IMMINGHAM EASTERN RO-RO TERMINAL

NAVIGATION RISK ASSESSMENT

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ABBREVIATIONS

Abbreviation	Definition
ABP	Associated British Ports
ABPmer	ABP Marine Environment Research Ltd
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
APT	Associated Petroleum Terminals (Immingham) Ltd
CHA	Competent Harbour Authority
COLREGS	International Regulations for Preventing Collisions at Sea 1972
DCO	Development Consent Order
DfT	Department for Transport
dwt	Dead Weight Tonnage
ES	Environmental Statement
ESE	East south east
FAME	Fatty Acid Methyl Esters
FSA	Formal Safety Assessment
GtGP	Guide to Good Practice on Port Marine Operations
HAZID	Hazard Identification
HES	Humber Estuary Services
HIT	Humber International Terminal
HP	Horsepower
Hs	Significant Wave Height
HSC	High Speed Craft
HW	High Water
IERRT	Immingham Eastern Ro-Ro Terminal
IBT	Immingham Bulk Terminal
IGET	Immingham Green Energy Terminal
IGT	Immingham Gas Terminal
IMO	International Maritime Organization
IOH	Immingham Outer Harbour
IOT	Immingham Oil Terminal
LOA	Length Overall
LW	Low Water
m	Metre
MAIB	Marine Accident Investigation Board
MHWS	Mean High Water Springs
MSMS	Marine Safety Management System
NASH	NASH Maritime Ltd
NE	North east
NRA	Navigation Risk Assessment
PEC	Pilot Exemption Certificate
PEIR	Preliminary Environmental Impact Report

PMSC	Port Marine Safety Code
RIDDOR	Reporting of Injuries, Diseases and Dangerous OccurrencesRegulations
Ro-Ro	Roll-on Roll-off
Ro-Pax	Ro-Ro Passenger
SHA	Statutory Harbour Authority
SW	South west
VTS	Vessel Traffic Services
WNW	West north west

1 Introduction

1.1 Overview

Associated British Ports (ABP) has submitted a Development Consent Order (DCO) application for the development of the Immingham Eastern Ro-Ro Terminal (IERRT) (the project). As part of the DCO application ABP has submitted an Environmental Statement (ES), which includes a non-technical Shipping and Navigation Impact Assessment chapter and a technical Navigation Risk Assessment (NRA) coordinated and prepared by ABPmer (ABP's internal consulting arm), which is referred to as the ABPmer NRA in this report.

DFDS Seaways (DFDS), are shipping operators within the Port of Immingham and are therefore relevant stakeholders. DFDS have been included in various consultations on the development of the ABPmer NRA, including hazard identification workshops, ship simulations and various other written communications. It is understood that throughout the stakeholder engagement process DFDS raised concerns, particularly in relation to the navigation safety of the IERRT development and the NRA methodology employed by ABPmer. DFDS also consider the ABPmer NRA has not adequately captured and addressed these safety concerns. The DFDS concerns have been captured within a Relevant Representation submitted to the Planning Inspectorate in response to the IERRT DCO application.

Following submission of the DCO and DFDS's Relevant Representation, and as the concerns had not been addressed, DFDS decided to commission an NRA independently of the ABPmer NRA to assess the safety aspects of shipping operations of the IERRT project in accordance with the requirements of the Port Marine Safety Code (PMSC)[1] and associated PMSC guidelines, the Guide to Good Practice on Port Marine Operations (GtGP)[2].

This document is an independent NRA for the IERRT development and has been prepared by Bishop Marine Consulting Ltd, NASH Maritime Ltd, Capt. Jonathan Bush (Marine Pilot and Marine Consultant) and with supporting insight from DFDS operations personnel and captains experienced at navigating Ro-Ro vessels to and from the Port of Immingham. Collectively, this is referred to as the Risk Assessment Team within this report.

This NRA assesses the operational phase of the IERRT development and any required additional risk controls necessary. Due to time limitations, assessment of the construction of simultaneous construction + operation phases have not been assessed. Understanding the long-term risk introduced by the operation of the IERRT was deemed essential to first assess the feasibility of the proposed operations. However, it is recognised that the shorter-duration construction and simultaneous construction + operation phases would present other hazards that would need to be systematically assessed using a consistent methodology as presented herein.

1.2 Requirements for Assessment

The requirement of the DFDS NRA is to produce an independent, structured and transparent NRA using a single methodology prescribed by the PMSC and its accompanying guideline, the GtGP.

1.3 Document Structure

The structure of this report is as follows:

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[1] Port Marine Safety Code, 2016 (PMSC), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918935/port-marine-safety-code.pdf

[2] A Guide to Good Practice on Port Marine Operations (GtGP), 2018, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/854521/MCGA-Port_Marine_Guide_to_Good_Practice_NEW-links.pdf

- Section 1: Introduction – Including overview of the Port of Immingham
- Section 2: IERRT Development
- Section 3: Navigation Baseline – including current and future vessel traffic, and previous incidents
- Section 4: Vessel Traffic Analysis – including detailed analysis of AIS data
- Section 5: Risk Assessment Methodology
- Section 6: Hazard Identification
- Section 7:Inherent Risk Assessment
- Section 8: Additional risk controls
- Section 9: Residual Risk Assessment
- Section 10: Conclusions and Recommendations

1.4 Assessment Approach

The current Port of Immingham's PMSC-compliant baseline risk assessment has not been received for this NRA. Therefore, this NRA adopts a PMSC-compliant NRA approach consistent with two previous risk assessments undertaken separately for other developments within ABP port areas – these are Marchwood Port development within ABP Southampton, and Able Marine Energy Park development within ABP Humber. These are outlined below and further specific details of how each have been applied are also discussed throughout Section 5, Risk Assessment Methodology.

1. **Marchwood Port development NRA** on behalf of Solent Gateway Ltd (Solent Gateway) in development in 2021[3] (within this document referred to as the Solent Gateway NRA). The Solent Gateway NRA was undertaken on the requirements of ABP Southampton, as the local Statutory Harbour Authority (SHA). The risk assessment methodology utilised the ABP Southampton PMSC navigation risk assessment and mapped changes to risk brought about by the Marchwood Port development on this agreed baseline. The assessment utilised risk matrices, algorithms and likelihood / consequence descriptors provided by ABP Southampton from their PMSC NRA software MarNIS, which is used at all 21 ABP ports for all PMSC NRA requirements. MarNIS is also used within ABP Humber and, as such, the approach and assessment undertaken in the Solent Gateway NRA is considered to be a proven PMSC-compliant risk assessment adequate for ABP Southampton and is equally appropriate for the IERRT development within ABP Humber.
2. **Able Marine Energy Park development NRA** by Marine and Risk Consultants Ltd (Marico Marine) on behalf of Able UK in 2021[4] (within this documents referred to as the Able NRA). The Able Marine Energy Park is a development located on the Humber estuary in Killingholme, immediately upriver of the Port of Immingham, and therefore resides within ABP Humber's coverage area. The Able NRA was originally undertaken in 2011 for the DCO application of that project and was subsequently revised in 2021 following material amendments to the project. The Able NRA specifically notes in relation to the update that "the NRA methodology will additionally be reviewed and updated in accordance with current industry best practice in agreement with ABP Humber". The methodology

[3] Marchwood Port Development NRA for Solent Gateway, 2021, https://docs.planning.org.uk/20210817/52/_NEWFO_DCAPR_215019/pr5ior0rhqjgkitu.pdf

[4] Able Marine Energy Park NRA for Able UK by Marico Marine, 2021, https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030006/TR030006-000135-TR030006-APP-6A-14-1.pdf

adopted therein is therefore considered to be compliant with ABP Humber risk assessment / safety management system processes.

The PMSC-compliant risk assessment is outlined in the GtGP, and is defined by a five-stage process, which are located within this NRA as follows:

- **Stage 1: Problem identification scoping and risk assessment design (information gathering)**
  - Section 1.6 – Port of Immingham
  - Section 2 – IERRT Development
  - Section 3 – Navigation Baseline (historical and future baseline vessel traffic)
  - Section 3.6 – Incident Analysis
  - Section 4 – Vessel Traffic Analysis
- **Stage 2: Hazard Identification**
  - Section 6 – Hazard Identification
- **Stage 3: Risk Analysis**
  - Section 5 – Risk Assessment Methodology
  - Section 7 – Inherent Risk Assessment
- **Stage 4: Assessment of existing risk control measures**
  - Section 7.1 – Embedded Risk Control Measures
  - Section 7.2 – Inherent Risk Assessment
- **Stage 5: Identification of new risk control measures**
  - Section 8 – Additional Risk Controls
  - Section 9 – Residual Risk Assessment

Although not a requirement of a PMSC style risk assessment, the Solent Gateway NRA undertook additional quantified risk modelling for collision, allision and grounding scenarios. Due to limited time available to conduct this NRA, the quantitative collision, allision and grounding modelling components have not been undertaken. Instead this NRA utilised an assessment of available historical incident data with historical, existing and future vessel movements at the Port of Immingham and developed a semi-qualitative approach with support from the practical exercise of local mariners, port operator and pilots. That is, an assessment of the number of incidents, vessel traffic and the introduction of the IERRT was used to inform qualitative judgement taking into account local insights.

1.4.1 Previous Contributing IERRT Assessments

During the preparation of the IERRT application and the ABPmer NRA, various documents and contributing assessments were produced. The contributing IERRT assessments considered in this NRA are outlined below, together with an explanation of how much of the assessment has been considered and on what basis.

1.4.1.1 ABPmer NRA

ABPmer has produced a qualitative NRA for the IERRT project[5]. DFDS, amongst various other local stakeholders and/or Interested Parties, have raised objections or criticisms of various aspects of the ABPmer NRA through their Relevant Representations[6] response to the consenting application. However, whilst these objections and criticisms form part of the reason that DFDS have undertaken this independent NRA, it is critical to note that the primary purpose of this NRA is purely to undertake an impartial, structured and transparent NRA of the IERRT using a PMSC-compliant methodology. It is not to opine on the specific objections raised by the various Interested Parties nor to specifically validate or invalidate them. As such, various objective and factual information contained within the ABPmer NRA also remain entirely relevant to supporting this NRA and these have been referenced when used. Subjective information or subjective interpretations of factual information; however, have not been carried through to allow this NRA to be undertaken on an entirely independent basis.

1.4.1.2 HAZIDs and Stakeholder Engagement

Several Hazard Identification (HAZID) workshops were undertaken during the preparation of the ABPmer NRA. These workshops are outlined in the ABPmer NRA and have been considered in preparation of this NRA (primarily for hazards identified, embedded mitigation measures and additional mitigation measures, which have subsequently been reviewed and revised or expanded upon where necessary as detailed in this report). The workshops are summarised below and further details of attendees can be found within the ABPmer NRA.

1. 29 October 2021 – Internal workshop held with internal ABP stakeholders with the primary purpose of informing the preparation of the Preliminary Environmental Impact Report (PEIR).

   Attendees: ABP stakeholders.

2. 07 April 2022 – External workshop #1 with internal ABP stakeholders and external port users and operators with the purpose reported to be extended hazard identification and risk assessment of the hazards identified from the internal workshop.

   Attendees: ABP stakeholders, Associated Petroleum Terminals (APT), NASH Maritime, Stena Line, DFDS and CLdN.

3. 16-17 August 2022 – External workshop #2 (two-day workshop) with ABP stakeholders and external port users and operators as per external workshop #1 and included an additional wider network of external stakeholders. The primary purpose for external workshop #2 was understood to be for information gathering from a wider external stakeholder group, advising changes made to adjustments in the NRA methodology (following feedback from external workshop #1), and the potential for and additional phase of operation in which operation would be possible during the construction phase.

   Attendees: ABP stakeholders, APT, NASH Maritime, Stena Line, DFDS, HR Wallingford, Exolum, Bishop Marine Consulting, Svitzer, Rix and James Fisher Everard.

The workshops were unable to fully cover the risk assessment scoring and as a result two further consultation periods were defined with email communication with the primary purpose to try and complete the risk scoring exercise (consultation period #1) and later for stakeholders to provide feedback on ABPmer's final risk assessment (consultation period #2).

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[5] TR030007-000368-8.4.10(a)_IERRT ES_Vol3_Appendix 10.1_Navigation Risk Assessment.pdf
https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030007/TR030007-000368-8.4.10(a)_IERRT%20ES_Vol3_Appendix%2010.1_Navigation%20Risk%20Assessment.pdf

[6] IERRT Interested Party Relevant Representations, https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/TR030007/representations

This report and NRA has been prepared with the awareness of the workshops and consultation periods previously undertaken but has applied a separate structured approach to hazard identification and risk scoring to allow an independent risk assessment process.

1.4.1.3 Ship Simulations

As part of the informative assessment and stakeholder involvement undertaken for the assessment of navigational safety and the preparation of the ABPmer NRA, ship simulations had been undertaken using the facilities at HR Wallingford and reports of these simulations' exercises include:

- Navigational Simulation Study, July 2022 (Part 1 [7] and Part 2 [8]).
- Navigational Simulation – Stakeholder Demonstrations [9].

There are various outstanding reservations that are shared between the external stakeholders / Interested Parties regarding the accuracy and reliability of the findings of the ship simulation exercise and as a result of this the confidence level of the findings from these ship simulations is reduced. Therefore, the findings from the ship simulations undertaken have not been used directly to inform this NRA on the ability (or inability) to navigate to and from the IERRT safely, but rather have been indirectly used to provide a higher-level objective view that the navigation to and from the IERRT berths is highly dynamic and challenging, with little room for error and limited redundancy. The Risk Assessment Team also considered that there exists a potential for deviation from the simulated exercises that could result in less favourable vessels being used at the IERRT in future. For example, the vessel used in the simulation was the DFDS Jinling Class – 238m length, 33m beam, 7m draft and are regular vessels operating within Immingham to and from the Immingham Outer Harbour (IOH). The vessel is equipped with a bow thruster, 2x controllable pitch propellors and Becker twisted flap rudders each providing a very high degree of control, response and manoeuvrability. For comparative context, the IERRT design vessels are 240m length, 35m beam and 8m draft but do not have machinery or vessel details specified. It was therefore noted by the Risk Assessment Team that vessels using the IERRT may not have the same manoeuvrability characteristics and that the design draft of the IERRT vessels was 1m deeper than the simulated vessels (being far more susceptible to strong currents or under keel clearance effects hampering manoeuvrability).

This NRA uses the objective finding that navigation and manoeuvring onto IERRT berths 1, 2 and 3 (particularly berth 3) present a significantly challenging navigational environment for arrival and departure (particularly arrival) in adverse weather which would likely result in more difficult navigational demands in real life.

1.5 Relevant Guidance

The following sections provide details on the legislation and guidance, procedures and practices required to be taken into account when conducting an NRA within a port area, such as is required for the project.

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[7] TR030007-000369-8.4.10(b)_IERRT ES_Vol3_Appendix10.2_Navigation Simulation Study - Part 1.pdf
https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030007/TR030007-000369-8.4.10(b)_IERRT%20ES_Vol3_Appendix10.2_Navigation%20Simulation%20Study%20-%20Part%201.pdf

[8] TR030007-000370-8.4.10(b)_IERRT ES_Vol3_Appendix10.2_Navigation Simulation Study - Part 2.pdf
https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030007/TR030007-000370-8.4.10(b)_IERRT%20ES_Vol3_Appendix10.2_Navigation%20Simulation%20Study%20-%20Part%202.pdf

[9] TR030007-000371-8.4.10(c)_IERRT ES_Vol3_Appendix 10.3 - Navigational Simulation _ Stakeholder Demonstrations.pdf,
https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030007/TR030007-000371-8.4.10(c)_IERRT%20ES_Vol3_Appendix%2010.3%20-%20Navigational%20Simulation%20_%20Stakeholder%20Demonstrations.pdf

1.5.1 Legislation

The following list provides a summary of the relevant legislation identified as part of this NRA outline review:

- The Humber Navigation Byelaws 1990
- Harbours Docks and Piers (Clauses) Act 1847
- Harbours Act 1964
- The Pilotage Act 1987 (Amendment) Regulations 2019
- Schedule 3, Transport Act 1981
- The Docks Regulations 1988
- Marine Navigation Act 2013
- International Ship and Port Facility Security Code 2004
- British Transport Docks Act 1972
- Transport Docks Act 1964
- Associated British Ports Act 1987
- The Associated British Ports (Immingham Outer Harbour) Harbour Revision Order 2004
- The Associated British Ports (Immingham Gas Jetty) Harbour Revision Order 2007
- Immingham Dock Revision Order 1966
- Merchant Shipping Act, 1894.

1.5.2 Guidance, Procedures, Practices

The following list provides a summary of the relevant guidance, procedures and practices identified as part of this NRA outline review:

- Port Marine Safety Code (PMSC)
- Port Marine Safety Code – "Guide to Good Practice on Port Marine Operations" (GtGP)
- MGN 401 (M+F) Amendment 3 Navigation: Vessel Traffic Services (VTS) and Local Port Services (LPS) in the UK
- IALA VTS Manual 2022 [10]
- IALA G1111 Establishing Functional Performance Requirements [11]
- ABP Pilotage Directions for Ships to Be Navigated in within the Humber Pilotage area [12]
- ABP Marine Safety Plan [13]

[10] IALA VTS Manual https://www.iala-aism.org/product/m0002/

[11] IALA G1111 Establishing Functional Performance Requirements, https://www.iala-aism.org/product/g1111/

12 ABP Pilotage Directions
https://www.humber.com/admin/content/files/Misc/The%20Humber%20Pilotage%20Directions%20Amended%202016.pdf

[13] ABP Marine Safety Plan https://www.abports.co.uk/media/hponb0o5/marine-safety-plan.pdf

- The Humber Pilot Handbook 2017
- Humber Passage Plan 2021 [14]
- Revised Guidelines for Formal Safety Assessments (FSA) for Use in The IMO Rule-Making Process, 2018 [15]
- Marine Navigation Act 2013 [16]
- The Pilotage Act 1987 (Amendment) Regulations 2019 [17]
- Immingham Docks Byelaws [18]
- General Directions for Navigation on the Humber [19]
- Humber Notices to Mariners (HNtMs) [20]

1.5.3 Port Marine Safety Code

As stated on the UK Government website, the PMSC sets out a national standard for every aspect of port marine safety. Its aim is to enhance safety for everyone who uses or works in the UK port marine environment. The PMSC is intended to be flexible enough that any size or type of harbour or marine facility will be able to apply its principles in a way that is appropriate and proportionate to local requirements.

The PMSC represents best-practice for management of port marine safety. It is applicable both to statutory harbour authorities and to other marine facilities which may not have statutory powers and duties and it is strongly recommended that organisations or facilities which are not a statutory harbour authority also seek a proportionate compliance with the PMSC.

The PMSC defines 10 keys measures of which the three listed below are recommended as the very minimum in order to comply, these are:

- 4. Duties and Powers: Comply with the duties and powers under existing legislation, as appropriate.
- 5. Risk Assessment: Ensure that marine risks are formally assessed and are eliminated or reduced to the lowest possible level, so far as is reasonably practicable, in accordance with good practice.
- 6. Marine Safety Management System: Operate an effective MSMS which has been developed after consultation, is based on formal risk assessment and refers to an appropriate approach to incident investigation.

[14] ABP Humber Passage Plan, https://www.humber.com/admin/content/files/Estuary%20Information/Humber%20%20Passage%20Plan%202021.pdf

[15] IMO FSA guidelines, https://wwwcdn.imo.org/localresources/en/OurWork/HumanElement/Documents/MSC-MEPC.2-Circ.12-Rev.2%20-%20Revised%20Guidelines%20For%20Formal%20Safety%20Assessment%20(Fsa)For%20Use%20In%20The%20Imo%20Rule-Making%20Proces...%20(Secretariat).pdf

[16] Marine Navigation Act 2013, https://www.legislation.gov.uk/ukpga/2013/23/contents

[17] Pilotage Act 1987, https://business.senedd.wales/documents/s96824/EM%20SICM527%20-%20The%20Pilotage%20Act%201987%20Amendment%20Regulations%202019.pdf

[18] Immingham Docks Byelaws, https://www.abports.co.uk/media/2trjujz5/immingham-dock-bye-laws.pdf

[19] General Directions for Navigation on the Humber, https://www.humber.com/admin/content/files/Notice%20to%20Mariners/Standing%20Notice%20to%20Mariners/SH_01_2001_NTM.pdf

[20] Humber Notices to Mariners (HNtMs), https://www.humber.com/Estuary_Information/Marine_Information/Notice_to_Mariners/

To secure marine safety, the PMSC tightly binds the use of a formal risk assessment of hazards and risks; the use of a MSMS to ensure risks are managed and controlled; and incident reporting and investigation which can feedback to enhance the ongoing update and review of hazards and risks.

The PMSC specifically states that "*an MSMS should be in place to ensure that all risks are identified and controlled – the more severe ones must either be eliminated or reduced to the lowest possible level, so far as is reasonably practicable (that is, such risks must be kept as low as reasonably practicable or "ALARP"). Organisations should consult, as appropriate, those likely to be involved in, or affected by, the MSMS they adopt. The opportunity should be taken to develop a consensus about safe navigation. The MSMS should refer to the use of formal risk assessment which should be reviewed periodically as well as part of post incident/accident investigation activity*".

The PMSC also recommends striving to maintain a consensus about safe navigation. This can be achieved through formal programmes of stakeholder engagement to review of relevant risk assessments with users of the facility or harbour.

At section 2.7 of the PMSC the formal risk assessments are required to:

- Identify hazards and analyse risks.
- Assess those risks against an appropriate standard of acceptability.
- Where appropriate consider a cost-benefit assessment of risk-reduction measures.

The GtGP (which is in conjunction with the PMSC) identifies the use of a risk matrix to compare risk levels based on its likelihood of occurrence and the consequences if it were occur. The risk matrix is then used to identify risks which are acceptable/tolerable, which are unacceptable/intolerable and those in between which can only be acceptable if the risks are reduced to "as low as reasonably practicable" (ALARP). The principle of ALARP therefore relates to risks between acceptable and unacceptable and what is "reasonably practicable" is dependent on the specific hazard, likelihood, consequence and the tolerability threshold of the impacted users. The acceptability or tolerability of risks that reside within the ALARP region therefore require further consideration and can only be considered acceptable/tolerable if the principle of ALARP is met such that no other risk controls can be adopted in order to further reduce risk.

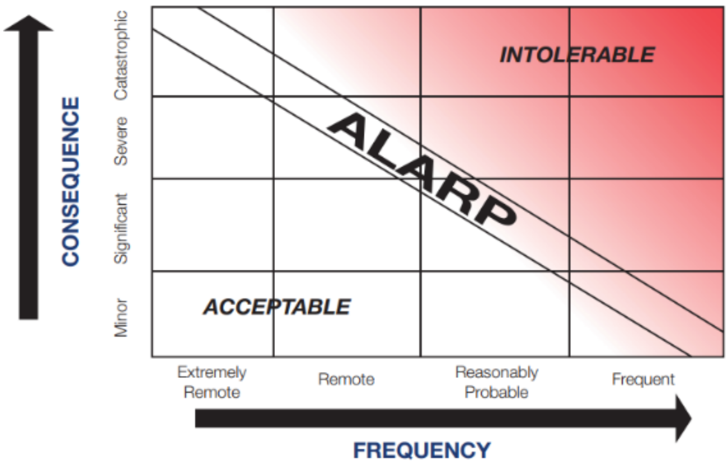

Figure 1: Example Risk Matrix used in GtGP (Source: GtGP)

1.6 Port of Immingham

1.6.1 Port Overview

The Port of Immingham is one of the largest UK ports by volume, handling more than 50 million tonnes per annum, and is the largest of the four Humber ports – Immingham, Grimsby, Hull and Goole. The Port of

Immingham is the UK's largest port by tonnage, and includes handing of products including agribulks, automotive, construction, containers, bulk energy, liquid bulks, rail freight, offshore wind, project cargo, Ro-Ro and Ro-Pax and steel.

The key Port of Immingham terminals are outline below and are shown in **Figure 2**, with a summary table of maximum ship dimensions shown in **Table 1**.

1.6.1.1 The Immingham Oil Terminal (IOT)

- The IOT is formed of two key parts: the River Berths and the Finger Pier, contacted to shore by an elevated piled jetty which carries all product piping. It is understood that product piping maintains charged pipework lines and therefore maintains oil and products with the lines when not in active use.
- The IOT River Berths are three riverside berths and handle large tankers for bulk oil / petroleum liquid cargo to serve two local oil refineries (which produce approximately 20% of the UK's petroleum products). The berths are primarily used for cargo import.
- The IOT Finger Pier are four finger pier berths (two on each side) and are used by smaller product tankers and local bunker barges for oil and chemical liquid bulk cargoes for local petroleum product distribution and Humber ship bunkering needs. The berths are primarily used for cargo export. Maximum vessel size is 104m and 8,500 dwt.
- The IOT is one of the busiest areas for vessel movements in the port, particularly on flood tides as the IOT Finger Pier has tidally restricted movements.

1.6.1.2 Immingham Eastern Jetty

- Immingham Eastern Jetty and a river berth primarily handling bulk hazardous liquid chemicals by chemical tankers with a maximum size of 213m and approximately 50,000 dwt.
- The Immingham East Jetty is a river berth primarily serviced by chemical tankers for the import of Fatty Acid Methyl Esters (FAME) and other dangerous chemicals. The imported FAME are used for the production of biodiesel.
- The Eastern Jetty is located immediately west (approximately 250m) from the proposed IERRT development.
- The eastern jetty also supports the Eastern Jetty tug barge which, being the permanent berth for the Immingham Fire Tug as the dedicated standby response tug for most of the Immingham river terminals, particularly those handling flammable cargoes. It is understood that the use of the Fire Tug has been required numerous times for machinery breakdowns, emergencies and pollution response.

1.6.1.3 Immingham Western Jetty

- The West Jetty is a river berth servicing product tankers, primarily for the import and export of hydrocarbons and dangerous chemicals such as caustic soda, dichloromethane and benzene. The maximum vessel size is the same as the Eastern Jetty of 213m and approximately 50,000 dwt.

1.6.1.4 Immingham Dock

- Immingham Dock is accessed via a lock with entry from the bellmouth entrance between the Eastern and West Jetties. It is used by a variety of ships and cargoes, including (but not limited to) containers, steel, fertiliser, bulk dry and liquid cargoes, scrap and Ro-Ro. Bunker barges also regularly enter the dock to service bunkering requirements within the dock area.

- The Immingham Container Terminal is contained within Immingham Dock and enables transhipment of deep-sea containers direct to Immingham on regular short-sea feeder vessels. The facility operates on a 24/7 basis and has three ship-to-shore cranes and four rubber-tyred gantry cranes supported by reach-stackers.
- The various berths within the dock have vessel size limits; but, in general, the limiting vessel size restricted by the lock is up to approximately 220m length, 26.8m beam and 10.36m draft with approximately 38,000 dwt.

1.6.1.5 Immingham Outer Harbour (IOH)

- The IOH is a river terminal used as a cargo handling facility for Ro-Ro freight vessels and unaccompanied freight trailers for continental freight distribution routes to European ports. It is used on dedicated freight routes operating regular daily services.
- The IOH consists of three berths with a maximum vessel size of 240m and approximately 18,500 dwt.

1.6.1.6 Immingham Bulk Terminal (IBT) / Humber International Terminal (HIT)

- These terminals serve as import facilities used for dry bulk cargoes by Panamax and Cape size bulk carriers. It is used for import of iron ore and coke for the manufacturer of steel at British Steel's Scunthorpe facility, as well as biomass pellets for Drax Power Station.
- The HIT consists of two berths with a maximum vessel size of 289m and approximately 200,000 dwt.
- The IBT consists of one berth with a maximum vessel size of 303m and approximately 200,000 dwt.

1.6.1.7 Immingham Gas Terminal (IGT)

- The IGT handles dangerous cargos including LPG up to 87,000 m^3. The terminal also handles white oil (up to 55,000 dwt) but no heavy oil products. Maximum vessel size is 280m.
- LPG carriers are considered higher risk vessels due to the carriage of dangerous substances and the potential for gas release, fire and/or explosion and fatality. These vessel will be transiting In the Immingham area.

1.6.1.8 South Killingholme Oil Jetty (SKJ) – Immediately up stream of the Port of Immingham

- The SKJ is located within South Killingholme, immediately adjacent to the IGT and handles similar cargoes – LPG and white oil. Maximum vessel size is understood to be 200m.

