have fair mitigation as a preventative control.

Construction-operation

- **Additional measures to ensure separation of marine works from Ro-Ro vessels proceeding to or departing IERRT** – this control specifically considered utilising VTS to move marine craft away from IERRT prior to Ro-Ro arriving in the berth pocket to prevent the hazardous event from occurring through not having a conflict of operations. This mitigation was considered for Risks CO1 and CO4 and was perceived to be very substantial mitigation in preventing a collision between a workboat and a Ro-Ro making it a preventative control.

- **Berthing criteria specific to operation-construction** – this control is present in CO5 and CO7 and describes the potential inclusion of elements such as tidal limits, tug requirements, amidst other potential weather limits (e.g. high winds). These berthing criteria will need to be specifically defined for their eventual use in mitigating hazardous scenarios. However, it was considered in the third workshop that this control could reasonably be used to mitigate the frequency of occurrence to a considerable degree and the consequence of hazardous scenarios to a fair degree (i.e. reducing the impact/allision). Therefore, this control has been considered as a detective control as it, if appropriately applied, could mitigate both the frequency and the consequence.

- **Special Instructions issued to Ro-Ro not to berth unless area is clear of marine works craft** – this control was applied to risks CO1 and CO4. It specifically considered having a standing special instruction to Ro-Ro vessels not to berth at the IERRT unless the area is clear of workboats. This mitigation would assist in covering any situation where VTS is unaware of a small craft in vicinity of the IERRT and would seek to prevent a workboat either being struck or swamped by the wash of the approaching Ro-Ro. This control was considered to be very substantial mitigation in the reduction of the frequency of occurrence of these hazardous scenarios, therefore it is a preventative control.

- **Additional pilotage training/ familiarisation** – this control was identified in the context of the additional training only being provided in the form of familiarisation (i.e. information based and not physical training). As a result the perceived reduction in risk was only considered to be minute when compared to providing hands on training as per other further applicable controls that discuss training as mitigation. This control would be preventative but only to a minimal level.

- **Additional storm bollards** – this control considered the potential to design the IERRT structure (over-engineer) to ensure that during catastrophic weather events the vessels would be able to maintain their mooring. For this control to be effective, for a vessel to be safely moored, it would require advanced warning to ensure that additional mooring was established. Therefore, this control is considered to be preventative. It was agreed at the third HAZID workshop that it could have a slight reduction in frequency of the hazardous event occurring.

- **Additional training to PEC and Pilots on manoeuvring during the operation-construction phase** – this control considered hands on training for PECs and Pilots and was identified for a hazard scenario that considers a Ro-Ro making significant contact (allision) with the IERRT infrastructure. During the third HAZID workshop the control was perceived to be considerable mitigation for the frequency of the hazardous event occurring. Further, it was considered that the additional training would aid the reduction of consequence by reducing the severity of the impact (for example), it was therefore also considered to be fair mitigation for the consequences of the hazardous scenario making this control a detective one.

- **Berth specific weather parameters** – this control is different to the previously cited control for specific berthing criteria as it considers the parameters from a perspective that the vessel is already berthed. It was discussed that this control could provide slight mitigation to the frequency of occurrence of the hazardous event and therefore it has been considered as a preventative control. It should be noted that the effectiveness of this control is contingent on the specific parameters set.

- **Charted safety area, berthing procedures** – this control considers including a charted safety area that can be applied/considered whilst a Ro-Ro is berthing (i.e. a no-go zone). It was identified that this control could provide slight mitigation to the frequency of occurrence of the hazardous event, in this case allision, with the Immingham Eastern Jetty and therefore is a preventative control. It should be noted that the effectiveness of this control is contingent on the specific parameters set.

- **During operation and construction ensure a safety boat/ tug is available to assist whilst a Ro-Ro is manoeuvring in close proximity** – this control considers a safety boat that is capable of either preventing a flat top barge from drifting onto the Eastern Jetty or is able to reduce the speed and impact of the resulting allision. Therefore, this control is a detective control as it is able to mitigate both the frequency and the consequence. It was discussed at the third HAZID workshop that this control could provide considerable mitigation to the frequency and fair mitigation to the consequence of the hazardous event were to occur.

- **Hooks with load monitoring** – this control was considered as a part of a hazardous scenario that involved a Ro-Ro vessel breaking free of its mooring. The load monitoring hooks could indicate if a line was about to snap and corrective action could be taken. Therefore, it is considered to be a preventative control that could provide fair mitigation in the reduction of frequency for the associated hazardous event occurring.

- **Incident Reporting - Dropped component** – this control specifically considered establishing a specific routine for reporting incidents related to components being dropped in the water to ensure that VTS is made aware without delay. This control is the same as the corresponding control identified in construction and was proposed to be implemented in the same fashion. Therefore, this was considered to be a preventative control. It was discussed that the frequency mitigation would be fair in preventing the hazardous scenario of a vessel colliding with the dropped object.

Operation

- **Berthing criteria** – this control is present in O1, O4, O5, O7 and O9 describes the potential inclusion of elements such as tidal limits, tug requirements, amidst other potential weather limits (e.g. high winds) during the IERRT's operation. These berthing criteria will need to be specifically defined for their eventual use in mitigating the hazardous scenario. However, it was perceived in the third HAZID workshop that this control could reasonably be considered to mitigate the frequency of occurrence to a considerable degree and the consequence of the hazardous scenario to a fair degree (i.e. reducing the impact/allision with infrastructure or the impact of grounding). Therefore, this control has been considered as a detective control as it, if appropriately applied, could mitigate both frequency and consequence.

- **Moving finger pier** – this control was discussed as a possible solution for the complete elimination of any risk that considers allision with the IOT Finger Pier. It was discussed for Risks O1-O3 as it was identified that the control would provide very substantial mitigation for both the frequency and the consequences of the associated hazard scenarios, therefore making this control 'detective'. The removal of the finger pier can be considered as purely preventative as the hazardous scenario cannot occur without the Finger Pier present.

- **Additional pilotage training/ familiarisation** – this control was identified in the context of the additional training provided being in the form of familiarisation (i.e. information based and not physical training) and is similar to the previously identified control of the same name in the Construction-Operation section. In operation, it has been identified as mitigation for risks O1 and O9. The perceived reduction in risk was only considered to be minimal when compared to providing hands-on training as per other further applicable controls that discuss training as mitigation. This control would be preventative but only to a small degree.

- **Charted safety area, berthing procedures** – this control considers including a charted safety area that can be applied/considered whilst a Ro-Ro is berthing (i.e. a no-go zone). This control is the same as the one identified in Construction-Operation but here is applied to risk O1 and O9. It was identified that this control could provide slight mitigation to the frequency of occurrence of the hazardous event, in this case allision, with the Immingham Eastern Jetty and therefore is a preventative control. It should be noted that the effectiveness of this control is contingent on the specific parameters set.

- **Tidal limitations/ weather restrictions** – the set of tidal limitations and weather restrictions considered in this control was to do with risks O2 and O3 which consider a tanker or a barge manoeuvring off the finger pier during a flood tide and striking the IERRT. It was suggested that the potential mitigation for this would be considerable for frequency and fair for consequence but that the control would likely have commercial impacts for the stakeholders which would likely make it unviable.

- **Additional storm bollards** – this control considered the potential to over-engineer the IERRT to ensure that during severe weather events vessels would be able to maintain their mooring. For this control to be effective vessels would require advanced warning to ensure that additional mooring was established. Therefore, this control is considered to be preventative. It was discussed at the third HAZID that it could have a slight reduction in frequency of the hazardous event occurring.

- **Additional Training** – this control considered hands on training for PECs and Pilots and was identified for a hazard scenario that considers a Ro-Ro making significant contact (allision) with the IERRT infrastructure. During the third HAZID workshop the control was perceived to be considerable mitigation for the frequency of the hazardous event occurring. Further, it was considered that the additional training would aid the reduction of consequence by reducing the severity of the impact (for example), it was therefore also considered to be fair mitigation for the consequences of the hazardous scenario making this control a detective one.

- **Increased use of tugs/ Additional tug provisions** – these controls are considered for risk O2 and O4 and are the same in all but name. They consider the use of tugs above what is currently prescribed as mitigation for allision during operation. Both controls were identified during the third HAZID workshop to potentially provide considerable frequency mitigation and fair consequence mitigation, therefore making it a detective control.

- **Berth specific weather parameters** – this control is the same as the control by the same name cited under the Construction-Operation section. It was discussed that this control could provide slight mitigation to the frequency of occurrence of the hazardous event and therefore it has been considered as a preventative control. It should be noted that the effectiveness of this control is contingent on the specific parameters set.

- **Hooks with load monitoring** – this control was considered as a part of a hazardous scenario that involved a Ro-Ro vessel breaking free of its mooring and is the same as the control discussed within the Construction-Operation section. The load monitoring hooks could indicate if a line was about to snap and corrective action could be taken. Therefore, it is perceived to be a preventative control that could provide fair mitigation in the reduction of frequency for the associated hazardous event occurring.

- **Impact protection** – this control considers substantially engineered impact protection for the IOT trunk way and could be constructed from piles (or similar methodology). It is considered to reduce the frequency of allision with the trunk way through added protection and the consequence of any impacts by substantially slowing an errant vessel down. This detective control was perceived to potentially mitigate both frequency and consequence to a very substantial extent.

- **Increase size of dredge pocket** – increasing the size of the dredge pocket was a control considered for the operational hazard of grounding. It was discussed to only have minute mitigation for the frequency of occurring as an errant vessel grounding could still ground in the vicinity of the dredge pocket even if it was made slightly larger. This control was also considered to be impractical due to the environmental implications of increasing the dredge pocket.

- **Marking safe water with AtoN** – this control considers marking the limit of safe water (for depth) between the Eastern Jetty and IERRT so that it is visually apparent where the limit is to tugs and other service craft. This control was considered to have fair mitigation in the prevention of grounding by reducing the frequency and is therefore a preventative control.

9.6 Risk analysis: Potential risk ranking

9.6.1 Table 31 shows the potential risk outcomes for the hazard scenarios as discussed in the HAZID workshops assuming application of the further applicable controls identified. The potential risk outcomes take into account the frequency reduction and consequence reduction from each risk control also discussed at the third HAZID workshop. The risks are ranked within their respective groups from most severe to least severe based on the greatest number per highest risk outcome category. Risks have been considered within their respective groups to avoid any issue with respects to timeframe noting that the duration of operation will exceed the duration of construction.

9.6.2 Of particular note are the risks associated with the further applicable control 'Moving the Finger Pier'. The third HAZID workshop considered this control would eliminate the risk, thus its potential risk outcome scores were 'No Practicable Risk' (NPR) for all receptors. This control was identified for O1, O2 and O3, it was discussed at the third HAZID workshop that the control would be noted for each risk as an eliminator (i.e., it removed the hazard entirely). It was discussed that if it was applied to every risk (applicable to the Finger Pier) in the workshop then the potential risk consequence and frequency would be rated NPR. To ensure that the mitigation of other controls identified could be considered and assessed against these risks the potential further applicable control of 'Moving the Finger Pier' was recorded for risks O2 and O3. However the mitigation impact was not applied for the 'Potential Frequency' and 'Potential Consequences' (as to do so would result in the risk not existing as demonstrated in risk O1).

Table 31 Hazard Scenarios ranked by Potential Risk

Risk No.	Hazard Category	Hazard Scenario	WC ML	Potential Risk Outcomes			
Construction				People	Property	Planet	Port Rep
C.4	Collision	Two craft associated with the marine works	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Low	Medium
C.6	Collision	Dredger collision with vessel at 'F' anchorage when disposing of dredge material	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Low	Medium
C.3	Allision	Commercial vessel with marine works	WC	Low	Low	Medium	Medium
			ML	Medium	Medium	Low	Medium
C.9	Other (Mooring)	Vessel mooring failure	WC	Low	Low	Low	Medium
			ML	Medium	Medium	Medium	Medium
C.1	Accidents to personnel	Person overboard during dredge/construction works	WC	Medium	Low	Low	Medium
			ML	Medium	Low	Low	Medium
C.5	Collision/ Allision	Commercial vessel enters construction area	WC	Medium	Medium	Low	Medium
			ML	Low	Low	Low	Low
C.10	Other (Cranage)	Component dropped during construction	WC	Low	Low	Medium	Low
			ML	Low	Medium	Low	Medium
C.11	Other (Swamping)	Workboat takes on water from excessive wash	WC	Medium	Low	Low	Medium
			ML	Low	Low	Low	Medium
C.7	Grounding	Dredger grounding whilst engaged in operations	WC	Low	Low	NPR	Low
			ML	Low	Low	Low	Medium
C.12	Other (Payload accident)	Incorrect payload distribution affects stability	WC	Low	Low	Low	Low
			ML	Low	Low	Low	Low
C.2	Allision	Dredger/construction vessel impact with IOT infrastructure	WC	Low	Low	Low	Low
			ML	Low	Low	NPR	Low
C.8	Hazardous substance accidents	Hazardous chemical spill from construction vessel	WC	N/A	N/A	N/A	N/A
			ML	N/A	N/A	N/A	N/A
Construction and Operation				People	Property	Planet	Port Rep
CO.7	Allision	Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2-3 with a tanker berthed on eastern jetty.	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Medium	Medium
CO.2	Other (Mooring)	Ro-Ro mooring failure in vicinity of marine works on IERRT	WC	Low	Medium	Low	Medium
			ML	Medium	Medium	Medium	Medium
CO.4	Other (Swamping)	Workboat takes on water from excessive wash from Ro-Ro	WC	Medium	Low	Low	Medium
			ML	Low	Low	Low	Low

Risk No.	Hazard Category	Hazard Scenario	WC ML	Potential Risk Outcomes			
CO.6	Other (Mooring)	Flat top barge breaks free of mooring	WC	Medium	Low	Medium	Low
			ML	Low	Low	Low	Low
CO.1	Collision	Craft associated with the marine works with a Ro-Ro Vessel	WC	Medium	Low	Low	Medium
			ML	Low	Low	NPR	Low
CO.3	Other (Cranage)	Component dropped during construction preventing Ro-Ro Operations	WC	Low	Low	Low	Low
			ML	Low	Low	Low	Medium
CO.5	Allision	Ro-Ro contact with IERRT infrastructure	WC	Low	Low	Low	Low
			ML	Low	Medium	Low	Low
Operation				People	Property	Planet	Port Rep
O.9	Allision	Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2-3 with a tanker berthed on eastern jetty.	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Medium	Medium
O.3	Allision	Barge manoeuvring on/off IOT Finger Pier (flood tide)	WC	Medium	Medium	Medium	Medium
			ML	Low	Medium	Low	Medium
O.8	Other (Mooring)	Ro-Ro vessel breaks free of moorings	WC	Medium	Medium	NPR	Medium
			ML	Medium	Medium	Low	Medium
O.2	Allision	Tanker manoeuvring on/off IOT Finger Pier (flood tide)	WC	Low	Low	Medium	Low
			ML	Low	Medium	Low	Low
O.4	Allision	Ro-Ro allision with IOT trunk way	WC	Low	Medium	Low	Low
			ML	Low	Medium	Low	Low
O.5	Allision	Ro-Ro contact with IERRT infrastructure	WC	Low	Medium	NPR	Low
			ML	Low	Low	Low	Medium
O.7	Grounding	Ro-Ro manoeuvring to south-western berth	WC	Low	Medium	Low	Low
			ML	Low	Low	Low	Low
O.1	Allision	Vessel proceeding to/from Immingham Eastern Ro-Ro with tanker moored at IOT Finger Pier	WC	NPR	NPR	NPR	NPR
			ML	NPR	NPR	NPR	NPR
O.6	Collision	Ro-Ro on passage to/from Immingham Eastern Ro-Ro Terminal with another vessel	WC	N/A	N/A	N/A	N/A
			ML	N/A	N/A	N/A	N/A

9.7 Risk Assessment and Cost-Benefit Analysis

9.7.1 The risk assessment and cost benefit analysis stages included the risk assessor (ABPmer) presenting the outcome of the risk assessment from the HAZID workshops. Displaying the risks in this way allows each hazard scenario to be considered with all controls from the list of further applicable controls. This allows an appreciation of how the risk outcome tracks with respect to the tolerability for each receptor and whether the risk is ALARP.

9.7.2 A risk assessment meeting was held on 04 October 2022 following the risk analysis from the HAZID workshops and all of the feedback received from stakeholders to that date. This meeting specifically sought to ensure that all stakeholder opinion had been considered objectively and represented in the Hazard Logs.

9.7.3 That objective consideration was then taken forwards as part of this NRA.

9.7.4 Following the risk assessment meeting, a cost benefit analysis meeting was held on 6 October 2022 to evaluate which potential further applicable controls to apply from the Hazard Log. Representatives from ABPmer, ABP, HES and Clyde & Co, legal team attended the cost-benefit analysis meeting. The completed Hazard Log at Annexes A - C has a row for recording 'Risk Assessment and Applied Controls' which was completed during the cost-benefit analysis process.