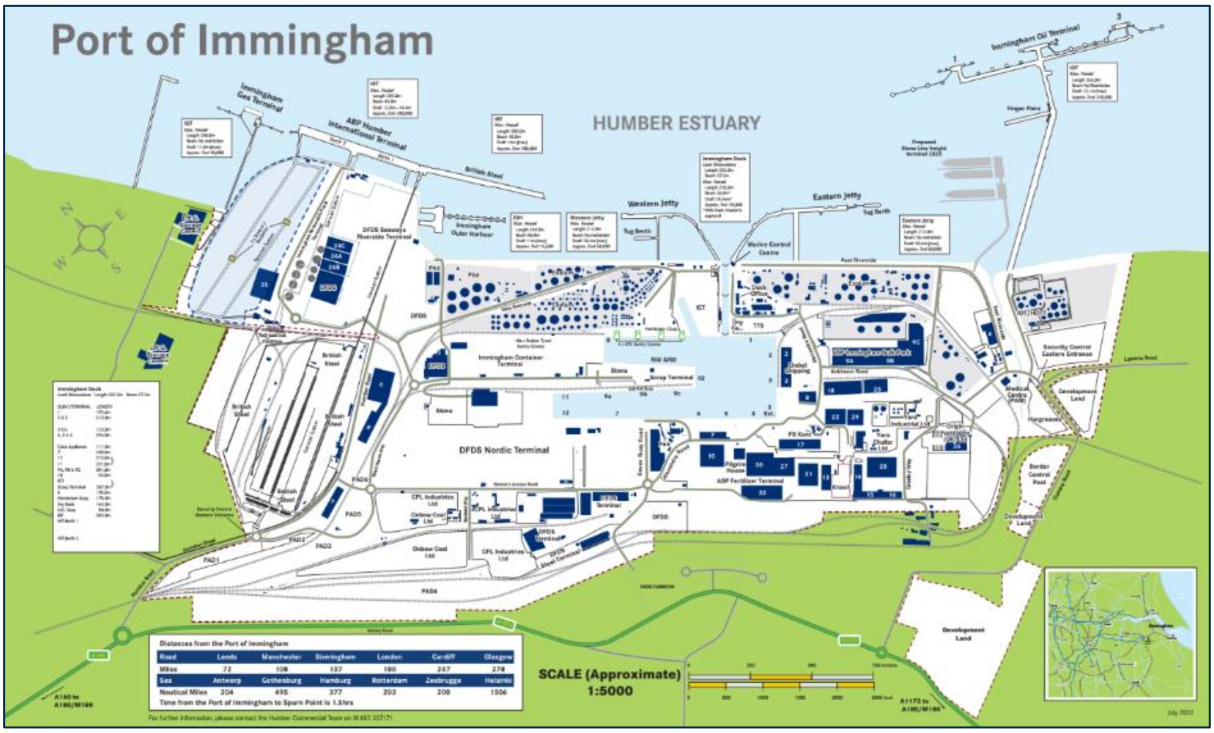

*Figure 2: Plan Overview for the Port of Immingham. Source: ABP Immingham website[21]. Note, the IERRT shown in this plan is not to scale – see IERRT Development section below (**Section 2**).*

Table 1: Maximum Vessel Dimensions for Port of Immingham Terminals. Source: ABP Immingham.

Terminal/Dock/Quay	Length (m)	Beam (m)	Draught (m)	Approx. Dwt
Immingham Dock	198.0	26.2	10.36	38,000
Immingham Dock *1	220.0	26.8 *3	10.36 *3	38,000
Eastern Jetty	213.0	No restrictions	10.4	50,000
Western Jetty	213.0	No restrictions	10.4	50,000
Immingham Oil Terminal (IOT)	366.0	No restrictions	13.1	290,000
Immingham Bulk Terminal (IBT)	303.0	45.0	14.0	200,000
Immingham Gas Terminal (IGT)	280.0	No restrictions	11.0	50,000
Humber International Terminal (HIT)	289.0	45.0	12.80-14.20 *2	200,000
Immingham Outer Harbour (IOH)	240.0	55.0	11	18,500
*1: These Immingham Dock values are from the plan overview for the Port of Immingham (**Figure 2**) and so have been included separately in the table. Other values are from the Port of Immingham website. *2: 12.80 - 14.40 according to the plan overview for the Port of Immingham (**Figure 2**). *3: With Dock Master's approval				

[21] Port of Immingham plan, Jul 2022 (ABP Port of Immingham website), https://www.abports.co.uk/media/0yoinmtg/immingham.pdf

2 IERRT Development

2.1 IERRT Infrastructure

The proposed IERRT development consists of three river berths numbered 1 (outer), 2 (inner north) and 3 (inner south) all serving both freight and passenger movements. The berths are located between the Eastern Jetty on the west and the IOT on the east, with the IERRT berth 1 located in close proximity to the tidally restricted IOT Finger Pier. The berth arrangement and location in Immingham Port are show in Figure 3**,** whilst **Figure 4** shows the IEERT with three vessels of 240 m length and 35 m beam alongside and the proximity of the IOT Finger Pier being less than 100m.

The berths are made up of piled finger piers with berthing and mooring infrastructure with a pile supported floating pontoon offloading dock connected to a piled accessway for vehicle movements ashore. The floating pontoon is understood to not have any berthing or mooring infrastructure and is assumed not designed for berthing and mooring loads.

The current location of the Eastern Jetty tug barge is an extension off the Eastern Jetty, between the jetty and the proposed IERRT berth 3. The location of the tug barge is shown on navigation charts (see **Figure 3**), although is not shown in ship simulations (see **Figure 5** to **Figure 8**). It is therefore unclear if this tug barge will removed, relocated or is planned remain in place; however, if the latter, this may influence the navigation or assist tug usage for navigating to and from berth 3.

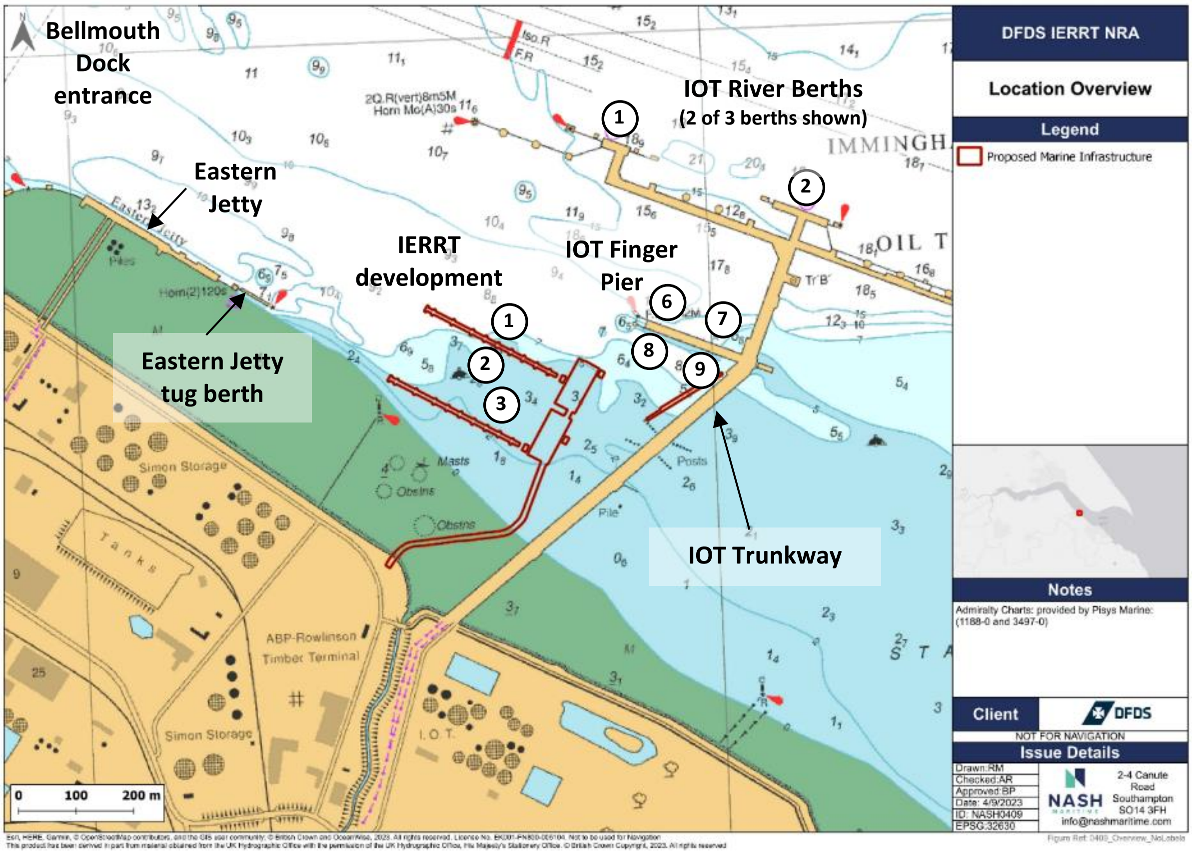

Figure 3: IERRT marine infrastructure location

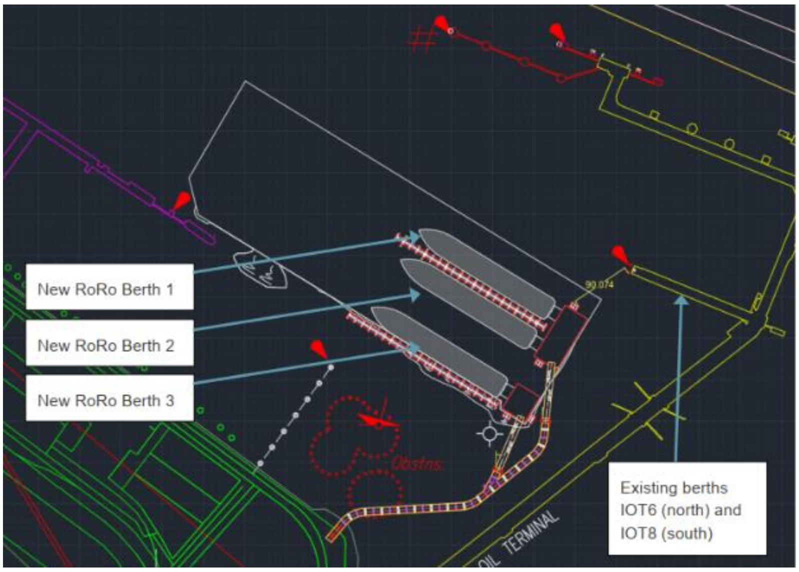

Figure 4: Layout with vessels - from IERRT Navigation Simulation report Part 1 (Note, old IERRT infrastructure design shown).

2.2 IERRT Design Vessels

The IERRT berths are capable of receiving vessels up to 240m length (overall, LOA), 35m breadth and 8m draft. However, specific details of the IERRT design vessels has not been defined including windage areas, propulsion and steering characteristics, thruster, etc. The vessels will be Ro-Ro and Ro-Pax vessels due to the intended operations and ability to handle more than 12 non-crew personnel and members of the general public – therefore these vessels would be classed as passenger vessels.

The nominated vessel size, compared to the large vessels currently operating locally is:

- IERRT project vessels (Ro-Pax, freight and more than 12 drivers / passengers): 240m x 35m x 8m
- DFDS Jinling Class (Ro-Ro, freight only, up to 12 drivers / passengers): 238m x 34m (as assessed in ship simulation with 7m draft)
- CLdN G9 Class (Ro-Ro, freight only, up to 12 drivers / passengers): 234m x 35m
- Stena T-Class (Ro-Pax, freight and more tan 12 drivers / passengers): 212m x 27m

The IERRT is intended to be operated by Stena who currently service the area through Killingholme with vessels including: Stena Transporter (212m x 26.7m x 6.3m), Stena Transit (212m x 26.7m x 6.3m), POL Maris (192m x 26m) and Hatche (192m x 26m).

2.3 IERRT Marine Throughput

The IERRT is intended to handle cargos of:

- Unaccompanied freight (trailers with no drivers). Classed as Ro-Ro cargo vessels.
- Accompanied freight (trailers with drivers). Classed as Ro-Pax cargo vessels (if more than 12 drivers).
- Passengers (car passengers, but no food passengers). Classed as Ro-Pax cargo vessels (if more than 12 drivers + passengers). It is stated in the IERRT development plans that up to 100 passengers may use the services.

The IERRT project vessels will operate every day (365 days per year) with the possible exception of Christmas day, with each berth having a regular liner service of a vessel arriving at the same time in the mornings and departing at the same times in the evening, and therefore three vessels alongside simultaneously each day. Hence, the IERRT will see six vessel movements per day (three arrivals and three departures). The terminal is intended to be operated in all conditions allowable by their future operating regulations, including adverse visibility and hours of darkness.

Within this area, the SHA for the development would be the Port of Immingham and the CHA for the development would be Humber Estuary Services (HES).

2.4 IERRT Navigation

2.4.1 Arrival

After passing the Holme Ridge No 9 buoy the tidal flow begins to change from the predominately east/west flow turning progressively more to the north to follow the shape of the estuary. Vessels at this point are reducing speed to comply with Humber Byelaws 14.3 [22] and not pass the IOT at a speed in excess of 5 knots.

As per accepted nautical navigational practice (Rule 9 The International Regulations for Preventing Collisions at Sea (COLREGs)), vessels remain to the starboard side of the channel and will pass any outbound traffic 'port to port' meaning inbound traffic remains to the north and outbound traffic to the south.

Due to the direction of the current in this area, which runs approximately 315° / 135°, mariners need to exercise caution to ensure their vessels do not set onto the Number 9A light float or No 11 Holme buoy on the flood tide or onto the IOT on the ebb tide. This tidal set is quite noticeable due to the direction of the tide in relation to the IOT, the slow speed (less than 5 knots) of vessels and is more pronounced when combined with leeway caused by strong predominately northerly or southerly winds.

Overtaking is discouraged at the IOT as per Standing Notices To Mariners SH23 Immingham Oil Terminal[23].

A 150m vessel exclusion zone exists from the jetty face of the IOT out into the navigational channel to protect vessels moored on its main deepwater berths (Standing Notices To Mariners SH34 Passing Immingham Jetties [24]).

Once past the upstream IOT mooring dolphin (A1 Dolphin) providing traffic allows the vessel then proceeds to the south.

This is achieved either reducing speed and turning the vessels head to port by around 20 degrees and allowing the ebb tide to set the vessel inside of the IOT main berth being careful not to be set onto the A1 dolphin, or by using engines, thrusters and any tug assistance (if employed) to drive the vessel around the A1 dolphin before turning back to starboard so that the vessel is stern to tide.

These two manoeuvres can be seen in Figure 5 (Ebb Tide) and Figure 6 (Flood Tide) as shown in the IERRT Ship Simulations, the applicants simulation exercises. However, it is noted that DFDS contest the direction of tide as indicated on the applicants simulations and therefore these figures are included for information only to assist explanation.

The average time taken for arrival manoeuvres from passing IOT 1 to being fast alongside is 30-45 minutes.

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[22] Humber Byelaws 14.3, https://www.humber.com/admin/content/files/Estuary%20Information/ha%20byelwas.PDF

[23] Standing Notices To Mariners SH23, https://www.humber.com/admin/content/files/Notice%20to%20Mariners/Standing%20Notice%20to%20Mariners/SH_23_2001_NTM.pdf

[24] Standing Notices To Mariners SH34, https://www.humber.com/admin/content/files/Notice%20to%20Mariners/Standing%20Notice%20to%20Mariners/SH_34_2011_NTM%20(revised).pdf

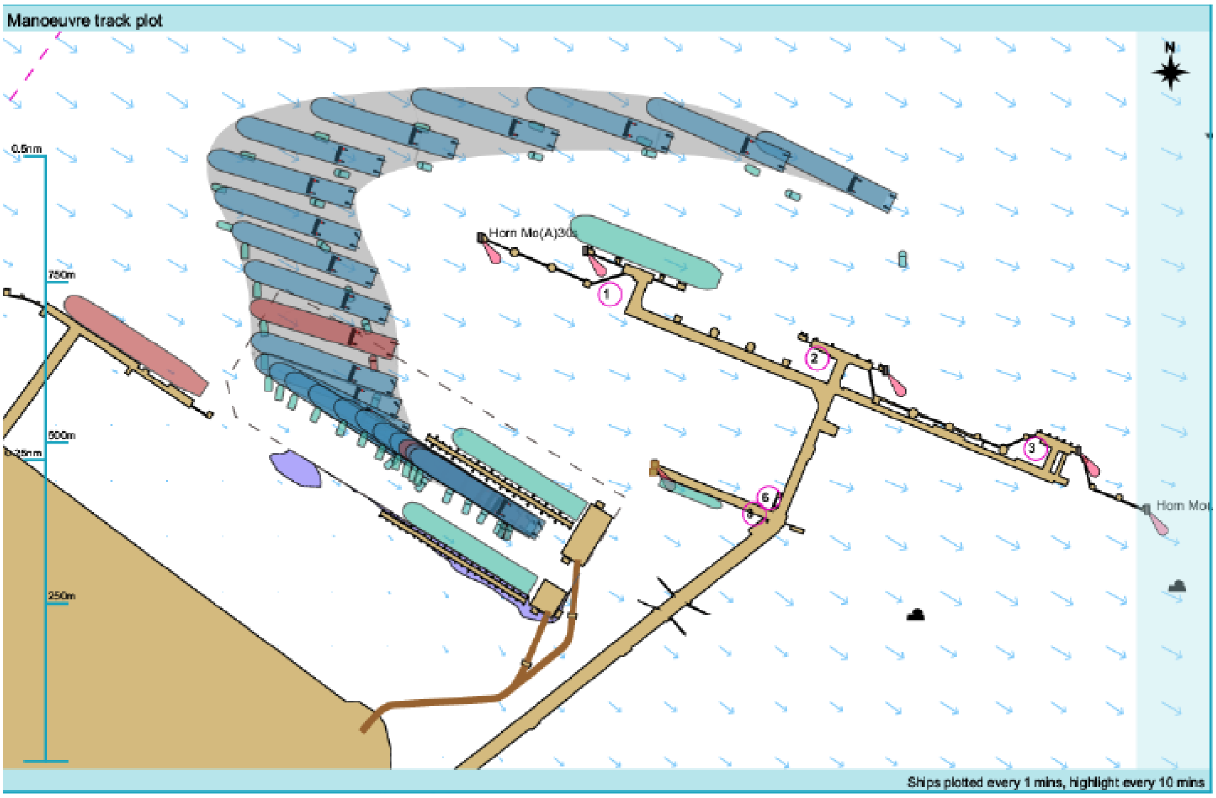

Figure 5: Ebb Tide Manoeuvre (Source: IERRT development Ship Simulations)

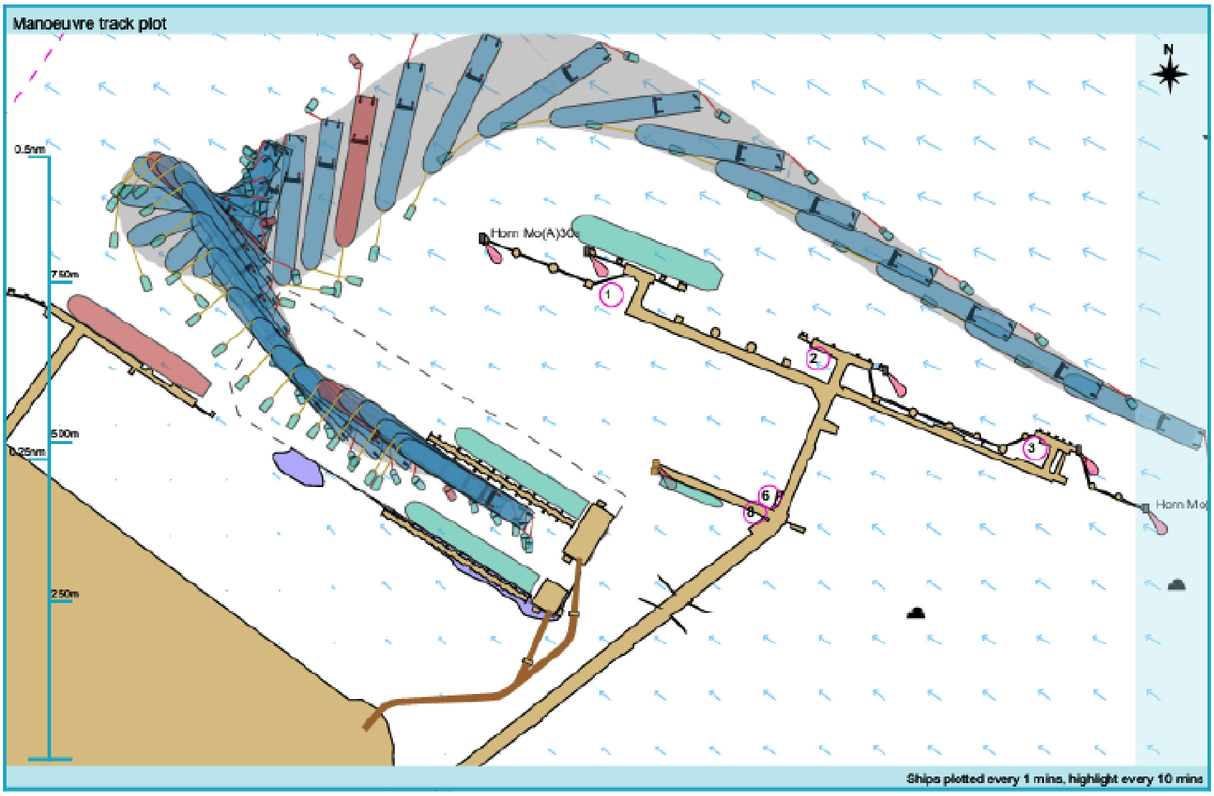

Figure 6: Flood Tide Manoeuvre (Source: IERRT development Ship Simulations)

2.4.2 Departure

Prior to 'letting go' their last mooring lines the Pilot or PEC holder must first receive traffic clearance from VTS Humber (VHF CH12) in accordance with Standing Notice To Mariners SH12 [25]. At this time they will be appraised of any nearby traffic movements and given the level of tide as indicated by the Immingham tide gauge.

Once clearance has been received a vessel lets go her remaining mooring lines and makes a whistle signal of one long blast as prescribed in Part III of the Humber Byelaws.

For a departure on the ebb tide the vessel must move the vessels head away from the pier to which she is made fast, using thrusters or tug assistance, to allow the tide to assist the vessel in moving away from the berth. Once clear of the terminal the vessel proceeds in a North Easterly direction to move well upstream of the IOT A1 dolphin before turning to starboard and proceeding outbound. Caution needs to be exercised to ensure sufficient clearance from the A1 dolphin to prevent the ebb tide setting the vessel onto here during the turn and also to ensure the vessel remains a minimum of 150m from the IOT at all times. The vessels speed when passing IOT must not exceed 5 knots as previously indicated.

Flood departures allow the vessel to turn much earlier given the tide will carry the vessel away from the IOT A1 dolphin but caution must be exercised to ensure the vessel remains close to the IOT on the starboard side of the channel to prevent any conflict with incoming vessels.

The two manoeuvres can be seen in Figure 7 and Figure 8 as shown in the IERRT Ship Simulations (stakeholder demonstration report), that details the applicant's simulation exercises. However, it is noted that DFDS contest the direction of tide as indicated on the applicant's simulations and therefore these figures are included for information only to assist explanation.

The average time taken for departures from letting go to being abeam of IOT 1 is approximately 20 minutes.

[25] Standing Notice To Mariners SH12, https://www.humber.com/admin/content/files/Notice%20to%20Mariners/Standing%20Notice%20to%20Mariners/SH_12_2009_NTM%20(revised).pdf

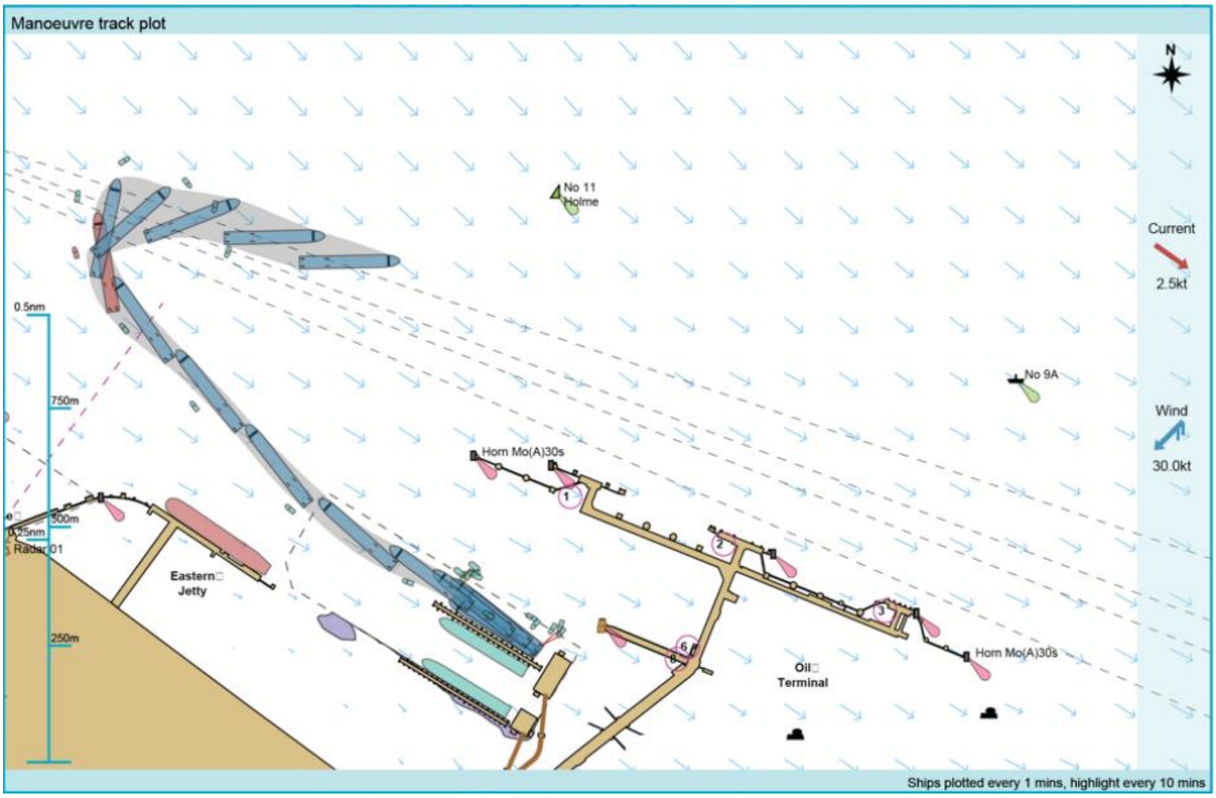

Figure 7: Departure on ebb tide (Source: IERRT development Ship Simulations)

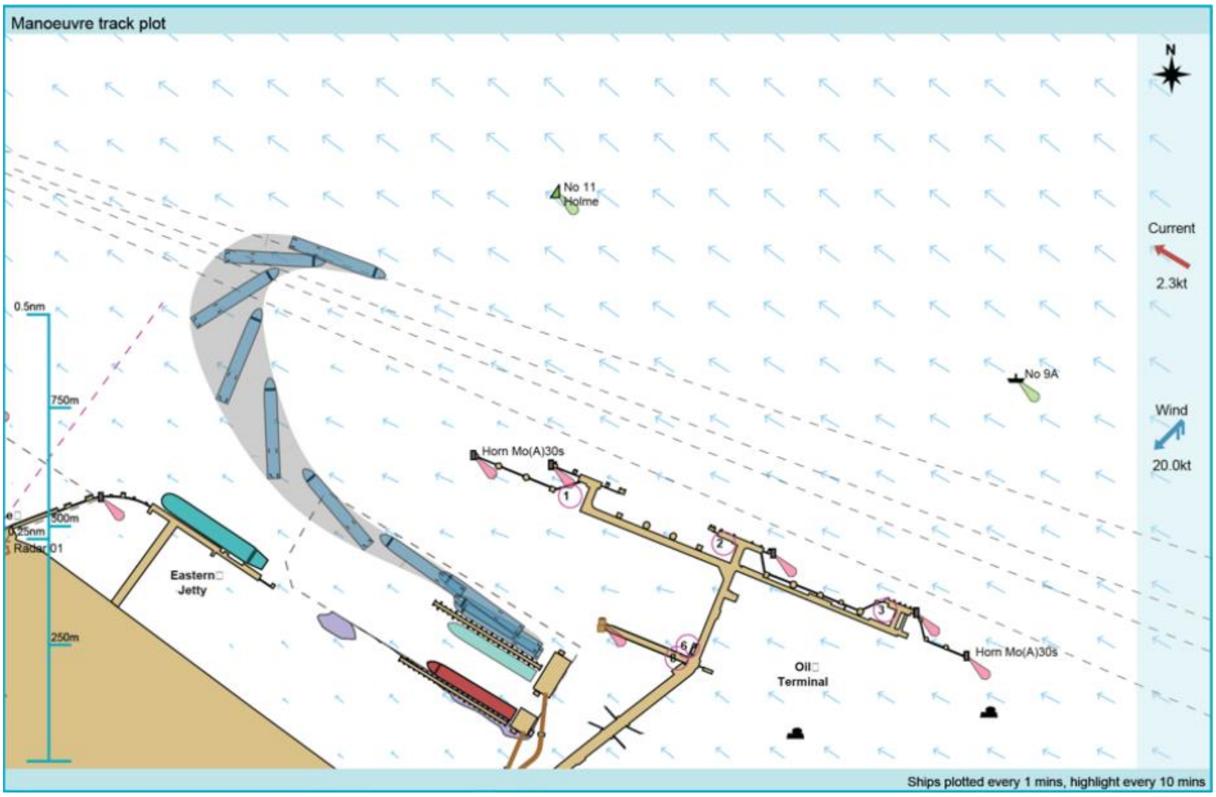

Figure 8: Departure on Flood Tide (Source: IERRT development Ship Simulations)

2.4.3 Berthing

2.4.3.1 Berth 1

This is the least complex berth to manoeuvre on and off from given the area the vessels have between the berth and southern side of the IOT. The potential issues when manoeuvring nearby this berth is with any mechanical issues or pilot/PEC error that could lead to the IERRT vessel being caught by the curt and/or wind in close proximity to the IOT Finger Pier or Trunkway

2.4.3.2 Berth 2

The manoeuvre on and off berth 2 is much more compromised due to the lack of available space to conduct the first few or final stages of the manoeuvre. This lack of available space is made even more apparent when berth 3 is occupied as it further reduces the available manoeuvring space by 35m (the beam of the proposed IERRT design vessel).

The lack of space is especially acute when employing tug assistance since the tug is most effective when positioned a reasonable distance (20-30m) away from the side of the vessel. This ultimately means that tug assisted manoeuvres would be severely hampered in this area.