9.7.5 As part of this process, the outcomes from each risk assessment in respect of whether the risk is tolerable has been considered in the context of ABP's tolerability criteria. This criterion is established separately for each of the four receptors (people, planet (environment), property, and port (business/reputation)). Tolerability positions are identified as a line on Figure 26 to Figure 29 and defined against each of the four receptors using the frequency and consequence scale on a five-by-five grid.

		Consequence				
		Negligible (No Injury)	Minor Injuries	Serious Injuries	Single Fatality	Multiple Fatalities
Likelihood	Rare	No Practicable Risk				
	Unlikely		Low	Tolerable		
	Possible			Medium		
	Likely				Significant	
	Almost Certain			Intolerable		Very High

Figure 26 People Tolerability Matrix

		Consequence				
		£0-10000	£10000-£750000	£750000-£4Million	£4Million-£8Million	Over £8Million
Likelihood	Rare	No Practicable Risk				
	Unlikely		Low	Tolerable		
	Possible			Medium		
	Likely				Significant	
	Almost Certain			Intolerable		Very High

Figure 27 Property Tolerability Matrix

		Consequence				
		No pollution	Tier 1 – No measurable impact	Tier1	Tier 2	Tier 3
Likelihood	Rare	No Practicable Risk				
	Unlikely		Low	Tolerable		
	Possible			Medium		
	Likely				Significant	
	Almost Certain				Intolerable	Very High

Figure 28 Planet Tolerability Matrix

		Consequence				
		None	Minor Reputation Damage	Moderate Reputation Damage	Serious Damage	Major Reputation Damage
Likelihood	Rare	No Practicable Risk				
	Unlikely		Low	Tolerable		
	Possible			Medium		
	Likely				Significant	
	Almost Certain				Intolerable	Very High

Figure 29 Port Tolerability Matrix

9.7.6 For a risk assessment outcome to be considered tolerable, it must fall to the left of the line. In considering tolerability it must be remembered that accepting any risk outcome is undesirable. To operate in environments that involve risk (particularly risk to people), however, there are always likely to be activities that could cause injury or death. The purpose of a thorough risk assessment is to ensure that these risks are reduced to a position that is ALARP through mitigation.

9.7.7 Following the application of tolerability the process of evaluating the further applicable controls was carried out. This was completed by considering the embedded risk outcome and whether or not it was both tolerable and ALARP. This evaluation was carried out by examining the further applicable controls and the potential reduction in risk perceived. The cost-benefit relationship compared the defined tolerability and reduction perceived, versus the cost of implementing the control. In all cases, the aim was to reduce tolerable risks through the application of further applicable controls. Where the cost was evaluated to be disproportionate to the amount of risk reduced, the further applicable control was not carried forward. This outcome is recorded in the final row of the risk assessment tables in Annexes 0, B and C.

9.8 Risk assessment: Applied controls

9.8.1 During the aforementioned analysis of cost-benefit analysis of the potential controls and determination of whether a tolerable and ALARP state had been reached the risks were assessed with respect to the data provided from the third HAZID workshop. Table 32 displays the overall risk outcome for each risk associated with the proposed IERRT development once the potential controls had been converted to applied controls. This is followed by a discussion on the applied controls to identify scenarios where outcomes differ from the potential risk outcomes.

Table 32 Hazard Scenarios Assessment Ranking with Applied Controls

Risk No.	Hazard Category	Hazard Scenario	WC ML	ALARP Risk Outcomes (Post Cost-Benefit Analysis)		Worst Credible Most Likely	
Construction				People	Property	Planet	Port Rep
C.4	Collision	Two craft associated with the marine works	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Low	Medium
C.3	Allision	Commercial vessel with marine works	WC	Low	Low	Medium	Medium
			ML	Medium	Medium	Low	Medium
C.9	Other (Mooring)	Vessel mooring failure	WC	Low	Low	Low	Medium
			ML	Medium	Medium	Medium	Medium
C.2	Allision	Dredger/construction vessel impact with IOT infrastructure	WC	Medium	Medium	Medium	Medium
			ML	Low	Low	Low	Low
C.1	Accidents to personnel	Person overboard during dredge/construction works	WC	Medium	Low	Low	Medium
			ML	Medium	Low	Low	Medium
C.5	Collision/ Allision	Commercial vessel enters construction area	WC	Medium	Medium	Low	Medium
			ML	Low	Low	Low	Low
C.6	Collision	Dredger collision with vessel at 'F' anchorage when disposing of dredge material	WC	Low	Medium	Medium	Medium
			ML	Low	Low	Low	Low
C.8	Hazardous substance accidents	Hazardous chemical spill from construction vessel	WC	Medium	Low	Medium	Low
			ML	Low	Low	Medium	Low
C.10	Other (Cranage)	Component dropped during construction	WC	Low	Low	Medium	Low
			ML	Low	Medium	Low	Medium
C.11	Other (Swamping)	Workboat takes on water from excessive wash	WC	Medium	Low	Low	Medium
			ML	Low	Low	Low	Medium
C.7	Grounding	Dredger grounding whilst engaged in operations	WC	Low	Low	NPR	Low
			ML	Low	Low	Low	Medium
C.12	Other (Payload accident)	Incorrect payload distribution affects stability	WC	Low	Low	Low	Low
			ML	Low	Low	Low	Low

Risk No.	Hazard Category	Hazard Scenario	WC ML	ALARP Risk Outcomes (Post Cost-Benefit Analysis)		Worst Credible Most Likely	
Construction and Operation				People	Property	Planet	Port Rep
CO.7	Allision	Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2 with a tanker berthed on eastern jetty	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Medium	Medium
CO.2	Other (Mooring)	Ro-Ro mooring failure in vicinity of marine works on IERRT	WC	Low	Medium	Low	Medium
			ML	Medium	Medium	Medium	Medium
CO.4	Other (Swamping)	Workboat takes on water from excessive wash from Ro-Ro	WC	Medium	Low	Low	Medium
			ML	Low	Low	Low	Low
CO.1	Collision	Craft associated with the marine works with a Ro-Ro Vessel	WC	Medium	Low	Low	Medium
			ML	Low	Low	NPR	Low
CO.3	Other (Cranage)	Component dropped during construction preventing Ro-Ro Operations	WC	Low	Low	Low	Low
			ML	Low	Low	Low	Medium
CO.5	Allision	Ro-Ro contact with IERRT infrastructure	WC	Low	Low	Low	Low
			ML	Low	Medium	Low	Low
CO.6	Other (Mooring)	Flat top barge breaks free of mooring	WC	Low	Low	Low	Low
			ML	Low	Low	Low	Low
Operation				People	Property	Planet	Port Rep
O.1	Allision	Vessel proceeding to/from Immingham Eastern Ro-Ro with tanker moored at IOT Finger Pier	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Medium	Medium
O.9	Allision	Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2-3 with a tanker berthed on eastern jetty	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Medium	Medium
O.8	Other (Mooring)	Ro-Ro vessel breaks free of moorings	WC	Medium	Medium	NPR	Medium
			ML	Medium	Medium	Medium	Medium
O.2	Allision	Tanker manoeuvring on/off IOT Finger Pier (flood tide)	WC	Medium	Medium	Medium	Medium
			ML	Low	Medium	Low	Medium
O.6	Collision	Ro-Ro on passage to/from Immingham Eastern Ro-Ro Terminal with another vessel	WC	Medium	Medium	Medium	Medium
			ML	Medium	Medium	Low	Low

Risk No.	Hazard Category	Hazard Scenario	WC ML	ALARP Risk Outcomes (Post Cost-Benefit Analysis)		Worst Credible Most Likely	
O.3	Allision	Barge manoeuvring on/off IOT Finger Pier (flood tide)	WC	Low	Medium	Medium	Medium
			ML	Low	Medium	Low	Medium
O.4	Allision	Ro-Ro allision with IOT trunk way	WC	Low	Medium	Low	Low
			ML	Low	Medium	Low	Low
O.5	Allision	Ro-Ro contact with IERRT infrastructure	WC	Low	Medium	NPR	Low
			ML	Low	Low	Low	Medium
O.7	Grounding	Ro-Ro manoeuvring to south-western berth	WC	Low	Medium	Low	Low
			ML	Low	Low	Low	Low

9.9 Risk assessment outcomes: Applied controls

9.9.1 This section discusses the differences (as applicable) between the further applicable controls/potential risk outcomes and the applied controls/ALARP risk outcomes displayed in Annexes A - C.

Construction

9.9.2 C1 – ***[Accidents to Personnel] Person overboard during dredge/construction works***. This risk possesses the same risk outcomes when comparing potential and ALARP however there has been an exclusion of one control and an inclusion of another not previously cited. The 'suitable PPE for construction personnel' control from the further applicable controls category has been removed as it was deemed that if construction personnel were to wear PPE that provided thermal protection in the water (e.g. dry suit/ immersion suit) then it would make conducting their duties more difficult and dangerous. However, with the applied control of a 'designated safety craft' being available to recover a person falling overboard, it was identified that the next most important control not yet considered was to make sure that a person falling overboard was detected. To ensure this, the control 'Contractor Risk Assessment Method Statement' was proposed specifically to include a provision that means personnel working in the vicinity of the water are not to do so alone. This control was discussed to have considerable mitigation to the consequence as the person accompanying the potential person overboard would be able to raise the alarm. The reduction in risk outcome from embedded to potential risk outcomes saw the 'People' receptor reduce from 'Major' to 'Moderate' for the worst credible scenario and from 'Moderate' to 'Minor' for the most likely scenario. The proposed mitigation for the applied controls was assessed to reduce consequence to the same degree as described above which is considered to be ALARP and within tolerability for each receptor.

9.9.3 C2 – ***[Allision] Dredger/construction vessel impact with IOT infrastructure***. This risk has changed between the potential risk outcome from seven 'low' and one 'NPR' and the ALARP risk at 4 'medium' and 4 'low'. The further applicable controls 'tidal restrictions' and 'marking construction area (exclusion zone)' have been taken forward however the implementation of 'IOT trunk way protection' specifically for mitigation from a dredger or construction vessel has not been taken forward at this time. This is because the cost of this control by far exceeds the reasonably practicable threshold of a dredger or construction vessel colliding with the IOT trunk way considering how the IOT is currently used, maintained, and operated in proximity of. Specifically, with respect to the movements of tankers, barges, survey vessels, maintenance dredging and other small craft as described in Section 3. IOT trunk way protection has not been ruled out (as an adaptive control during operation) however and may form part of the operational 'adaptive procedures' control of which the specific details will be determined on a progressive basis and managed by the Humber Estuary Services. An additional control of 'site specific dredge plan' was discussed so that the dredger would operate in consideration of the prevalent tidal flows in the vicinity of the IOT trunk way. Therefore, this risk was reduced from the embedded outcomes of seven 'medium' and one 'low' to the ALARP outcome of 4 'medium' and 4 'low' at which point the risk was considered to be ALARP and within tolerability for each receptor.

9.9.4 C3 – ***[Allision] Commercial vessel with marine works***. This risk was assessed during the HAZID workshops and considered to reduce from an embedded risk outcome of eight 'medium' outcomes to five 'medium' and three 'low' outcomes. The further applicable controls discussed were 'marking construction area (exclusion zone)', 'adaptive procedures', and 'guard (support) vessel'. All three of these further applicable controls were deemed to be required to make this risk ALARP and as so were applied. The ALARP outcomes of this risk are also inside the limits of tolerability.

9.9.5 C4 – ***[Collision] Two craft associated with the marine works***. This risk was discussed during the HAZID workshop and informed by the existing MSMS for Immingham and HES, this resulted in an embedded risk outcome of seven 'medium' and one 'low'. The only further applicable control to be identified for this risk was 'marking construction area (exclusion zone)' which was considered to have slight mitigation for frequency. It was perceived that in the workshop that this was insufficient to reduce the potential worst credible frequency from unlikely to rare and the most likely frequency from likely to possible. During the risk assessment and cost-benefit analysis stages it was considered that 'Constructor RAMS' could include a provision that locally managed vessel movements which was considered to also have a slight impact on frequency. Even with the application of these two controls in the risk assessment and applied controls section it was not perceived to reduce the frequency of occurrence for either the worst case or the most likely and as a result, with the inclusion of these two controls, the risk is deemed to be ALARP. Additionally, the ALARP outcomes of this risk are inside the previously defined limits of tolerability.

9.9.6 C5 – ***[Collision/Allision] Commercial vessel enters construction area***. This risk was assessed during the third HAZID workshop to have an embedded risk outcome including six 'medium' outcomes and two 'low' outcomes. The further applicable controls then discussed were; 'marking construction area (exclusion zone)', 'Adaptive procedures', 'personnel management during tanker berthing' and 'guard (support) vessel'. These controls were considered to have a combination of mitigation impacts for both consequence and frequency. As a result, the opinion of the third HAZID workshop's subject matter experts was that the potential risk outcomes for this risk are three 'medium' and five 'low'. Each of these controls was carried over through the cost-benefit analysis to the risk assessment and applied controls section resulting in the same outcomes for the risk which is also considered to be ALARP and tolerable. During the risk assessment stage it was noted that the analysis of potential risk consequences had a logical error which was corrected for the post cost-benefit analysis consequences. Specifically, the potential risk consequences saw a reduction in the most likely property receptors consequence from 'minor' to 'negligible' however no mitigation within the further applicable controls was deemed to be able to have that effect. It was considered that this same control's impact on the worst credible scenario's people receptor was not enough to reduce the embedded consequence from 'extreme' to 'moderate'. This consideration was incorporated into the post cost-benefit analysis consequence by categorising the consequence for the people receptor as 'major'.

9.9.7 C.6 – ***[Collision] Dredger collision with vessel at 'F' anchorage when disposing of dredge material***. This risk had an embedded risk outcome including seven 'medium' and one 'low'. The only further applicable control identified for this risk was 'adaptive procedures' which was considered too has the potential to provide very substantial mitigation to the frequency. In the third HAZID workshop this control was not considered to be sufficient to reduce the frequency for the worst credible and most likely scenarios and as such the potential risk outcomes remained the same. During the cost-benefit analysis discussion an additional control was proposed that HES would in addition ensure the 'closure of 'F' anchorage', therefore significantly reducing the likelihood of a collision, this control is deemed to substantially mitigate the frequency at which the hazard scenarios could occur and in combination with the '[project specific] adaptive' procedures' control it was assessed that the worst credible scenario's frequency was reduced to 'rare', and the most likely scenario's frequency was reduced to 'unlikely'. This brought the already tolerable risk to an ALARP state with ALARP risk outcomes including three 'medium' and five 'low'.

9.9.8 C.7 – ***[Grounding] Dredger grounding whilst engaged in operations***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes four 'medium' and four 'low'. The only further applicable control raised during the HAZID workshop was 'adaptive procedures' specifically citing additional training for dredge operators. This further applicable control was perceived to mitigate the frequency of the hazard scenarios very substantially and as a result the potential risk outcomes include one 'medium', six 'low' and one 'NPR'. This control was taken forward through the cost-benefit analysis and the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.9 C.8 – ***[Hazardous substance accidents] Hazardous chemical spill from construction vessel***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that included three 'medium' and five 'low'. This risk had no further applicable controls identified in the HAZID workshop however during the cost-benefit analysis discussion two controls in addition to the embedded controls were identified. Specifically, 'constructor RAMS', and 'control of contractors through management', these controls were both perceived to have a slight impact on the frequency of occurrence of the hazard scenarios however this was not deemed substantial enough to reduce the worst credible frequency from 'unlikely' or the most likely frequency from 'likely'. With the addition of these two controls the risk, which is well within the tolerability limit, was considered to be ALARP.

9.9.10 C.9 – ***[Other (Mooring)] Vessel mooring failure***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes six 'medium' and two 'low'. The only further applicable control raised during the HAZID workshop was 'guard (support) vessel' which could be a tug or other vessel as appropriate. This further applicable control was perceived to mitigate the frequency of the hazard scenarios to a fair degree and as a result the potential risk outcomes discussed in the third HAZID workshop included five 'medium' and three 'low'. This control was taken forward through the cost-benefit analysis and the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.11 C.10 – ***[Other (Cranage)] Component dropped during construction***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes six 'medium' and two 'low'. The only further applicable control raised during the HAZID workshop was 'incident reporting - dropped component' specifically citing establishment of a specific routine for reporting incidents related to components being dropped in the water to ensure that VTS is made aware without delay. This further applicable control was perceived to mitigate the frequency of the hazard scenarios to a fair degree and as a result the potential risk outcomes include three 'medium' and five 'low'. This control was taken forward through the cost-benefit analysis and was supplemented by the inclusion of a 'post construction hydrographic survey' which is perceived to provide slight mitigation to the frequency of the hazard scenario occurring in the event that an undetected and submerged or semi-submerged object would be identified on completion. This addition created no change between the potential risk frequency and the post cost-benefit analysis risk frequency whilst bringing the risk to an ALARP state, within tolerability limits.

9.9.12 C.11 – ***[Other (Swamping)] Workboat takes on water from excessive wash***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that included six 'medium' and two 'low'. The only further applicable control raised during the HAZID workshop was 'Marking construction area (exclusion zone)'. This further applicable control was perceived to mitigate the frequency of the hazard scenarios to a slight degree and as a result the potential risk outcomes discussed in the third HAZID workshop include three 'medium' and five 'low'. This control was taken forward through the cost-benefit analysis and was supplemented by the inclusion of 'Contractor RAMS' and 'Notices to Mariners' which had not been previously considered in the embedded controls of this risk. Each of these controls was perceived to provide slight mitigation to the frequency of the hazard scenarios occurring however, this addition created no change between the potential risk frequency and the post cost-benefit analysis risk frequency whilst bringing the risk to an ALARP state, within tolerability limits.

9.9.13 C.12 – ***[Other (Payload accident)] Incorrect payload distribution affects stability***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes five 'medium' and three 'low'. The only further applicable control raised during the HAZID workshop was the inclusion of a 'loading/ unloading plan' specifically developed to ensure stability is maintained while unloading/ loading occurs. This further applicable control was perceived to mitigate the frequency of the hazard scenarios to a considerable degree and as a result the potential risk outcomes discussed at the third HAZID workshop included eight ‘low’. This control was taken forward through the cost-benefit analysis and was supplemented by the inclusion of a ‘Contractor RAMS’ and ‘Harbour Master’s consent of works’ (i.e. consent provided by HES and Immingham for loading/ unloading operations). Each of these controls was perceived to provide slight mitigation to the frequency of the hazard scenarios occurring. These additional controls, however, provided no perceived change between the potential risk frequency and the post cost-benefit analysis risk frequency whilst bringing the risk to an ALARP state, within tolerability limits.

Construction-operation

9.9.14 CO.1 – ***[Collision] Craft associated with the marine works with a Ro-Ro Vessel***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes seven ‘medium’ and one ‘low’. The further applicable controls raised during the third HAZID workshop were ‘special Instructions issued to Ro-Ro not to berth unless area is clear of marine works craft’ and ‘additional measures to ensure separation of marine works from Ro-Ro vessels proceeding to or departing IERRT’ specifically citing VTS moving craft away from the area during Ro-Ro arrivals and departures. These further applicable controls were perceived both to mitigate the frequency of the hazard scenarios very substantially and as a result the potential risk outcomes include two ‘medium’, five ‘low’ and one ‘NPR’. These controls were taken forward through the cost-benefit analysis and were supplemented by including a control for a ‘port liaison officer’ to assist VTS and contractor communications. This added control was perceived to mitigate the frequency to a fair degree. Following this, the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.15 CO.2 – ***[Other (Mooring)] Ro-Ro mooring failure in vicinity of marine works on IERRT***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes eight ‘medium’. The further applicable controls raised during the HAZID workshop were ‘Hooks with load monitoring’, ‘additional storm bollards’ and, ‘berth specific weather parameters’. These further applicable controls were perceived to mitigate the frequency of the hazard scenarios to a variety of degrees and as a result the potential risk outcomes discussed in the third HAZID workshop included six ‘medium’ and two ‘low’. The ‘hooks with load monitoring’ and ‘additional storm bollards’ controls were not taken forward through the cost-benefit analysis as it was determined that the embedded control ‘mooring analysis’ would provide the appropriate answer and to over-engineer a solution would undermine the process whilst not returning meaningful risk mitigation to an already tolerable risk. The cost-benefit analysis discussion did however take forwards the ‘berth specific weather parameters’ control which is perceived to provide slight mitigation to the frequency of the worst credible scenario reducing the frequency from ‘unlikely’ to ‘rare’. At this point the risk was deemed to be ALARP, whilst also remaining within tolerability limits.

9.9.16 CO.3 – ***[Other (Cranage)] Component dropped during construction preventing Ro-Ro Operations***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes four 'medium' and four 'low'. The only further applicable control raised during the HAZID workshop was 'incident reporting - dropped component' specifically citing establishment of a specific routine for reporting incidents related to components being dropped in the water to ensure that VTS is made aware without delay. This further applicable control was perceived to mitigate the frequency of the hazard scenarios to a fair degree and as a result the potential risk outcomes include one 'medium' and seven 'low'. The reason for the differential potential outcome between this risk and Risk C10 of the same name is due to Risk C10 considering the dropped component striking a tanker whereas this worst credible hazard scenario considered the dropped component striking a Ro-Ro vessel. This control was taken forward through the cost-benefit analysis and was supplemented by the inclusion of a 'post construction hydrographic survey' which is perceived to provide slight mitigation to the frequency of the hazard scenario occurring in the event that an undetected and submerged or semi-submerged object would be identified on completion. This addition created no change between the potential risk frequency and the post cost-benefit analysis risk frequency whilst bringing the risk to an ALARP state, within tolerability limits.

9.9.17 CO.4 – ***[Other (Swamping)] Workboat takes on water from excessive wash from Ro-Ro***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes three 'significant', three 'medium' and two 'low'. The further applicable controls raised during the HAZID workshop were 'special instructions issued to Ro-Ro not to berth unless area is clear of marine works craft' and 'additional measures to ensure separation of marine works from Ro-Ro vessels proceeding to or departing IERRT' which specifically cited VTS involvement in moving marine craft away from pier being berthed on prior to Ro-Ro arriving in the berth pocket. These further applicable controls were both perceived to mitigate the frequency of the hazard scenarios very substantially and as a result the potential risk outcomes discussed at the third HAZID workshop include two 'medium' and six 'low'. Both of these controls were taken forward through the cost-benefit analysis and the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.18 CO.5 – ***[Allision] Ro-Ro contact with IERRT infrastructure***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes two 'significant', five 'medium' and one 'low'. The further applicable controls raised during the HAZID workshop were 'additional training to PEC and Pilots on manoeuvring during the operation-construction phase' and 'berthing criteria specific to operation-construction'. These further applicable controls were both perceived to mitigate the frequency of the hazard scenarios considerably and the consequence to a fair degree. This is because a well-trained and familiar PEC/Pilot, specifically for a particular berth/change, provides the skill required to both avoid the hazardous event occurring and, if it does occur, they will have taken appropriate action to reduce the impact as much as possible. Further, specific berthing criteria inherently seeks to reduce the frequency of occurrence, but it can also reduce the consequence if elements such as tugs, weather or tide are considered. It should be noted that the reduction effects on frequency for this control in particular are dependent on the berthing criteria applied. As a result of applying these controls the potential risk outcomes includes one 'medium' and seven 'low' as determined within the third HAZID workshop. These controls were taken forward through the cost-benefit analysis and the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.19 CO.6 – ***[Other (Mooring)] Flat top barge breaks free of mooring***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes three 'significant', one 'medium' and four 'low'. The only further applicable control raised during the HAZID workshop was 'during operation and construction ensure a safety boat/tug is available to assist whilst a Ro-Ro is manoeuvring in close proximity'. This control specifically considers having an assisting vessel able to prevent flat top barge from drifting onto the Eastern Jetty able to reduce the speed and impact of the resulting allision. This further applicable control was perceived to mitigate the frequency of the hazard scenarios considerably and the consequence to a fair degree. As a result the potential risk outcomes discussed at the third HAZID workshop include two 'medium' and six 'low'. During the cost-benefit analysis stage an additional control was brought forward to further reduce this risk, specifically, 'Barges cannot be moored in the vicinity of a berthing Ro-Ro'. This control was perceived to mitigate frequency of the hazard scenarios occurring to a considerable degree. With these two controls the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.20 CO.7 – ***[Allision] Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2 with a tanker berthed on Eastern Jetty***. This risk was not discussed at the third HAZID workshop but was brought forward (as two separate risks) in correspondence by DFDS dated 29 August 2022 as part of the first round of stakeholder consultation following the third HAZID workshop. The associated spreadsheet contained embedded risk outcomes without the consideration of any controls. This risk was further evaluated, and applied controls seen from similar scenarios within this NRA and amalgamated the two risks (arrival and departure) into a single one that considered arrival/departure. This was due to the hazard scenario addressing the consequences of a tanker being struck whilst berthed on the Eastern Jetty rather than assessing which direction the Ro-Ro vessel was potentially going when potential identified allision could occur in the context of this risk. This risk was then re-assessed, with the inclusion of controls and with the potential row (see Annex B, CO.7, third row) completed. Additionally, it was included in the Construction-Operation and Operation contexts for analysis and comment during the second round of stakeholder consultation. Once comprehensive consideration had been given to risk CO.7 (and O.9) by external stakeholders it was determined to have an embedded risk outcome that includes two significant and six 'medium'. The additional applicable controls considered to further mitigate this risk were 'charted safety area, berthing procedures', 'additional pilotage training/ familiarisation' and 'berthing criteria' specifically to consider tide, tugs and/or weather. Berthing criteria was perceived to have the same mitigation here as described in other risks and resulted in frequency being mitigated to a considerable degree and consequence to a fair degree. The same logic was then applied to the other two further applicable controls; charted safety area, berthing procedures and additional pilotage training/familiarisation which were perceived to provide frequency mitigations of slight and minute respectively. These further applicable controls resulted in the potential risk including eight ‘medium’ outcomes. All of these controls were discussed during the risk assessment and cost-benefit analysis stages, and it was decided to take them all forwards. This risk was then deemed to be ALARP, whilst also being within tolerability limits.

Operation

9.9.21 O.1 – ***[Allision] Vessel proceeding to/from Immingham Eastern Ro-Ro with tanker moored at IOT Finger Pier***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes three ‘significant’ and five ‘medium’. The further applicable controls raised during the HAZID workshop were ‘move finger pier to east side of trunk way’, ‘charted safety area, berthing procedures’, ‘additional pilotage training/ familiarisation’, and ‘berthing criteria’ specifically citing the potential for tidal limits, tugs, or weather limits (to be determined). The further applicable control involving the IOT Finger Pier moving to the other side of the IOT was immediately identified to be a control that would eliminate the risk as it would not be possible to hit the IOT Finger Pier if it was not there. It should be noted that this control alone would be sufficient to reduce all outcomes to ‘NPR’ and as such, in risks O.2 and O.3 this control was included but the mitigation was not applied to avoid a situation where any risk considering the IOT Finger Pier was mitigated to the maximum potential. This allowed the assessment of each risk (O.1-O.3) in comparison to one another and see how different mitigations affected the potential risk outcomes rather than comparing three sets of ‘NPR’. It is imperative to understand in so doing that the potential to move the IOT Finger Pier was brought up and discussed for each relevant risk at the cost-benefit analysis. The risk assessment and cost-benefit analysis discussion saw the inclusion of the other three remaining controls (i.e. all except moving the finger pier) and considered if these alone were sufficient for the risk to be considered ALARP and tolerable. ‘Berthing criteria’ and ‘charted safety area, berthing procedures’ were considered in the same way for this risk as has elsewhere been done so in this section with frequency mitigation of considerable and slight respectively, whilst the added potential implications of specific berthing criteria also saw the inclusion of consequence mitigation to a fair degree. Finally, the inclusion of pilotage training and familiarisation was amalgamated into ‘project specific adaptive procedures’. These procedures have been identified in this risk assessment to account for the potential changing of restrictions placed upon the operations of the IERRT whilst familiarisation takes place. These measures could include a variety of sub controls that will start out as very imposing and as experience grows, they may be relaxed progressively by HES. Specifically, adaptive procedures could include the requirement for tugs (number and size), tidal restrictions, weather parameters, additional training, and physical protection such as piles to protect the IOT trunk way if later deemed to be required. Adaptive procedures specific to this proposed development are perceived to have the possibility to mitigate frequency to a considerable degree and consequence to a fair degree depending on the specific details of the included controls. With these three controls in place the ALARP risk outcome was determined to be eight 'medium'. Discussion during the cost-benefit analysis then centred around whether or not the IOT Finger Pier being moved would be reasonably practicable. It was ultimately determined that the movement of the finger pier was not reasonably practicable in the context of the other controls applied and the risk was declared to be ALARP, whilst also being within tolerability limits.

9.9.22 O.2 – ***[Allision] Tanker manoeuvring on/off IOT Finger Pier (flood tide)***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes five 'significant', one 'medium' and two 'low'. The further applicable controls raised during the HAZID workshop were 'increased use of tugs' and 'tidal limitations/weather restrictions'. This resulted in a potential risk outcome of two 'medium' and six ' low'. However, the tidal restrictions discussed here in light of the tanker operations were identified to not be appropriate during the cost-benefit analysis as it would have commercial implications for the operator of the IOT. Further, the control of moving the IOT Finger Pier was also discussed but as per the rationale of risk O.1 it was not taken forward in the cost-benefit analysis. The further applicable control regarding tugs was taken forward however, as part of adaptive procedures which were then holistically included in the risk assessment and applied controls section of this risk. Due to the adaptive nature of this control it is assessed to have less frequency mitigation than permanently applying the increased use of tugs perceived to mitigate the frequency and as a result the mitigation was perceived to be considerable for frequency and fair for consequence. The ALARP risk outcome was then assessed as six 'medium' and two 'low'. The risk was then deemed to be ALARP, whilst also being within tolerability limits.

9.9.23 O.3 – ***[Allision] Barge manoeuvring on/off IOT Finger Pier (flood tide)***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes four 'significant' and four 'medium'. The further applicable controls raised during the HAZID workshop were 'moving the finger pier' and 'tidal limitations/ weather restrictions'. As described in risk O.2, however, this control was discussed as being applied to the operator and the commercial implications were not favourable for its support. This further applicable control regarding tide and weather limitations was taken forward as part of adaptive procedures which were then holistically included in the risk assessment and applied controls section of this risk. Again, the discussion around the movement of the IOT Finger Pier found that this control was too expensive and potentially too impactful on the environment for the benefit it could provide in mitigating the risk. That is, the project specific adaptive procedures are sufficient to satisfy the reasonably practicable criteria. The ALARP risk outcome was assessed to be five 'medium' and three 'low', at this point the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.24 O.4 – ***[Allision] Ro-Ro allision with IOT trunk way***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes eight 'significant'. The further applicable controls raised during the HAZID workshop were 'Impact protection', 'berthing criteria' and, 'additional tug provisions'. These further applicable controls were perceived to mitigate the frequency and the consequence of the risk to varying degrees which can be found in Annex C, most notably, the control for impact protection was perceived to be very substantial mitigation for both frequency and consequence. As a result the potential risk outcomes included two 'medium', and six 'low'. The cost-benefit analysis meeting discussed the potential to include impact protection as part of the potential adaptive control measures. Provisions for the inclusion of impact protection have been included in the DCO application for IERRT but the impact protection measures will only be provided if considered necessary as part of the project specific adaptive controls. If, during the management of this risk in the future, HES determines that (for example) to berth without tugs on an ebb tide would require impact protection as mitigation then this is included within the context of 'adaptive procedures'. This risk was then reassessed in the context of the applied controls and had an ALARP outcome of two 'medium' and six 'low'. This was deemed to be ALARP whilst also being within tolerability.

9.9.25 O.5 – ***[Allision] Ro-Ro contact with IERRT infrastructure***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes three 'medium' and five 'low'. The further applicable controls raised during the HAZID workshop were the same as for risk CO.5 of the same name whilst this risk is considered sans 'construction'. The further applicable controls identified in the third HAZID workshop were 'additional training', 'berthing criteria'. These further applicable controls are both perceived to mitigate the frequency of the hazard scenarios considerably and mitigate the consequence to a fair degree. As a result the potential risk outcomes include two 'medium', five 'low' and one 'NPR'. These controls were taken forward through the cost-benefit analysis and the berthing criteria was further specified as needing to exist for each of the three berths. At this point the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.26 O.6 – ***[Collision] Ro-Ro on passage to/from Immingham Eastern Ro-Ro Terminal with another vessel***. This risk was discussed at the third HAZID workshop and was requested to be drawn from the HES MSMS. The receptor outcomes were interpolated and distributed as part of the first round of consultation following the third HAZID workshop. The embedded risk outcome that includes six 'medium' and two 'low'. No further applicable controls were identified as this risk is currently monitored in practice and is considered ALARP within the context of the embedded controls, whilst also being within tolerability limits.

9.9.27 O.7 – ***[Grounding] Ro-Ro manoeuvring to south-western berth***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes four 'medium' and four 'low'. The further applicable controls raised during the HAZID workshop were 'increase size of dredge pocket', 'berthing criteria' and, 'marking safe water with AtoN'. These further applicable controls were perceived to mitigate the frequency of the hazard scenarios to a minute, considerable and fair degree respectively with the berthing criteria control also having a fair degree of mitigation on the hazard scenario's consequence. As a result the potential risk outcomes include one 'medium' and seven 'low'. Increasing the size of the dredge pocket was discussed at the cost-benefit analysis however the ecological implications of doing so and the minimal mitigation offered caused this control to fall outside of reasonable practicability. The remaining controls were taken forward through the cost-benefit analysis and the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.28 O.8 – ***[Other (Mooring)] Ro-Ro vessel breaks free of moorings***. This risk was discussed at the third HAZID workshop and had an embedded risk outcome that includes seven 'medium' and one 'NPR'. The further applicable controls raised during the HAZID workshop included 'hooks with load monitoring', 'additional storm bollards', and 'berth specific weather parameters'. These further applicable controls were perceived to mitigate the frequency of the hazard scenarios to a fair, very substantial and slight degree respectively. As a result the potential risk outcomes included six 'medium', one 'low' and one 'NPR'. The addition of hooks with load monitoring and additional storm bollards were considered superfluous in the cost-benefit analysis discussion as there is an embedded control for a mooring analysis that will provide the correct solution and prevent overengineering needlessly. However, the control regarding weather parameters was taken forwards as this could aid prevention of a worst credible hazard scenario occurring with minimal cost. Following this inclusion the risk was deemed to be ALARP, whilst also being within tolerability limits.