The restrictive nature of the area between berths 2 and 3 also prevents the turbulent wash from the vessel or the tugs to adequately disperse which reduces the effectiveness of thrusters, propellers and tug drive units. This turbulent wash can be potentially dangerous for assisting tugs in terms of maintaining control of the tug and possible swamping (water on deck).

2.4.3.3 Berth 3

Berth 3 shares many of the difficulties and issues of berth 2 in terms of reduced manoeuvring space and presents an additional difficulty from the prevailing winds in the area being south westerly, blowing off berth 3 toward berth 2. This means the vessel will regularly be pushed by the wind off the berth and onto berth 2 (or a vessel moored thereon). Additionally the proximity of the Eastern Jetty chemical berth (and any vessel moored thereon) makes manoeuvres into the berth 2/3 berthing pocket highly challenging, particularly on the ebb tide.

The Eastern Jetty tug barge is unclear if it will remain in its current location; however, if the barge were to remain in position then it is also in a highly vulnerable position from IERRT vessels and their attending tugs, especially when manoeuvring away from the berth on the ebb tide. The Eastern Jetty tug barge and the tug/s moored alongside would be susceptible to a possible contact (allision) during IERRT vessel movements or from a breakaway incident, and possible wash effects or swamping caused by the use of engines and thrusters by the passing IERRT vessels or their attending tugs.

3 Navigation Baseline

The Humber Estuary is one the busiest trading ports in the UK and is the busiest shipping estuary, based on the UK Department for Transport's (DfT) port ship arrivals by port[26] [27]. Shipping movements are primarily made up of Tankers, Dry Bulk and Ro-Ro ship types.

The DfT data shows that every year since 2011 the Port of Immingham and Grimsby (shown combined within the DfT data), is the second busiest port for ship arrivals in the UK, following Dover. The data also shows that every year since 2019 Immingham and Grimsby has been the busiest port for tanker arrivals. Summaries of the DfT data for Immingham and Grimsby is shown within Section 3.4.

The Humber estuary is exceptionally busy and a key trading area for the UK. It is also located in a region of high tidal range and therefore experiences very high tidal currents and the varying estuary landscape creates a complex tidal flow system. Furthermore, the Port of Immingham is relatively compact with numerous terminals operating in close proximity with a high volume of vessel movements. This makes Immingham a challenging navigational area with a notably high number of reported incidents.

This section describes an overview of the baseline navigation environment including navigation management, metocean information, historical vessel traffic, future vessel traffic and historical incidents.

3.1 Management of Navigation

Vessel traffic management at the Port of Immingham and on the Humber Estuary is managed by ABP. ABP therefore acts as the:

- Statutory Harbour Authority for Port of Immingham
- Statutory Harbour Authority for the Humber Estuary
- Competent Harbour Authority for the provision of pilots on the whole of the Humber Estuary
- Vessel Traffic Services / Local Port Service
- Local Lighthouse Authority

3.1.1 Vessel Traffic Service

ABP Humber operate a 24/7 Vessel Traffic Service which is compulsory for all sea going vessels and craft when entering the Humber VTS area which is defined as:

(A straight line drawn from EASINGTON CHURCH in the county of EAST RIDING of YORKSHIRE (Latitude 53° 39'. 02 North, Longitude 000° 06'. 90 East)) in a direction 086° (T) to a position 53° 40'. 00 North 0° 30'. 00 East then a straight line in a direction 180° (T), to a position 53° 30'. 00 North, Longitude 0° 30'. 00 East. Then a straight line in a direction 262° (T), to the site of the former DONNA NOOK BEACON in the county of NORTH LINCOLNSHIRE (Latitude 53° 28'. 40 North: Longitude 000° 09'. 23 EAST). The RIVER OUSE up to SKELTON railway bridge and the river TRENT to KEADBY bridge.).

[26] DfT port and waterborne freight statistics: UK Ports Ship arrivals, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1171863/port0602.ods

[26] DfT port and waterborne freight statistics: UK ports, ship arrivals by type and deadweight, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1171862/port0601.ods

The service provides AIS coverage throughout the VTS area and RADAR tracking within the area bounded by the Humber bridge and the seaward limits of the VTS area. The Humber approaches working VHF channel is Channel 14. Mid Humber channel 12 and upper Humber river channel 15.

3.1.2 Pilotage and Towage

As the competent Harbour Authority (CHA) for the river Humber, including river Ouse and River Trent, ABP operates a compulsory pilotage service within the meaning of the pilotage act 1987. The service is compulsory for all ships over 60m in length unless carrying a Pilotage Exemption Certificate Holder (PEC) onboard as described within the Associated British Ports Pilotage Directions for Ships to Be Navigated within the Humber Pilotage Area. Additionally, compulsory pilotage extends to vessels 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.

Generally, all vessels inward who require a tug/s to berth at Immingham Dock, Eastern or West Jetty, IBT, HIT, IGT or South Killingholme Oil Jetty must reduce their speed and complete making tugs fast before the vessel passes berth No.3 of the Immingham Oil Terminal.

3.2 MetOcean Conditions

Metocean conditions are discussed below. The data within this section has not been independently verified and no modelling or validation exercise has been undertaken. For waves and tides, the ABPmer metocean assessment has been taken as accurate and been used in this NRA. For wind and current, the ABPmer metocean assessment has been further considered to determine the implications of inaccuracies before being used in this NRA. Where the accuracy of the data would have serious implications to the assessment of risk, only the indicative information and general trends and/or observations from the data have been used in this NRA.

A summary of potential serious risk implications of inaccuracies are:

- Current speed and, particularly, direction. Incorrect assumptions or overly simplified current direction estimates in and around the IERRT terminal, or changes to the current flows at other berths due to the IERRT terminal, the Ro-Ro / Ro-Pax vessels moored there and/or the bathymetric changes from dredging, can introduce changes to the present tidal flow which can be critical to safe, repeatable and predicable navigation.
- Wind speed and direction, including gusting. Wind speed and direction plus the variation of speed (e.g. gusting) and direction can have implications of the complexity of navigation, particularly for slow speed manoeuvring for high-sided (high windage area) vessels such as Ro-Ro / Ro-Pax vessels. Additionally, the effects of rapidly varying wind speed due to wind shielding effects from Ro-Ro / Ro-Pax vessels on other vessels can be critical for the safe, repeatable and predicable navigation.
- The effects of global warming are widely accepted to introduce more erratic and severe weather during the lifetime of the project. The effects of this would typically be to increase the historical severe weather periods including winds, tides (water levels general), waves and current. For wind and current particularly, this could present further risk implications later in the IERRT lifecycle.

3.2.1 Wind

It is understood that two sets of wind data exist for the Immingham regions: a 2.5 year dataset from the Humberside Airport, located approximately 13 km south west of the project site inland measured at a height of 10m (spanning Jan 2019 – Jun 2021); and a separate 1 year dataset from the Immingham Maritime Control Centre, located within the Port of Immingham measured at a height of 24m (spanning Aug 2020 – Aug 2021).

ABPmer has used the wind data from the Humberside Airport weather station, however, a benchmarking exercise against local wind measurements, either for average wind speeds or the gust intensity, has not been undertaken. The sampling period for the maximum speeds of the wind (such as if this is peak gusting speed or maximum hourly averaged speed) is also not clearly defined and therefore the reliability of how accurately this reflects the wind data at the site is unknown.

This NRA does not have the actual data recorded from the Port of Immingham; however, a previous 2021 ship simulation report by HR Wallingford[28] contains a breakdown of this data in the form of wind roses and summary comments. Differences were observed between the ABPmer wind assessment (using Humberside Airport data) and the HR Wallingford assessment (using Port of Immingham data), and since no comparative benchmarking exercise has been undertaken to correlate the Humberside Airport data to the local area, the Risk Assessment Team has considered the local Port of Immingham Data better representative of local conditions for the purposes of this risk assessment and would be representative of the wind experienced by a Ro-Ro / Ro-Pax vessel. The following indicative wind information and trends have been applied when considering risk in this NRA:

- Wind direction is most prevalent from the south west and, to a lesser extent, south. This is wind blowing off-berth for the IERRT and in the direction of the IOT Finger Pier.
- Highest wind speeds are from the south, south west and north.
- Winds show marginal seasonality.
- Average wind speed is predominately less than 23 knots (Force 6) with gusting predominately less than 29 knots (Force 7).
- Large variability is observed with south westerly mean wind speeds up to 29 knots (Force 7) and gusts up to knots 41 knots (Force) occurring. And northerly wind speeds up to 39 knots (Force 8) and gusts up to 47 knots (Force 9).
- Please note that wind data has not been provided and an independent assessment has not been undertaken. Values are based on limited wind rose information and wind gusting intensity and sampling duration are also not defined.

3.2.2 Waves

Wave measurements were taken by ABPmer and wave information from this has been used in this NRA. Waves show the following general information and trends:

- Wave direction is predominately from the north west and south east, being in line with the longest fetch on the waterway.
- Waves are typically less than 0.5 m significant wave height (Hs), but were recorded up to 0.84 m Hs.

[28] DJR6612-RT002-R03-00 Project Sugar – ABP Humber – Immingham East Development Navigation Simulation Study, Dec 2021 (HR Wallingford)

3.2.3 Current

Due to the high tidal range, large estuary volume, and relatively narrow constraints to the flow of water, the tidal currents within the Humber and at the Port of Immingham are very high and complex. Tidal measurements are understood to have been undertaken and used within the ABPmer NRA and a current profile has been applied in the ship simulations; however, due to the potential significance of tidal current inaccuracies it is only the indicative current information and trends that have been within the study area (particularly the manoeuvring area, IERRT terminal and IOT finger pier) that have been applied when considering risks in this NRA. The potential for inaccuracies arises due to:

- The high magnitude of the current speeds
- The differing current directions at various tide levels due to the local bathymetry (mud banks)
- The introduction of changes to this bathymetry caused by dredging
- The blockages of the tidal flow areas caused by deeper draft IERRT larger vessels and the potential for this to cause funnelling of the current
- The potential for higher than anticipated currents caused by storm surges (the tidal information provided by ABPmer also indicates the maximum tide was a result of storm surge and it is understood that negative surge can also result in tide heights lower than estimated. Surge heights are an increase or decrease in water level above the normal tidal influences. Depending on when the surge is experienced this can also result in increased current flow speeds if increase or decrease in surge aligns with the flooding or ebb tide.)

From the Admiralty Sailing Direction: North Sea (West) Pilot, the tidal streams off Immingham have an flood speed of 3.5 knots (spring) and 4.5 knots ebb. It also comments that terminal in the area can at times reach 4 knots for flood tides and 7 knots for ebb tides. Typical tidal flow of 3.5 knots flood and 4.5 knots ebb is also approximately consistent with ABP depth sounding drawings[29] and navigational charts.

- Therefore, whilst there is uncertainty in the accuracy of tidal current approximations and whilst those potential inaccuracies have the potential for significant implications on navigational risk, the general information summary statements below were considered when assessing risks in this NRA:
- The current is very strong with approximately 3.5 knots flood and 4.5 knots ebb springs, resulting in a challenging navigational environment.
- The current direction is not 180° in opposing directions between flood and ebb tides and further that the current direction may vary also between high or low water closer to the river edge.
- The current flow speeds and direction may vary due to the IERRT terminal, dredged area and other vessels alongside the IERRT, and most notably, at the IOT Finger Pier.

3.2.4 Tide

Tidal data was reviewed by ABPmer and tidal information from this review has been used in this NRA. Tides show the following general information and trends:

- Tidal range is large, with 7.3 m Mean High Water Springs (MHWS), which introduces large ebb and flood tidal currents (as noted above).

[29] Immingham Roads - Surveyed 18th April https://abpnotify.co.uk/AbpPublishedDocuments/_Immingham%20Roads%20-%20Surveyed%2018th%20April%20to%203rd%20May%202023%20(B&W).pdf

- Storm surge is possible and can combine with tides to introduce higher than predicted water levels. Maximum tide + surge record is approximately 9 m.
- Negative surge is understood to occur which can result in 0.5 m lower tide heights than predicted. Tide data is monitored by Vessel Traffic Services (VTS) from a tide gauge at Spurn.

3.3 Usage of the Navigational Area

The Immingham outer dock area (from the western end of the IOT to the eastern end of the IBT southwards) is already a busy and challenging navigational area that requires a considerable amount of traffic co-ordination in order to allow safe vessel operations. This area has vessels moving from the following key terminals:

1. IOT Finger Pier
2. Eastern Jetty
3. Immingham Dock
4. Western Jetty
5. IOH

In addition to the complexity of the area generally in relation to the traffic density is the requirement for vessels to sit within this location to await entry into the lock or their berth at IOT finger piers. These 'stemming' operations involve a vessel sitting head to tide (effectively facing into the tidal current) using minimal engine to counteract the current so they remain effectively stopped in relation to the seabed.

There are three general areas where vessels wait and stem the tide:

1. Off the Eastern Jetty – vessels for the dock sit heading WNW stemming the ebb tide awaiting their entry into Immingham Dock
2. Off the Western Jetty – vessels for the dock sit heading ESE stemming the flood tide awaiting their entry into Immingham Dock
3. Off the Eastern Jetty – vessels for the IOT Finger Pier sit heading ESE stemming the flood tide awaiting their berth becoming unoccupied on the IOT Finger Pier. An analysis of examples of vessels stemming in this area is shown in Section 4.5.2.

The use of the stemming areas improves the efficiency of the port allowing vessels to quickly enter the dock or berth once the lock/berth becomes available which in addition to time saving also reduces the labour required by combining the letting go of one vessel and the securing of the next.

The proposed terminal will sit between the IOT Finger Pier and Eastern Jetty and introduce up to six additional movements a day each expected to take up to 45 minutes on arrival and 20 minutes on departure. It is expected such movements would prevent vessels from stemming off the Eastern Jetty for either the Immingham Dock or the IOT Finger Pier thus compromising port efficiency. It is as yet unknown if the risks inherent in the physical presence of the IERRT would compromise vessel stemming off the Eastern Jetty at all times.

The coordination of traffic in this area is commonly extremely challenging for VTS Humber, this is most significant in the early evening when many of the scheduled liner services from Hull, Killingholme, IOH and Immingham Dock are scheduled to depart within a few minutes of each other. When these movements coincide with IOT Finger Pier or Immingham Eastern and/or West Jetty movements it increases complexity and pressure. Furthermore, when these movements coincide with the high water period (HW -2h to HW) there is also the added complexity of combination with large vessel movements (Passage Plan Vessels) leaving and berthing on the deep water berths (IOT, IBT, HIT).

3.4 Historical Vessel Traffic

Historical vessel traffic has been based on the DfT historical freight data and includes ship arrivals by port. Immingham and Grimsby are combined within the data but can be used to inform the study on vessel traffic volumes. Detailed vessel traffic analysis including track plots and vessel movement densities are detailed in Section 4.

Table 2 below indicates the DfT data for ship arrivals to Immingham and Grimsby since 2009. The basis on which the data was gathered was changed in 2017, making it difficult to directly compare the data from 2009 – 2017, with data from 2017 – 2022. The data for 2017 was undertaken on both bases though, and has been reproduced here as taken from the DfT source. Ship arrival numbers are vessels arriving into Immingham and Grimsby. On the basis that vessels only make only two movements per port arrival (one inbound and one outbound) and do not visit more than one terminal per arrival, the number of vessel movements is also shown. The representative average of number of arrivals and number of movements per day is also based on a calendar year. The tonnage throughput of Immingham and Grimsby can also be obtained through the DfT data which indicates that the amount of cargo moved through the ports remains relatively constant (apart from 2020 following effects of COVID). Combined with the information below that vessel numbers have reduced this shows that vessel capacity, and therefore most likely size, has been increasing.

Port arrivals for the Humber include Immingham and Grimsby, Hull, Rivers Hull and Humber, Goole, River Trent and River Ouse. This is indicative of the usage of the Humber waterway and, to an extent, of largely of the volume of traffic transiting past Immingham onto Hull, Goole and other river terminals further upstream. This has been included to provide insight into the potential for disruption in the event of a blockage or incident on the Humber. The DfT data captures commercial vessel port arrivals but does not capture the high volumes of the various small vessels, local service vessels and other vessel movements that will be operating within the study area. In essence, the data confirms that the waterway within the study area around Immingham is a very highly utilised maritime space.

Table 2: DfT Ship Arrivals Immingham/Grimsby 2009-2022

Year	Immingham and Grimsby				Humber			
	All cargo vessel arrivals *1	Average arrivals per day	Movements (in and out)	Average movements per day	All cargo vessel arrivals *1	Average arrivals per day	Movements (in and out)	Average movements per day
2009	7334	20.1	14668	40.2	12,046	33.0	24,092	66.0
2010	7923	21.7	15846	43.4	12,971	35.5	25,942	71.1
2011	8752	24.0	17504	48.0	14,108	38.7	28,216	77.3
2012	9383	25.7	18766	51.4	14,691	40.2	29,382	80.5
2013	8799	24.1	17598	48.2	13,681	37.5	27,362	75.0
2014	8572	23.5	17144	47.0	13,257	36.3	26,514	72.6
2015	8959	24.5	17918	49.1	13,688	37.5	27,376	75.0
2016	8548	23.4	17096	46.8	13,131	36.0	26,262	72.0
2017 *2	7912	21.7	15824	43.4	12,545	34.4	25,090	68.7
2017 *3	7500	20.5	15000	41.1	12,094	33.1	24,188	66.3
2018	7197	19.7	14394	39.4	12,199	33.4	24,398	66.8
2019	7126	19.5	14252	39.0	11,859	32.5	23,718	65.0
2020	6511	17.8	13022	35.7	10,333	28.3	20,666	56.6

Year	Immingham and Grimsby				Humber			
	All cargo vessel arrivals *1	Average arrivals per day	Movements (in and out)	Average movements per day	All cargo vessel arrivals *1	Average arrivals per day	Movements (in and out)	Average movements per day
2021	6636	18.2	13272	36.4	10,244	28.1	20,488	56.1
2022	6683	18.3	13366	36.6	9,930	27.2	19,860	54.4
*1 data from DfT. Includes commercial vessels for Tankers, Ro-Ro, Container and Other Dry Cargo. Excludes "Other Vessels" category and "Passenger vessels. *2 calculated on old basis (2017 and before) *3 calculated on new basis (2017 and after).								

3.5 Future Vessel Traffic

3.5.1 Baseline Vessel Traffic – Excluding IERRT

The future baseline traffic projections used by ABPmer are based on global economies a 1% increase on tonnage has applied throughput. The estimated future growth is shown in Table 3 below (and Table 12 of the ABPmer NRA). The future planned infrastructure developments other than the IERRT may also cause more pronounced jumps than the general 1% growth assumed for vessel numbers operating in and around Immingham. These potential future developments include:

- Able Marine Energy Park located in South Killingholme, immediately upstream of Immingham. Predicted vessel numbers are: 500 per annum, including offshore installation vessels, heavy support vessels and cargo ships.
- Importantly, offshore wind development projects will often involve high volume / short duration construction schedules to reduce construction time and costs. The usage profile for the Able Marine Energy Park may vary significantly year on year and in peak and non-peak construction times.
- ABP's proposed Immingham Green Energy Terminal (IGET)[30] [31] located immediately downstream of the IOT (opposite side of IOT trunkway to IERRT). Introduction of liquid green hydrogen production and necessary imports of ammonia. Predicted vessel numbers are 292 per annum, up to 250m in length (55,000 tonnes).

As discussed above, the DfT data captures commercial vessel port arrivals but does not capture the high volumes of the various small vessels, local service vessels and other vessel movements that will be operating within the study area. With more commercial vessel moment, there will also be a corresponding increase of other vessels, including port service vessels, to support this growth. These vessel movements will further contribute to the increased usage of the waterway.

When considering future baseline scenarios and risk profiles, it is important to recognise that the total number of waterway movements will increase substantially throughout a 50 year project lifespan and potentially further still for the undefined extended lifetime of the IERRT terminal beyond 50 years.

[30] IGET website, https://immin ghamget.co.uk/

[31] IGET PEIR addendum https://imminghamget.co.uk/wp-content/uploads/2023/05/IGET-Supplementary-Consultation-Report-final.pdf

Table 3: Estimated Future Growth at Immingham and Grimsby

Immingham and Grimsby				
Future year	Projected vessel arrivals	Average arrivals per day	Vessel movements (in and out)	Average movements per day
2019	7126	19.5	14252	39.0
2022	7342	20.1	14684	40.2
2030	7950	21.8	15900	43.6
2040	8782	24.1	17564	48.1
2050	9701	26.6	19402	53.2
2060	10716	29.4	21432	58.7
2070	11837	32.4	23674	64.9
2072	12075	33.1	24150	66.2

3.5.2 Baseline Vessel Traffic – Including IERRT

The IERRT development is planned to accommodate three vessels per day for every day of the year excluding Christmas. Total additional movements of Ro-Ro's / Ro-Pax's for the IERRT will increase the baseline growth estimates by up to 2,190 vessel movements per year. In 2030 this assumes a total of 18,090 vessel movements per year – a 14% increase in vessel traffic from the baseline year 2030 and reasonably comparable to the busiest year 2012 with 18,766 vessel movements. In the 50 year projection, the year 2072, this assumes a total of 26,340 vessel movements per year – a 66% increase in vessel traffic from the baseline year 2030 and a 40% increase on the busiest year in DfT data, 2012.

As discussed in Section 3.4, the additional small service vessels will also be required to support the Ro-Ro / Ro-Pax operations, such as towage, dredgers, survey vessel, etc, will also increase the amount of small vessels operating within the Port of Immingham above the projected vessel numbers.

3.6 Incident Analysis

Historical incident data has been assessed from local UK-based incident data records and international data sources or literature. These primarily include the two sources listed below:

- MAIB incident data records (1992-2021) for UK-based incidents and Immingham local incidents.
- MarNIS incident data records (2011-2020) or local Immingham incidents recorded by ABP. Incident data information from ABPmer NRA has been used to facilitate this assessment.

3.6.1 Notable Incidents in Immingham and on the Humber

A summary of major incidents that have occurred in Immingham or on the Humber are shown in Table 4 below to assesses the findings and/or circumstances that are relevant to the geographical location of the navigational waterway.

Abridged details of the incidents are included in the table; however, in summary these incidents indicate the following repeated factors:

- Strong tidal flow
- Dense fog and adverse visibility

- Navigating around or in proximity to other vessels

Table 4: Maritime Incidents at Immingham/Humber

Incident	Vessels	Incident Date	Description
Collision	Petunia Seaways and Peggotty	19/05/2016	*(MAIB)* Petunia Seaways collided with the historic motor launch Peggotty after the skipper of Peggotty became disorientated in the dense fog and took the motor launch into the shipping channel and the path of Petunia Seaways, which was not sounding a regular fog signal at the time of incident. The motor launch suffered severe structural damage and began to take on water but a local pilot launch crew were able to rescue the skipper and other person on-board so that there were no injuries or significant pollution.
Collision	City of Rotterdam and Primula Seaways	03/12/2015	*(MAIB)* The car carrier City of Rotterdam collided with the ferry Primula Seaways in dense fog after the pilot became disorientated (due to relative motion illusion) and failed to correct the carrier's path which had been set toward the path of inbound ferry. Both vessels were sustained major damage but made their way to Immingham without assistance. There were no serious injuries or pollution.
Collision	Audacity and Leonis	23/01/2015	*(MAIB)* Tanker Audacity collided with cargo vessel Leonis in the Humber Estuary precautionary area during dense fog. Cause attributed to Pilots on both vessels not making a full assessment of risk of collision and poor VTS procedures.
Contact (Allision)	CFL Patron	29/08/2010	*(MAIB)* The general cargo vessel CFL Patron suffered a controllable pitch propeller (CPP) control power failure while manoeuvring at 1.6 knots in the lock at Immingham docks. Despite the master's attempts to recover control of the CPP system, the pitch remained at approximately 40% ahead, causing the vessel to accelerate. Although a forward spring was deployed and the tug Guardsman attempted to slow the vessel's progress by pushing, the vessel impacted heavily with the outer lock gates at 3.7 knots. Minor damage was sustained to vessel and tug. Significant damage was sustained to lock gates. Ship owner was encouraged to tighten up pre-departure checks and preparedness for propulsion failure. Cause of failure not able to be identified.
Contact (Allision)	Fast Ann	19/01/2010	*(MAIB)* Fast Ann, an unmanned cargo ship, broke free from its moorings and collided with IOT infrastructure. Despite VTS endeavouring to identify the radar target and a tug endeavouring to secure a line to the vessel, efforts were hampered by a 4-knot spring ebb tide and dense fog. Risk assessments and procedures were reviewed, particularly regarding unmanned vessels during spring tides.
Collision	Fast Filip and berthed Tanker	06/07/2008	*(MAIB)* General cargo vessel Fast Filip was heading down river from Goole on an ebb tide during hours of darkness, destined for Immingham Dock. ABP Pilot onboard, good visibility. Vessel commenced a turn around the stern of an inbound ferry, resulting in colliding with a tanker berthed at IOT1. Alongside vessel sustained a hole in the hull plating. Cause identified as Pilot's lack of planning and situational awareness, plus poor awareness of the effect of tidal stream and speed. Poor bridge resource management also identified.

Incident	Vessels	Incident Date	Description
Collision	Ro-Ro vessel with multiple smaller vessels (MAIB database anonymised)	02/04/2002	*(MAIB)* A high sided RORO/LOLO vessel sailed from the berth in marginal but steady winds. When the vessel approached a critical point in the manoeuvre where the vessel entered the basin a strong squall passed through the area. Vessel was blown onto the lea berths which were occupied at this time. The port anchor was let go but was too late to prevent contact with the moored craft.
Contact (Allision)	Stena Gothica	02/04/2002	*(MAIB)* During hours of darkness, Ro-Ro vessel Stena Gothica struck the eastern jetty, during a spring ebb tide, while approaching Immingham lock. A 3-metre gash was sustained in the port side shell plating below the waterline, leading to a large ingress of water into the lower cargo hold. Cause was identified as the master's decision to take the con prior to the lock, and his under estimation of the strength of the tide.
Collision	Bulk Carrier and Oil Tanker (MAIB database anonymised)	01/12/2000	*(MAIB)* bulk carrier was inbound for Immingham Bulk Terminal. She had a pilot embarked and had secured a tug on her bow before reaching the oil terminal. In anticipation of having to turn off the entrance to the dock, the pilot reduced the vessel's speed as she approached the oil terminal. Making only 3 knots with a 20 knot wind on her port quarter and in strong flood stream she lost steerage and turned towards an oil tanker moored alongside the oil terminal. Corrective action was taken by the pilot using helm, engine and bow tug, but failed to prevent collision. Subsequent investigation highlighted that: vessel's speed was insufficient to maintain steerage in prevailing conditions.
Contact (Allision)	Bohinj	02/02/2000	(*Local Expertise*) Cargo Vessel Bohinj allided with the IOT after the vessel lost steerage on passage to Immingham Dock. This was because the pilot was unable to maintain control of the vessel in the strong tide.
Collision	Xuchanghai and Aberdeen	12/12/2000	*(MAIB)* Bulk carrier Xuchanghai, inward to Immingham Dock, collided with the moored shuttle tanker Aberdeen, berthed at IOT3. Aberdeen sustained holes in her hull plating above the waterline. A contributing cause was poor safety arrangements and procedures in respect of ABP for vessels proceeding to Immingham Dock and other vessels in the vicinity of Immingham Oil Terminal. NtM09/2001 was retrospectively published in which a minimum passing distance and a location by which tugs should be secured was outlined.

3.6.2 MAIB Incident DATA

The MAIB dataset between number of incidents for the approximate Immingham area, broken down by incident type, is shown in Table 5 below for the period 1992 to 2021.

The analysis has focussed on the incidents that provide insights to the navigation risk of the IERRT project. Incidents that unrelated to ship navigation and navigational risk have been excluded. The data indicates that contacts (allisions) are the most likely incident type reported to the MAIB with over 50% of these key incident categories for navigation, followed by mechanical failures, collisions, then fires / explosions. From this data, the 20 year average for shown there are around 9 incidents per year. The most recent 10 years average shows around 11.5 incidents per year. The most recent 5 years average shows around 13.2 incidents per year. It is not clear what the increase in yearly average in more recent years is due to; however, this is likely due to more incidents being reported, rather than more incidents occurring.

Table 5: MAIB Incidents 1992-2021

Year	Collision	Contact	Fire / Explosion	Mechanical Failure	Total per year
Proportion	**13%**	**52%**	**9%**	**26%**	**100%**
Total per type	**25**	**96**	**17**	**48**	**186**
2021	2	3	1	4	10
2020	0	9	2	8	19
2019	3	6	0	2	11
2018	1	5	0	4	10
2017	3	8	1	4	16
2016	1	7	0	7	15
2015	0	13	4	3	20
2014	2	4	1	1	8
2013	1	3	1	3	8
2012	1	1	0	1	3
2011	1	3	1	1	6
2010	1	4	0	0	5
2009	2	3	0	0	5
2008	2	6	0	1	9
2007	2	3	0-	1	6
2006	0	9	1	0	10
2005	0	1	1	1	3
2003	1	0	0	1	2
2002	0	5	1	1	7
2000	1	0	1	1	3
1999	0	1	0	0	1
1997	1	0	0	0	1
1996	0	1	1	0	2
1995	0	1	0	3	4
1994	0	0	0	1	1
1992	0	0	1	0	1

3.6.3 MarNIS Incident Data

ABP uses the MarNIS incident reporting database for the Humber and incidents recorded from 2011 – 2020 had been provided to ABPmer to undertake the ABPmer NRA. The MarNIS incident database also logs incidents that do not require reporting to the MAIB and, therefore, it can potentially provide greater clarity on the number of incidents that have occurred in the Port of Immingham study area. The MarNIS data is tabulated in Table 5 of the ABPmer NRA. From all incident categories, the incidents that are unrelated to ship navigation and navigational risk have been excluded leaving only the key incident categories of Collision, Equipment Failure (Vessel), Fire / Explosion, Grounding, Impact with Structure and Striking with Ship (Moored). These are reproduced below in Table 6.