9.9.29 O.9 – ***[Allision] Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2-3 with a tanker berthed on eastern jetty***. This risk was included in Operation in addition to Construction-Operation to allow stakeholders the opportunity to raise any difference of opinion between how this risk might be affected differently within each environment. Risk O.9 therefore was drafted with the same controls and mitigation as risk CO.7. Considerations for the risk assessment and applied controls were discussed at the cost-benefit analysis meeting where this risk was deemed ALARP and within tolerability. For further detail, see paragraph 9.9.20 (Risk CO.7).

10 Summary

10.1.1 The NRA considers potential impacts to all vessels that operate within the study area and the Port of Immingham. The baseline environment for the commercial shipping and recreational navigation has been described through a desk-based compilation of datasets and included AIS data, tidal data, considerations from the vessel simulation study and data collected from the HAZID workshops.

10.1.2 The HAZID workshops have identified a set of 28 hazard scenarios associated with the proposed development. Through a set of defined stages, drawn from the PMSC, a risk assessment process has evaluated the outcome risk to be both tolerable and in an ALARP state. This indicates that the risks associated with the proposed development are suitably mitigated by the controls either currently in place or by controls that will be established to further reduce risk.

10.1.3 It is recommended that this risk assessment is used to inform amendments to the Marine Safety Management System that is currently in place at the Port of Immingham to ensure that risks are appropriately captured, monitored, and updated as required based on the latest information available as time goes on.

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12 Abbreviations/Acronyms

Acronym	Definition
ABP	Associated British Ports
ABPmer	ABP Marine Environmental Research Ltd
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
APT	Associated Petroleum Terminals (Immingham) Ltd
AtoN	Aids to Navigation
AWAC	Acoustic Wave and Current
BDB Pitmans	Bircham Dyson Bell and Pitmans LLP
C	Construction
CCTV	Closed-Circuit Television
CD	Chart Datum
CHA	Competent Harbour Authority
CLdN	CLdN Group
CO	Construction and Operation
COLREGs	International Regulations for Preventing Collisions at Sea 1972
COVID	Coronavirus
CRO	CLdN Group
DCO	Development Consent Order
DFDS	Det Forenede Dampskibs-Selskab
DfT	Department for Transport
DOS	Disk Operating System
DWT	Deadweight
EIA	Environmental Impact Assessment
ES	Environmental Statement
FSA	Formal Safety Assessment
GLA	General Lighthouse Authority
GT	Gross Tonnage
GtGP	Guide to Good Practice on Port Marine Operations
HAZID	Hazard Identification
HASB	Harbour Authority Safety Board
HES	Humber Estuary Service
HESMEP	Humber Estuary Serious Marine Emergency Plan
HM	His (Her) Majesty's

Acronym	Definition
HUMEX	Humber Oil Spill Incident Management Exercise
IALA	International Association of Marine Aids to Navigational and Lighthouse Authorities
ID	Identity
IERRT	Immingham Eastern Ro-Ro Terminal
IMM	Immingham
IMO	International Maritime Organization
IOH	Immingham Outer Harbour
IOT	Immingham Oil Terminal
ISM	International Safety Management
LLA	Local Lighthouse Authority
LOA	Length Overall
LPS	Local Port Services
MAIB	Marine Accident Investigation Branch
MARNIS	Marine Accident Incident Reporting Database
MCA	Maritime and Coastguard Agency
MCC	Marine Control Centre
MCGA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
ML	Most Likely
MSMS	Marine Safety Management System
NASH	NASH Maritime Ltd.
NPR	No Practicable Risk
NPSfP	National Policy Statement for Ports
NRA	Navigational Risk Assessment
O	Operation
OREI	Offshore Renewable Energy Installations
PANAR	Providers Aids to Navigation Availability Reporting
PAVIS	Port and Vessel Information System
PEC	Pilot Exemption Certificate
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
PMSC	Port Marine Safety Code
PPE	Personal Protective Equipment
RAMS	Risk Assessment Method Statement
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations

Acronym	Definition
Rix	Rix Petroleum Ltd.
RNLI	Royal National Lifeboat Institution
Ro-Ro	Roll-On/Roll-Off
RYA	Royal Yachting Association
SHA	Statutory Harbour Authority
SMS	Safety Management System
SOP	Standard Operating Procedure
STCW	Standards of Training, Certification and Watchkeeping
SteerCo	ABP Steering Committee
THLA	Trinity House Lighthouse Authority
TSHD	Trailer Suction Hopper Dredger
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency
VLS	Very Large Ship
VTS	Vessel Traffic Services
WC	Worst Credible
WL	Water Level

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

13 Glossary

Term	Definition
Adverse weather conditions	Conditions during which navigation or mooring of vessels is adversely affected
AIS failure	A failure of the 'Automatic Identification System' equipment which provides vessel automated location signals
Cargo handling	The management, loading and unloading of goods from a vessel
COLREGs failure to comply	A failure of a crew on a vessel to observe the requirements of the International Regulations for Preventing Collisions at Sea 1972 (as amended), informally known as the 'rules of the road'
Communication failure - equipment	Failure of communications between personnel (specifically due to equipment failure)
Communication failure - Operational/procedural	Failure of communications between personnel (due to equipment failure, language problems or misunderstandings) – which is operational and/or procedural
Communication failure - Personnel	Failure of communications between personnel (due to equipment failure, language problems, procedural reporting failures or misunderstandings)
Competence	A measure of the experience and qualification of the mariner
Designated berth unavailable	The berth at which the vessel is planned to use, is not available
Excessive vessel speed	The vessel is travelling too fast in the given situation
Failure to comply with safe systems of work	A failure to follow the stated 'safety systems of work' as part of the safety management system
Failure to comply with Towage guidelines	When carrying out towing within a port, guidelines for the safe operation of this activity are published
Failure to comply with VTS/LPS/SOPs instructions	A failure of ship or port personnel to follow the stated instructions of the Local Port Service (as written within Standard Operating Procedures)
Failure to follow passage plan	The journey/voyage plan of the vessel, is not followed by the crew or embarked pilot
Fire/Explosion	Fire/Explosion
Human error	Human error

Term	Definition
Human error/fatigue - Port/Marine Personnel	Human error – port/dock employees
Human error/fatigue - Ship Personnel	Errors made by personnel working onboard the vessel
Inaccurate vessel details provided	Information provided by the vessel's Master, crew or vessel agent is inaccurate
Inadequate bridge resource management	A lack of human resource, or competent resource on the vessels bridge to carry out navigation and/or shipboard functions
Inadequate maintenance/inspection	An inadequate maintenance or inspection regime by the port or a vessel
Inadequate number/type tugs	A lack of tug resource
Inadequate procedures in place onboard vessel	The vessel's Safety Management System is not followed as stated or does not adequately prescribe for this operation
Inadequate procedures shoreside	The procedures for port or third-party contractor staff are not followed as stated or do not adequately prescribe for this operation
Inadequate training/competence - Others	Training and/or competence of others (not associated with a vessel or the port)
Incapacitated master (drinks/drugs)	Consumption of alcohol or the use of drugs by a mariner, specifically the vessel's Master (Captain)
Incorrect assessment of tidal flow	An incorrect interpretation of the tidal flow or the effects it will have on vessel navigation by a mariner
Interaction	Vessels interact when one passes close to another, causing a deviation in course or movement in berthed vessels. The greater the speed, the more pronounced the interaction
Language problems	Difficulties caused by language/understanding between personnel
Malicious action by external parties	A third party carried out a malicious, egregious, or intentional action
Protest by external parties	Protests
Restricted visibility	The restriction of visibility through atmospheric conditions, such as fog, mist, heavy rain, or snow
Risk Assessment, Incomplete/not reviewed	Completion of the risk assessment writing, checking or review process

Term	Definition
Ship/Tug/Launch failure	Failure, of any type, by a ship/tug/launch involved in a maritime operation
Shoreside light backscatter	The background lights in the port and/or harbour obscure or affect navigational lights of other vessels or aids to navigation, such as buoys
Tug failure towing equipment	A tug whilst providing services to another vessel, may suffer a failure in the tow wire/rope or associated equipment
Vessel breakdown or malfunction	A breakdown, malfunction or defect with equipment onboard the vessel
Vessel fails to notify hazardous cargo	Vessels carrying dangerous cargos are required to report these in advance to the harbour authority
Weather and hydro failure - equipment	Failure of equipment used to measure environmental conditions

Annexes

A Navigational Risk Assessment: Construction

Table A1 Hazard Category: Accidents to personnel; Scenario: Person overboard during dredge/construction works; Risk ID C1

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	Control	Comment								
Communication failure - Operational/procedural	Communications equipment	Vessels have VHF radios available	Person falls overboard, isn't detected, and drowns, no pollution, no property damage and negative local publicity.	Possible	People	Major (4)	Person falls overboard and is recovered from the water, suffering serious injuries.	Poss ble	People	Moderate (3)
Inadequate procedures in place onboard vessel	Personal Locator Beacon	HES requirement			Property	Negligible (1)			Property	Negligible (1)
Failure to comply with safe systems of work					Planet	Negligible (1)			Planet	Negligible (1)
Vessel breakdown or malfunction	Support vessel	Has dual function as safety vessel		3	Port	Moderate (3)		3	Port	Minor (2)
Towing equipment failure	Local Port Service	Immingham Marine Control Centre (MCC)								
Loss of vessels stability (due to other than loss of watertight integrity)	Vessel safety management system (ISM code)	Requires emergency procedures to be available								
Inadequate training/competence - Others										
Adverse weather conditions										
Restricted visibility										
Human error/fatigue - Vessel/ Marine Personnel										
Risk Assessment, Incomplete/not reviewed										
Poor situational awareness	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.								
Interaction with passing vessel										
	Emergency services equipment - shore side	Ambulance service								
	CCTV coverage	CCTV coverage of the port and approaches. Maintenance contract support								
Further Applicable Controls	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Control										
Suitable PPE for construction personnel		Very Substantial	Contractor checks by HES, discussions around additional thermal protection to prevent exposure	Possible	People	Moderate (3)	Possible	People	Minor (2)	
					Property	Negligible (1)		Property	Neglig ble (1)	
					Planet	Negligible (1)		Planet	Neglig ble (1)	
Designated safety craft		Considerable		3	Port	Moderate (3)	3	Port	Minor (2)	
Risk Assessment and Applied Controls	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Control										
Designated safety craft		Considerable		Possible	People	Moderate (3)	Possible	People	Minor (2)	
Constructor RAMS		Considerable	To include no lone working		Property	Negligible (1)		Property	Neglig ble (1)	
					Planet	Negligible (1)		Planet	Neglig ble (1)	
				3	Port	Moderate (3)	3	Port	Minor (2)	

Table A2 Hazard Category: Allision; Scenario:Dredger/construction vessel impact with IOT infrastructure; Risk ID C2

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	Control	Comment								
Vessel breakdown or malfunction	Safety/support boat or tug	To manage barges	Dredge/construction vessel makes heavy contact with trunk way, causing a tier 3 pollution and significant damage to property. Multiple deaths to personnel working on the trunk way and negative international damage to port reputation.	Unlikely	People	Extreme (5)	Loss of control causes the flat top barge to contact the piles of trunk way. Minor pollution and injuries to personnel occur. Stop to operations while inspections are carried out on the IOT piles, minor interruptions to IOT operations.	Possible	People	Minor (2)
Towing equipment failure	Local Port Service	Immingham Marine Control Centre (MCC)			Property	Extreme (5)			Property	Minor (2)
Inadequate number/type tugs					Planet	Extreme (5)			Planet	Negligible (1)
Excessive vessel speed	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.		2	Port	Extreme (5)		3	Port	Minor (2)
Poor situational awareness										
Interaction with passing vessel										
Communication failure - Personnel	Communications equipment	Vessels have VHF radios available								
Manoeuvre misjudged										
Human error/fatigue - Vessel Personnel										
Inadequate bridge resource management										
Inadequate procedures in place onboard vessel	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
Inadequate training/competence - Others										
Adverse weather conditions										
Restricted visibility										
COLREGs failure to comply										
Incorrect assessment of tidal flow										
	Oil spill contingency plans	Covers the response to a pollution event								

Further Applicable Controls Control	Frequency Mitigation	Consequence Mitigation	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence	
Tidal restrictions	Fair		Vessel dependant	Rare	People	Minor (2)	Rare	People	Minor (2)
IOT trunk way protection	Very Substantial	Very Substantial			Property	Minor (2)		Property	Minor (2)
Marking construction area (exclusion zone)	Slight		Marking around the extremity of the construction zone		Planet	Minor (2)		Planet	Negligible (1)
				1	Port	Minor (2)	1	Port	Minor (2)

Risk Assessment and Applied Controls Control	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence	
Tidal restrictions	Fair		Vessel dependant as appropriate	Rare	People	Extreme (5)	Unlikely	People	Minor (2)
Marking construction area (exclusion zone)	Slight		Marking around the extremity of the construction zone		Property	Extreme (5)		Property	Minor (2)
Site specific dredge plan	Fair		Designed with prevalent tidal flows considered		Planet	Extreme (5)		Planet	Negligible (1)
				1	Port	Extreme (5)	2	Port	Minor (2)

Table A3 Hazard Category: Allision; Scenario: Commercial vessel with marine works; Risk ID C3

Risk Analysis: Causes	Embedded Controls: Control	Embedded Controls: Comment	Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Failure to follow passage plan	Passage planning	All vessels are required to operate in accordance with their passage plans	Tanker proceeding to IOT Finger Pier makes contact with marine works resulting in damage to hull and loss of cargo. Incident results in; a single fatality from impact, tier 3 pollution, and international reputation damage. Delay to marine works and operations at IOT during response and following investigation.	Unlikely	**People**	Major (4)	Tanker transiting to berth makes contact with infrastructure at slow speed, leading to minor damage to vessel, no loss of cargo, minor injuries to crew and minor delays to marine works caused by investigations and ship survey.	Almost Certain	**People**	Minor (2)
Towing equipment failure	Towage, available and appropriate	Available at the port			**Property**	Major (4)			**Property**	Minor (2)
Inadequate number/type tugs					**Planet**	Extreme (5)			**Planet**	Negligible (1)
Excessive vessel speed	Byelaws	Statutory powers of direction		2	**Port**	Extreme (5)		5	**Port**	Minor (2)
COLREGs failure to comply	International COLREGs 1972 (as amended)	All ships operate in accordance with COLREGs								
Manoeuvre misjudged	Harbour Authority requirements	Expert local knowledge and updated on activities (pilotage PEC requirements)								
Inadequate bridge resource management										
Restricted visibility	Aids to navigation, Provision and maintenance of	Port lights and visual aids overseen by LLA and GLA. Signal lights.								
Adverse weather conditions										
Communication failure - Operational/procedural	Communications equipment	Vessels have VHF radios available								
High traffic density	AIS/Radar coverage	VTS monitor movements of vessels in the Harbour Area								
Notice to Mariners failure to observe	Notices to mariners	Issued by the Harbour Authority with information about the development								
Human error/fatigue - Vessel Personnel	Training of port marine/operations personnel	Port's marine training policy								
Inadequate procedures in place onboard vessel										
Vessel breakdown or malfunction	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
Interaction with passing vessel	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.								
Poor situational awareness										
Incorrect assessment of tidal flow										
	Oil spill contingency plans	Covers the response to a pollution event								

Further Applicable Controls: Control	Frequency Mitigation	Consequence Mitigation	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence	
Marking construction area (exclusion zone)	Slight		Marking around the extremity of the construction zone	Rare	**People**	Major (4)	Likely	**People**	Minor (2)
					Property	Major (4)		**Property**	Minor (2)
Adaptive procedures	Very Substantial		Training of PEC or Pilots		**Planet**	Extreme (5)		**Planet**	Negligible (1)
Guard (support) vessel	Fair		Could be tug or additional vessel	1	**Port**	Extreme (5)	4	**Port**	Minor (2)

Risk Assessment and Applied Controls: Control	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence	
Guard (support) vessel	Fair		Should be tug or another suitable vessel	Rare	**People**	Major (4)	Likely	**People**	Minor (2)
					Property	Major (4)		**Property**	Minor (2)
Project specific adaptive procedures	Very Substantial		Familiarisation training of PEC or Pilots		**Planet**	Extreme (5)		**Planet**	Negligible (1)
Marking construction area (exclusion zone)	Slight		Marking around the extremity of the construction zone	1	**Port**	Extreme (5)	4	**Port**	Minor (2)

Table A4 Hazard Category: Collision; Scenario: Two craft associated with the marine works; Risk ID C4