The MarNIS data indicates that approximately 183 incidents per year occur in the area (all incidents) and approximately 134 incidents per year for those key incident categories for navigational risk. The data indicates that Equipment Failures are the most likely incident type reported in MarNIS with 58% of the reported incidents within the key incident categories for navigation risk. This is followed by Impact with Structure (contact), then to a far lesser extent Collisions, Striking with Ship (Moored), Grounding and Fires / Explosion.

From the data, the 10 years average shows around 133.8 incidents per year. The most recent 5 years average shows around 121.8 incidents per year. Compared to MAIB data, it can be seen that the MarNIS system captures a substantially larger number of reported incidents which did not require reporting to the MAIB.

It can be seen in **Figure 9** below that there is significant concentration of incidents around several key locations including:

- High concentration of equipment failure incidents (light green dots) reported near the IOT and on approaches to the Port of Immingham.
- Notable concentration of impacts with structures (magenta dots) around the IOT infrastructure.
- Notable concentration of impact with structures (magenta dots) around the other Ro-Ro terminals in Killingholme and the Immingham Bulk Terminal (DFDS)

Table 6: MarNIS Incident Data 2011-2020

Year	Collision ship - ship	Equipment failure (vessel)	Fire / Explosion	Grounding	Impact with Structure	Striking with ship (moored)	Total per year
Proportion	**2%**	**58%**	**1%**	**2%**	**34%**	**2%**	**100%**
Total per type	**32**	**778**	**20**	**28**	**452**	**28**	**1338**
2020	1	63	2	1	23	1	91
2019	5	45	0	0	22	2	74
2018	3	81	0	6	30	0	120
2017	4	132	4	4	55	4	203
2016	3	77	2	6	30	3	121
2015	4	88	3	5	36	0	136
2014	2	84	2	2	47	4	141
2013	3	84	3	1	77	5	173
2012	5	72	1	0	66	6	150
2011	2	52	3	3	66	3	129

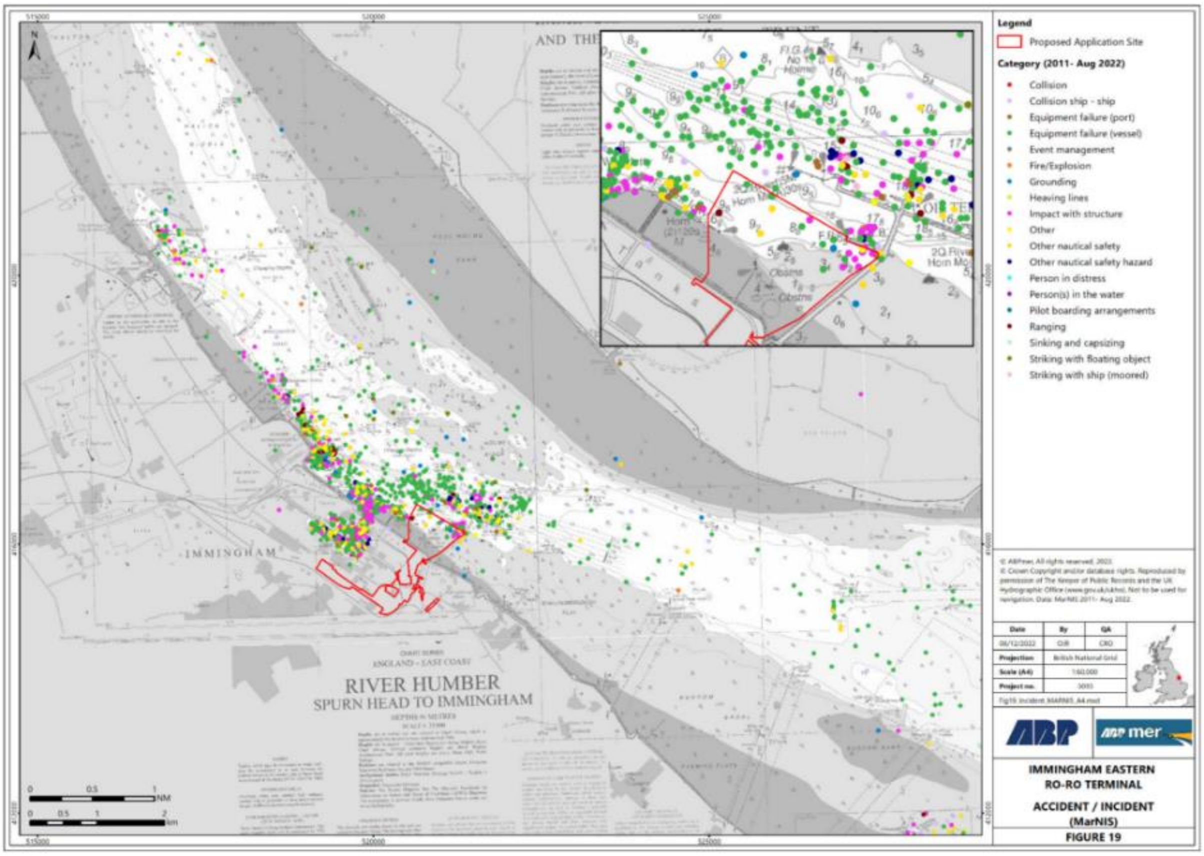

Figure 9:Accidents / Incidents recorded in MarNIS (from ABPmer NRA, Figure 19)

3.6.4 Summary

Historical incidents indicate that Contact / Impact with Structures and Mechanical / Equipment Failures are the most prevalent incident type. The cited causes of historical incidents in area regularly refer to strong currents, winds and adverse visibility being some of the dominating contributing factors.

A high level analysis of incidents and vessel movements using the most recent five years data is outlined for MAIB-reportable incidents benchmarked against DfT ship arrivals data. When considering these averages, it should be noted that the DfT data consists of arrivals for both Immingham and Grimsby, whereas the MAIB data is focussed on the Immingham area only.

Using the yearly DfT vessel data in Table 2 above, and the yearly MAIB incident data in Table 5 above, the number of vessel movements per incident has been assessed for each year. Over the most recent five years, on average there is one incident every 1,316 vessel movements. Broken down as (rounded figures):

- 1 collision every 9,370 movements
- 1 contact every 3,200 movements
- 1 fire / explosion every 13,900 movements
- 1 mechanical / damage every 4,800 movements

The MarNIS data cannot be as readily used to relate incidents and movements because these incidents are recorded across a broader range of incidents severities and would likely include a large number of incidents that occur on/by/to vessels that are not captured within the DfT commercial vessel data. Therefore, without the details of the MarNIS incident database, or the details of each incident, the indicative incident rates can not be derived.

The comparison of MAIB and MarNIS incident numbers (13.2 vs 121.8 incidents per year on average, respectively) are however, informative and indicate that the MAIB dataset considerably understates the number of incidents that have significant potential to result in serious consequences. The above incident assessment can be used to provide guidance into the potential likelihood of occurrence when considered alongside the unique factors of the proposed development, such as location, manoeuvring difficulty, manoeuvring time, proximity to structures, route or vessels, etc.

4 Vessel Traffic Analysis

To establish an indication of current traffic levels and disposition of vessel traffic activity in the vicinity of Immingham Dock, AIS data was collated from an AIS received located at the IOT. AIS data is an informational broadcast of vessel parameters including speed, heading, location (coordinates), course, etc together with vessel particulars such as vessel name, size, type, length, breadth, etc. The AIS data for the months of June and July 2023 were analysed to better understand the general / representative disposition of vessel movements in and around the study area. The data used is for the summer months and the full extent of seasonal vessel traffic variations may also fluctuate. For the purpose of this NRA the study area is as illustrated by the red boundary in **Figure 10**. However, AIS data tracks outside of this study area are also included in data visualisation plots.

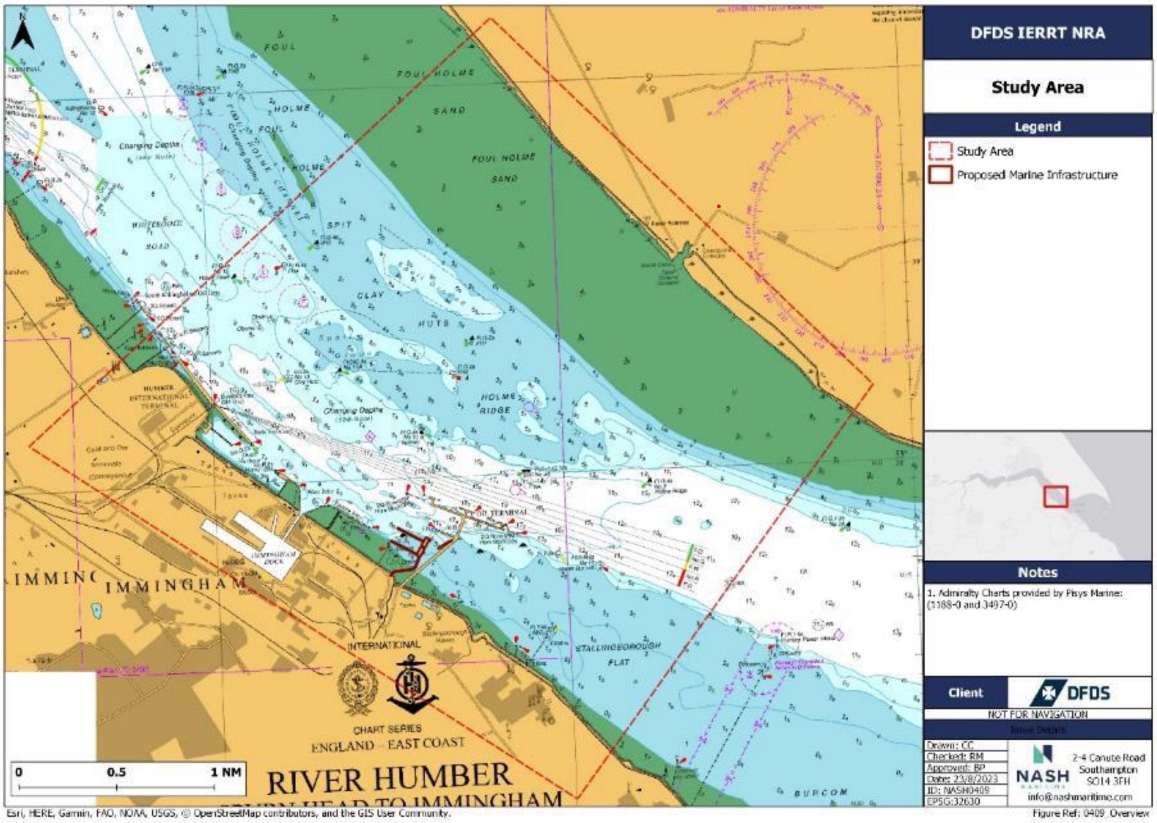

Figure 10: Study Area.

To establish an understanding of vessel movement and passage through the study area the following analysis was conducted:

- Vessel track and density analysis by vessel type (see **Section 4.1**);
- Vessel activity around individual terminals and jetties within the study area (see **Section 4.2**);
- Gate analysis (vessels passing across a defined line) across two sections within the study area (see **Section 4.3**);
- Tidal analysis of vessel movements on the ebb and flood tide, and 1 hour either side of high and low water (see **Section 4.4**); and
- Swept path analysis of tankers berthing / unberthing at IOT Finger Pier in proximity to the proposed infrastructure (see **Section 4.5**).

Together these analyses provide the evidence behind the understanding and characterisation of vessel traffic that informs the identification and assessment of navigation risk within this NRA.

4.1 Vessel Track and Density Analysis by Vessel Type

Vessel traffic analysis was undertaken on the AIS datasets based on the follow vessel type classifications:

- Cargo Vessels e.g. container ships, Ro-Ro cargo vessels;
- Tankers e.g. oil/chemical tankers, LNG/LPG tankers, estuarial barges;
- Passenger Vessels e.g. ferries;
- Tug and Service Vessels e.g. tugs, pilot vessels, dredgers, SAR, military / law enforcement vessels, port tenders, survey vessels;
- High Speed Craft (HSC);
- Recreational Vessels e.g. sailing vessels, pleasure cruisers; and
- Fishing Vessels.

4.1.1 Cargo Vessels

The River Humber has serval cargo terminals resulting in a high density of cargo vessel transits. As shown in **Figure 11,** Immingham Dock receives both container and Ro-Ro cargo vessels typically <200m whilst the DFDS terminal at Immingham Outer Harbour (IOH) receives larger Ro-Ro cargo vessels of up to 250m LOA. Over the 2 months of data collection, there were approximately 1000 cargo vessel transits (~17 per day) into Immingham Dock, and 300 cargo vessel transits (~5 per day) to IOH.

As shown in **Figure 12**, the highest cargo vessel density lies within the centre of the main navigation channels and alongside berths in Immingham Dock and IOH. Typically, larger vessels (>200m LOA) and vessels accessing Immingham Dock / IOH transit through the deeper southern channel whilst smaller cargo vessels passing through the region use the shallower / narrower northern channel.

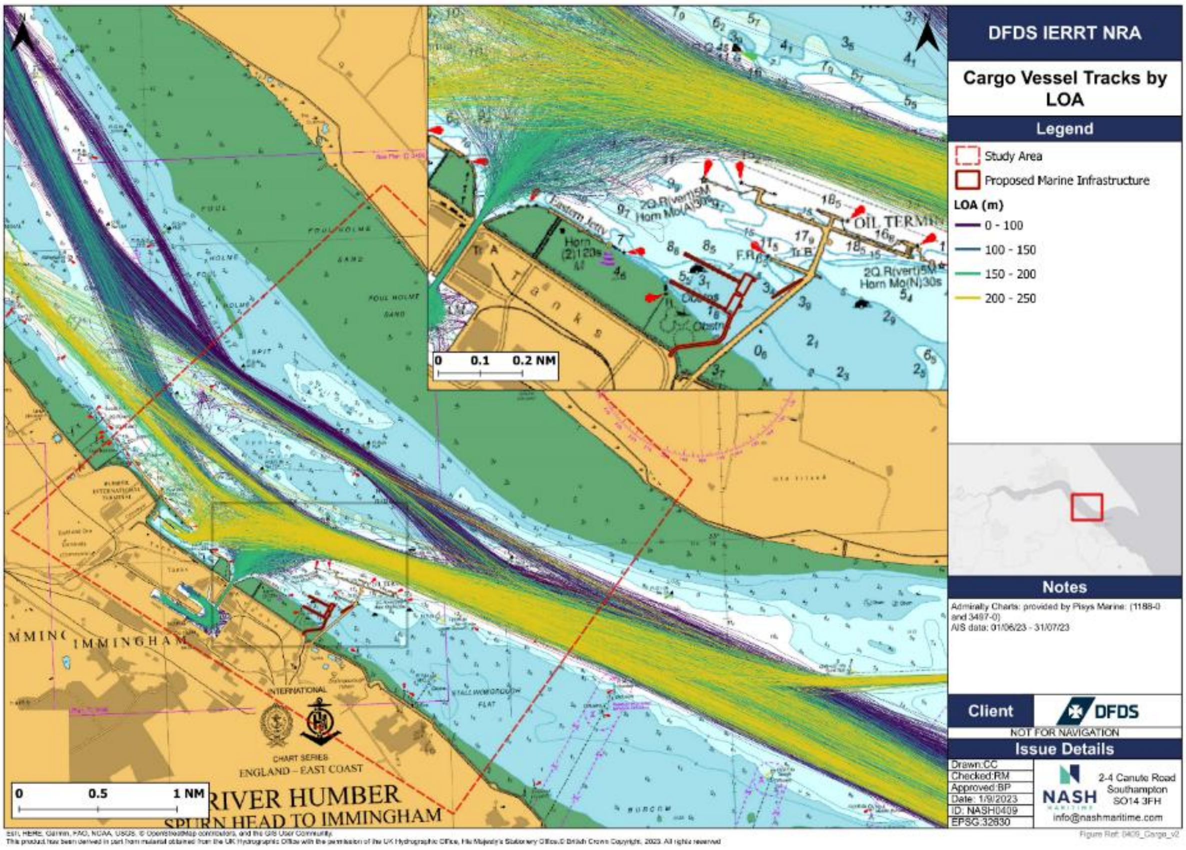

Figure 11: Cargo Vessel Tracks.

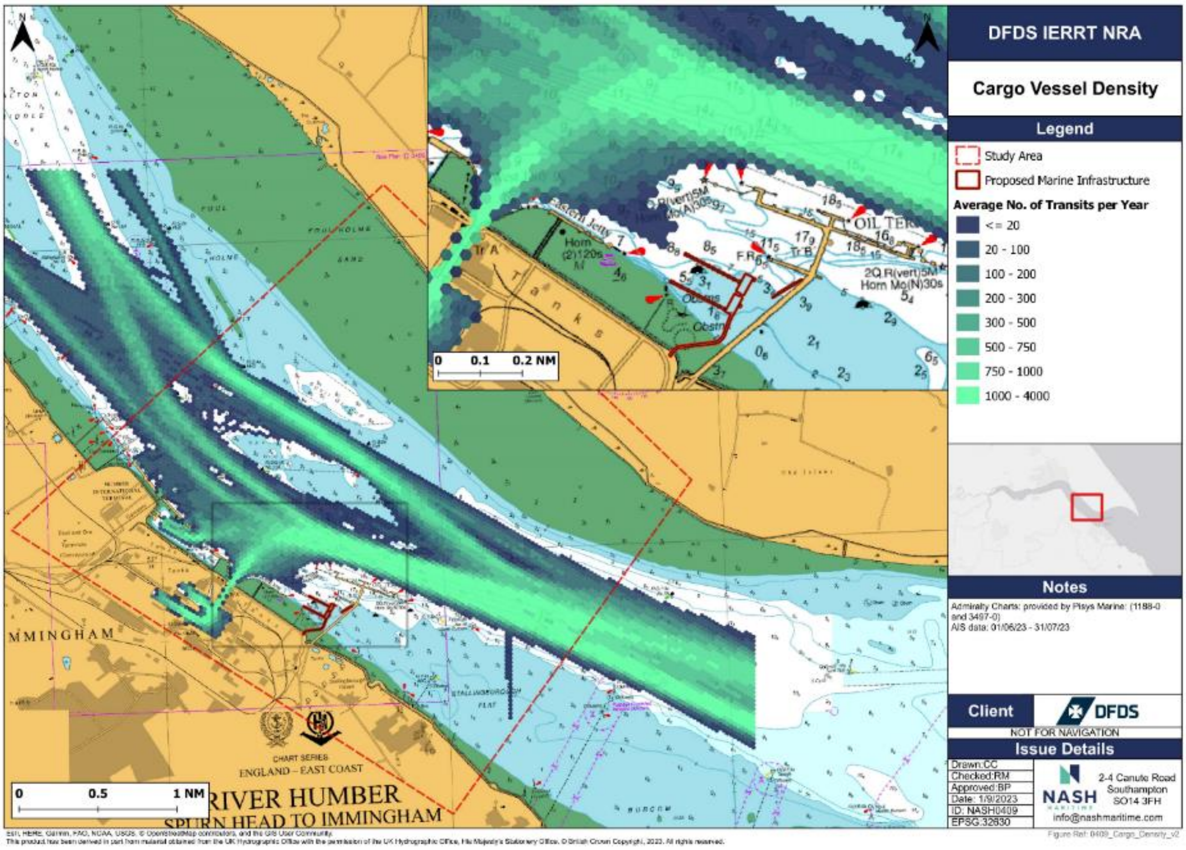

Figure 12: Cargo Vessel Transit Density.

4.1.2 Tankers

As shown in **Figure 13** and **Figure 14,** there are several oil / gas terminals in the Humber region resulting in a high density of tanker and estuarial barge activity within the study area. These include:

- Immingham Oil Terminal (IOT);
- IOT Finger Pier; and
- Immingham Gas Terminal (IGT) / South Killingholme Oil Jetty.
- IOT has 3 berths and receives tankers between 100 - 275m LOA, with approximately 4 tanker visits per day. IOT Finger Pier is positioned within 100m of the proposed infrastructure and receives over 120 tankers per month (~4 tankers per day). All tankers visiting IOT Finger Pier are exclusively <100m LOA. IGT / South Killingholme Oil Jetty are positioned to the west of the study area and are less busy than the other oil / gas terminals in the region. Over the study period, 177 tanker transits were recorded at IGT / South Killingholme Oil Jetty which is just under 3 transits per day.

There is considerable tanker activity on the Eastern Jetty and West Jetty which are situated either side of the entrance to Immingham Dock. The jetties are used as holding locations for tankers waiting to berth / depart. Over the two month period of data collection, tankers utilised the jetties on approximately 130 occasions.

- **Figure 14** shows that approximately 95% of tankers accessing terminals / jetties in the study area use the southern channel to navigate. Across the 2 month period, there are only 30 tanker transits navigating the northern channel to pass through the region, all of which are <100m LOA.

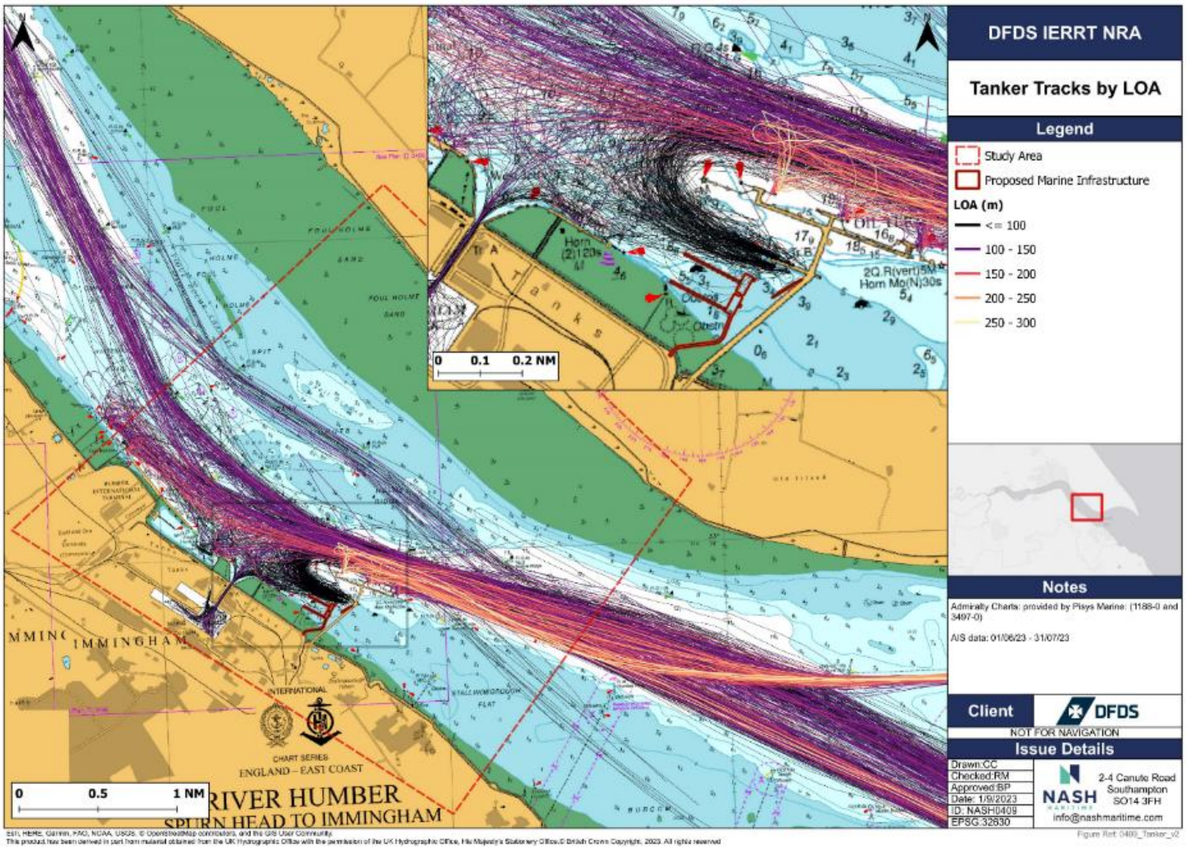

Figure 13: Tanker Tracks.

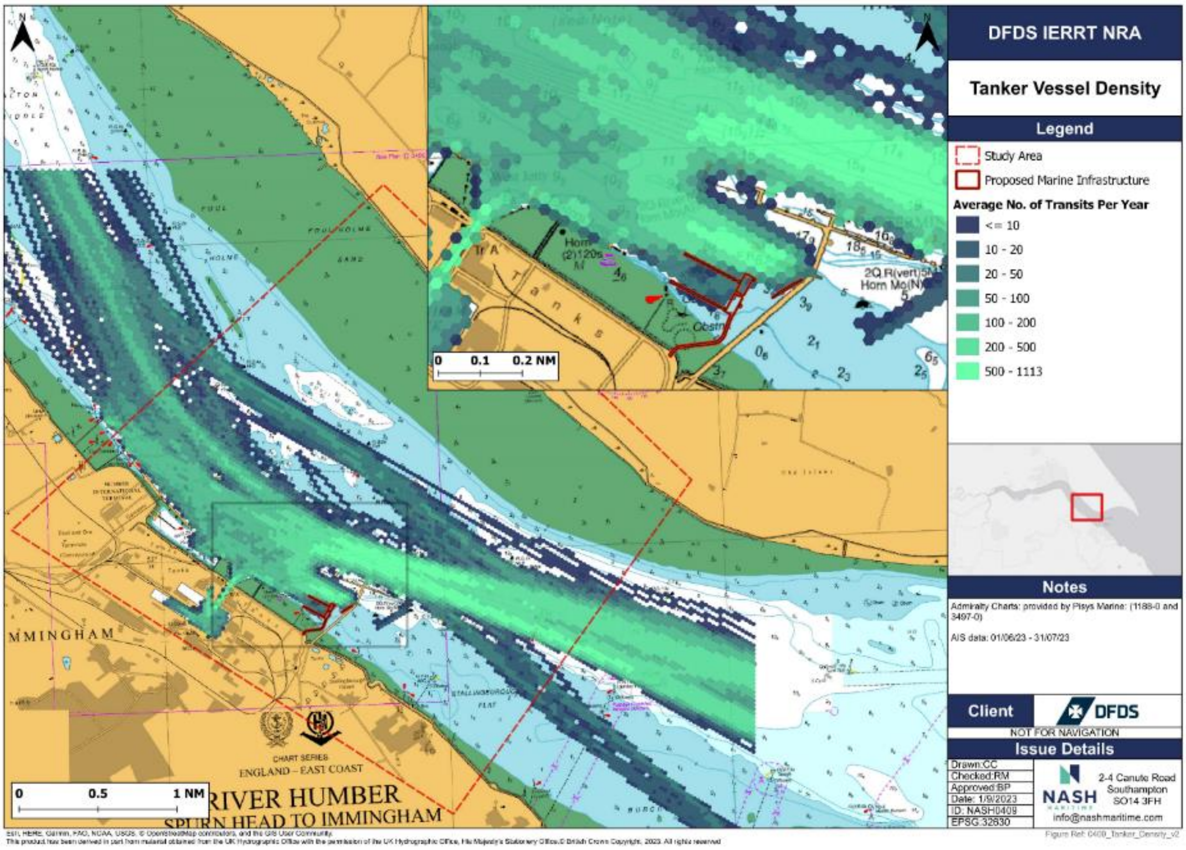

Figure 14: Tanker Transit Density.

4.1.3 Passenger Vessels

Figure 15 and **Figure 16** show that there are several ferries operated by Stena Line and P&O Ferries that transit through the study area. All P&O ferries pass through the study area as they transit to / from the terminal in Hull which is situated further upriver. All Stena Line ferries berth at the Killingholme which is located 1.4nm northwest of the study area.

Over the two month period of data collection, there were ~240 ferry transits of which 64% used the southern navigation channel and the remaining 36% used the northern channel. The ferries recorded during this period range in length from 170 – 215m.

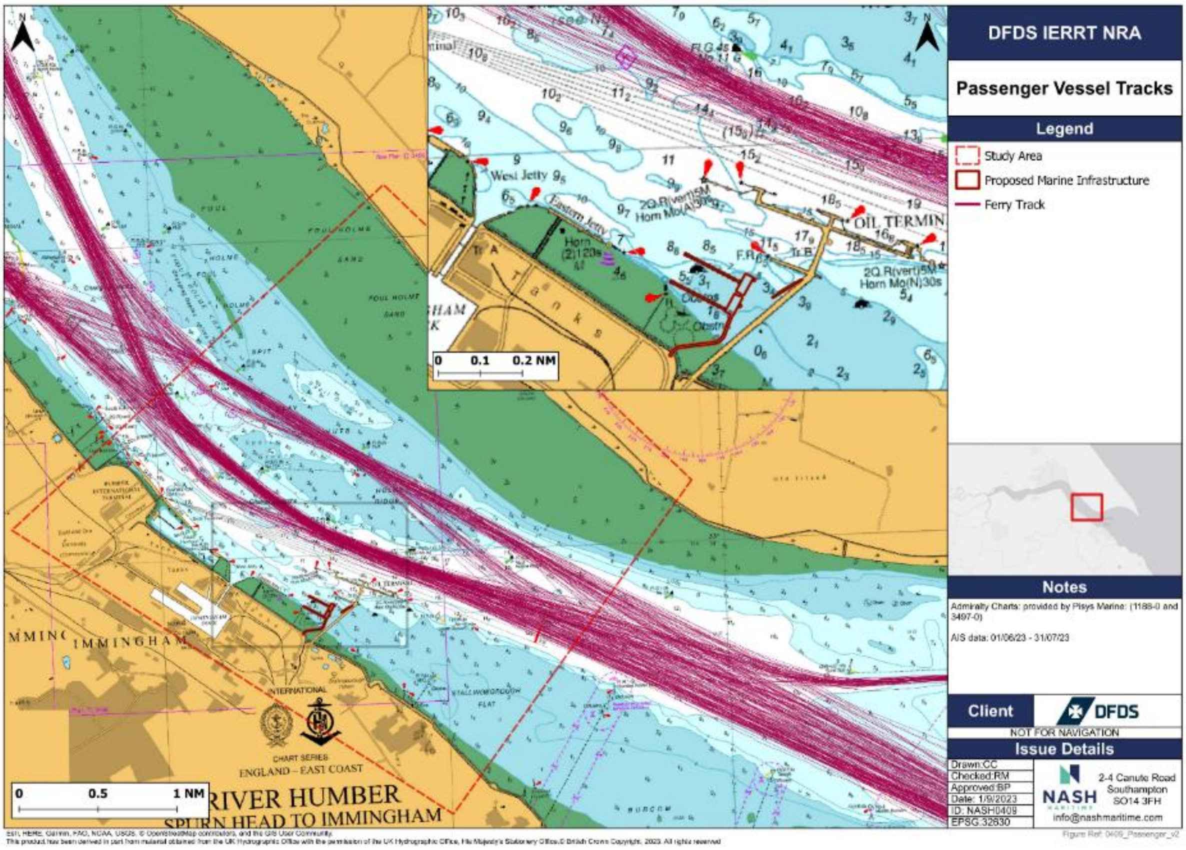

Figure 15: Passenger Vessel Tracks.