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Towage guidelines - failure to comply	Tugs - availability of appropriate	Control measure for specific vessels	One marine works craft sinks causing multiple fatalities, moderate damage to the vessels involved (£750,000-4 million). Tier 2 pollution from bunker tank and hazardous cargo. Major impact on Port Business and reputation.	Unl kely	People	Extreme (5)	Minor damage to both vessels. No measurable pollution from bunkers or cargo. Minor injuries to personnel. Minor disruption to Port Business and reputation.	Likely	People	Minor (2)
Tugs - inadequate number/type ordered or supplied					Property	Moderate (3)			Property	Minor (2)
Procedures - vessel, inadequate	Passage planning	Arrival/departure - advance notice of			Planet	Moderate (3)			Planet	Negligible (1)
Traffic density - high	VTS broadcast - traffic information			2	Port	Major (4)		4	Port	Minor (2)
Human Annex/Fatigue	Fatigue and Health monitoring									
Restricted visibility	Aids to navigation - provision and maintenance of	Monitored by Trinity house as GLA (PANAR)								
Adverse weather conditions										
Aid to Navigation - failure (out of position/unlit)	Notices to mariners									
Bridge resource management -inadequate	Ship personnel - training	STCW requirement for commercial vessels								
Breakdown/malfunction - vessel	Emergency plan exercises	HUMEX exercise run once per year covering different scenarios								
VTS Radar failure - equipment or display	AIS coverage	VTS have AIS coverage for the entire area to support vessels with AIS								
AIS failure - equipment or display										
Adverse tide /current	Tidal information - accurate	Oceanwise system with DOS backup and visual boards								
VTS/LPS instructions - failure to comply	Harbour/Dock Masters powers (inc. special directions)	Provide powers to intervene								
Byelaws/harbour directions/local regulations - failure to comply	Byelaws	Applicable to all vessels navigating in the Humber SHA								
Interaction from other vessels										
Manoeuvre misjudged										
Communication failure - personnel										
Vessel obstructing fairway / Traffic Separation Scheme	General directions	Provide powers to intervene								
	Unusual vessels - specific risk assessments	Control measure for specific vessels								
COLREGs - failure to comply	International COLREGs 1972 (as amended)	Provides navigational guidance								
Communication failure - equipment (VHF, telephone, etc.)	Local port service (LPS)									
	Oil spill contingency plans	Humber Clean reauthorised by MCA in 2021								

Further Applicable Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Marking construction area (exclusion zone)	Slight		Around the extremity of the construction zone	Unl kely	People	Extreme (5)	Likely	People	Minor (2)	
					Property	Moderate (3)		Property	Minor (2)	
					Planet	Moderate (3)		Planet	Negligible (1)	
				2	Port	Major (4)	4	Port	Minor (2)	

Risk Assessment and Applied Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Contractor RAMS	Slight		Locally managed vessel movements	Unl kely	People	Extreme (5)	Likely	People	Minor (2)	
Marking construction area (exclusion zone)	Slight		Around the extremity of the construction zone		Property	Moderate (3)		Property	Minor (2)	
					Planet	Moderate (3)		Planet	Negligible (1)	
				2	Port	Major (4)	4	Port	Minor (2)	

Table A5 Hazard Category: Collision/Allision; Scenario: Commercial vessel enters construction area; Risk ID C5

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	Control	Comment								
Failure to comply with Towage guidelines	Towage, available and appropriate	Available at the port	Tanker enters construction area and collides with a jack-up barge; which flips the jack up causing multiple fatalities to personnel. The tanker struck the barge on the fore peak causing damage forward of the collision bulkhead, moderate pollution from jack-up barge. Major damage to property and international publicity.	Unlikely	People	Extreme (5)	Tanker or barge has an allision with constructed infrastructure resulting in a glancing blow with minor damage to barge, no pollution, minor injuries to personnel and little local publicity.	Possible	People	Minor (2)
Inadequate number/type tugs					Property	Major (4)			Property	Minor (2)
Failure to follow passage plan	Passage planning	All vessels are required to operate in accordance with their passage plans			Planet	Minor (2)			Planet	Neglig ble (1)
Manoeuvre misjudged	Harbour Authority requirements	Expert local knowledge and updated on activities (pilotage PEC requirements)		2	Port	Extreme (5)		3	Port	Minor (2)
Communication failure - Operational/procedural	Communications equipment	Vessels have VHF radios available								
AIS failure/ lack of AIS	AIS/Radar coverage	VTS monitor movements of vessels in the Harbour Area								
Incorrect assessment of tidal flow	Accurate tidal measurements	Live tidal data supplied by VTS								
Adverse weather conditions										
Inadequate training/competence - Others	Training of port marine/operations personnel	Port's marine training policy								
Excessive vessel speed	Byelaws	Statutory powers of direction								
Notice to Mariners failure to observe	Notices to mariners	Issued by the Harbour Authority with information about the development								
Restricted visibility	Aids to navigation, Provision and maintenance of	Port lights and visual aids overseen by LLA and GLA. Signal lights.								
COLREGs failure to comply	International COLREGs 1972 (as amended)	All ships operate in accordance with COLREGs								
Human error/fatigue - Vessel Personnel	Standing Orders/SOPs	Vessel and Company safety procedures								
Vessel breakdown or malfunction	Vessel maintenance	Scheduled maintenance program for vessel equipment								
Inadequate procedures in place onboard vessel	Vessel safety management system (ISM code)	Requires emergency procedures to be available								
High traffic density	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.								
Interaction with passing vessel	Local Port Service	Immingham Marine Control Centre (MCC)								
Risk Assessment, Incomplete/not reviewed										
Inadequate bridge resource management										
	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
	Oil spill contingency plans	Covers the response to a pollution event								

Further Applicable Controls Control	Frequency Mitigation	Consequence Mitigation	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence		
Marking construction area (exclusion zone)	Slight		Marking around the extremity of the construction zone	Unlikely	People	Moderate (3)	Unl kely	People	Minor (2)	
Adaptive procedures	Very Substantial		Training of PEC or Pilots		Property	Major (4)		Property	Neglig ble (1)	
Personnel management during tanker berthing		Fair			Planet	Minor (2)		Planet	Neglig ble (1)	
Guard (support) vessel	Fair		Could be a tug or an additional vessel	2	Port	Moderate (3)	2	Port	Minor (2)	

Risk Assessment and Applied Controls Control	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence		
Marking construction area (exclusion zone)	Slight		Marking around the extremity of the construction zone	Unlikely	People	Moderate (4)	Unl kely	People	Minor (2)	
Project specific adaptive procedures	Very Substantial		Familiarisation training of PEC and Pilots		Property	Major (4)		Property	Neglig ble (2)	
Personnel management during tanker berthing		Fair			Planet	Minor (2)		Planet	Neglig ble (1)	
Guard (support) vessel	Fair		Should be tug or another suitable vessel	2	Port	Moderate (3)	2	Port	Minor (2)	

Table A6 Hazard Category: Collision; Scenario: Dredger collision with vessel at 'F' anchorage when disposing of dredge material; Risk ID C6

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	Control	Comment								
Communication failure - equipment	Communications equipment	Vessels have VHF radios available	Collision between dredger and bunker vessel whilst it is at anchor in 'F' anchorage. Damage to both vessels hull resulting in loss of cargo from bunker vessel, a single fatality, tier 3 pollution. Disruption to all operations on the Humber during pollution response, international negative publicity.	Unlikely	People	Moderate (3)	Collision at slow speed whilst dredger depositing dredge material. Minor contact damage, minor damage to dredger or construction plant. Minor injuries or pollution, minor delay to marine works.	Possible	People	Minor (2)
Communication failure - Personnel					Property	Extreme (5)			Property	Minor (2)
Communication failure - Operational/procedural					Planet	Extreme (5)			Planet	Negligible (1)
Adverse weather conditions				2	Port	Extreme (5)		3	Port	Minor (2)
Human error/fatigue - Vessel Personnel										
Inadequate bridge resource management										
Risk Assessment, Incomplete/not reviewed										
Incorrect assessment of tidal flow										
Manoeuvre misjudged										
Inadequate procedures in place onboard vessel										
Restricted visibility	International COLREGs 1972 (as amended)	All ships operate in accordance with COLREGs								
High traffic density	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.								
Vessel breakdown or malfunction	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
	Notices to mariners	Issued by the Harbour Authority with information about the development								
	Emergency services equipment - shore side	Ambulance service								
	Oil spill contingency plans	Covers the response to a pollution event Availability of pollution response equipment Port has an MCA approved response plan in place								
Further Applicable Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Adaptive procedures	Very Substantial		Training of PEC or Pilots	Unlikely	People	Moderate (3)	Possible	People	Minor (2)	
					Property	Extreme (5)		Property	Minor (2)	
					Planet	Extreme (5)		Planet	Negligible (1)	
				2	Port	Extreme (5)	3	Port	Minor (2)	
Risk Assessment and Applied Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Project specific adaptive procedures	Very Substantial		Familiarisation training of PEC or Pilots	Rare	People	Moderate (3)	Unlikely	People	Minor (2)	
Closure of 'F' anchorage	Very Substantial		Anchorage closed to vessels during disposal of dredge material		Property	Extreme (5)		Property	Minor (2)	
					Planet	Extreme (5)		Planet	Negligible (1)	
				1	Port	Extreme (5)	2	Port	Minor (2)	

Table A7 Hazard Category: Grounding; Scenario: Dredger grounding whilst engaged in operations; Risk ID C7

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Failure to follow passage plan	Passage planning	All vessels are required to operate in accordance with their passage plans	Dredger grounds whilst engaged in dredging operations resulting in damage to dredge equipment and vessel becoming stranded. Potential of serious injuries to personnel during the vessel grounding. Towage required to refloat dredger and £750,000 to 4 million of damage to dredger which requires survey and inspection. Significant delays to marine works and negative local publicity. No pollution.	Unlikely	**People**	Moderate (3)	Dredger grounds but is able to refloat under its own power. Minor delay to operations whilst dredge equipment checked for damage. No injuries, no pollution.	L kely	**People**	Negligible (1)
Communication failure - Personnel	Communications equipment	Vessels have VHF radios available			**Property**	Moderate (3)			**Property**	Negligible (1)
Incorrect assessment of tidal flow	Accurate tidal measurements	Live tidal data supplied by VTS			**Planet**	Negligible (1)			**Planet**	Negligible (1)
	Availability of latest hydrographic information	Available via local charts and regular surveys.		2	**Port**	Major (4)		4	**Port**	Minor (2)
	Towage, available and appropriate	Available at the port								
Restricted visibility	Aids to navigation, Provision and maintenance of	Port lights and visual aids overseen by LLA and GLA. Signal lights.								
Vessel breakdown or malfunction	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.								
Poor situational awareness										
Inadequate procedures in place onboard vessel										
Adverse weather conditions										
Notice to Mariners failure to observe										
Risk Assessment, Incomplete/not reviewed										
Failure of Aid to Navigation (out of position/unlit)										
Human error/fatigue - Vessel Personnel										
Further Applicable Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Adaptive procedures	Very Substantial		Additional training of dredge operators	Rare	**People**	Moderate (3)	Likely	**People**	Negligible (1)	
					Property	Moderate (3)		**Property**	Negligible (1)	
					Planet	Negligible (1)		**Planet**	Negligible (1)	
				1	**Port**	Major (4)	4	**Port**	Minor (2)	
Risk Assessment and Applied Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Project specific adaptive procedures	Very Substantial		Familiarisation/training of dredge operators	Rare	**People**	Moderate (3)	Likely	**People**	Negligible (1)	
					Property	Moderate (3)		**Property**	Negligible (1)	
					Planet	Negligible (1)		**Planet**	Negligible (1)	
				1	**Port**	Major (4)	4	**Port**	Minor (2)	

Table A8 Hazard Category: Hazardous substance accidents; Scenario: Hazardous chemical spill from construction vessel: Risk ID C8

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Human error/fatigue - Vessel/ Marine Personnel			Damage to hydraulic systems result in oil entering the water. Minor injuries to personnel due to burns from hot hydraulic oil either during pollution response or from burst hose. Tier 2 oil pollution response required and negative publicity for the port, delay to works during pollution response.	Unlikely	People	Moderate (3)	Oil spill on deck from plant or refuelling results in a small amount of oil entering the water. Tier 1 response required. No injuries, minor impact to operation and no local publicity.	Likely	People	Negligible (1)
Inadequate procedures in place onboard vessel					Property	Minor (2)			Property	Negligible (1)
Vessel breakdown or malfunction	Vessel maintenance	Scheduled maintenance program for vessel equipment			Planet	Major (4)			Planet	Minor (2)
Communication failure - Operational/procedural	Communications equipment	Vessels have VHF radios available		2	Port	Minor (2)		4	Port	Negligible (1)
Failure to comply with safe systems of work										
Inadequate maintenance/inspection										
Inadequate training/competence - Others										
Poor situational awareness										
	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
	Oil spill contingency plans	Covers the response to a pollution event								
Further Applicable Controls	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Control										
No Further Applicable Controls Identified					People			People		
					Property			Property		
					Planet			Planet		
					Port			Port		
Risk Assessment and Applied Controls	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Control										
Contractor RAMS	Slight		Vessel management and maintenance covered	Unlikely	People	Moderate (3)	Likely	People	Negligible (1)	
Control of contractors through management	Slight				Property	Minor (2)		Property	Negligible (1)	
					Planet	Major (4)		Planet	Minor (2)	
				2	Port	Minor (2)	4	Port	Negligible (1)	

Table A9 Hazard Category: Other (Mooring); Scenario: Vessel mooring failure; Risk ID C9

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Human error/fatigue - Vessel Personnel			Unmanned barge has mooring failure and drifts resulting in allision or grounding. Cargo (piles/construction materials) enter the water; major delay to operations whilst barge and cargo recovered. Negative local publicity, minor delays to construction works and no injuries.	Possible	**People**	Negligible (1)	Construction craft or barge has a single mooring line failure but does not result in a breakout. Additional mooring lines used to secure craft, no injuries, no pollution, minor delay to works.	Almost Certain	**People**	Negligible (1)
Inadequate procedures in place onboard vessel					**Property**	Minor (2)			**Property**	Negligible (1)
Communication failure - Operational/procedural	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.			**Planet**	Negligible (1)			**Planet**	Negligible (1)
Adverse weather conditions				3	**Port**	Moderate (3)		5	**Port**	Negligible (1)
Failure of berth mooring systems	Adequate berth fendering	Port has strategically placed fendering								
Interaction with passing vessel										
	Towage, available and appropriate	Available at the port								
	Communications equipment	Vessels have VHF radios available								

Further Applicable Controls	Frequency Mitigation	Consequence Mitigation	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence		
Control										
Guard (support) vessel	Fair		Could be a tug or an additional vessel	Unlikely	**People**	Negligible (1)	Almost Certain	**People**	Negligible (1)	
					Property	Minor (2)		**Property**	Negligible (1)	
					Planet	Negligible (1)		**Planet**	Negligible (1)	
				2	**Port**	Moderate (3)	5	**Port**	Negligible (1)	

Risk Assessment and Applied Controls	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence		
Control										
Guard (support) vessel	Fair		Should be tug or another suitable vessel	Unlikely	**People**	Negligible (1)	Almost Certain	**People**	Negligible (1)	
					Property	Minor (2)		**Property**	Negligible (1)	
					Planet	Negligible (1)		**Planet**	Negligible (1)	
				2	**Port**	Moderate (3)	5	**Port**	Negligible (1)	

Table A10 Hazard Category: Other (Cranage); Scenario: Component dropped during construction; Risk ID C10

Risk Analysis: Causes	Embedded Controls: Control	Embedded Controls: Comment	Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Human error/fatigue - Marine personnel			Component dropped in to water in the approach channel causing underwater obstruction, Harbour Authority not notified. Transiting tanker or barge, on passage to IOT, makes contact with the obstruction causing damage to hull. This results in the puncturing of both hulls, tier 3 pollution, serious injuries, vessel out of service requiring survey and repair. Negative national port reputational damage.	Unlikely	**People**	Moderate (3)	Dropped component within construction area, reported to port and operations ceased until item is recovered. No injuries, minor damage, minor delay to works.	Likely	**People**	Negligible (1)
Communication failure - Operational/procedural	Communications equipment	Vessels have VHF radios available			**Property**	Major (4)			**Property**	Minor (2)
Communication failure - Personnel					**Planet**	Extreme (5)			**Planet**	Negligible (1)
Adverse weather conditions				2	**Port**	Major (4)		4	**Port**	Minor (2)
Failure to comply with safe systems of work										
Risk Assessment, Incomplete/not reviewed										
Loss of vessels stability (due to other than loss of watertight integrity)										
Interaction with passing vessel										
Port Equipment (Inc. craft) mechanical breakdown/system malfunction	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.								
Inadequate training/competence - Others										
Lifting equipment failure	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								

Further Applicable Controls: Control	Frequency Mitigation	Consequence Mitigation	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence		
Incident Reporting - Dropped component	Fair		Establish a specific routine for reporting incidents related to components being dropped in the water to ensure that VTS is made aware without delay	Rare	**People**	Moderate (3)	Possible	**People**	Negligible (1)	
					Property	Major (4)		**Property**	Minor (2)	
					Planet	Extreme (5)		**Planet**	Negligible (1)	
				1	**Port**	Major (4)	3	**Port**	Minor (2)	