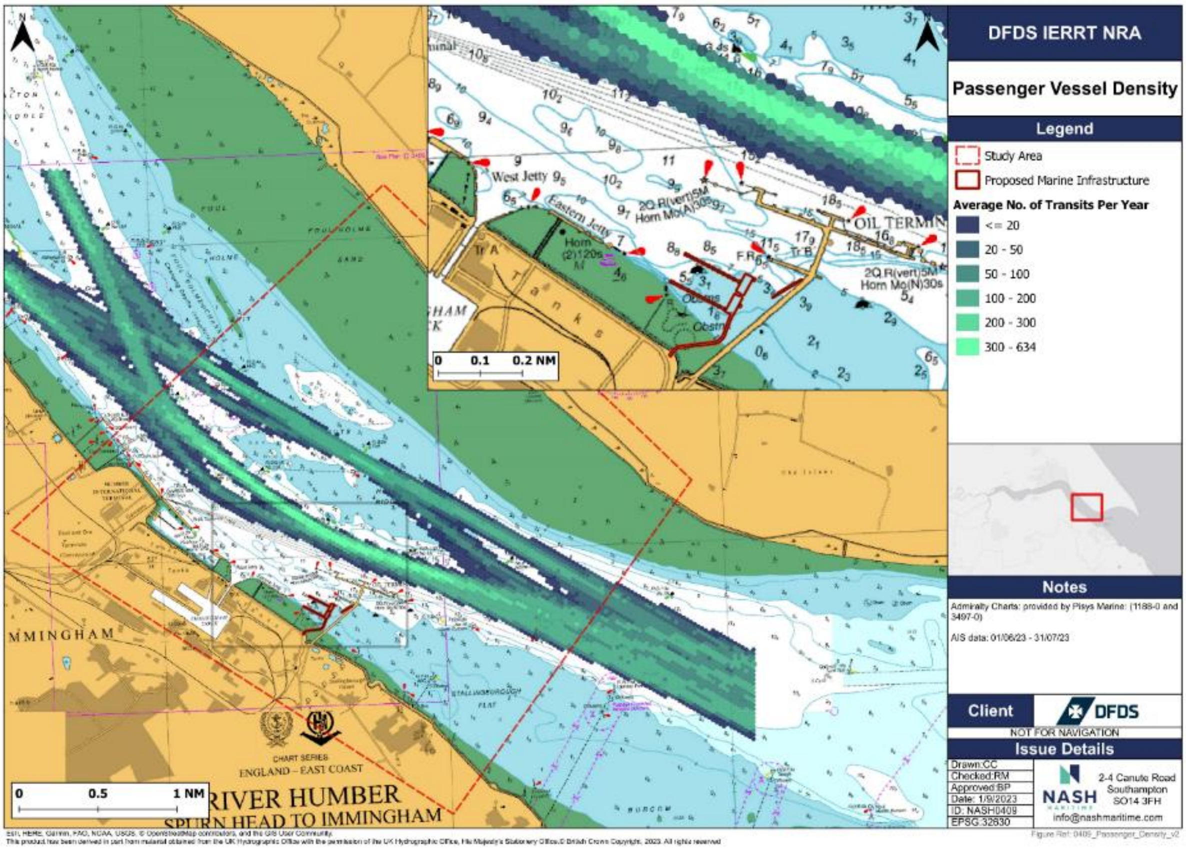

Figure 16: Passenger Vessel Transit Density.

4.1.4 Tug and Service Vessels

Figure 17 and **Figure 18** show a significant number of tug and service vessel movements within the study area due to the high level of commercial activity taking place.

On average there are ~33 tug movements within the study area per day, however, this fluctuates daily with the number of tankers / cargo vessels operating within the region on any given day. Tug activity is concentrated around the jetties and terminals as well as Immingham Dock as they assist larger vessels arriving / departing their berths.

There is limited pilot vessel, port tender, SAR and law enforcement activity within the study area. Most transits show vessels passing through the region, with only ~10 transits showing vessels operating in proximity to the port of Immingham.

Figure 17 shows that several hydrographic surveys have been conducted within the study area by the vessels *Humber Sounder* and the *Humber Surveyor.* All surveys are scheduled in advance and are periodically undertaken to confirm channel and berth depths. **Figure 19** shows that there's significant dredging activity within Immingham Dock and the IOH berths, with the spoil ground being situated on Holme Ridge within the centre of the river. There were up to 70 dredger transits within both Immingham Dock and around the IOH berths over the 2 month data collection period. Dredgers of up to 80m LOA were utilised. It is worth noting that dredging takes place over concentrated periods of time in which several trips between berth and spoil ground are made successively. As with the hydrographic surveys, dredging is scheduled ahead of time and typically coordinated around commercial cargo movements. The additional maintenance dredging requirements of the IERRT would require similar patterns of works as shown below with transits from the IERRT marine development site across the main channel to the spoil groups at and near Holme Ridge.

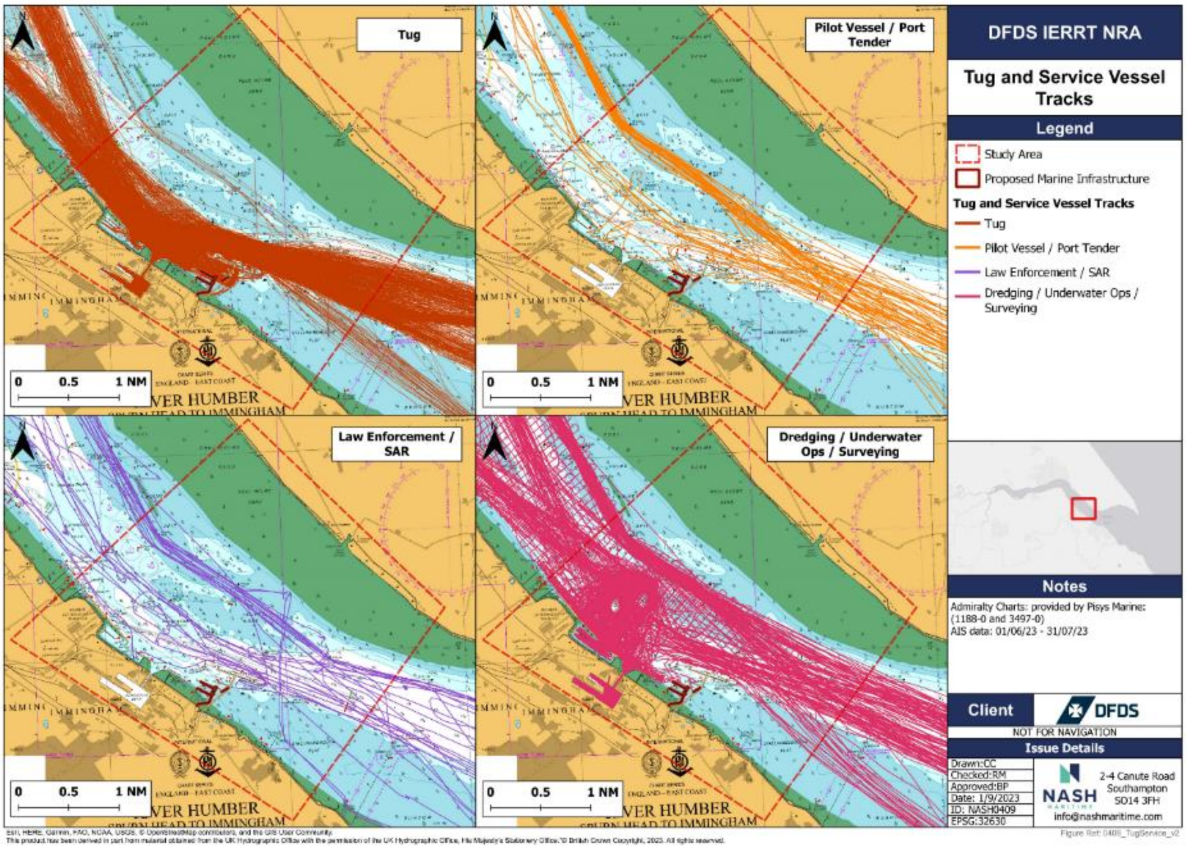

Figure 17: Tug and Service Vessel Tracks.

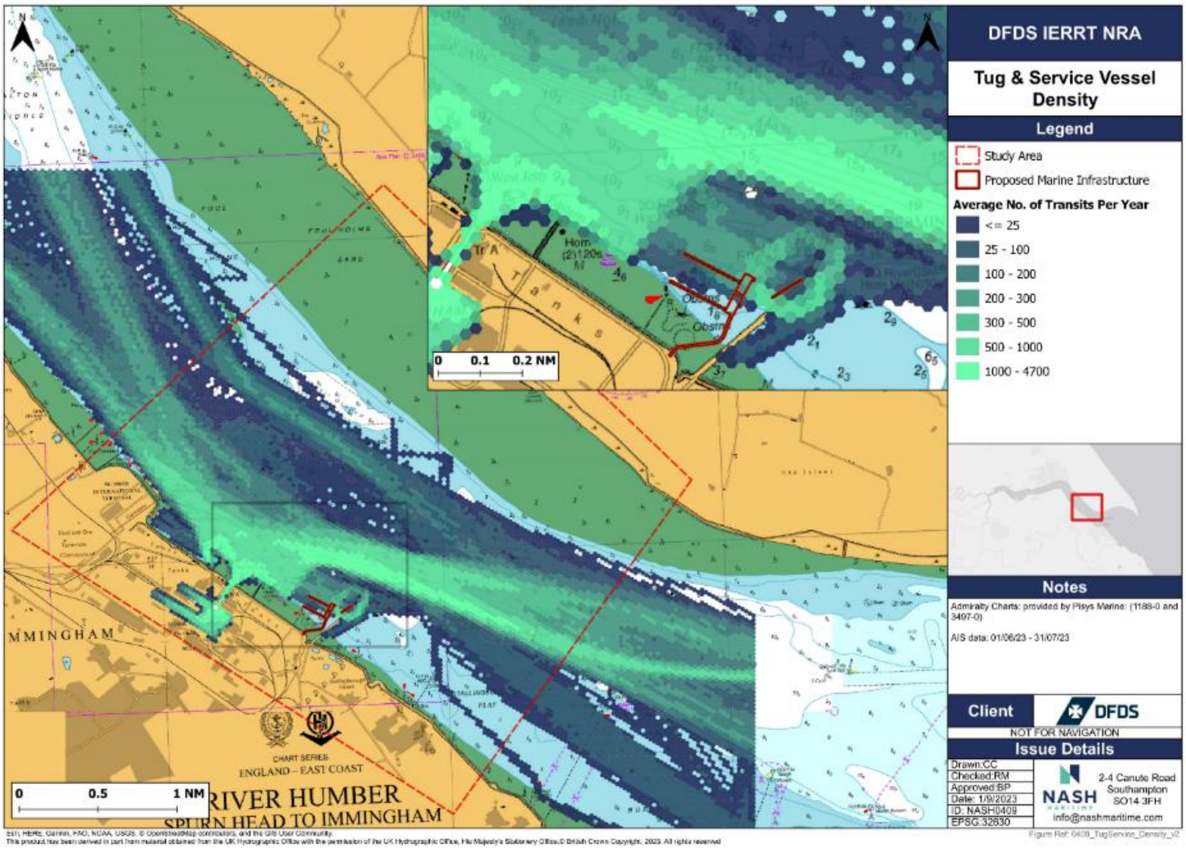

Figure 18: Tug and Service Vessel Transit Density.

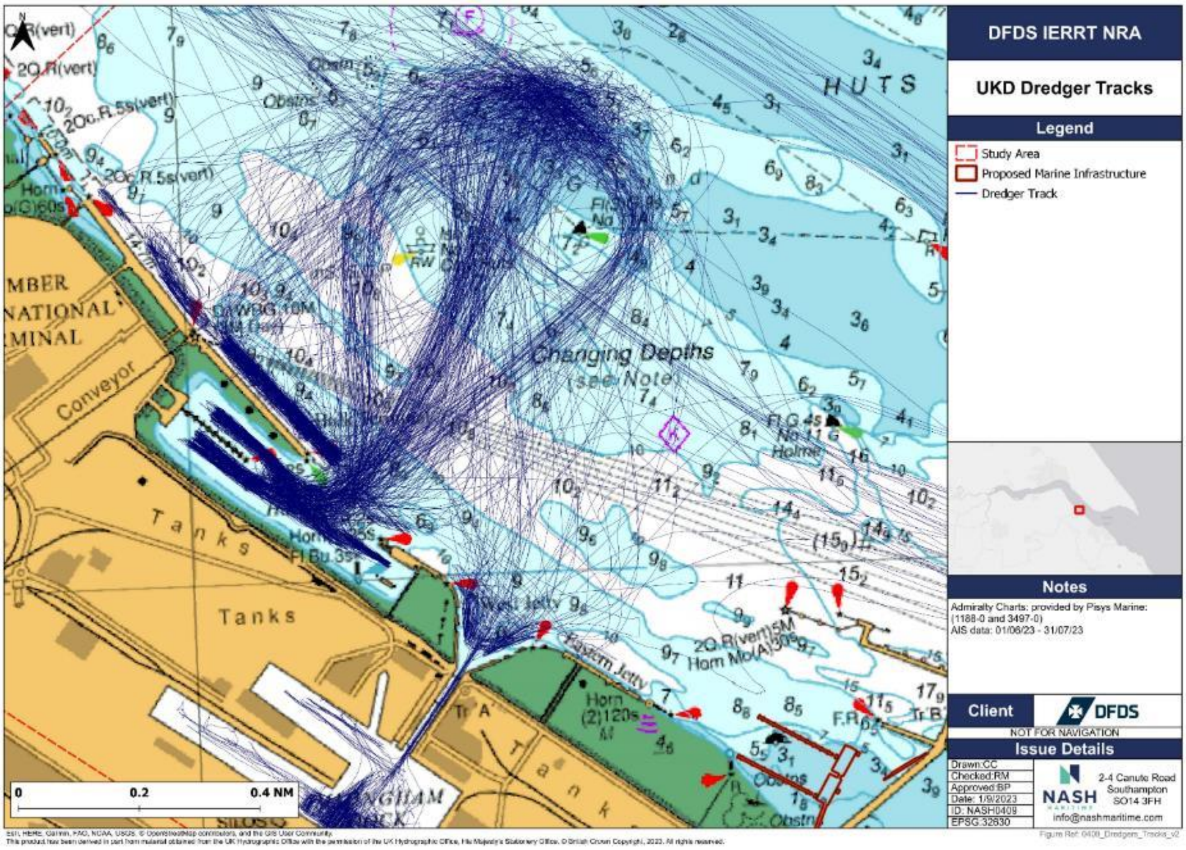

Figure 19: Dredger Tracks and Transit Density.

4.1.5 Other Vessels

Other vessel activity within the study area is very limited, as shown in **Figure 20**. All recreational, fishing and HSC transits show vessels passing through the region, the majority of which use the northern channel.

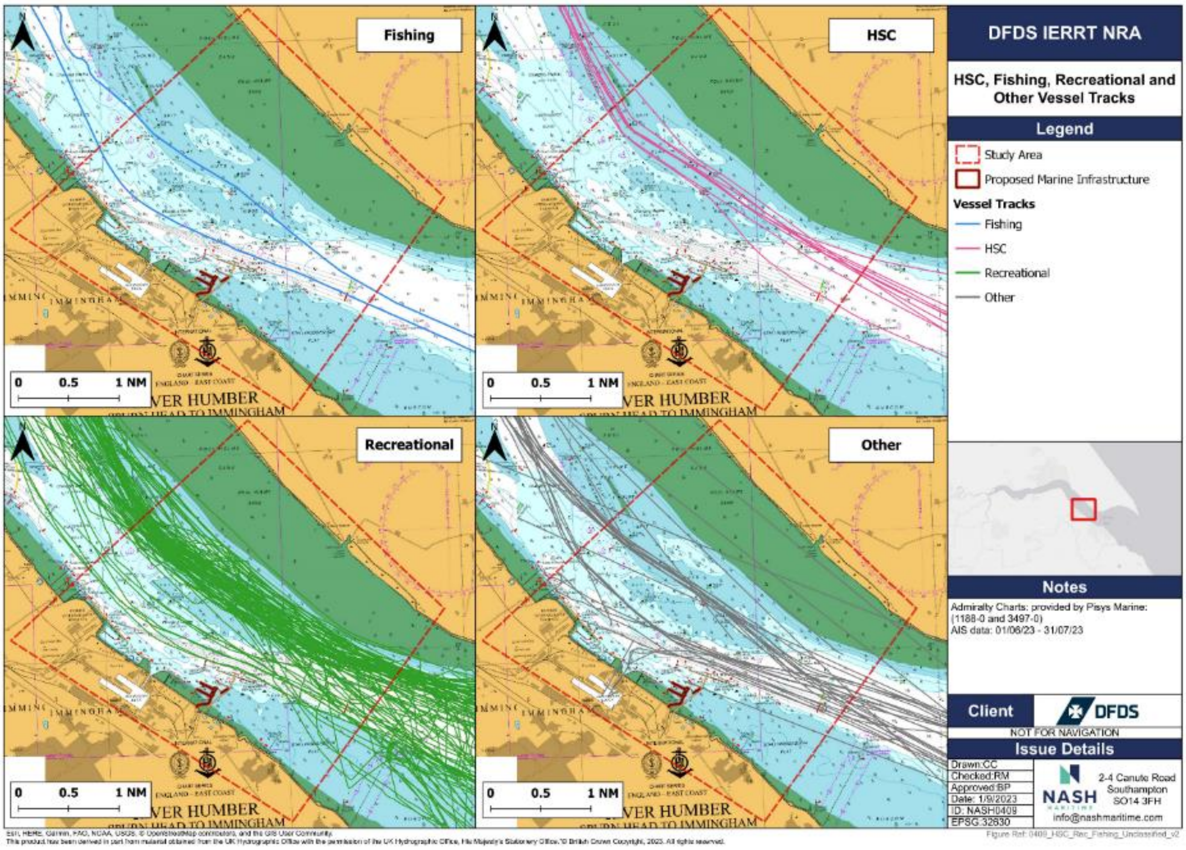

Figure 20: HSC, Recreational, Fishing and Unclassified Vessel Tracks.

4.2 Vessel Activity by Terminal

Table 7 and **Table 8** provide examples of frequent commercial callers and the largest vessels at each jetty / terminal within the study area over Jun / Jul 2023. In general, the largest vessels most commonly call at IOH, IOT, Immingham Dock and the ABP Humber International Terminal (HIT) / IBT ranging from 200 – 274m.

Cargo, tanker and tug tracks have been isolated for each jetty / terminal in order to determine how tankers and cargo vessels:

1. Typically approach / depart each terminal / jetty within the study area; and
2. Utilise different spaces to manoeuvre into position / stem the tide.

Figure 21 and **Figure 22** show that vessels arriving / departing IOT, IGT and HIT / IBT typically approach / leave the berth in a relatively direct manner using predominantly small manoeuvres. In contrast, vessels arriving / departing IOH, Eastern Jetty and West Jetty appear to swing at varying degrees in order to approach / leave the berth. This is most likely due to vessels trying to stem the tide or avoiding other large commercial vessels in transit within the immediate area. Vessels approaching / departing Immingham Dock use the region directly north of the lock to manoeuvre into place and align with the dock entrance which lies between the Eastern and West Jetties. It is understood that the Jetties are used by tugs and tankers if they are required to wait before entering Immingham Dock or departing from the port of Immingham.

All jetties / terminals have vessels approaching / departing exclusively from downriver other than Immingham Dock which is the only location that has vessels approaching / departing from upriver.

In order to approach / depart IOT Finger Pier, tankers must swing around the western extent of IOT. This takes them within close proximity of the proposed IERRT infrastructure.

Table 7: Frequent large commercial callers at each terminal within the study area during Jun / Jul 2023.

Jetty / Terminal	Vessel Type	Vessel Name	Vessel LOA (m)	MMSI Number	No. Visits
ABP Humber International Terminal / Immingham Bulk Terminal	Cargo	Golden Fortune	229	538008727	2
Eastern Jetty	Tanker	Sulphur Genesis	95	256656000	4
Immingham Dock	Cargo	Britannia Seaways	197	219825000	43
	Tanker	Christian Essberger	100	255805753	6
Immingham Gas Terminal	Tanker	Vortex	88	255805640	14
Immingham Outer Harbour	Cargo	Hollandia Seaways	238	219234000	52
Immingham Oil Terminal Finger Pier	Tanker	Shannon Fisher	85	308539000	29
Immingham Oil Terminal	Tanker	Murray Star	123	215178000	8
West Jetty	Tanker	Cobaltwater	100	246545000	5

It should be noted that the two month data collection period for this study may not capture all vessels frequently using the jetties / terminals outlined in **Table 7**. Additionally, other large (or larger) vessels than those detailed in **Table 8** may also use the jetties / terminals outside of the data period assessed. For example, the IOH regularly sees other large Ro-Ro vessels operating at the terminal including Scandia Seaways (235m), Ficaria Seaways (230m), Selandia Seaways (197m), Ark Dania (195m) and Ark Germania (195m).

Table 8: Largest commercial vessel to call at each jetty / terminal within the study area during Jun / Jul 2023.

Jetty / Terminal	Vessel Type	Vessel Name	Vessel LOA (m)	MMSI Number
ABP Humber International Terminal / Immingham Bulk Terminal	Cargo	Kaupang	180	636021568
Eastern Jetty	Tanker	CB Baltic	183	255806263
Immingham Dock	Cargo	Federal Mayumi	200	538004646
	Tanker	Dutch Emerald	118	246436000
Immingham Gas Terminal	Tanker	Silver Cindy	183	538005746
Immingham Outer Harbour	Cargo	Hollandia Seaways	238	219234000
Immingham Oil Terminal Finger Pier	Tanker	Wisby Argan	100	259746000
Immingham Oil Terminal	Tanker	Nobleway	274	564912000
West Jetty	Tanker	Alfred N	169	538006805

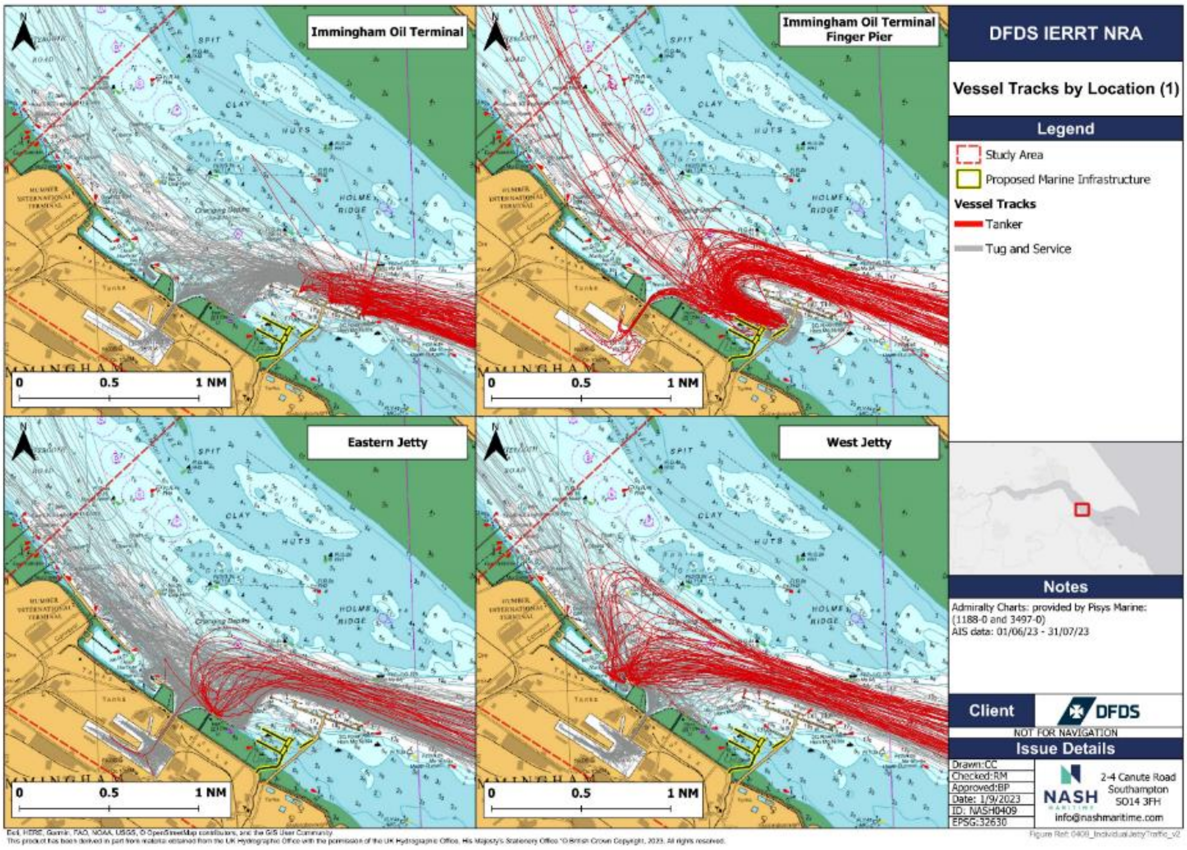

Figure 21: Tanker and Tug Tracks by location (1).

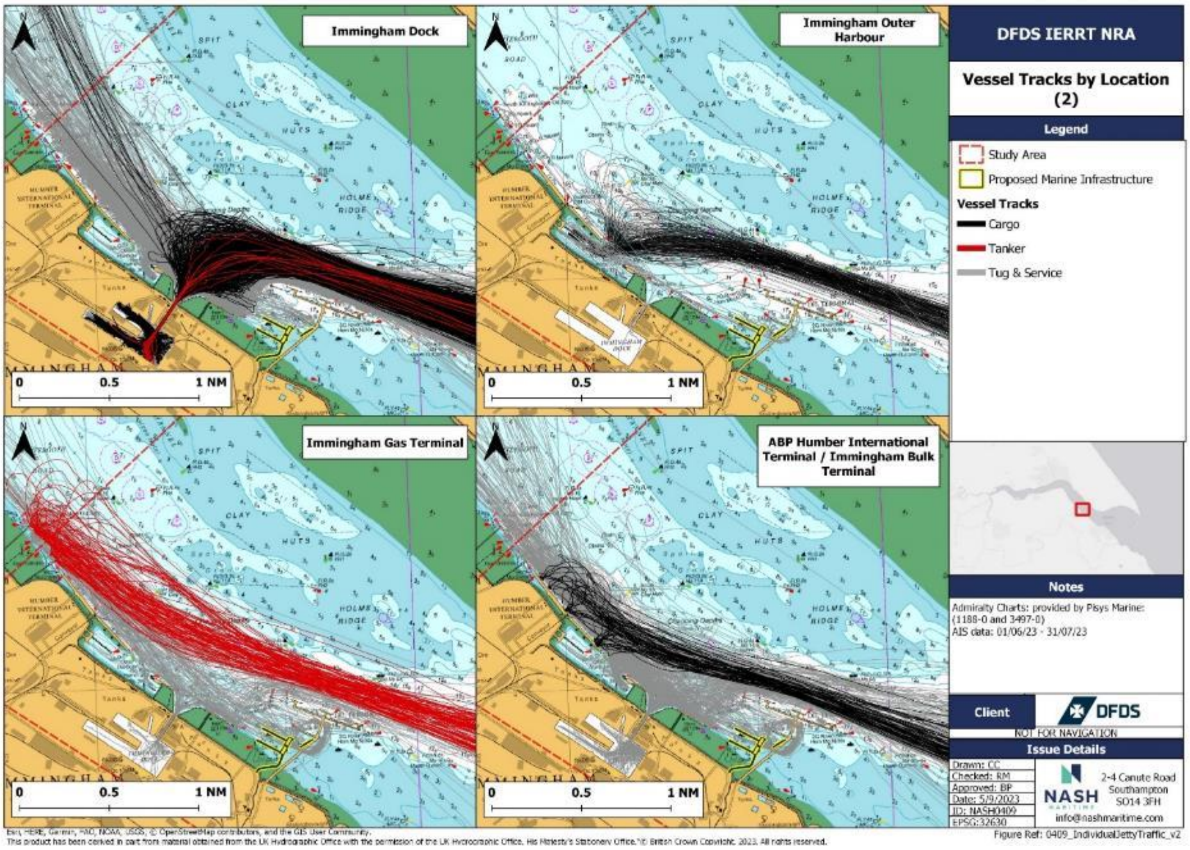

Figure 22: Tanker, Cargo and Tug Tracks by Location (2).