Risk Assessment and Applied Controls: Control	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence		
Incident Reporting - Dropped component	Fair		Establish a specific routine for reporting incidents related to components being dropped in the water to ensure that VTS is made aware without delay	Rare	**People**	Moderate (3)	Possible	**People**	Negligible (1)	
					Property	Major (4)		**Property**	Minor (2)	
					Planet	Extreme (5)		**Planet**	Negligible (1)	
Post Construction Hydrographic Survey	Slight		Post construction multibeam survey required to be undertaken by contractor	1	**Port**	Major (4)	3	**Port**	Minor (2)	

Table A11 Hazard Category: Other (Swamping); Scenario: Workboat takes on water from excessive wash; Risk ID C11

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	Control	Comment								
Human error/fatigue - Vessel Personnel	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency	Workboat with low freeboard takes on water from excessive wash caused by a tanker. The stability is affected, and the craft capsizes with multiple fatalities, tier 1 pollution and an extreme impact to port reputation and programme.	Rare	People	Extreme (5)	Workboat takes on a small amount of water during adverse weather conditions and operations are halted. Minor delay to works, no pollution or injuries.	Almost Certain	People	Negligible (1)
Inadequate procedures in place onboard vessel					Property	Moderate (3)			Property	Negligible (1)
Excessive vessel speed	Vessel speed	Vessel speed reduced during berthing			Planet	Minor (2)			Planet	Negligible (1)
	Communications equipment	Vessels have VHF radios available		1	Port	Extreme (5)		5	Port	Minor (2)
	AIS/Radar coverage	VTS monitor movements of vessels in the Harbour Area								
Failure to comply with safe systems of work	Byelaws	Statutory powers of direction								
Interaction with passing vessel	Vessel safety management system (ISM code)	Requires emergency procedures to be available								
Poor situational awareness	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts								
	Oil spill contingency plans	Covers the response to a pollution event								

Further Applicable Controls	Frequency Mitigation	Consequence Mitigation	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence		
Control										
Marking construction area (exclusion zone)	Slight		Around the extremity of the construction zone	Rare	People	Extreme (5)	Possible	People	Negligible (1)	
					Property	Moderate (3)		Property	Negligible (1)	
					Planet	Minor (2)		Planet	Negligible (1)	
				1	Port	Extreme (5)	3	Port	Minor (2)	

Risk Assessment and Applied Controls	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence		
Control										
Marking construction area (exclusion zone)	Slight		Around the extremity of the construction zone	Rare	People	Extreme (5)	Possible	People	Negligible (1)	
Contractor RAMS	Slight		Locally managed vessel movements and deconflicted with tankers		Property	Moderate (3)		Property	Negligible (1)	
					Planet	Minor (2)		Planet	Negligible (1)	
Notices to mariners	Slight		To notify keep clear areas	1	Port	Extreme (5)	3	Port	Minor (2)	

Table A12 Hazard Category: Other (Payload related accident); Scenario: Incorrect payload distribution affects stability; Risk ID C12

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Inadequate training/competence - Others			Incorrect unloading/loading of barge results in stability being compromised. Barge develops significant list causing construction materials to enter the water, the barge to flood and sink causing tier 2 pollution. Materials and barge present a hazard to navigation until recovered. Major delay to works. Threat to personnel could result in a death in the worst credible scenario, either from rapid movement of the flat top barge or from exposure in the water.	Unlikely	People	Major (4)	Vessel takes on list whilst loading and operations cease. Cargo requires unloading causing delay to operations. No injury, damage, or pollution.	Likely	People	Negligible (1)
Communication failure - Operational/procedural	Communications equipment	Vessels have VHF radios available			Property	Major (4)			Property	Negligible (1)
Adverse weather conditions					Planet	Major (4)			Planet	Negligible (1)
Failure to comply with safe systems of work				2	Port	Major (4)		4	Port	Minor (2)
Risk Assessment, Incomplete/not reviewed	Safety/Support Vessel									
Loss of vessels stability (due to other than loss of watertight integrity)	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
Inadequate procedures shoreside										
Inadequate maintenance/inspection										
Human error/fatigue - Marine personnel	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts								
	Oil spill contingency plans	Covers the response to a pollution event								
Further Applicable Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Loading/Unloading Plan	Considerable		Develop plan to ensure stability is maintained while unloading/ loading	Rare	People	Major (4)	Unlikely	People	Neglig ble (1)	
					Property	Major (4)		Property	Neglig ble (1)	
					Planet	Major (4)		Planet	Neglig ble (1)	
				1	Port	Major (4)	2	Port	Minor (2)	
Risk Assessment and Applied Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Loading/Unloading Plan	Considerable		Develop plan to ensure stability is maintained while unloading/ loading	Rare	People	Major (4)	Unlikely	People	Neglig ble (1)	
Contractor RAMS	Slight		Control of contractors by ABP		Property	Major (4)		Property	Neglig ble (1)	
Harbour Master's consent of works	Slight		Consent given by HES and Immingham		Planet	Major (4)		Planet	Neglig ble (1)	
				1	Port	Major (4)	2	Port	Minor (2)	

B Navigational Risk Assessment: Construction/Operation

Table B1 Hazard Category: Collision; Scenario: Craft associated with the marine works with a Ro-Ro Vessel ; Risk ID CO1

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	Control	Comment								
Failure to comply with Towage guidelines	Towage, available and appropriate	Local tug coverage. Towage guidelines in place	Manoeuvring speed collision with no avoiding action leading to multiple fatalities for personnel on marine works boat. Potential for minor hull breach on Ro-Ro vessel, serious impact to property, significant consequence to the environment including a tier 2 pollution event, and serious consequence to the port business and reputation.	Unlikely	People	Extreme (5)	Low speed glancing collision that shunts/pushes marine works craft. Minor injuries from impact, moderate impact to property (£750,000-£4 Million), no appreciable consequence to the environment and minor damage to the port's business/reputation.	Possible	People	Minor (2)
Failure to follow passage plan	Passage planning	Required for all commercial vessels			Property	Major (4)			Property	Moderate (3)
Incorrect assessment of tidal flow	Accurate tidal measurements				Planet	Major (4)			Planet	Negligible (1)
	Availability of latest hydrographic information	Available via local charts and regular surveys.		2	Port	Extreme (5)		3	Port	Minor (2)
Communication failure - Personnel	Communications - traffic broadcast	VTS provide vessel traffic information								
Manoeuvre misjudged	Harbour Authority requirements	Expert local knowledge and updated on activities (pilotage PEC requirements)								
Inadequate bridge resource management										
Inadequate procedures in place onboard vessel										
Poor situational awareness										
Vessel breakdown or malfunction	Vessel propulsion redundancies	Twin propellers, two engines and an auxiliary back up								
Adverse weather conditions										
AIS failure/ lack of AIS										
Excessive vessel speed	Byelaws	Statutory powers of direction								
Restricted visibility	Aids to navigation, Provision and maintenance of	Port lights and visual aids overseen by LLA and GLA. Signal lights.								
High traffic density	Vessel Traffic Services	Control vessel movements and coordinate emergency response								
Excessive vessel speed	Local Port Service	Immingham Marine Control Centre (MCC)								
Human error/fatigue - Pilot/ Vessel Personnel	Safety/Support Boat	To aid response to incidents								
Construction and Operation occurring concurrently	Arrival/Departure, advance notice of	Vessels required to provide notice to VTS								
COLREGs failure to comply										
	Oil spill contingency plans	Covers the response to a pollution event								
Further Applicable Controls										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Special Instructions issued to Ro-Ro not to berth unless area is clear of marine works craft	Very Substantial			Rare	People	Extreme (5)	Rare	People	Minor (2)	
Additional measures to ensure separation of marine works from Ro-Ro vessels proceeding to or departing IERRT	Very Substantial		VTS moves marine craft away from pier being berthed on prior to Ro-Ro arriving in the berth pocket		Property	Major (4)		Property	Moderate (3)	
					Planet	Major (4)		Planet	Negligible (1)	
				1	Port	Extreme (5)	1	Port	Minor (2)	
Risk Assessment and Applied Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Contractor RAMS	Very Substantial		Locally managed vessel movements and deconflicted with other vessel movements	Rare	People	Extreme (5)	Rare	People	Minor (2)	
					Property	Major (4)		Property	Moderate (3)	
Port Liaison Officer	Fair		Port Liaison officer to assist communications between VTS and contractors		Planet	Major (4)		Planet	Negligible (1)	
Special Instructions issued to Ro-Ro not to berth unless area is clear of marine works craft	Very Substantial			1	Port	Extreme (5)	1	Port	Minor (2)	

Table B2 Hazard Category: Other (Mooring); Scenario: Ro-Ro mooring failure in vicinity of marine works on IERRT; Risk ID CO2

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	Control	Comment								
Communication failure - Operational/procedural	Communications equipment	Vessels have VHF radios available, and can alert	Vessel breaks moorings, ramp holds stern on the berth and acts as a pivot point causing vessel to swing into marine works or marine works craft. This in turn creates significant damage to the marine works stopping construction and operation until repaired. Serious injuries caused by impact of Ro-Ro on the works or with a vessel, with the potential to cause a single death. Potential for a tier 1 pollution event caused by damage to the marine works craft.	Unlikely	People	Major (4)	Single mooring failure but vessel remains alongside. Further mooring lines used. Minor delay to operations while infrastructure is repaired minor cost to port. Minor little local publicity. Minor injury.	Almost Certain	People	Minor (2)
Human error/fatigue - Vessel Personnel					Property	Extreme (5)			Property	Minor (2)
Failure to follow onboard vessel procedures					Planet	Moderate (3)			Planet	Negligible (1)
Tidal flow (Strong)	Additional lines/increase mooring	As required for conditions		2	Port	Extreme (5)		5	Port	Minor (2)
Adverse weather conditions										
Failure of berth mooring systems	Mooring analysis	Mooring analysis to be undertaken								
Interaction with passing vessel	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.								
Construction and Operation occurring concurrently	Towage, available and appropriate	Available at the port, standby								
	Adequate berth fendering	Port has strategically placed fendering								

Further Applicable Controls	Frequency Reduction	Consequence Reduction	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence		
Control										
Hooks with load monitoring	Fair			Rare	People	Major (4)	Almost Certain	People	Minor (2)	
Additional storm bollards	Very Substantial				Property	Extreme (5)		Property	Minor (2)	
Berth specific weather parameters	Slight				Planet	Moderate (3)		Planet	Negligible (1)	
				1	Port	Extreme (5)	5	Port	Minor (2)	

Risk Assessment and Applied Controls	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence		
Control										
Berth specific weather parameters	Slight			Rare	People	Major (4)	Almost Certain	People	Minor (2)	
					Property	Extreme (5)		Property	Minor (2)	
					Planet	Moderate (3)		Planet	Negligible (1)	
				1	Port	Extreme (5)	5	Port	Minor (2)	

Table B3 Hazard Category: Other (Cranage); Scenario: Component dropped during construction preventing Ro-Ro Operations; Risk ID CO3

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Lifting equipment failure	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency	Component dropped in water causing semi-submerged obstruction that is not notified to the Harbour Authority. Ro-Ro vessel makes contact with the obstruction causing damage to hull, minor pollution, vessel out of service requiring survey and repair. Significant port reputational damage and interruption to construction and operation. Serious injuries as a result of impact on obstruction.	Unlikely	**People**	Moderate (3)	Dropped component (in water) reported, construction and operations cease until it is recovered. No injuries, no damage, minor delay to works.	Likely	**People**	Negligible (1)
Port Equipment (inc. craft) mechanical breakdown/system malfunction					**Property**	Major (4)			**Property**	Negligible (1)
Loss of vessels stability (due to other than loss of watertight integrity)					**Planet**	Minor (2)			**Planet**	Negligible (1)
Communication failure - Personnel/ Operational/procedural	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.		2	**Port**	Major (4)		4	**Port**	Minor (2)
Interaction with passing vessel										
Adverse weather conditions										
Failure to comply with safe systems of work										
Risk Assessment, Incomplete/not reviewed										
Inadequate training/competence - Others										
Construction and Operation occurring concurrently	Safety/Support Boat									
Human error/fatigue - Marine personnel										
	Communications equipment	Vessels have VHF radios available								
Further Applicable Controls **Control**	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Incident Reporting - Dropped component	Fair		Establish a specific routine for reporting incidents related to components being dropped in the water to ensure that VTS is made aware without delay	Rare	**People**	Moderate (3)	Possible	**People**	Negligible (1)	
					Property	Major (4)		**Property**	Negligible (1)	
					Planet	Minor (2)		**Planet**	Negligible (1)	
				1	**Port**	Major (4)	3	**Port**	Minor (2)	
Risk Assessment and Applied Controls **Control**	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Incident Reporting - Dropped component	Fair		Establish a specific routine for reporting incidents related to components being dropped in the water to ensure that VTS is made aware without delay	Rare	**People**	Moderate (3)	Possible	**People**	Negligible (1)	
					Property	Major (4)		**Property**	Negligible (1)	
					Planet	Minor (2)		**Planet**	Negligible (1)	
Post Construction Hydrographic Survey	Slight		Post construction mult beam survey required to be undertaken by contractor	1	**Port**	Major (4)	3	**Port**	Minor (2)	

Table B4 Hazard Category: Other (Swamping); Scenario: Workboat takes on water from excessive wash from Ro-Ro; Risk ID CO4

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Inadequate procedures in place onboard vessel	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency	Workboat with low freeboard takes on water from excessive wash due to Ro-Ro operating in close proximity. The stability is affected, and the craft capsizes with multiple fatalities, tier 1 pollution and significant delay to operations and construction while incident is managed. Extreme reputational damage to the port	Poss ble	**People**	Extreme (5)	Workboat takes on a small amount of water and operations are halted while minor swamping is addressed. Minor delay to works, no pollution and minor injuries for any personnel falling/loosing balance due to the wash.	Likely	**People**	Minor (2)
Marine works vessel operating in close proximity to Ro-Ro berthing	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.			**Property**	Major (4)			**Property**	Negligible (1)
Excessive vessel speed	Byelaws	Statutory powers of direction			**Planet**	Minor (2)			**Planet**	Negligible (1)
Interaction with passing vessel				3	**Port**	Extreme (5)		4	**Port**	Minor (2)
Failure to comply with safe systems of work										
Poor situational awareness										
Construction and Operation occurring concurrently										
	Vessel safety management system (ISM code)	Requires emergency procedures to be available								
	Oil spill contingency plans	Covers the response to a pollution event								
Further Applicable Controls										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Additional measures to ensure separation of marine works from Ro-Ro vessels proceeding to or departing IERRT	Very Substantial		VTS moves marine craft away from pier being berthed on prior to Ro-Ro arriving in the berth pocket	Rare	**People**	Extreme (5)	Unlikely	**People**	Minor (2)	
Special Instructions issued to Ro-Ro not to berth unless area is clear of marine works craft	Very Substantial				**Property**	Major (4)		**Property**	Neglig ble (1)	
					Planet	Minor (2)		**Planet**	Neglig ble (1)	
				1	**Port**	Extreme (5)	2	**Port**	Minor (2)	
Risk Assessment and Applied Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Additional measures to ensure separation of marine works from Ro-Ro vessels proceeding to or departing IERRT	Very Substantial		VTS moves marine craft away from pier being berthed on prior to Ro-Ro arriving in the berth pocket	Rare	**People**	Extreme (5)	Unlikely	**People**	Minor (2)	
					Property	Major (4)		**Property**	Neglig ble (1)	
					Planet	Minor (2)		**Planet**	Neglig ble (1)	
Special Instructions issued to Ro-Ro not to berth unless area is clear of marine works craft	Very Substantial			1	**Port**	Extreme (5)	2	**Port**	Minor (2)	

Table B5 Hazard Category: Allision; Scenario: Ro-Ro contact with IERRT infrastructure; Risk ID CO5

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Inadequate number/type tugs	Towage, available and appropriate	Available at the port; correct configuration taken	Ro-Ro collides with the infrastructure, serious damage to vessel and pontoon, disrupting operation to berths 1 and 2 and delaying construction of 3 whilst repairs occur. Minor pollution from debris, serious injuries to personal from impact, greater than £8 million of damage, serious negative national publicity and closed for operations.	Possible	**People**	Moderate (3)	Ro-Ro has a slow speed impact with pier during berthing leading to minor damage to vessel and pier, minor injuries, no pollution, minor delay to operations and minor delay to construction whilst repairs occur.	Likely	**People**	Minor (2)
Failure to comply with Towage guidelines	Towage, available and appropriate	Available at the port; correct configuration taken			**Property**	Extreme (5)			**Property**	Minor (2)
Adverse weather conditions	Monitoring of met ocean conditions	Weather forecasts obtained and compared with limits			**Planet**	Minor (2)			**Planet**	Negligible (1)
Incorrect assessment of tidal flow				3	**Port**	Major (4)		4	**Port**	Minor (2)
Restricted visibility	Aids to navigation, Provision and maintenance of	Port lights and visual aids overseen by LLA and GLA. Signal lights.								
Human error/fatigue - Pilot/ Vessel Personnel	Harbour authority requirements	Training and authorisation of Pilots/PECs in line with HES Pilotage Directions								
Excessive vessel speed										
Poor situational awareness										
Inadequate bridge resource management										
Inadequate procedures in place onboard vessel										
Manoeuvre misjudged	Vessel simulation study	Testing of vessel arrivals and manoeuvring to inform the design								
	Berthing procedures									
Vessel breakdown or malfunction	Vessel propulsion redundancies	Twin propellers, two engines and an auxiliary back up								
Ship/Tug/Launch failure										
Communication failure - Personnel	Vessel Traffic Services	Control vessel movements and coordinate emergency response								
Construction and Operation occurring concurrently										
	Local Port Service	Immingham Marine Control Centre (MCC)								
	Design criteria	Built to withstand a collision at certain level (set out in building design standards)								