Figure 22 shows that Immingham Dock is significantly the busiest location within the study area with up to 24 cargo vessel transits on the busiest day recorded in Jun / Jul 2023. Even on the quietest day, Immingham Dock received 5 cargo vessels which equates to the average daily movements for several other jetties / terminals within the study area. ABP HIT / IBT, IOT and IOH also have relatively high levels of commercial activity with approximately 4-5 cargo or tanker transits per day.

It is evident that most, if not all, cargo vessel arrivals / departures at Immingham Dock are assisted by tugs, as are vessels calling at ABP HIT / IBT. Both IOT and IOT Finger Pier appear to have tugs assisting vessels on the majority of occasions, but it does not appear to occur for every movement. The Ro-Ro cargo vessels berthing at the IOH are not typically assisted by tugs.

Table 9: Total number of cargo, tanker and tug transits and daily average, minimum, and maximum for each terminal in the study area.

Jetty / Terminal	Total no. of transits over Jun / Jul 2023			Average no. of transits per day			No. of transits on busiest day			No. of transits on quietest day		
	Cargo	Tanker	Tug	Cargo	Tanker	Tug	Cargo	Tanker	Tug	Cargo	Tanker	Tug
Humber International Terminal / Immingham Bulk Terminal	267	11	287	4	0	5	15	0	6	0	0	0
Eastern Jetty	0	32	265	0	1	4	0	2	7	0	0	1
Immingham Dock	978	15	1029	16	0	17	24	0	22	5	0	7
Immingham Gas Terminal	0	131	84	0	2	1	0	8	3	0	0	0
Immingham Outer Harbour	280	0	9	5	0	0	5	0	3	2	0	0
Immingham Oil Terminal Finger Pier	0	109	83	0	2	1	0	7	0	0	0	0
Immingham Oil Terminal	0	242	117	0	4	2	0	11	5	0	0	0
West Jetty	0	92	90	0	2	1	0	7	1	0	0	0

4.3 Gate Analysis

To better understand the existing vessel traffic flows approaching / departing the port of Immingham, a gate analysis was carried out. Two gates were established as illustrated in **Figure 23** and **Figure 24** to analyse the frequency of vessel transiting through different regions of the study area.

Figure 23 shows that vessels arriving into the port of Immingham are relatively evenly spread across the gate, other than a high concentration at the entrance of IOH in which vessels must arrive and depart through the 330m gap between IBT and West Jetty. There are three relatively distinct departing routes on the western, central and eastern portion of the gate that are used by IOH and west Jetty, Immingham Dock, and IOT Finger Pier and Eastern Jetty, respectively.

Figure 24 shows that the southern channel experiences a significant amount of vessel traffic transiting both up and down river. The busiest portion of the gate for outbound vessels is just south of the centre of the channel with ~5 transits per day, and is mostly likely due to commercial vessels departing the port of Immingham. The inbound vessels are more spread over the gate with the highest portion towards the north of the gate, most likely as a result of vessels passing through the region and using the southern channel to navigate.

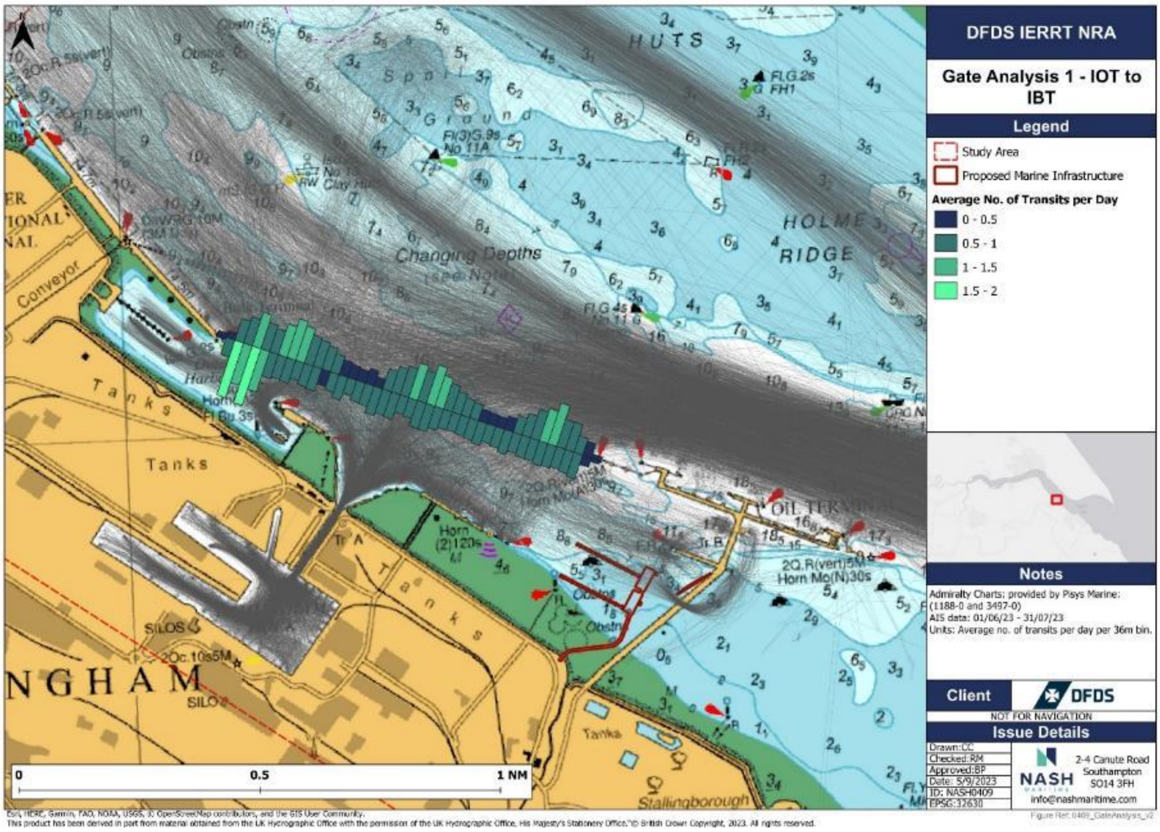

Figure 23: Gate 1: IOT - IBT Gate Analysis.

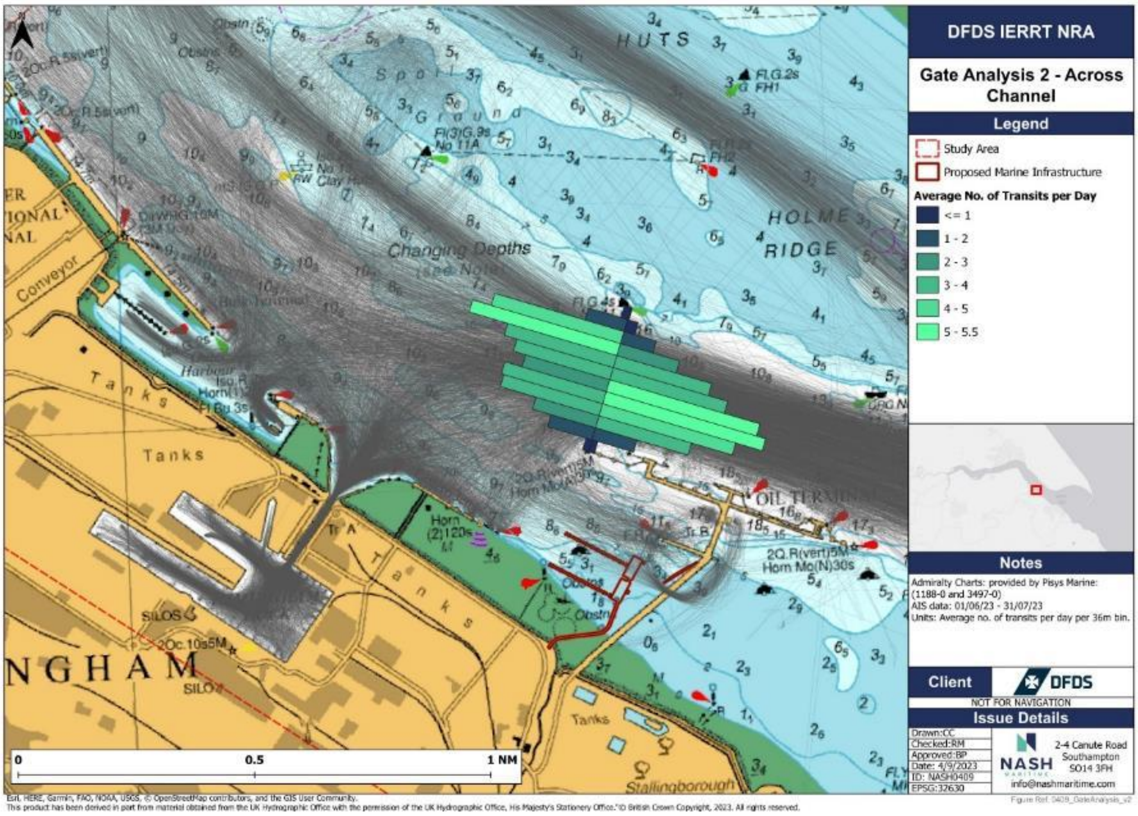

Figure 24: Gate 2: Channel Gate Analysis.

Figure 25 shows the average number of vessel transits for each day across both gates, classified by vessel type. It is evident that tug and service vessels are the most active vessel type within the port of Immingham, with over twice as many tug and service transits as cargo transits per day. In contrast, gate 2 shows that there are approximately the same number of cargo and tug and service vessel transits per day within the southern channel.

There are more tanker transits per day within the southern channel than there are within the port of Immingham mostly likely because the tanker terminals are positioned east and west of Immingham Dock and therefore tankers are not often required to pass between IOT and IBT.

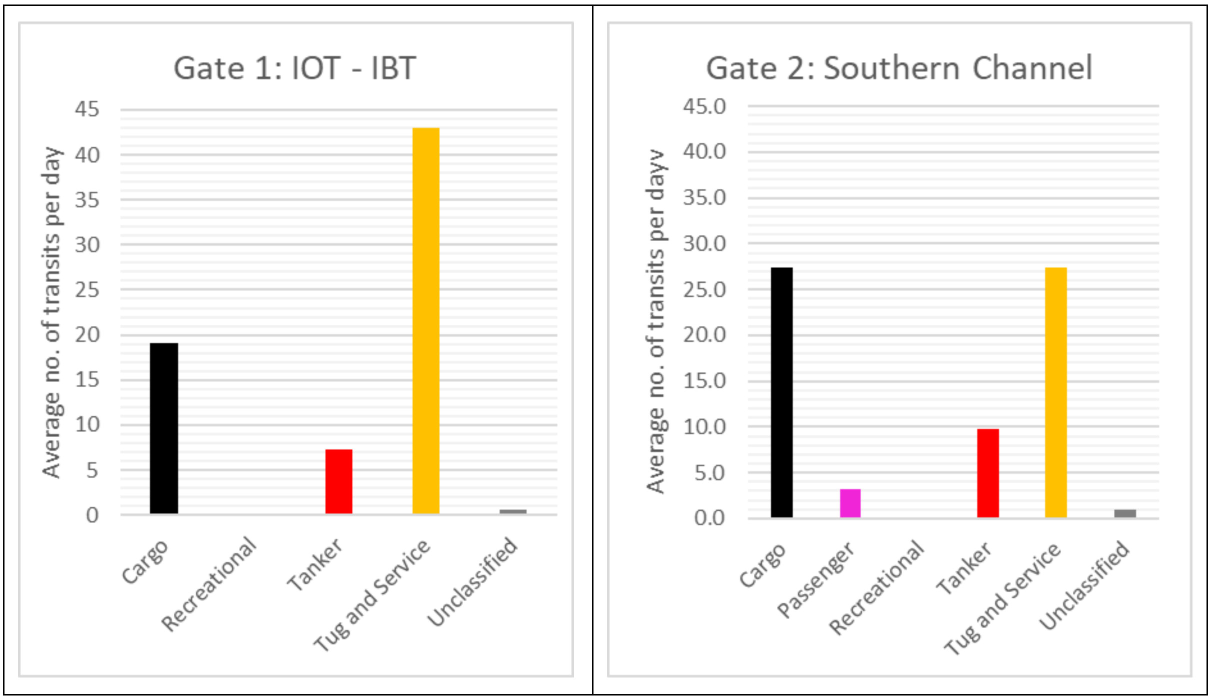

Figure 25: Gate analysis results - Average no. of transits per day

On the busiest days, **Table 10** shows that gate 1 has ~100 tug and service movements, and 47 cargo / tanker movements which is over double the average number of transits per day. Gate 2 has significantly less tug and service transits per day but on average has 23% more tanker and cargo vessels transiting through the channel on the busiest day, most likely due to commercial vessels passing through the region and using the southern channel for navigation.

Table 10: Gate analysis results – total number of vessel transits and daily averages, minimums, and maximums.

Vessel Movements - Gate 1: IOT - IBT				
Vessel Type	**Total no. of transits over Jun / Jul 23**	**Average no. of transits per day**	**Maximum no. of transits in a day**	**Minimum no. of transits in a day**
Cargo	1145	19	28	11
Recreational	9	<1	4	2
Tanker	439	7	19	2
Tug and Service	2579	43	100	16
Unclassified	35	1	5	1
Vessel Movements - Gate 2: Southern Channel				
Vessel Type	**Total no. of transits over Jun / Jul 23**	**Average no. of transits per day**	**Maximum no. of transits in a day**	**Minimum no. of transits in a day**
Cargo	1647	27	38	16
Passenger	160	3	5	1
Recreational	5	<1	2	1
Tanker	618	10	20	3
Tug and Service	1645	27	50	9
Unclassified	38	1	3	1

4.4 Tidal Analysis

Tidal analysis was conducted in order to determine how each vessel type utilises different tidal states and currents to travel inbound or outbound within the study area. **Figure 26** and **Table 11** highlight two significant trends:

1) Tankers predominantly arrive / depart on the flood tide for both Gate 1 and Gate 2; and
2) Cargo vessels utilise both the flood and ebb tide relatively equally for arriving / departing across Gate 1 and Gate 2 (as expected for liner services).

It is also worth noting that the increase in tanker movements on the flood tide results in more tug and service transits on the flood as they assist the larger tankers arriving / departing.

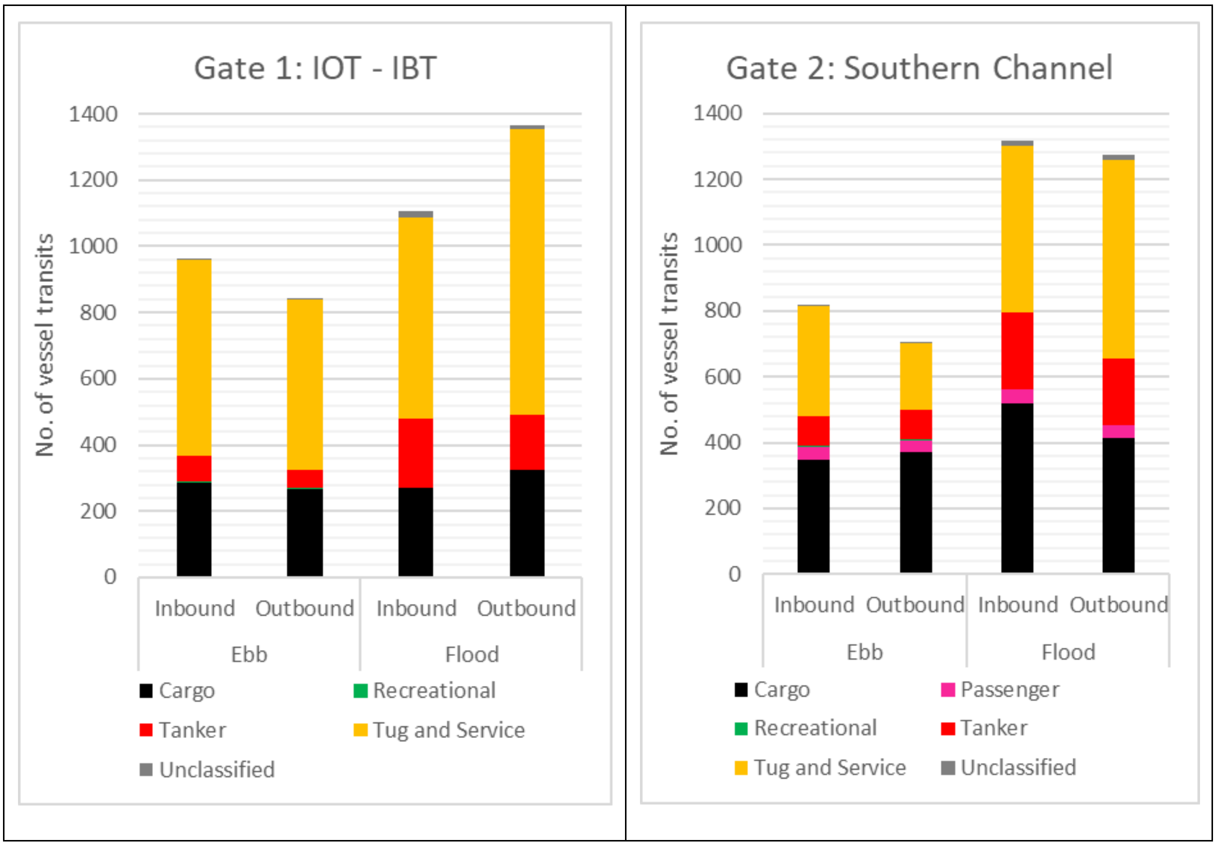

Figure 26: Total number of inbound and outbound vessel transits on the flood and ebb tide across gate 1 and gate 2.

Table 11: Average number of inbound and outbound vessel transits per day over gate 1 and gate 2 on the flood and ebb tide.

Average no. of vessel transits per day								
Vessel Type	**Gate 1: IOT - IBT**				**Gate 2: Southern Channel**			
	Ebb tide		**Flood tide**		**Ebb tide**		**Flood tide**	
	Inbound	**Outbound**	**Inbound**	**Outbound**	**Inbound**	**Outbound**	**Inbound**	**Outbound**
Cargo	5	4	4	5	6	6	9	7
Passenger	NA	NA	NA	NA	1	1	1	1
Recreational	<1	<1	<1	<1	<1	<1	<1	<1
Tanker	1	1	3	3	2	2	4	3
Tug and Service	10	9	10	14	6	3	8	10

Unclassified	<1	<1	<1	<1	<1	<1	<1	<1

Figure 27 and **Table 12** show vessel transits 1 hour either side of low water / high water and highlight 3 significant trends:

1) Tankers predominantly arrive / depart over high water across Gate 1 and Gate 2 (there were approximately double the number of tanker transits over high water than low water across both gates);
2) Cargo vessels utilise both high water and low water relatively equally for arriving / departing across Gate 1 and Gate 2; and
3) Passenger activity through Gate 2 is highest over low water for inbound and outbound transits (~97% of transits recorded across Gate 2 were over low water).

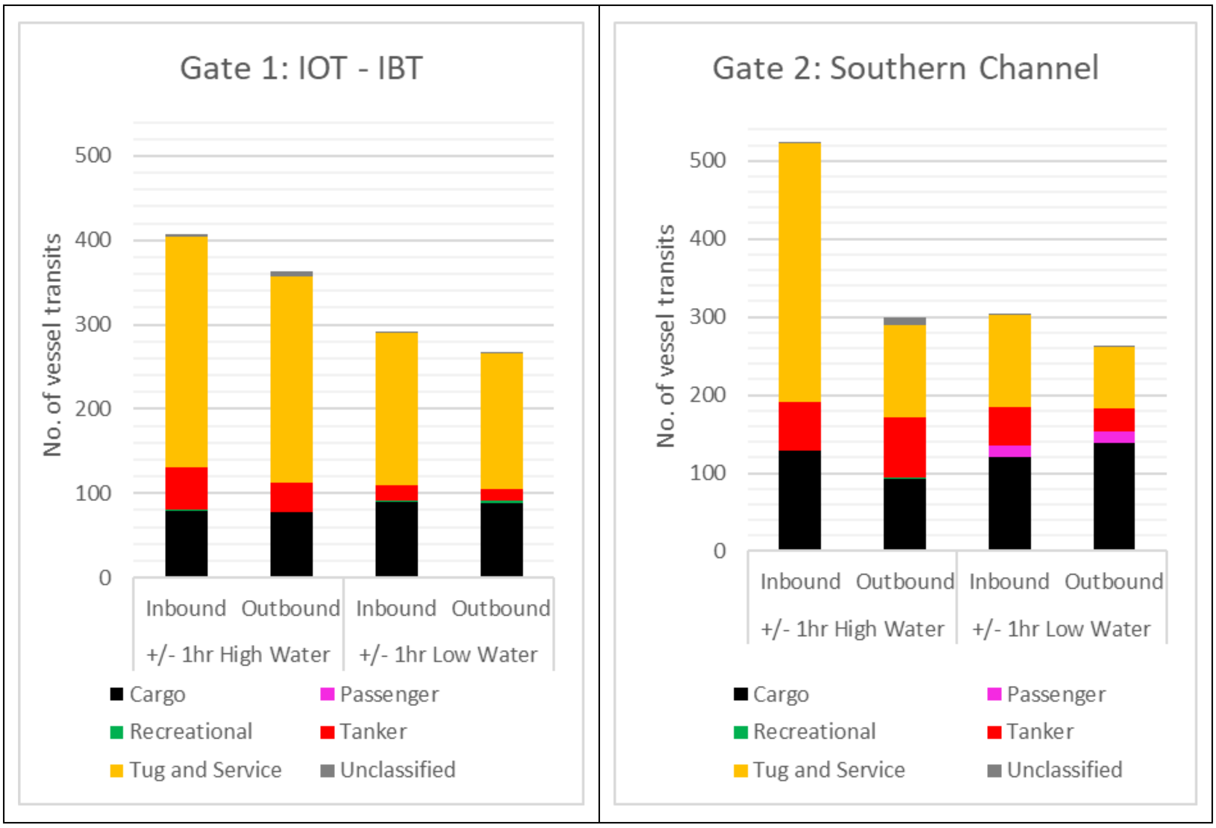

Figure 27: Total number of inbound and outbound vessel transits over high and low water across gate 1 and gate 2.

Table 12: Total number of inbound and outbound vessel transits over high and low water across gate 1 and gate 2.

Total number of vessel transits								
Vessel Type	**Gate 1: IOT - IBT**				**Gate 2: Southern Channel**			
	+/- 1hr High Water		**+/- 1hr Low Water**		**+/- 1hr High Water**		**+/- 1hr Low Water**	
	Inbound	**Outbound**	**Inbound**	**Outbound**	**Inbound**	**Outbound**	**Inbound**	**Outbound**
Cargo	79	78	90	89	128	93	121	138
Passenger	NA	NA	NA	NA	1	0	15	16
Recreational	2	0	1	2	0	1	0	0
Tanker	50	35	19	14	62	78	49	29
Tug and Service	273	244	181	161	331	117	118	78
Unclassified	3	6	1	2	1	10	1	2

4.5 Swept Path Analysis

4.5.1 IOT Finger Pier

The proposed infrastructure is positioned approximately 105m from the IOT Finger Pier making it the closest terminal to the proposed project. To illustrate how large vessels manoeuvre within the immediate region of the proposed infrastructure, swept path analysis of tankers arriving / departing the IOT Finger Pier was undertaken (excluding estuarial barges).

Figure 28 shows the swept path density exposure time of all tankers arriving / departing IOT Finger Pier over Jun / Jul 2023. The north (6 and 7) and south (8 and 9) berths of the Finger Pier have the longest exposure times of over 6 hours from vessels remaining alongside. The immediate approaches to the berths also have long exposure times of 1 – 6 hours as vessels slow down to moor alongside the berths. Further away from the Finger Pier, the passages taken by approaching / departing tankers vary between tankers taking a tight turn (within 100m) around the west end of IOT, to tankers turning up to 1km away from the IOT Finger Pier before approaching. This results in lower exposure times across the spread. Exposure times within 100m of the proposed infrastructure are over 6 hours.

This exposure is primarily only on the flood tide due to the tidal restrictions at the IOT finger Pier, hence the "available" period of operation of the IOT finger Pier is effectively halved comparted to combined flood and ebb tides. The consecutive arrivals of the IERRT vessels will be up to 45 minutes each arrival, therefore 135 minutes for three vessels or approximately 60 min each if allowing a gap for tugs and between IERRT vessels, this would be 3 hours occupied for IEERT vessels. When this aligns with the time required for IOT finger Pier operations (departure of berthed vessel, stemming of awaiting vessel and arrival and morning of awaiting vessel), the occupied time of the immediate area around the I IERRT development and the Eastern Jetty is highly constrained.

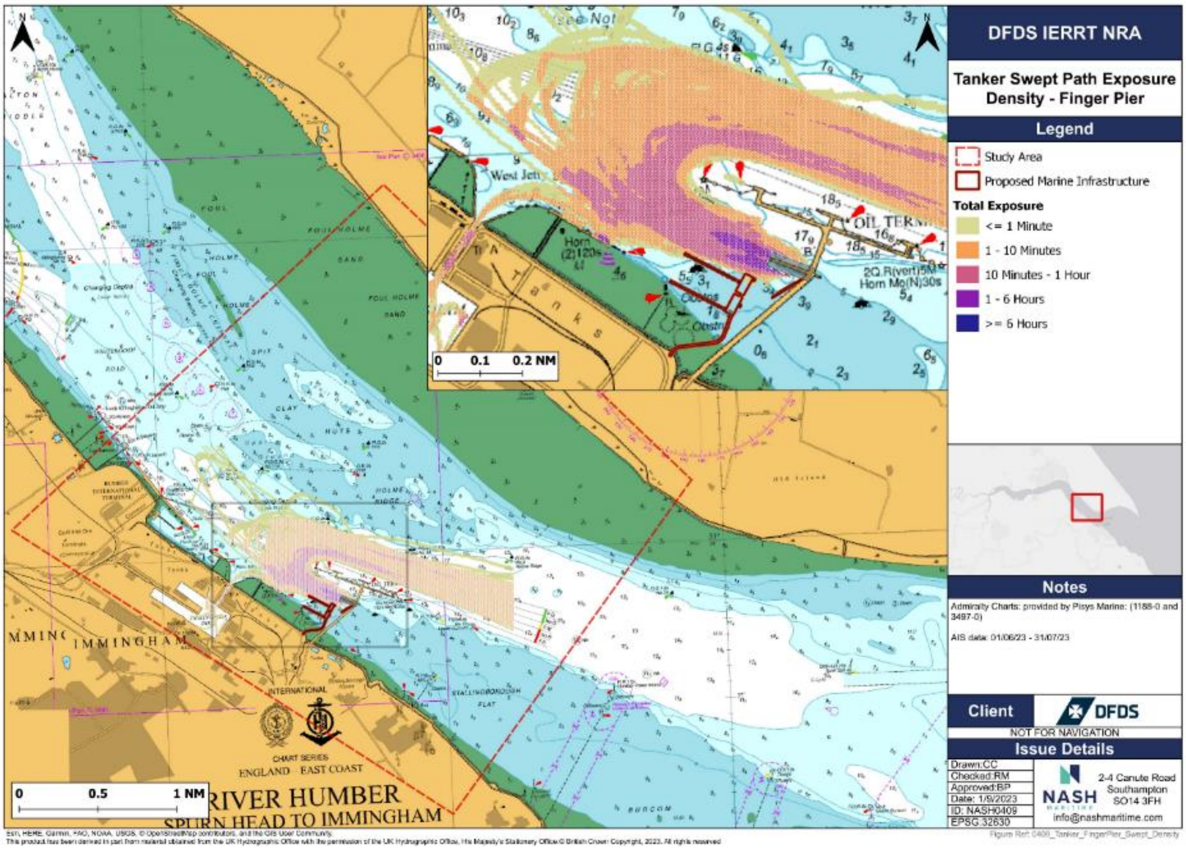

Figure 28: Tanker swept path density for Immingham Oil Terminal Finger Pier.

4.5.2 Stemming Area

Stemming areas can be observed for IOT Finger Pier vessels holding station just off the Eastern Jetty in the density plot shown above in **Figure 28.** Additionally, **Figure 29** below shows several swept paths of tankers approaching the IOT Finger Pier. All tankers shown have utilised the region in front of Immingham Dock or Eastern Jetty as a stemming area to wait before approaching their berth. Waiting periods range from 17 – 30 mins for the vessels shown. Stemming the tide is a regular occurrence and is covered under ABP Humber Standing Notice to Mariners SH22 [32].

Other than *Thun Blythe*, all the tankers shown in **Figure 29** wait between 160m (*Sarnia Liberty*) and 60m (*Solway Fisher*) in front of Eastern Jetty before approaching their berth at the IOT Finger Pier. *Thun Blythe* waits 400m in front of the entrance to Immingham Docks. It is also worth noting that the vessel *Sarnia Cherie* comes within 50m of the proposed infrastructure whilst waiting 19 minutes before approaching its berth.