Further Applicable Controls	Frequency Reduction	Consequence Reduction	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence		
Control										
Additional training to PEC and Pilots on manoeuvring during the operation-construction phase	Considerable	Fair		Rare	**People**	Minor (2)	Possible	**People**	Negligible (1)	
Berthing criteria specific to operation-construction	Considerable	Fair			**Property**	Major (4)		**Property**	Minor (2)	
					Planet	Minor (2)		**Planet**	Negligible (1)	
				1	**Port**	Moderate (3)	3	**Port**	Negligible (1)	

Risk Assessment and Applied Controls	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence		
Control										
Additional training to PEC and Pilots on manoeuvring during the operation-construction phase	Considerable	Fair		Rare	**People**	Minor (2)	Possible	**People**	Negligible (1)	
Berthing criteria specific to operation-construction	Considerable	Fair	Reduction effect of Frequency is dependent on the level of berthing criteria applied		**Property**	Major (4)		**Property**	Minor (2)	
					Planet	Minor (2)		**Planet**	Negligible (1)	
				1	**Port**	Moderate (3)	3	**Port**	Negligible (1)	

Table B6 Hazard Category: Other (Mooring); Scenario: Flat top barge breaks free of mooring; Risk ID CO6

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Communication failure - Operational/procedural	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.	Wash from a berthing Ro-Ro breaks the flat top barge free of its mooring whilst constructing berth 3 and drifts down towards the Eastern Jetty. The following allision with the jetty causes a tier 3 pollution event that substantially effects port reputation and delays operations of all port users. Serious injuries are incurred to those on the flat top barge and damage is likely to cost £4-8 million to repair.	Possible	**People**	Moderate (3)	Flat top-barge has a single mooring line failure but does not result in a breakout. Additional mooring lines used to secure craft, no injuries, no pollution, minor delay to works.	L kely	**People**	Negligible (1)
Human error/fatigue - Vessel Personnel					**Property**	Major (4)			**Property**	Negligible (1)
Failure to follow onboard vessel procedures					**Planet**	Extreme (5)			**Planet**	Negligible (1)
Adverse weather conditions	Additional lines/increase mooring			3	**Port**	Major (4)		4	**Port**	Negligible (1)
Tidal flow										
Failure of berth mooring systems	Adequate berth fendering	Port has strategically placed fendering								
Interaction with passing vessel	Communications equipment	Vessels have VHF radios available, and can alert								
Construction and Operation occurring concurrently										
Further Applicable Controls										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
During operation and construction ensure a safety boat/ tug is available to assist whilst a Ro-Ro is manoeuvring in close proximity	Considerable	Fair	Assisting vessel is either able to prevent flat top barge from drifting onto the Eastern Jetty or is otherwise able to reduce the speed and impact of the resulting allision.	Unlikely	**People**	Moderate (3)	Likely	**People**	Neglig ble (1)	
					Property	Minor (2)		**Property**	Neglig ble (1)	
					Planet	Moderate (3)		**Planet**	Neglig ble (1)	
				2	**Port**	Minor (2)	4	**Port**	Neglig ble (1)	
Risk Assessment and Applied Controls										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Guard Support Vessel	Considerable	Fair	Available as appropriate - able to prevent flat top barge from drifting onto the Eastern Jetty or is otherwise able to reduce the speed and impact of the resulting allision.	Rare	**People**	Moderate (3)	Likely	**People**	Neglig ble (1)	
					Property	Minor (2)		**Property**	Neglig ble (1)	
					Planet	Moderate (3)		**Planet**	Neglig ble (1)	
Barges cannot be moored in the vicinity of a berthing Ro-Ro	Considerable			1	**Port**	Minor (2)	4	**Port**	Neglig ble (1)	

Table B7 Hazard Category: Allision; Scenario: Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2 with a tanker berthed on eastern jetty; Risk ID CO7

Risk Analysis Causes	Embedded Controls Control	Comment	Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Inadequate number/type tugs	Towage, available and appropriate	Available at the port	Ro-Ro makes contact with berthed tanker resulting in a significant allision that punctures the tanker's double hull leading to a tier 3 pollution event with release of toxic chemical. Causing major risk to life and environment both short and long term. Incident results in multiple fatalities, sever damages to both vessels and berth infrastructure for an amount greater than £8M. Negative international news that significantly affects the ports reputation and port operations.	Unlikely	**People**	Extreme (5)	An approaching Ro-Ro loses control and makes slow contact with berthed tanker resulting in an allision that damages cargo pipes, leading to a tier 3 pollution event with release of toxic chemical. Moderate damage to port infrastructure and vessel, serious injuries to personnel, and negative national port reputational damage.	Possible	**People**	Moderate (3)
	Towage guidelines	Correct configuration			**Property**	Extreme (5)			**Property**	Moderate (3)
Navigation equipment failure	Passage planning	Required for all commercial vessels			**Planet**	Extreme (5)			**Planet**	Extreme (5)
Adverse weather conditions	Monitoring of met ocean conditions	Met Ocean data collected and compared with operation limits		2	**Port**	Extreme (5)		3	**Port**	Major (4)
Incorrect assessment of tidal flow										
High traffic density	Vessel Traffic Services	Control vessel movements and coordinate emergency response								
Excessive vessel speed										
Human error/fatigue - Pilot/ Vessel/ Marine Personnel	Harbour Authority requirements	Expert local knowledge and updated on activities (pilotage PEC requirements)								
Manoeuvre misjudged										
Limited area for manoeuvring										
Vessel breakdown or malfunction	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
Failure of berth mooring systems										
Communication failure - Personnel										
	Oil spill contingency plans	Covers the response to a pollution event								

Further Applicable Controls Control	Frequency Reduction	Consequence Reduction	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence	
Berthing criteria	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)	Rare	**People**	Extreme (5)	Unlikely	**People**	Moderate (3)
Charted safety area, berthing procedures	Slight				**Property**	Extreme (5)		**Property**	Moderate (3)
Additional pilotage training/ familiarisation	Minute				**Planet**	Extreme (5)		**Planet**	Extreme (5)
				1	**Port**	Extreme (5)	2	**Port**	Major (4)

Risk Assessment and Applied Controls Control	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence	
Specific berthing criteria for each of the three berths	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)	Rare	**People**	Extreme (5)	Unlikely	**People**	Moderate (3)
Charted safety area, berthing procedures	Slight				**Property**	Extreme (5)		**Property**	Moderate (3)
Additional pilotage training/ familiarisation	Fair				**Planet**	Extreme (5)		**Planet**	Extreme (5)
				1	**Port**	Extreme (5)	2	**Port**	Major (4)

C Navigational Risk Assessment: Operation

Table C1 Hazard Category: Allision; Scenario: Vessel proceeding to/from Immingham Eastern Ro-Ro with tanker moored at IOT Finger Pier; Risk ID O1

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Adverse weather conditions	Monitoring of met ocean conditions	Met Ocean data collected and compared with operation limits	Ro-Ro makes contact with berthed tanker resulting in a significant allision that punctures the tanker's double hull leading to a tier 3 pollution event with poss ble ignition of the petrochemical. That could cause a fire which significantly damages the vessel and/or infrastructure. Incident results in multiple fatalities, and negative international news that significantly affects the ports reputation and port operations.	Unlikely	**People**	Extreme (5)	An approaching Ro-Ro misses its berth and continues to the IOT Finger Pier which results in a low speed glancing collision, dislodging a tanker from its berth causing a tier 3 pollution event. Major damage to port infrastructure and vessel, serious injuries to personnel, and negative national port reputational damage.	Possible	**People**	Moderate (3)
Incorrect assessment of tidal flow					**Property**	Extreme (5)			**Property**	Major (4)
Restricted visibility					**Planet**	Extreme (5)			**Planet**	Extreme (5)
Inadequate bridge resource management	Passage planning	Required for all commercial vessels		2	**Port**	Extreme (5)		3	**Port**	Major (4)
Failure to follow passage plan										
Inadequate procedures in place onboard vessel										
Manoeuvre misjudged										
Vessel breakdown or malfunction	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
Ship/Tug/Launch failure										
Failure to comply with Towage guidelines	Towage guidelines	Correct configuration								
Inadequate number/type tugs	Towage, available and appropriate	Available at the port								
Interaction with passing vessel	Vessel Traffic Services	Control vessel movements and coordinate emergency response								
Poor situational awareness										
Communication failure - Personnel										
Excessive vessel speed	Harbour Authority requirements	Expert local knowledge and updated on activities (pilotage PEC requirements)								
Human error/fatigue - Vessel Personnel										
	Oil spill contingency plans	Covers the response to a pollution event								
Further Applicable Controls										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Move finger pier to east side of trunk way	**Very Substantial**	**Very Substantial**	**Control eliminates risk**	Rare	**People**	Negligible (1)	Rare	**People**	Negligible (1)	
Charted safety area, berthing procedures	Slight				**Property**	Negligible (1)		**Property**	Negligible (1)	
Additional pilotage training/ familiarisation	Minute		*(Amalgamated into Adaptive procedures)*		**Planet**	Negligible (1)		**Planet**	Negligible (1)	
Berthing criteria	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)	1	**Port**	Negligible (1)	1	**Port**	Negligible (1)	
Risk Assessment and Applied Controls										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Project specific adaptive procedures	Considerable	Fair	Adaptive procedures during familiarisation period as operational experience gained (e.g. tugs, tidal restrictions, delayed start of use of berth 1 during familiarisation period)	Rare	**People**	Moderate (3)	Unlikely	**People**	Minor (2)	
Charted safety area, berthing procedures	Slight				**Property**	Major (4)		**Property**	Moderate (3)	
Specific berthing criteria for each of the three berths	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)		**Planet**	Moderate (3)		**Planet**	Major (4)	
				1	**Port**	Moderate (3)	2	**Port**	Minor (2)	

Table C2 Hazard Category: Allision; Scenario: Tanker manoeuvring on/off IOT Finger Pier (flood tide); Risk ID O2

Risk Analysis – Causes	Embedded Controls – Control	Embedded Controls – Comment
Inadequate number/type tugs	Towage, available and appropriate	Available at the port
Failure to comply with Towage guidelines	Towage guidelines	Correct configuration
Adverse weather conditions	Monitoring of met ocean conditions	Weather forecasts obtained and compared with limits
Restricted visibility		
Incorrect assessment of tidal flow		
Anchors not cleared	Anchors cleared and ready for use	Arrest/slow ship movement prior to impact
Inadequate bridge resource management	Harbour Authority requirements	Expert local knowledge and updated on activities (pilotage PEC -requirements)
Inadequate procedures in place onboard vessel		
Excessive vessel speed		
Manoeuvre misjudged		
Poor situational awareness		
Human error/fatigue - Pilot/ Vessel Personnel		
Ship/Tug/Launch failure	Training of port marine/operations personnel	Port's marine training policy
Vessel breakdown or malfunction		
Communication failure - Personnel		
	Adequate berth fendering	On IERRT infrastructure

Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Tanker manoeuvres off finger pier and collides with Ro-Ro terminal. The allision has potential to cause a single fatality to a shoreman on the Ro-Ro infrastructure. The impact punctures both hulls of the tanker and causes a tier 3 pollution, serious damage to port reputation and negative national publicity. £4 - 8 million of property damages.	Possible	People	Major (4)	Tanker collides with another vessel or structure and does not puncture their hull resulting in little local publicity, moderate property damages (£750,000 - £4 million) and no injuries.	Likely	People	Negligible (1)
		Property	Major (4)			Property	Moderate (3)
		Planet	Extreme (5)			Planet	Negligible (1)
	3	Port	Major (4)		4	Port	Minor (2)

Further Applicable Controls – Control	Frequency Reduction	Consequence Reduction	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence	
Increased use of tugs	Very Substantial		*(Amalgamated into Adaptive procedures)*	Rare	People	Moderate (3)	Unlikely	People	Negligible (1)
Tidal limitations/ weather restrictions	Considerable	Fair	The control may have commercial impact to stakeholder's operations		Property	Major (4)		Property	Moderate (3)
					Planet	Extreme (5)		Planet	Negligible (1)
Moving finger pier	*Very Substantial*	*Very Substantial*	*Control eliminates risk*	1	Port	Major (4)	2	Port	Minor (2)

Risk Assessment and Applied Controls – Control	Frequency Reduction	Consequence Reduction	Comment
Project specific adaptive procedures	Considerable	Fair	Adaptive procedures during familiarisation period as operational experience gained (e.g. tugs, tidal restrictions, delayed start of use of berth 1 during familiarisation period) Including additional simulation training

Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence	
Unlikely	People	Moderate (3)	Possible	People	Negligible (1)
	Property	Major (4)		Property	Moderate (3)
	Planet	Extreme (5)		Planet	Negligible (1)
2	Port	Major (4)	3	Port	Minor (2)

Table C3 Hazard Category: Allision; Scenario: Barge manoeuvring on/off IOT Finger Pier (flood tide); Risk ID O3

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Anchors not cleared	Anchors cleared and ready for use	Arrest/slow ship movement prior to impact	Barge manoeuvres off finger pier and collides with Ro-Ro terminal. Possibility to cause a single fatality which punctures the barge's hull and causes a tier 3 pollution event. Major Impact on port reputation, serious national publicity and £4 - 8 million of damages to property.	Possible	**People**	Major (4)	Barge collides with another berthed vessel or structure and does not puncture the hull; minor little local publicity, minor property damages (£10,000-750,000) and no injuries.	Almost Certain	**People**	Neglig ble (1)
Inadequate number/type tugs	Towage, available and appropriate	Available at the port			**Property**	Major (4)			**Property**	Minor (2)
Failure to comply with Towage guidelines	Towage guidelines	Correct configuration			**Planet**	Extreme (5)			**Planet**	Neglig ble (1)
Adverse weather conditions	Monitoring of met ocean conditions	Weather forecasts obtained and compared with limits		3	**Port**	Major (4)		5	**Port**	Minor (2)
Restricted visibility										
Incorrect assessment of tidal flow										
Inadequate bridge resource management	Harbour Authority requirements	Expert local knowledge and updated on activities (pilotage PEC requirements)								
Inadequate procedures in place onboard vessel										
Excessive vessel speed										
Manoeuvre misjudged										
Poor situational awareness										
Human error/fatigue - Pilot/ Vessel Personnel										
Ship/Tug/Launch failure	Training of port marine/operations personnel	Port's marine training policy								
Vessel breakdown or malfunction										
Communication failure - Personnel										
	Adequate berth fendering	On IERRT infrastructure								
Further Applicable Controls										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Tidal limitations/ weather restrictions	Considerable	Fair	The control may have commercial impact to stakeholder's operations	Unlikely	**People**	Major (4)	Likely	**People**	Negligible (1)	
					Property	Major (4)		**Property**	Minor (2)	
					Planet	Extreme (5)		**Planet**	Negligible (1)	
Moving finger pier	*Very Substantial*	*Very Substantial*	*Control eliminates risk*	2	**Port**	Major (4)	4	**Port**	Minor (2)	
Risk Assessment and Applied Control										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Project specific adaptive procedures	Considerable	Fair	Adaptive procedures during familiarisation period as operational experience gained (e.g. tugs, tidal restrictions, delayed start of use of berth 1 during familiarisation period)	Unlikely	**People**	Minor (2)	Possible	**People**	Negligible (1)	
					Property	Moderate (3)		**Property**	Minor (2)	
					Planet	Extreme (5)		**Planet**	Negligible (1)	
				2	**Port**	Moderate (3)	3	**Port**	Minor (2)	

Table C4 Hazard Category: Allision; Scenario: Ro-Ro allision with IOT trunk way; Risk ID O4