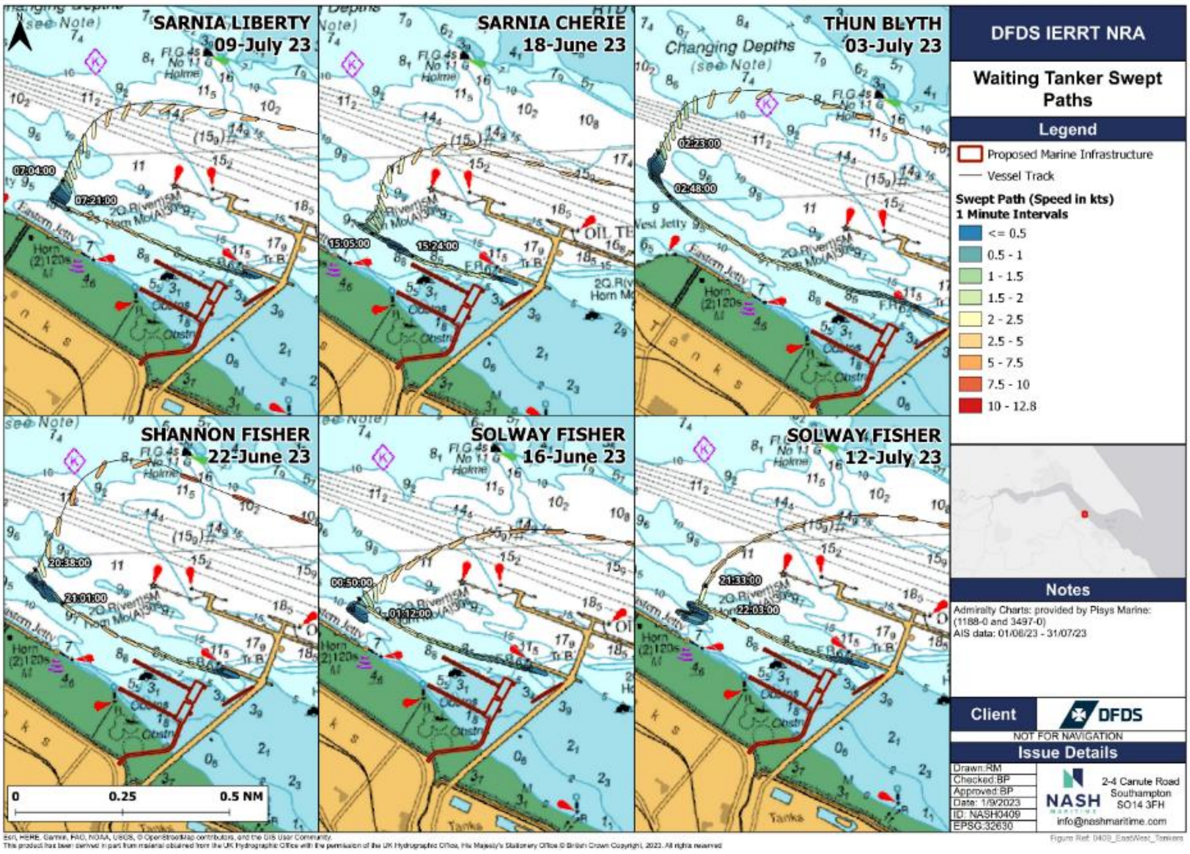

Figure 29: Examples of stemming area use from AIS data

[32] SH_22_2002_NTM (revised), https://www.humber.com/admin/content/files/Notice%20to%20Mariners/Standing%20Notice%20to%20Mariners/SH_22_2002_NTM%20(revised).pdf

5 Risk Assessment Methodology

5.1 Introduction

As discussed in Section 1.4, this NRA adopts a PMSC-compliant NRA approach consistent with two previous risk assessments undertaken separately for other developments within ABP port areas – these are Marchwood Port development within ABP Southampton, and Able Marine Energy Park development within ABP Humber.

The risk assessment methodology is based on the International Maritime Organisation (IMO) Formal Safety Assessment methodology which is presented within **Figure 30**. This includes five steps:

1. FSA Step 1 – Hazard Identification.
2. FSA Step 2 – Score Risk (that is, the Risk Assessment).
3. FSA Step 3 – Identify Risk Controls (that is, Additional Risk Controls).
4. FSA Step 4 – Cost-Benefit Analysis, undertaken if necessary.
5. FSA Step 5 – Recommendations.

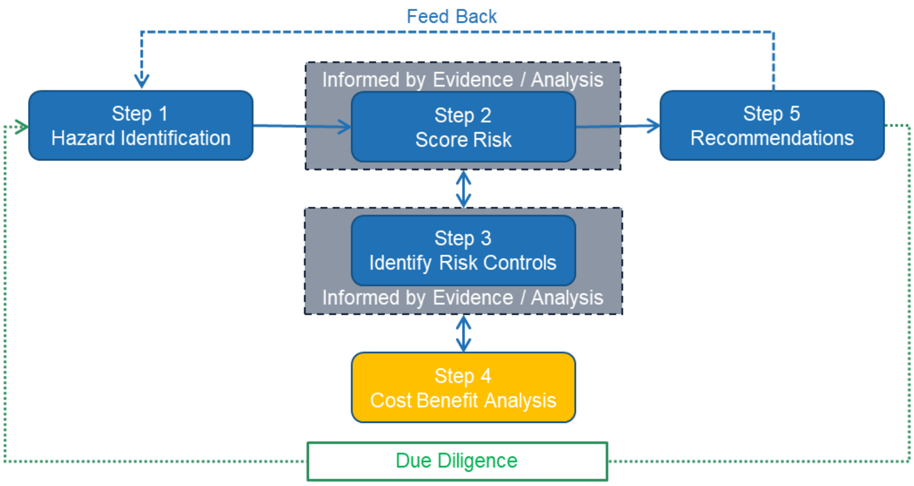

Figure 30: Formal Safety Assessment Process

Within the NRA, the following definitions apply:

- **Hazard** – an unwanted event resulting in adverse consequences.
- **Likelihood** – a determination of how likely a hazard is to occur.
- **Consequence** – the magnitude of the consequences should a hazard occur.
- **Risk** – a non-dimensional measure of hazard consequence and likelihood.
- **Embedded risk control measures** – a risk control measure that is already in place.
- **Additional risk control measures** – a risk control measure that is put in place specifically for the project scheme under consideration.
- **Baseline Assessment of Navigation Risk** – an assessment of hazard risk prior to the proposed operation being in place (this is considered to be the Port Authority's existing NRA. For ABP ports, this is captured within navigation risk assessment software, MarNIS, as was used in the Solent Gateway NRA and the Able NRA. The Port of Immingham's existing NRA has not been provided and has therefore not been used in this NRA).

- **Inherent Assessment of Navigation Risk** – an assessment of hazard risk with the proposed operation occurring including existing ("Embedded") risk control or mitigation measures.
- **Residual Assessment of Navigation Risk** – an assessment of hazard risk with the proposed operation occurring including existing ("Embedded") risk control or mitigation measures, and "additional" project / risk control or mitigation measures.

5.2 Risk Assessment Methodology

NRA's of new developments in existing ports benefit from utilising the definitions contained within the Port's current baseline NRA. This approach allows the findings of further NRAs to be easily compared to the ports existing risk profile and to allow newly identified risks to be seamlessly integrated back into the Port's NRA, where necessary. The Solent Gateway NRA was prepared in this way by using the ABP Southampton baseline NRA (as recorded in MarNIS); and, comparably, the Able NRA has been prepared in agreement with ABP Humber (although not specifically referencing ABP Humber's MarNIS system). Since ABP Humber's baseline NRA and MarNIS information are currently unavailable, this NRA has been prepared using the definitions of likelihood, consequence, risk matrix and acceptability/tolerability as previously adopted in these other NRAs. This is further explained in each subsection below.

The risk assessment methodology requires that marine hazards are identified and assessed in relation to hazard likelihood and hazard consequence to generate a hazard risk score:

$$Navigation\ Risk = likelihood\ of\ hazard\ occurrence\ \times\ consequence\ of\ hazard\ occurrence$$

5.2.1 Hazard Likelihood

In order to determine hazard likelihood, the assessment uses a likelihood classification table to allocate likelihood scores to hazards – see **Table 13**.

The likelihood categorisation used in the ABPmer NRA did not provide any quantitative upper or lower bounds to allow objective judgement for the likelihood of occurrence of a hazard. Therefore, the Able NRA, having been previously prepared with agreement by ABP Humber, has been adopted in this NRA.

Table 13: Hazard Likelihood Classifications.

Likelihood Score	Descriptor	Definition
1	Remote	An event that could be expected to occur less than once > 1, 000 years.
2	Unlikely	An event that could be expected to occur once in 1,000 years.
3	Possible	An event that could be expected to occur once in 100 years.
4	Likely	An event that could be expected to occur once in 10 years.
5	Frequent	An event that could be expected to occur yearly

5.2.2 Hazard Consequence

Hazard consequence classifications are as shown in **Table 14** and relate in board terms to hazard outcome to four categories: People, Property, Environment and Port business. These four categories align with the four categories recommended by the PMSC and its GtGP risk assessment process.

The consequence categorisation used in this NRA is the same as the MarNIS consequence categorisation provided by ABP Southampton and used in the Solent Gateway NRA. This is also the same as the consequence categorisation sued in the ABPmer NRA and is therefore assumed to be in alignment with the ABP Humber MarNIS.

Table 14: Hazard Consequence Classifications.

Consequence Score	People	Property	Environment	Port business
0 - Negligible	No injury	Negligible £0 - £10,000	None No incident - or a potential incident/near miss	None
1 - Minor	Minor injury(s)	Minor £10,000 - £750,000	No Measurable Impact An incident or event occurred, but no discernible environmental impact. Tier 1 but no pollution control measures needed.	Minor Little local publicity. Minor damage to reputation. Minor loss of revenue, £0- £750,000.
2 - Moderate	Serious injury(s) MAIB/RIDDOR reportable injury.	Moderate £750,000 - £4 million	Minor An incident that results in pollution with limited/local impact. Tier 1, Harbour Authority pollution controls measures deployed.	Moderate Negative local publicity. Moderate damage to reputation. Moderate loss of revenue, £750,000 - £4m.
3 - Serious	Single fatality	Serious £4 million - £8 million	Significant Has the potential to cause significant damage and impact. Tier 2, pollution control measures from external organisations required.	Serious Negative national publicity. Serious damage to reputation. Serious loss of revenue, £4m - £8m.
4 - Major	Multiple fatalities	Major More than £8 million	Major Has the potential to cause catastrophic and/or widespread damage. Tier 3, requires major external assistance.	Major Negative national and international publicity. Major damage to reputation. Major loss of revenue, more than £8 million.

5.2.3 Risk Matrix

A risk matrix is then used to combine the likelihood score and the consequence scores for each hazard to generate an inherent assessment of risk. Based on the evaluation of the impact of the proposed operation, each hazard is scored using the matrix as defined in **Table 15**. Hazard risk scores are assessed separately for the "*most likely*" and the "*worst credible*" outcomes of an individual hazard. In total therefore there are eight scores: 4x hazard scores for "most likely" and 4x hazard scores for "worst credible" (one each for People, Property, Environment and Port business).

Hazard risk scores for each individual hazard consequence are then brought together using a weighted averaging formula to give a single overall risk score. The averaging formula, which generates a single risk score on a scale of 1 to 10 is generated by taking the average of:

- The highest "Mostly Likely" risk score;
- Average of the "Mostly Likely" risk scores;
- The highest "Worst Credible" risk score; and
- Average of the "Worst Credible" risk scores.

The Risk Matrix used in this NRA is the same as the MarNIS risk score matrix provided by ABP Southampton and used in the Solent Gateway NRA. This is also the same as the risk score matrix used in the Able NRA in agreement with ABP Humber. The ABPmer NRA did not use a structured risk calculation and used a substantially different matrix to the MarNIS risk matrix, therefore, it has not been used in this NRA.

Table 15: MarNIS Risk Score Matrix.

Risk Matrix							
Frequency	Frequent	5	0	6	8	9	10
	Likely	4	0	3	6	7	8
	Possible	3	0	2	4	6	7
	Unlikely	2	0	2	3	5	6
	Remote	1	0	1	3	4	5
			0	1	2	3	4
			Negligible	Minor	Moderate	Serious	Major
			Consequence				

5.2.4 Acceptability / Tolerability

Hazards with risk scored at "Negligible" or "Low" would be deemed acceptable, which puts the acceptability threshold at risk scores lower than 3.0 (see **Table 16** for risk score classifications). Where hazards are scored between 3 to 5.99 (Medium) then additional control measures are necessary unless their cost is disproportionate to their benefit – e.g. following the As Low As Reasonable Practicable (ALARP) principle. Where hazard risk scores are greater than 6.0 ("Significant" or "High" risk), risk controls must be identified and allocated to hazards to reduce risk. Hazard risk scores are then recalculated using the same method as above and a residual assessment of risk determined.

The acceptability / tolerability of risk used in this NRA is the same as used in the Solent Gateway NRA provided by ABP Southampton. The Able NRA and its agreed approach with ABP Humber indicates slightly different risk scores separating the risk levels. However, the score threshold between "Medium" and "Significant" risk remains the same (being the threshold between "Intolerable" and "Tolerable if ALARP"), which is therefore assumed to remain equally appropriate between ABP Humber and ABP Southampton.

Table 16: Hazard risk score classifications.

Risk Level	Risk Score	Tolerability
Negligible	0 - 0.99	Acceptable
Low	1 - 2.99	Acceptable
Medium	3 - 5.99	Tolerable if ALARP
Significant	6 - 8.99	Intolerable

Risk Level	Risk Score	Tolerability
High	9 - 10	Intolerable

5.3 Stakeholder Consultation

Stakeholder consultation and feedback used in this NRA has been obtained from various sources, including:

- Hazard Workshop with the Risk Assessment Team and DFDS.
- Various regular meetings and discussions with the Risk Assessment Team and DFDS.
- Relevant Representations from various parties in response to the development application.
- Information from previous Hazard Workshops undertaken by ABP.

The stakeholder consultation was used to gather local feedback, contributions and obtained consensus from the key local expertise of those listed in **Table 17**. The consultation was focused on navigational safety, hazard identification, review of embedded risk controls, inherent risk assessment (scoring), additional mitigation measures and residual risk assessment (scoring).

Table 17: Summary of Consultees

Representative	Name	Occupation
Bishop Marine Consulting	Graham Bishop	Marine Expert / Port Management Expert
Jonathan Bush (Independent consultant)	Jonathan Bush	(Captain) Marine Expert / Local Pilotage Expert
DFDS	Jesper Hartvig Nielsen	(Captain) Head of Fleet Management
DFDS	Kim Carlsson	(Captain) Current DFDS Ro-Ro Captain
DFDS	Thomas Stephensen	(Captain) Current DFDS Ro-Ro Captain
NASH Maritime	Brocque Preece	Principal Consultant
NASH Maritime	Claire Conning	Maritime Consultant
NASH Maritime	Jamie Holmes	Director

As described in **Section 1.4.1**, two ABP-led Hazard Workshops and two other consultation windows were held with external stakeholders during the development of the ABPmer NRA. DFDS stakeholders engaged with for this NRA were also involved in the previous stakeholder hazard workshops and additional information gathered from these has been taken into consideration when undertaking this NRA.

6 Hazard Identification

The hazard identification approach adopted was a systematic and structured approach based on the study team and consultation to reach a consensus on appropriate hazards, and appropriate level of granularity of those hazards, to carried forward to the risk assessment.

The process involved the following stages:

- **Stage 1** – Review data gathered during the data gathering phase, including historical data, vessel traffic analysis, IERRT project definition and current and future vessel traffic scenarios.
- **Stage 2** – Identify appropriate Hazard Types that may be present due to the IERRT development, the IERRT Ro-Ro / Ro-Pax vessels or changes to the waterway operations due to the IERRT project.

- **Stage 3** – Identify appropriate Vessel Types as receptors for collision hazards to provide an appropriate level of detail within the risk assessment, such as by grouping vessels with different likelihood or consequence, in order to allow identification of key hazards and key risk areas during the risk assessment.
- **Stage 4** – Identify appropriate Contact Scenarios for berth, structure or moored vessel related contact hazards to provide an appropriate level of detail within of risk assessment, such as specific berths having different likelihood or consequences.
- **Stage 5** – Review all permutations of potential hazard types with various vessel type receptors and/or various contact scenarios and determine viability and credibility of each individual hazard scenario in consultation with local navigation experts. Viable hazards to be carried forward into risk assessment.

The sections below describe the outcomes of the structured hazard identification process.

6.1 Hazard Types

A review of historical incidents, data and project information was used to define Hazard Types. Six hazard types were identified and are summarised and defined in **Table 18.**

Table 18: Identified Hazards

Hazard Type ID #	Hazard Types	Definition
1	Collision	Collision between two vessels underway (also includes striking of an anchored vessel).
2	Contact (Allision)	Vessel makes contact with Fixed or Floating Object (FFO) (e.g. quay, pile, shoreline, buoy or moored vessel).
3	Breakaway	Vessel breaks away from securely moored position, may result in damage to non-vessel objects.
4	Grounding	Vessel makes contact with shore or river bed
5	Fire	The uncontrolled process of combustion characterised by heat or smoke or flame or any combination of these aboard a vessel when alongside IERRT.
6	Foundering / Swamping	Loss of stability, buoyancy or water tight integrity (e.g. may be caused by severe adverse weather, mechanical failure or water on deck) leading to capsize and/or sinking.

6.2 Vessel Types

A review of the Vessel Traffic Analysis was used to define Vessel Types. The following vessel categories were identified as having defined difference in likelihood or consequence and therefore providing an appropriate level of detail within the risk assessment. Seven Vessel Types were identified and are summarised and defined in **Table 19.**

Table 19: Vessel Categories

Vessel ID #	Vessel Types	Description
1	Coastal Tanker	Smaller product tankers (generally 80m – 100m in length) which trade predominantly to UK and near European ports distributing refined oil

Vessel ID #	Vessel Types	Description
		products and fuels. Typical berths: Immingham Oil Terminal (IOT) Finger Pier berths 6 or 8.
2	Bunker Barge	Estuarial barges undertaking distribution of refined products to terminals further inland and direct delivery of bunker fuels to ships in Hull, Immingham and Grimsby. Typical berths: Immingham Oil Terminal (IOT) Finger Pier berths 7 and 9.
3	Cargo	Commercial vessels carrying dry cargo such as containers, bulk cargo, automobiles or trailers between two ports, including DFDS vessels. Example typical terminals: Immingham Dock, Immingham Bulk Terminal (IBT), Humber International Terminal (HIT) and Immingham Outer Harbour (IOH).
4	Tanker	Larger commercial liquid bulk carriers generally (generally 100m in length) carrying cargo such as gas as liquid, oil or chemicals between two ports. Example typical terminals: Immingham Oil Terminal (IOT) river berths, Immingham Gas Terminal (IGT), South Killingholme Oil Jetty, Immingham Eastern Jetty.
5	Tug, Service and Other Small Vessel	Tugs, dredgers, workboats, port service, law enforcement and survey vessels.
6	Passenger	Ro-Pax vessels transiting within the main channel and to / from Immingham Dock.
7	Project Vessel (Passenger / Drivers)	Vessels navigating to and from IERRT. Ro-Pax vessels capable of carrying passengers and/or truck drivers.

6.3 Contact Scenarios

A review of the project location, manoeuvring areas and local existing infrastructure was used to define the Contact Scenarios. The following contact scenarios were identified as having defined difference in likelihood or consequence and therefore providing an appropriate level of detail within the risk assessment. Seven Vessel Types were identified and are summarised and defined in **Table 20.**

Table 20: Contact Hazards

Contact Scenarios	Detail
IOT Trunkway	IOT Trunkway from shore to finger pier and river berths
IOT Finger Pier	IOT Finger Pier including berths 6, 7, 8 and 9 and vessel moored alongside.
IOT River berths	IOT River Berths including berths 1, 2 and 3, mooring dolphins and vessel moored alongside.
IERRT Jetty	IERRT including berths 1, 2 and 3 and vessels moored alongside.
Eastern Jetty	Eastern Jetty berth, Mooring dolphins and vessels moored alongside (including Tanker or Bunker Barge alongside Tanker)

6.4 Hazards Identified

A review of the credibility of each permutation of the above Hazard Types, Vessel Types, Contact Scenarios was used to refine the final hazard list relevant to the introduction of risks or change in the level of risk, brought on by the introduction of the IERRT and associated Ro-Ro / Ro-Pax operations.

There were 27 individual hazards identified which and are summarised in **Table 21**.

Table 21: Final Hazard List

HazID	Hazard Type	Hazard Title
1	Collision	Collision - Project Vessel (Passenger / Driver) ICW Project Vessel (Passenger / Driver)
2	Collision	Collision - Project Vessel (Passenger / Driver) ICW Coastal Tanker
3	Collision	Collision - Project Vessel (Passenger / Driver) ICW Bunker Barge
4	Collision	Collision - Project Vessel (Passenger / Driver) ICW Cargo
5	Collision	Collision - Project Vessel (Passenger / Driver) ICW Tanker
6	Collision	Collision - Project Vessel (Passenger / Driver) ICW Tug, Service and Other Small Vessel
7	Collision	Collision - Project Vessel (Passenger / Driver) ICW Passenger
8	Contact (Allision)	Contact (Allision) - Coastal Tanker with IOT Trunkway
9	Contact (Allision)	Contact (Allision) - Bunker Barge with IOT Trunkway
10	Contact (Allision)	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Trunkway
11	Contact (Allision)	Contact (Allision) - Coastal Tanker with IOT Finger Pier (or moored vessel)
12	Contact (Allision)	Contact (Allision) - Bunker Barge with IOT Finger Pier (or moored vessel)
13	Contact (Allision)	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Finger Pier (or moored vessel)
14	Contact (Allision)	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT River berths (or moored vessel)
15	Contact (Allision)	Contact (Allision) - Coastal Tanker with IERRT Jetty (or moored vessel)
16	Contact (Allision)	Contact (Allision) - Bunker Barge with IERRT Jetty (or moored vessel)
17	Contact (Allision)	Contact (Allision) - Tanker with IERRT Jetty (or moored vessel)
18	Contact (Allision)	Contact (Allision) - Tug, Service and Other Small Vessel with IERRT Jetty (or moored vessel)
19	Contact (Allision)	Contact (Allision) - Project Vessel (Passenger / Driver) with IERRT Jetty (or moored vessel)
20	Contact (Allision)	Contact (Allision) - Project Vessel (Passenger / Driver) with Eastern Jetty (or moored vessel)
21	Breakaway	Breakaway - Coastal Tanker at IOT Finger Pier
22	Breakaway	Breakaway - Bunker Barge at IOT Finger Pier
23	Breakaway	Breakaway - Project Vessel (Passenger / Driver) at IERRT Jetty

HazID	Hazard Type	Hazard Title
24	Breakaway	Breakaway - Tanker at Eastern Jetty
25	Grounding	Grounding - Project Vessel (Passenger / Driver)
26	Fire	Fire - Project Vessel (Passenger / Driver) at IERRT Jetty
27	Foundering / Swamping	Foundering / Swamping - Tug, Service and Other Small Vessel from Project Vessel thrust

7 Inherent Risk Assessment

Navigation hazards shown in **Table 21** above were identified following the hazard identification process described in Section 6. A total of 27 individual navigation hazards were identified and their associated risk was assessed. This section describes the:

- Embedded risk controls
- Inherent risk assessment – assumes all embedded risk controls are in place.
- Hazards identified as Significant.
- Additional risk controls identified to reduce risk where necessary
- Residual risk assessment – assumes all embedded and additional risk controls are in place.

7.1 Embedded Risk Control Measures

Embedded risk controls were discussed at the ABP-led Hazard Workshops. 28 embedded risk controls were identified in this process, as listed in the ABPmer NRA. Whilst some of these embedded mitigation measures seem duplicated (or so similar that they could be grouped), they have all been carried over for use in this NRA. In addition to this, the additional risk control of "Pilotage" was not specifically listed within the ABPmer NRA; however, this is considered to be an existing embedded risk control which has also been included in this NRA. Therefore, there are a total of 29 embedded risk controls applied here and are considered to be included in the inherent risk assessment, as shown in **Table 22**.

Table 22: Embedded Risk Control Measures.

#	Control Name	#	Control Name
1	Towage, available and appropriate	16	Accurate tidal measurements
2	Harbour Authority requirements	17	Availability of latest hydrographic information
3	Vessel Traffic Services	18	Berthing procedures
4	Towage guidelines	19	Arrival/Departure, advance notice of
5	Monitoring of met ocean conditions	20	Byelaws
6	Oil spill contingency plans	21	Communications - traffic broadcast
7	Passage planning	22	Design criteria
8	Adequate berth tendering	23	Hydrographic Survey
9	Aids to navigation, Provision and maintenance of	24	International COLREGs 1972 (as amended)

#	Control Name	#	Control Name
10	Anchors cleared and ready for use	25	Joint emergency drills with VTS and Port staff
11	Communications equipment	26	Mooring analysis
12	Local Port Service	27	Vessel simulation study
13	Port Facility Emergency Plan	28	Weather limits
14	Training of port marine/operations personnel	29	Pilotage
15	Vessel propulsion redundancies		

7.2 Inherent Risk Assessment

The inherent assessment of risk was reviewed (in terms of hazard likelihood and consequence scoring) by the Risk Assessment Team, to score hazards in relation to the IERRT development – a summary table of which is provided in **Table 23**. The results of this NRA are contained in full in the "*Risk Assessment Logs*" which are contained within **Annex A**.

Table 23 below shows the inherent risk assessment summary with hazards ranked in order from highest risk to lowest risk. The assessment identified:

- 4 "*significant*" hazards – classified as *Intolerable*.
    - 3 Contact (Allision) hazards
    - 1 Collision hazard
- 21 "*medium*" hazards – classified as *Tolerable if ALARP*.
- 2 "*low*" hazards – classified as *Acceptable*.

The significant hazards are further described in the following subsections.

Table 23: Inherent Risk per Hazard (sorted by descending inherent risk score)

Haz ID	Scenario Name	Inherent Risk	
		Risk Score	Classification
20	Contact (Allision) - Project Vessel (Passenger / Driver) with Eastern Jetty (or moored vessel)	6.7	Significant
13	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Finger Pier (or moored vessel)	6.4	Significant
10	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Trunkway	6.4	Significant
2	Collision - Project Vessel (Passenger / Driver) ICW Coastal Tanker	6.0	Significant
23	Breakaway - Project Vessel (Passenger / Driver) at IERRT Jetty	5.8	Medium
15	Contact (Allision) - Coastal Tanker with IERRT Jetty (or moored vessel)	5.7	Medium
27	Foundering / Swamping - Tug, Service and Other Small Vessel from Project Vessel thrust	5.6	Medium
3	Collision - Project Vessel (Passenger / Driver) ICW Bunker Barge	5.5	Medium
21	Breakaway - Coastal Tanker at IOT Finger Pier	5.4	Medium
22	Breakaway - Bunker Barge at IOT Finger Pier	5.4	Medium
11	Contact (Allision) - Coastal Tanker with IOT Finger Pier (or moored vessel)	5.3	Medium
12	Contact (Allision) - Bunker Barge with IOT Finger Pier (or moored vessel)	5.3	Medium

Haz ID	Scenario Name	Inherent Risk	
		Risk Score	Classification
16	Contact (Allision) - Bunker Barge with IERRT Jetty (or moored vessel)	5.3	Medium
14	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT River berths (or moored vessel)	4.9	Medium
4	Collision - Project Vessel (Passenger / Driver) ICW Cargo	4.6	Medium
5	Collision - Project Vessel (Passenger / Driver) ICW Tanker	4.4	Medium
19	Contact (Allision) - Project Vessel (Passenger / Driver) with IERRT Jetty (or moored vessel)	4.1	Medium
8	Contact (Allision) - Coastal Tanker with IOT Trunkway	3.9	Medium
9	Contact (Allision) - Bunker Barge with IOT Trunkway	3.9	Medium
24	Breakaway - Tanker at Eastern Jetty	3.9	Medium
17	Contact (Allision) - Tanker with IERRT Jetty (or moored vessel)	3.8	Medium
6	Collision - Project Vessel (Passenger / Driver) ICW Tug, Service and Other Small Vessel	3.8	Medium
7	Collision - Project Vessel (Passenger / Driver) ICW Passenger	3.7	Medium
26	Fire - Project Vessel (Passenger / Driver) at IERRT Jetty	3.7	Medium
1	Collision - Project Vessel (Passenger / Driver) ICW Project Vessel (Passenger / Driver)	3.6	Medium
25	Grounding - Project Vessel (Passenger / Driver)	2.8	Low
18	Contact (Allision) - Tug, Service and Other Small Vessel with IERRT Jetty (or moored vessel)	2.5	Low

7.2.1 Significant / Intolerable hazards

The hazards assessed to be significant / intolerable are detailed in the subsections below. These have been assessed for likelihood and consequences from the Most Likely and Worst Credible scenario as agreed by consensus with the Risk Assessment Team.

When considering likelihood, the scenarios were considered with respect to the potential of IERRT project vessels movements of 2,190 movements per year during operational phase (or 730 berth per berth per year). That is:

- Up to 21,900 vessel movements over 10 years (7,300 movements per berth)
- Up to 109,500 vessel movements over the 50 year lifespan of the IERRT (36,500 movements per berth). Noting also that IERRT information also states that the lifespan of the terminal is intended to be longer than the nominal 50 years.

This was also considered against the historical incident rate for contact (allision) from MAIB records of one in every 3,200 vessel movements (one collision every 9,370 movements, one contact every 3,200 movements, one fire / explosion every 13,900 movements and one mechanical / damage incident every 4,800 movements), coupled with an understanding that actual incident rates, including near-misses, are significantly higher based on the Immingham area MarNIS incident records. The hazard scenarios were then qualitatively assessed by the Risk Assessment Team factoring in the location of the IERRT, the environmental conditions, the future vessel traffic and traffic density, and other relevant factors.

When considering consequence, the scenarios were considered with respect to the Most Likely and Worst Credible outcomes for the hazards groups of People, Property, Environment and Port business. These are outlined in the following paragraphs for each of the significant / intolerable hazards.