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Anchors not cleared	Anchors cleared and ready for use	Arrest/slow ship movement prior to impact	Ro-Ro vessel collides with IOT trunk way, severing the charged pipeline causing a tier 3 pollution incident. Possibility of ignition and fire when the motor spirit pipeline is burst due to its flammability. Two refineries must be closed for a considerable time in order to repair the pipeline. This causes significant impacts for multiple weeks and has national affect to petroleum production. Multiple fatalities, negative international publicity for port and greater than £8 million of damage to port infrastructure.	Possible	**People**	Extreme (5)	Ro-Ro has a slow speed impact with IOT trunk way leading to minor damage to vessel and distortion of pipe line on trunk way. Single fatality to personnel on the trunk way and tier 3 pollution, negative international publicity and greater than £8 million of damages to the port.	Poss ble	**People**	Major (4)
Inadequate number/type tugs	Towage, available and appropriate	Available at the port			**Property**	Extreme (5)			**Property**	Extreme (5)
Failure to comply with Towage guidelines	Towage guidelines	Correct configuration			**Planet**	Extreme (5)			**Planet**	Extreme (5)
Adverse weather conditions	Weather limits	Wind limit e.g. 35 knots		3	**Port**	Extreme (5)		3	**Port**	Extreme (5)
Restricted visibility										
Incorrect assessment of tidal flow										
Vessel breakdown or malfunction	Vessel propulsion redundancies	Two propellers, two engines and auxiliary power								
Human error/fatigue - Pilot/ Vessel Personnel	Harbour Authority requirements	Expert local knowledge of the area including tidal regime								
Poor situational awareness	Vessel Traffic Services	Control vessel movements and coordinate emergency response								
Excessive vessel speed	Local Port Service	Immingham Marine Control Centre (MCC)								
Inadequate bridge resource management	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
Inadequate procedures in place onboard vessel	Oil spill contingency plans	Covers the response to a pollution event								
Communication failure - Personnel	Communications equipment	Vessels have VHF radios available								
Ship/Tug/Launch failure	Training of port marine/operations personnel	Port's marine training policy								
Further Applicable Controls										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Impact protection	Very Substantial	Very Substantial	Impact fendering and buttress protection	Rare	**People**	Minor (2)	Unlikely	**People**	Minor (2)	
Berthing criteria	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)		**Property**	Extreme (5)		**Property**	Moderate (3)	
Additional tug provisions	Considerable	Fair			**Planet**	Minor (2)		**Planet**	Minor (2)	
				1	**Port**	Minor (2)	2	**Port**	Minor (2)	
Risk Assessment and Applied Control										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Specific berthing criteria for each of the three berths	Considerable		Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)	Unl kely	**People**	Extreme (5)	Unlikely	**People**	Major (4)	
Project specific adaptive procedures	Considerable	Fair	Adaptive procedures during familiarisation period as operational experience gained (e.g. tugs, tidal restrictions, delayed start of use of berth 1 during familiarisation period, impact protection)		**Property**	Extreme (5)		**Property**	Extreme (5)	
					Planet	Extreme (5)		**Planet**	Extreme (5)	
				2	**Port**	Extreme (5)	2	**Port**	Extreme (5)	

Table C5 Hazard Category: Allision; Scenario: Ro-Ro contact with IERRT infrastructure; Risk ID O5

Risk Analysis – Causes	Embedded Controls – Control	Embedded Controls – Comment	Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Inadequate number/type tugs	Towage, available and appropriate	Available at the port; correct configuration taken	Ro-Ro collides with the infrastructure causing serious damage to vessel but limited damage to pontoon. Disrupting operation to two of the three berths, no pollution, minor injuries to personnel, greater than £8 million of damage, serious negative national publicity, and delays to operation.	Unlikely	People	Minor (2)	Ro-Ro has a slow speed impact with pier during berthing leading to minor damage to vessel and pier, no injuries, no pollution, minor delay to operations.	Likely	People	Negligible (1)
Failure to comply with Towage guidelines	Towage guidelines	Correct configuration			Property	Extreme (5)			Property	Negligible (1)
Adverse weather conditions	Monitoring of met ocean conditions	Weather forecasts obtained and compared with limits			Planet	Negligible (1)			Planet	Negligible (1)
Incorrect assessment of tidal flow				2	Port	Major (4)		4	Port	Minor (2)
Restricted visibility	Aids to navigation, Provision and maintenance of	Port lights and visual aids overseen by LLA and GLA. Signal lights.								
Human error/fatigue - Pilot/ Vessel Personnel	Harbour Authority requirements	Training and authorisation of Pilots/PECs in line with HES Pilotage Directions								
Excessive vessel speed										
Poor situational awareness										
Inadequate bridge resource management										
Inadequate procedures in place onboard vessel										
Manoeuvre misjudged	Berthing procedures	Aligned with ports berthing requirements								
Failure to follow passage plan	Local Port Service	Immingham Marine Control Centre								
Ship/Tug/Launch failure	Vessel propulsion redundancies	Two propellers, two engines and auxiliary power								
Vessel breakdown or malfunction	Vessel Traffic Services	Control vessel movements and coordinate emergency response								
Communication failure - Personnel										
	Design criteria	Built to withstand a collision at certain level (set out in building design standards)								
	Berthing procedures	Aligned with ports berthing requirements								
	Vessel simulation study	Testing of vessel arrivals and manoeuvring to inform the design								

Further Applicable Controls – Control	Frequency Reduction	Consequence Reduction	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence		
Additional Training	Considerable	Fair		Rare	People	Minor (2)	Likely	People	Negligible (1)	
Berthing criteria	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)		Property	Extreme (5)		Property	Negligible (1)	
					Planet	Negligible (1)		Planet	Negligible (1)	
				1	Port	Major (4)	4	Port	Minor (2)	

Risk Assessment and Applied Control – Control	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence		
Additional Training	Considerable	Fair	For Pilots/PECs on all 3 berths	Rare	People	Minor (2)	Possible	People	Negligible (1)	
Specific berthing criteria for each of the three berths	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)		Property	Major (4)		Property	Negligible (1)	
					Planet	Negligible (1)		Planet	Negligible (1)	
				1	Port	Moderate (3)	3	Port	Minor (2)	

Table C6 Hazard Category: Collision; Scenario: Ro-Ro on passage to/from Immingham Eastern Ro-Ro Terminal with another vessel; Risk ID O6

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	Control	Comment								
Failure to comply with Towage guidelines	Towage, available and appropriate	Local tug coverage. Towage guidelines in place	Manoeuvring speed collision with no avoiding action leading to multiple fatalities, hull breach, serious impact to property, significant consequence to the environment including a tier 2 pollution event, and serious consequence to the port business and reputation.	Unlikely	People	Extreme (5)	Low speed glancing collision with bridge crew taking avoiding action, minor injuries, minor impact to property, no appreciable consequence to the environment or to the port's business/reputation.	Poss ble	People	Minor (2)
High traffic density	Communications - traffic broadcast	VTS provide vessel traffic information			Property	Major (4)			Property	Minor (2)
COLREGs failure to comply	International COLREGs 1972 (as amended)	Safe conduct of ships at sea			Planet	Major (4)			Planet	Negligible (1)
Restricted visibility				2	Port	Major (4)		3	Port	Negligible (1)
Failure to follow passage plan	Passage planning	Required for all commercial vessels								
Vessel breakdown or malfunction	Vessel propulsion redundancies	Twin propellers, two engines and an auxiliary back up								
AIS failure/ lack of AIS	Vessel Traffic Services	Control vessel movements and management								
Excessive vessel speed										
Incorrect assessment of tidal flow	Accurate tidal measurements	Live tidal data supplied by VTS								
Excessive vessel speed	Byelaws	Statutory powers of direction								
Poor situational awareness	Aids to navigation, Provision and maintenance of	Port lights and visual aids overseen by LLA and GLA. Signal lights.								
Human error/fatigue - Pilot/ Vessel Personnel	Harbour Authority requirements	Expert local knowledge and updated on activities (pilotage PEC requirements)								
Inadequate bridge resource management										
Inadequate procedures in place onboard vessel										
Manoeuvre misjudged										
Ship/Tug/Launch failure	Joint emergency drills with VTS and Port staff	Emergency exercises and HESMEP								
Communication failure - Personnel	Local Port Service	Immingham Marine Control Centre								
Adverse weather conditions										
	Availability of latest hydrographic information	Available via local charts and regular surveys.								
	Arrival/Departure, advance notice of	Vessels required to provide notice to VTS								
	Oil spill contingency plans	Covers the response to a pollution event								

Further Applicable Controls	Frequency Reduction	Consequence Reduction	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence	
Control									
No Further Applicable Controls identified					People			People	
					Property			Property	
					Planet			Planet	
					Port			Port	

Risk Assessment and Applied Control	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence	
Control									
Risk assessed against relevant MSMS' (HES/IMM)				Unlikely	People	Extreme (5)	Possible	People	Minor (2)
ALARP with embedded controls					Property	Major (4)		Property	Minor (2)
					Planet	Major (4)		Planet	Negligible (1)
				2	Port	Major (4)	3	Port	Negligible (1)

Table C7 Hazard Category: Grounding; Scenario: Ro-Ro manoeuvring to south-western berth; Risk ID O7

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	**Control**	**Comment**								
Human error/fatigue - Pilot/ Vessel Personnel			Ro-Ro proceeding to berthing at IERRT grounds on mud and is refloated on next tide, disruption to Stena timetable. The vessel grounded stern first resulting in damages to propulsion which requires survey and repair. Stops operation on berth 1 whilst vessel is aground. No pollution, minor injuries to crew and passengers, minor local publicity.	Unlikely	**People**	Minor (2)	Vessel grounds briefly but able to refloat and continues to the berth. Minor delay to operations, minimal damage to vessel. Minor injuries, no pollution and little local port reputational damage.	Possible	**People**	Minor (2)
Inadequate bridge resource management	Communications equipment	Vessels have VHF radios available			**Property**	Moderate (3)			**Property**	Minor (2)
Inadequate procedures in place onboard vessel	Passage planning	All vessels are required to operate in accordance with their passage plans			**Planet**	Neglig ble (1)			**Planet**	Negligible (1)
Inadequate dredging	Availability of latest hydrographic information	Available via local charts and regular surveys.		2	**Port**	Minor (2)		3	**Port**	Minor (2)
Adverse weather conditions	Towage, available and appropriate	Available at the port								
Incorrect assessment of tidal flow	Accurate tidal measurements	Live tidal data supplied by VTS								
Restricted visibility	Aids to navigation, Provision and maintenance of	Two blue lights to be positioned on the southern berth of the IERRT to indicate the edge of the dredged area.								
Vessel breakdown or malfunction	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.								
Inadequate hydrographic surveying	Hydrographic Survey	Accurate regular survey as required by PMSC								

Further Applicable Controls										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Increase size of dredge pocket	Minute			Unlikely	**People**	Minor (2)	Unlikely	**People**	Minor (2)	
Berthing criteria	Considerable	Fair	Procedures and further parameters for berth 3		**Property**	Moderate (3)		**Property**	Minor (2)	
Marking safe water with AtoN	Fair				**Planet**	Neglig ble (1)		**Planet**	Negligible (1)	
				2	**Port**	Minor (2)	2	**Port**	Minor (2)	

Risk Assessment and Applied Control										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Specific berthing criteria for each of the three berths	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)	Unlikely	**People**	Minor (2)	Unlikely	**People**	Minor (2)	
Marking safe water with AtoN	Fair		AtoN positioned to visually aid manoeuvre and limits		**Property**	Moderate (3)		**Property**	Minor (2)	
Additional Training	Considerable		For Pilots/PECs on all 3 berths		**Planet**	Neglig ble (1)		**Planet**	Negligible (1)	
				2	**Port**	Minor (2)	2	**Port**	Minor (2)	

Table C8 Hazard Category: Other (Mooring); Scenario: Ro-Ro vessel breaks free of moorings; Risk ID O8

Risk Analysis	Embedded Controls		Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Causes	Control	Comment								
Human error/fatigue - Vessel Personnel			Vessel breaks mooring, all lines break but ramp temporally holds stern on the pontoon acting as a pivot point causing vessel to swing towards the IOT Finger Pier. Subsequent allision causes damage to pier, and vessels rests on the end of the finger pier causing damage to the fenders. Potential that a multi death incident occurs as ramp dislodges from the IERRT pontoon. Significant damage to vessel from slow allision with infrastructure, possible minor pollution, significant delays to operations and major international reputational damage.	Rare	People	Extreme (5)	Single mooring line failure but vessel remains alongside, vessel puts out additional mooring lines. Minor delay to operations and/or minor cost to port. Minor little local publicity and minor injury.	Almost Certain	People	Minor (2)
Failure to follow onboard vessel procedures					Property	Extreme (5)			Property	Minor (2)
Communication failure - Operational/procedural	Communications equipment	Vessels have VHF radios available, and can alert			Planet	Negligible (1)			Planet	Negligible (1)
Interaction with passing vessel	Vessel Traffic Services	Coordinate an emergency response and manage traffic in the area; all ships in the Humber area are notified of shipping movements by regular VHF traffic and information broadcasts.		1	Port	Extreme (5)		5	Port	Minor (2)
Failure of berth mooring systems	Mooring analysis	Mooring analysis to be undertaken								
Tidal flow										
Adverse weather conditions										
	Adequate berth fendering	Port has strategically placed fendering								
Further Applicable Controls										
Control	**Frequency Reduction**	**Consequence Reduction**	**Comment**	**Potential Worst Credible Frequency**	**Potential Worst Credible Consequence**		**Potential Most Likely Frequency**	**Potential Most Likely Consequence**		
Hooks with load monitoring	Fair			Rare	People	Extreme (5)	Likely	People	Minor (2)	
Additional storm bollards	Very Substantial				Property	Extreme (5)		Property	Minor (2)	
Berth specific weather parameters	Slight				Planet	Negligible (1)		Planet	Negligible (1)	
				1	Port	Extreme (5)	4	Port	Minor (2)	
Risk Assessment and Applied Control										
Control	**Frequency Mitigation**	**Consequence Mitigation**	**Comment**	**Post Cost Benefit Analysis Worst Credible Frequency**	**Post Cost Benefit Analysis Worst Credible Consequence**		**Post Cost Benefit Analysis Most Likely Frequency**	**Post Cost Benefit Analysis Most Likely Consequence**		
Berth specific weather parameters	Slight			Rare	People	Extreme (5)	Almost Certain	People	Minor (2)	
					Property	Extreme (5)		Property	Minor (2)	
					Planet	Negligible (1)		Planet	Negligible (1)	
				1	Port	Extreme (5)	5	Port	Minor (2)	

Table C9 Hazard Category: Allision; Scenario: Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2-3 with a tanker berthed on eastern jetty; Risk ID O9

Risk Analysis Causes	Embedded Controls Control	Comment	Worst Credible Scenario	Frequency	Consequence		Most Likely Scenario	Frequency	Consequence	
Adverse weather conditions	Monitoring of met ocean conditions	Met Ocean data collected and compared with operation limits	Ro-Ro makes contact with berthed tanker resulting in a significant allision that punctures the tanker's double hull leading to a tier 3 pollution event with release of toxic chemical. Causing major risk to life and environment both short and long term. Incident results in multiple fatalities, sever damages to both vessels and berth infrastructure for an amount greater than £8M. Negative international news that significantly affects the ports reputation and port operations.	Unlikely	People	Extreme (5)	An approaching Ro-Ro loses control and makes slow contact with berthed tanker resulting in an allision that damages cargo pipes, leading to a tier 3 pollution event with release of toxic chemical. Moderate damage to port infrastructure and vessel, serious injuries to personnel, and negative national port reputational damage.	Possible	People	Moderate (3)
Incorrect assessment of tidal flow					Property	Extreme (5)			Property	Moderate (3)
Navigation equipment failure	Passage planning	Required for all commercial vessels			Planet	Extreme (5)			Planet	Extreme (5)
Excessive vessel speed				2	Port	Extreme (5)		3	Port	Major (4)
	Towage guidelines	Correct configuration								
Inadequate number/type tugs	Towage, available and appropriate	Available at the port								
Manoeuvre misjudged	Harbour Authority requirements	Expert local knowledge and updated on activities (pilotage PEC requirements)								
High traffic density	Vessel Traffic Services	Control vessel movements and coordinate emergency response								
Communication failure - Personnel										
Vessel breakdown or malfunction	Port Facility Emergency Plan	Details the Harbour Authority's response to an emergency								
Limited area for manoeuvring										
Failure of berth mooring systems										
Human error/fatigue - Pilot/ Vessel / Marine Personnel										
	Oil spill contingency plans	Covers the response to a pollution event								

Further Applicable Controls Control	Frequency Reduction	Consequence Reduction	Comment	Potential Worst Credible Frequency	Potential Worst Credible Consequence		Potential Most Likely Frequency	Potential Most Likely Consequence		
Berthing criteria	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)	Rare	People	Extreme (5)	Unlikely	People	Moderate (3)	
Charted safety area, berthing procedures	Slight				Property	Extreme (5)		Property	Moderate (3)	
Additional pilotage training/ familiarisation	Minute				Planet	Extreme (5)		Planet	Extreme (5)	
				1	Port	Extreme (5)	2	Port	Major (4)	

Risk Assessment and Applied Control Control	Frequency Mitigation	Consequence Mitigation	Comment	Post Cost Benefit Analysis Worst Credible Frequency	Post Cost Benefit Analysis Worst Credible Consequence		Post Cost Benefit Analysis Most Likely Frequency	Post Cost Benefit Analysis Most Likely Consequence		
Specific berthing criteria for each of the three berths	Considerable	Fair	Tidal limits, tugs, method etc. (e.g. no vessel movements during high winds)	Rare	People	Extreme (5)	Unlikely	People	Moderate (3)	
Charted safety area, berthing procedures	Slight				Property	Extreme (5)		Property	Moderate (3)	
Additional pilotage training/ familiarisation	Minute				Planet	Extreme (5)		Planet	Extreme (5)	
				1	Port	Extreme (5)	2	Port	Major (4)	

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