7.2.1.1 *Contact (Allision) - Project Vessel with Eastern Jetty (or moored vessel)*

Haz ID	Scenario Name	Risk Score	Classification
20	Contact (Allision) - Project Vessel (Passenger / Driver) with Eastern Jetty (or moored vessel)	6.7	Significant

This hazard considered an allision by the IERRT Ro-Ro / Ro-Pax vessel with either:

- The Eastern Jetty infrastructure.
- A tanker berthed at the Eastern Jetty.
- A bunker barge alongside a tanker berthed at the Eastern Jetty conducting bunker transfers.

The IERRT vessel approaching the IERRT inner berth 2 or 3 could make contact with a tanker moored at the Eastern Jetty. This is most likely result in minor damages to both vessels and due to the size and displacement of the IERRT vessel, combined with the force of the current, could realistically cause a breakaway of the tanker from the berth. In the worst credible scenario, the tanker could be taking on bunker fuel from a bunker barge alongside. The reduced sea room may result in heavy contact with the bunk barge (and tanker and damaging the eastern jetty), causing substantial loss of flammable cargo, loss of chemical products, loss of the barge and barge crew, and possible fire with the IERRT carrying large number of drivers or passengers.

From local expertise, an allision with the Eastern Jetty or moored tanker is understood not to have occurred in recent history and as such the potential baseline likelihood would be considered low. The location of the IERRT terminal, specifically berths 2 and 3 (inner berths) (having 1,460 movements per year) and the potential for prevailing conditions to result in challenging navigational environment, the Most Likely scenario was considered to be Likely (once in 10 years) and Worst Credible to be Unlikely (once in 1000 years).

7.2.1.2 *Contact (Allision) - Project Vessel with IOT Finger Pier (or moored vessel)*

Haz ID	Scenario Name	Risk Score	Classification
13	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Finger Pier (or moored vessel)	6.4	Significant

This hazard considered a allision by the IERRT Ro-Ro / Ro-Pax vessel with either:

- The IOT Finger Pier infrastructure.
- A tanker or bunker barge moored at the IOT Finger Pier.

In similar circumstances as HazID 10 above (IERRT Ro-Ro-/ Ro-Pax allision with the IOT trunkway), the size of the IERRT project vessels and the design of the finger pier not being able to withstand an impact from this size of vessel, combined with the force of the current and/or wind would realistically result in severe or catastrophic loss of the finger pier with significant loss of product in the Humber, and due to the high utilisation of these berths, the potential to cause a product tanker or bunker barge breakaway (and ensuring potential for damage to the IOT trunkway). Due to the proximity of the IOT Finger Pier and the small amount of time available to allow recovery the IERRT project vessel in the event of an incident, the potential for this hazard occurrence is higher.

Most Likely scenario was considered to be Likely (once in 10 years) and Worst Credible to be Unlikely (once in 1000 years).

7.2.1.3 *Contact (Allision) - Project Vessel with IOT Trunkway*

Haz ID	Scenario Name	Risk Score	Classification
10	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Trunkway	6.4	Significant

This hazard considered an allision by the IERRT Ro-Ro / Ro-Pax vessel with the IOT trunkway feeding oil and petroleum products to all river berths and finger pier berths.

The IERRT vessel approaching the IERRT outer berth 1 could lose control (from various causes), moving astern in a strong ebb current with strong winds and contacting the IOT trunkway. The consequences of this scenario are driven by the potential for significant consequences resulting from both the Most Likely and Worst Credible scenarios. Due to the size and displacement of the IERRT project vessel and the trunkway not being designed to withstand heavy impacts, combined with the force of the current and/or wind would realistically result in severe damage or catastrophic loss to the trunkway. It is understood that the pipelines on the trunkway are charged and any rupture of a pipe would result in substantial loss of oil products in the river. The strong current would result in widespread pollution and significant oil spill containment / clean up and the ensuing port or Humber operational downtime. This scenario would also likely result in heavy contact being made with the finger pier as the IERRT project vessel's bow is caught by the current.

Most Likely scenario was considered to be Possible (once in 100 years) and Worst Credible to be Unlikely (once in 1000 years).

7.2.1.4 Collision – Project Vessel in collision with Coastal Tanker

Haz ID	Scenario Name	Risk Score	Classification
2	Collision – Project Vessel (Passenger / Driver) ICW Coastal Tanker	6.0	Significant

This hazard considered a collision between the IERRT Ro-Ro / Ro-Pax vessel and a product tanker.

The IERRT vessels and product tankers using the IOT Finger Pier will use the same navigational space and general approach to access their respective berths. During times where the three regular liner service movements of the IERRT project vessels coincide with the flood and high tide, this would also coincide with the IOT Finger Pier movement restrictions for flood tide only. This is evident in the Vessel Traffic Analysis gate analysis indicating higher tanker movements at over these periods. This would ultimately then result in higher than normal demand for the navigational space during flood tides for the three IERRT berths and up to four IOT Finger Pier berths. An issue with either vessel, an abort or reattempt by either vessel or the elevated time pressures on both vessels may result in an increased potential for close encounters and/or human error. This could then result in collisions being more frequent than previously observed in MAIB incident data. A collision would most likely result in damages to both vessels; however, could result in a heavy contact causing a hull puncture of the product tanker, loss of cargo and loss of vessel with crew fatalities.

Most Likely scenario was considered to be Likely (once in 10 years) and Worst Credible to be Unlikely (once in 1000 years).

8 Additional Risk Controls

Based on the hazards which were assessed and subsequently classified as either Medium or Significant, additional risk controls (RCs) were identified – RC01 to RC06. These are further described and defined in the following subsections.

- RC01: Berthing / unberthing criteria
- RC02: Standby tug provision
- RC03: Deconfliction plan
- RC04: Mooring equipment and infrastructure

- RC05: Impact protection for IOT Trunkway
- RC06: Moving finger pier

Additional risk controls were identified in the ABPmer NRA through their previous hazard workshops and these have been carried through to this NRA where it had been deemed appropriate. It is noted that some additional risk controls identified within the ABPmer NRA were considered to be so similar to other risk controls identified that these have been combined; or they were risk controls that should already be in place during the project development and implementation that these have instead been considered as embedded risk controls.

8.1 RC01: Berthing / unberthing criteria

Detailed guidance and requirements relating to specific weather parameters, tidal limitations / weather restrictions and appropriate tug provision for each IERRT berth. This would define safe operating window for each berth for berthing, unberthing and leave berth limits.

This risk control would apply environmental condition limitations that are commensurate with the inherently higher risk of the IERRT project due to its vessel sizes and terminal location in close proximity to other sensitive infrastructure. These may include specific limits for each IERRT berth, reflecting the relative complexity of the berthing manoeuvres and specific hazards at each. These berthing / unberthing criteria may include:

- Maximum wind conditions per wind direction.
- Maximum wind speed in combination with peak current in ebb and flood.
- Maximum conditions for adverse visibility or during the hours of darkness (this risk control assumes that appropriate aids to navigation are already implemented as an expected embedded risk control).

The effectiveness of this risk control is highly dependent on the actual limitation thresholds placed on the berthing and unberthing manoeuvrers.

This risk control combines various ABPmer identified risk controls.

8.2 RC02: Standby tug provision

Provision of an additional tug stationed on immediate standby on-site to assist in the event of an emergency, mechanical failure, towline parting, breakaway from berth, manoeuvring difficulties or fire onboard the IERRT project vessels. The primary intention of this additional risk control is to reduce the potential consequences of emergency situations during IERRT project vessels and product tankers using the IOT Finger Pier.

This assumes the standby tug is over and above the defined normal tug requirements for IERRT movements which is already an embedded risk control and any other weather-related berthing / unberthing criteria covered under RC01. This risk control extends to a standby tug whilst IERRT vessels are moored in the event of adverse weather forecasts or other situations with elevated risk, such as manoeuvrers near the Eastern Jetty tankers handing dangerous cargo. It is assumed the Eastern Jetty tug barge will be removed as per the simulations undertaken which show free vessel and tug usage in the vicinity of the existing tug berth. However, if the current East Jetty tug berth is not removed then it is assumed this standby tug would remain on standby for the Eastern Jetty tankers during movements of the IERRT project vessels. A larger standby tug provision may also be extended to vessels operating to and from the IOT Finger Pier due to increased complexity of vessel berthing from reduced manoeuvring space, reduced margin for error and varying wind and tidal currents.

Due to the close proximity of the IERRT to critical infrastructure, there are practical safety limitations that may limit the effectiveness of this risk control. For example, active assistance by a standby tug may not be possible if placing the standby tug or its crew in danger (such as a crush zone or where susceptible to girting).

This risk control combines various ABPmer identified risk controls.

8.3 RC03: Deconfliction plan

A defined and regulated extension of the current Humber VTS and Port of Immingham management of vessel movements that is specific to IERRT project vessel movements. The primary intention of this additional risk control is to reduce the potential for collisions. The deconfliction plan may include:

- Greater restrictions on permitted vessel movements during IERRT project arrival and departures. Including restrictions on nearby vessel movements until the IERRT vessel is safely moored alongside (to reduce aborted minoveries causing increased collision risk).
- Restrictions to alongside bunkering operations at the Eastern Jetty during IERRT project vessel movements.
- Prioritisation to tidally restricted vessel movements at the IOT Finger Pier to ensure adequate time for manoeuvrers on and off the IOT finger Pier during flood tides.
- Allocation of additional or dedicated stemming areas for displaced third-party vessels currently using the Eastern Jetty stemming area whilst awaiting lock access or berths at the IOT Finger Pier.
- Extended duration of restrictions for third-party vessel movements during IERRT project vessel approach and departure due to potential for aborted manoeuvrers requiring longer use of the navigable waters.

8.4 RC04: Mooring equipment and infrastructure

Mooring monitoring equipment and larger capacity mooring infrastructure (including mooring hooks) to facilitate enhanced mooring capability over and above the base design, such as mooring hooks with load monitoring, additional storm bollards and pre-defined mooring plans specific to each visiting vessel. The primary intention of this additional risk control is the reduce the potential for IERRT project vessel breakaway.

The effectiveness of this risk control is limited by the effectiveness of the moored vessel mooring lines to effectively secure the moored vessel (capacity, conditions, winch brake capacity and available number of mooring points of the vessel).

This risk control combines various ABPmer identified risk controls.

8.5 RC05: Impact protection for IOT Trunkway

Substantially engineered impact protection for the IOT trunkway to mitigate consequences resulting from contact (allision). This risk control provides protection of the IOT trunkway for hazards involving the increase in risk from IERRT project vessel contacts, and situations that may result in a breakaway of product tankers at the IOT Finger Pier (including both direct contact by IERRT project vessels or thrust wash effects on vessels moored at the IOT Finger Pier).

The effectiveness of this risk control is dependent on the design of the impact protection and the speed and size of vessel this would arrest. However, this risk control assumes that the impact protection would be designed to withstand the largest IERRT project vessel at relatively high speed (noting the speed of the spring ebb tide can reach over 4 knots). This risk control assumes the impact protection is as per the indicative impact protection advised in the ABPmer NRA and within the IERRT outline documentation.

This risk control is carried over from the ABPmer identified risk controls.

8.6 RC06: Moving finger pier

The relocation of the finger pier berths from their current location in close proximity to proposed IERRT. Full relocation of the IOT Finger Pier to the other side of the IOT trunkway is assumed to not be an option due to the IGETT proposed development by ABP. The relocation of the finger pier is therefore assumed only feasible as either:

a) Relocation of the higher risk inner berths 8 and 9 of the IOT Finger Pier to a location closer to the IOT River Berths; but leaving the finger pier infrastructure and outer berths 6 and 7 in place. This assumes that the fendering infrastructure for the inner berths 8 and 9 would remain in place and maintained to allow partial protection of the finger pier infrastructure from minor impacts. However, this would increase the available manoeuvring room for IERRT project vessels, increase the room for error, and remove the key hazard of contact with a moored product tanker (or bunker barge) and its subsequent breakaway.

b) Complete relocation of the entire finger pier towards the IOT river berths. This would reduce the risk associated with impact to the finger pier (or moored vessels); however, would also expose a greater portion of the IOT trunkway which would require extended impact protection.

For the purposes of this risk assessment, this additional risk control assumes that "a) relocation of the higher risk berths 8 and 9" is elected so as to reduce the key risk associated with contact with a moored product tanker or bunker barge at these berths, which could feasibly result in a breakaway and the potential additional IOT trunkway impact risk. However, the potential for contact with the IOT Finger Pier infrastructure remains.

This risk control is carried over from the ABPmer identified risk controls and further defined (with assumptions).

9 Residual Risk Assessment

The inherent risk assessment was then re-scored with the additional risk controls in place (in terms of hazard likelihood and consequence scoring) by the Risk Assessment Team – a summary table of which is provided in **Table 24**. The results of this NRA are contained in full in the "*Risk Assessment Logs*" which are contained within **Annex B**.

Table 24 below shows the inherent risk assessment summary with hazards ranked in order from highest risk to lowest residual risk, alongside the previous scoring of inherent risk. The assessment identified:

- 0 "*significant*" hazards – classified as *Intolerable*.
- 23 "*medium*" hazards – classified as *Tolerable if ALARP*.
- 4 "*low*" hazards – classified as *Acceptable*.

The hazards previously defined as significant hazards in the inherent risk assessment are further described in the following subsections.

Table 24: Residual Risk per Hazard (sorted by descending residual risk score).

Haz ID	Scenario Name	Inherent Risk		Applicable Additional Risk Controls	Residual Risk	
		Risk Score	Classification		Risk Score	Classification
20	Contact (Allision) - Project Vessel (Passenger / Driver) with Eastern Jetty (or moored vessel)	6.7	Significant	RC01 RC02 RC03	5.6	Medium
13	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Finger Pier (or moored vessel)	6.4	Significant	RC01 RC02 RC06	5.4	Medium

Haz ID	Scenario Name	Inherent Risk		Applicable Additional Risk Controls	Residual Risk	
		Risk Score	Classification		Risk Score	Classification
14	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT River berths (or moored vessel)	4.9	Medium	RC01 RC03	4.9	Medium
2	Collision - Project Vessel (Passenger / Driver) ICW Coastal Tanker	6.0	Significant	RC03 RC06	4.5	Medium
3	Collision - Project Vessel (Passenger / Driver) ICW Bunker Barge	5.5	Medium	RC03	4.5	Medium
11	Contact (Allision) - Coastal Tanker with IOT Finger Pier (or moored vessel)	5.3	Medium	RC06	4.4	Medium
12	Contact (Allision) - Bunker Barge with IOT Finger Pier (or moored vessel)	5.3	Medium	RC02 RC06	4.4	Medium
21	Breakaway - Coastal Tanker at IOT Finger Pier	5.4	Medium	RC01 RC06	3.9	Medium
22	Breakaway - Bunker Barge at IOT Finger Pier	5.4	Medium	RC01 RC06	3.9	Medium
5	Collision - Project Vessel (Passenger / Driver) ICW Tanker	4.4	Medium	RC03	3.9	Medium
24	Breakaway - Tanker at Eastern Jetty	3.9	Medium	-	3.9	Medium
15	Contact (Allision) - Coastal Tanker with IERRT Jetty (or moored vessel)	5.7	Medium	RC06	3.8	Medium
17	Contact (Allision) - Tanker with IERRT Jetty (or moored vessel)	3.8	Medium	-	3.8	Medium
6	Collision - Project Vessel (Passenger / Driver) ICW Tug, Service and Other Small Vessel	3.8	Medium	RC03	3.8	Medium
4	Collision - Project Vessel (Passenger / Driver) ICW Cargo	4.6	Medium	RC03	3.7	Medium
7	Collision - Project Vessel (Passenger / Driver) ICW Passenger	3.7	Medium	RC03	3.7	Medium
1	Collision - Project Vessel (Passenger / Driver) ICW Project Vessel (Passenger / Driver)	3.6	Medium	RC03	3.6	Medium
27	Foundering / Swamping - Tug, Service and Other Small Vessel from Project Vessel thrust	5.6	Medium	RC01 RC06	3.6	Medium
26	Fire - Project Vessel (Passenger / Driver) at IERRT Jetty	3.7	Medium	RC02	3.6	Medium
16	Contact (Allision) - Bunker Barge with IERRT Jetty (or moored vessel)	5.3	Medium	RC06	3.4	Medium
10	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Trunkway	6.4	Significant	RC01 RC02 RC05	3.3	Medium
23	Breakaway - Project Vessel (Passenger / Driver) at IERRT Jetty	5.8	Medium	RC01 RC02 RC04 RC05 RC06	3.3	Medium
19	Contact (Allision) - Project Vessel (Passenger / Driver) with IERRT Jetty (or moored vessel)	4.1	Medium	RC01 RC02	3.2	Medium
9	Contact (Allision) - Bunker Barge with IOT Trunkway	3.9	Medium	RC05 RC06	2.8	Low
8	Contact (Allision) - Coastal Tanker with IOT Trunkway	3.9	Medium	RC05 RC06	2.8	Low
25	Grounding - Project Vessel (Passenger / Driver)	2.8	Low	RC01 RC02 RC03	2.8	Low
18	Contact (Allision) - Tug, Service and Other Small Vessel with IERRT Jetty (or moored vessel)	2.5	Low	-	2.5	Low

9.1 Previous Significant / Intolerable hazards

9.1.1.1 Contact (Allision) - Project Vessel with Eastern Jetty (or moored vessel)

Haz ID	Scenario Name	Inherent Risk		RCs	Residual Risk	
		Score	Classification		Score	Classification
20	Contact (Allision) - Project Vessel (Passenger / Driver) with Eastern Jetty (or moored vessel)	6.7	Significant	RC01 RC02 RC03	5.6	Medium

This was the highest ranked hazard in the inherent risk assessment and remains the highest risk in the residual risk assessment.

Additional risk controls applicable:

- RC01 Berthing / unberthing criteria
- RC02 Standby tug provision
- RC03 Deconfliction plan

These risk controls would limit the berthing and unberthing manoeuvres to remain within safer operating windows, particularly at the IERRT inner berths 2 and 3 and the provision of a standby tug in the event of failure. This primarily results in lower likelihood which has been reduced. These could potentially result in reduced consequences; however, due to the proximity of the Eastern Jetty to the manoeuvring space for berths 2 and 3, this was not deemed sufficient to reduce the consequence scores as the effect of the risk controls may not be immediate enough to reduce or prevent the incident. The condition plan could be applied to restrictions in Eastern Jetty tanker bunkering or bunker barge being alongside which reduces the worst credible outcome, but not the consequence scores.

Most Likely scenario was reduced from Likely (once in 10 years) to Possible (once in 100 years) and Worst Credible was reduced from Unlikely (once in 1000 years) to Remove (once in more than 1000 years).

9.1.1.2 Contact (Allision) - Project Vessel with IOT Finger Pier (or moored vessel)

Haz ID	Scenario Name	Inherent Risk		RCs	Residual Risk	
		Score	Classification		Score	Classification
13	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Finger Pier (or moored vessel)	6.4	Significant	RC01 RC02 RC06	5.4	Medium

This was the equal second highest ranked hazard in the inherent risk assessment and remains the second highest risk in the residual risk assessment.

Additional risk controls applicable:

- RC01 Berthing / unberthing criteria
- RC02 Standby tug provision
- RC06 Moving finger pier

These risk controls would limit the berthing and unberthing manoeuvres to remain within safer operating windows, particularly at the IERRT outer berth 1 due to its proximity to the IOT Finger Pier inner berths (8 and 9), and the provision of a standby tug in the event of failure within the manoeuvring space. This primarily results in lower likelihood which has been reduced. The inherent consequences were previously associated with contact (allision) with the moored product tanker or bunker barge. With these IOT Finger Pier berths relocated the scenario would be altered to contact (allision) with the IOT Finger Pier infrastructure and not a moored vessel.

However, as there is now greater margin for error and greater time allowed for the standby tug to actively prevent the incident, the resulting consequences of a large IERRT project vessel contacting the IOT Finger Pier infrastructure were agreed to remain similar to the inherent risk of contact with a moored vessel.

Most Likely scenario was reduced from Likely (once in 10 years) to Possible (once in 100 years) and Worst Credible was reduced from Unlikely (once in 1000 years) to Remove (once in more than 1000 years).

9.1.1.3 Contact (Allision) - Project Vessel with IOT Trunkway

Haz ID	Scenario Name	Inherent Risk		RCs	Residual Risk	
		Score	Classification		Score	Classification
10	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Trunkway	6.4	Significant	RC01 RC02 RC05	3.3	Medium

This was the equal second highest ranked hazard in the inherent risk assessment and reduced to the 21st (of 27) highest risk in the residual risk assessment.

Additional risk controls applicable:

- RC01 Berthing / unberthing criteria
- RC05 Impact protection for IOT trunkway

Impact protection for IOT trunkway has a substantial capacity for risk reduction. As described in Section 8.5, this assumes the impact protection is appropriately deigned to withstand high energy impacts from maximum sized vessels. This risk control therefore assumes that contact with the IOT trunkway would not result in catastrophic loss of the trunkway, ruptured trunkway pipelines, etc and as a result this alters the scenarios to result in contact with the trunkway impact protection. This risk was then scored on this basis which reduced the consequences with frequency reductions from berthing / unberthing criteria.

Most Likely scenario was reduced from Possible (once in 100 years) to Unlikely (once in 1000 years) and Worst Credible was reduced from Unlikely (once in 1000 years) to Remove (once in more than 1000 years).

Consequences were heavily reduced throughout all consequence categories on both Most Likely and Worst Credible.

9.1.1.4 Collision - Project Vessel in collision with Coastal Tanker

Haz ID	Scenario Name	Inherent Risk		RCs	Residual Risk	
		Score	Classification		Score	Classification
2	Collision - Project Vessel (Passenger / Driver) ICW Coastal Tanker	6.0	Significant	RC03 RC06	4.5	Medium

This was the fourth highest ranked hazard in the inherent risk assessment and remains as the fourth highest risk in the residual risk assessment.

Additional risk controls applicable:

- RC03 Deconfliction plan
- RC06 Moving finger pier

The deconfliction plan was agreed to be effective in reducing the potential for the IERRT project vessels and product tankers visiting the IOT finger berths operating on the same tidal window with competing priorities. Additionally, moving the finger pier berths were also considered to contribute to the reduction in this risk as this would alter the movements of some of the product tankers further from the IERRT and could increase the tidal window permitted to move vessels on and off the relocated berths – therefore, marginally reducing the demand on high water or flood tide movements. It was agreed that neither risk control would result in a reduction of the consequences in the event of a collision, although both risk controls were agreed to reduce the hazard likelihood. The risk control of berthing / unberthing criteria was also considered, but could potentially restrict IERRT project vessel movements to a narrower operational window which was considered to negate potential benefits of this risk control.

Most Likely scenario was reduced from Likely (once in 10 years) to Possible (once in 100 years) and Worst Credible was reduced from Unlikely (once in 1000 years) to Remove (once in more than 1000 years).

10 Conclusions and Recommendations

10.1 Conclusions

The navigational risk introduced by the proposed Immingham Eastern Ro-Ro Terminal (IERRT) has been independently assessed following navigational safety concerns raised about the terminal and it's intended operations. This navigational risk assessment was undertaken by a core team of maritime risk assessment professionals, local expertise and port operations subject matter experts. The methodology employed by this navigational risk assessment used the Port Marine Safety Code (PMSC) requirements and it's associated Guide to Good Practice of Port Marine Operations (GtGP) recommendations which is consistent with previous risk assessments undertaken in agreement with ABP Southampton (the Solent Gateway NRA) and ABP Humber (the Able Marine Energy Park NRA)

The focus of the risk assessment was navigational safety of the operational phase of the terminal. The construction and simultaneous construction + operation of the terminal presents other specific risks not assessed here; however, by assessing the inherent operational phase risk only, an informed judgement on the through-life risk can be obtained, together with appropriate risk controls.

10.2 Navigation baseline and future baseline summary of conclusions:

The below summary outlines key findings from a review of the current port, future operations and the IERRT development.

1. The Humber estuary vessel traffic and Marine Safety Management System (MSMS) is managed by ABP though ABP Humber, Humber Estuary Services (HES) and Local Port Services (LPS) of the Port of Immingham.
2. The Port of Immingham is the UK's largest port by tonnage throughput and whilst ship arrival numbers have reduced over recent years the port's total tonnage throughput has maintained relatively steady indicating fewer but larger vessels are utilising the port.
3. The IERRT development would introduce a regular liner service with three vessels arriving regularly in the morning and departing regularly in the evening, totalling six vessel movements per day or 2,190 Ro-Ro / Ro-Pax vessels per year.
4. The proposed design vessels are of 240m length, 35m beam and 8m draft, making them some of the largest vessels operating within the Port of Immingham. These vessel types (Ro-Ro / Ro-Pax) are noted to have inherently high windage areas and are more susceptible to high wind forces.
5. The location of the IERRT is in close proximity to existing high-risk port infrastructure at the Immingham Oil Terminal (IOT) (oil and oil products) and the Immingham Eastern Jetty (chemical). Due to the liner service, they will operate consistently on all tides, including across tidal windows that other tidally restricted vessels are limited to, such as vessel currently operating at the IOT finger Pier.
6. Future baseline vessel traffic at the Port of Immingham and on the Humber has been assumed to steadily increase over the nominal service life of the IERRT of 50 years, such that by 2072 the port would experience a 66% increase in vessel traffic from a baseline year 2030 (including vessel operations of the IERRT).
7. Baseline risk profile of the navigational waters on the Humber estuary and within the Port of Immingham present challenging navigational wind and tidal current conditions. In summary:
    a. High tidal range with tidal currents up to 3.5 knots ebb and 4.5 knots flood.

   b. Varying near shore current profile due to high tidal range, existing bathymetry and banks, and potential future differences due to the IERRT dredged areas and blockage effects of IERRT vessels, pontoons and infrastructure.

   c. Occurrence of high winds with the predominate direction acting towards existing high-risk port infrastructure of the IOT.

8. Incident records repeatedly cite the following key causes or contributing factors. These factors are likely to remain the same or worsen in the future:

   a. High currents and effect of those currents on the vessel during slow-speed manoeuvring.

   b. Adverse visibility.

   c. Navigating around or in proximity to other vessels.

9. The navigation baseline assessment in this NRA was informed by 2 months of detailed AIS data analysis including vessel traffic analysis, traffic density analysis, gate analysis and swept path analysis. This indicated:

   a. The IOT finger pier is highly utilised and is restricted to flood tide movements. Vessel movements on and off regularly use the navigational space of the proposed IERRT terminal and berthing area.

   b. Vessel numbers are substantially higher over high water and during flood tides passing the Humber estuary and within the Port of Immingham access basin.

   c. Vessels currently hold position and stem the tide in the navigational space proposed for IERRT vessel manoeuvring whilst awaiting clear IOT finger pier berths to become free (also understood whilst awaiting Immingham Dock lock access). For IOT berths, these would be stemming on flood tide.

10.3 Navigation risk assessment summary of conclusions:

The below summary outlines the findings of the risk assessment and the additional risk controls identified.

1. A structured hazard identification process identified 27 individual hazards across 6 hazard categories brought about by the IERRT development mostly related to collision or contact (allision) scenarios.

2. The key contributing factors to risk relate to the primary aspects summarised below. Each factor can be considered in isolation but, importantly, these aspects are not mutually exclusive and could occur in combination.

   a. Challenging navigational environment with very high current flow and high winds.

   b. The close proximity to existing high-risk infrastructure of the IOT and Eastern Jetty.

   c. Low margin for error due to the immediate proximity of the IOT Finger Pier resulting in little time for recovery and limited availability for system redundancy.

   d. Catastrophic consequences resulting from an occurrence of a contact (Allision) hazard with the IOT Finger Pier (including moored vessel), IOT trunkway, and Eastern Jetty (including moored vessel).

   e. Increased risk on IERRT vessels due to up to 100 non-crew passengers as either accompanied freight drivers and/or members of the open public.

f. The potential for future vessel traffic to increase, resulting in increased pressure on marine operators, particularly on the flood tide, and larger potential for disruption in the event of incidents or delays.

g. There is an identified and credible potential for the occurrence of one incident resulting in the materialisation of multiple hazards and the resulting occurrence of multiple catastrophic consequences – for example, mechanical failure of IERRT project vessels in a strong ebb tide causing a contact with a moored tanker at the IOT Finger Pier causing a breakaway, causing the IOT tanker to contact the IOT trunkway, causing rupture of pipelines.

h. Highest collision risk times will be flood tide and high water with greater number of vessel movements and commercial pressure of tidally restricted movements at IOT finger pier berths.

3. The assessment of inherent risk resulted in:

   a. Four "significant" hazards (intolerable).

   b. 21 "medium" hazards (tolerable if ALARP).

   c. Two "low" hazards (acceptable).

4. The assessment of residual risk resulted in:

   a. Zero "significant" hazards (intolerable).

   b. 23 "medium" hazards (tolerable if ALARP).

   c. Four "low" hazards (acceptable).

5. The reduction of the four "significant" (intolerable) hazards resulted from the application of six additional identified risk controls. All identified risk controls were agreed by the Risk Assessment Team to be required in order to reduce the significant risks to ALARP. This was due to limitations in the effectiveness of each independent risk control when applied independently (as discussed in Section 8). The six identified risk controls include:

   a. Risk Control RC01: Berthing / unberthing criteria

   b. Risk Control RC02: Standby tug provision

   c. Risk Control RC03: Deconfliction plan

   d. Risk Control RC04: Mooring equipment and infrastructure

   e. Risk Control RC05: Impact protection for IOT trunkway

   f. Risk Control RC06: Moving finger pier

6. Other higher-risk hazards were already assessed to be "medium" / tolerable if ALARP and whilst a "medium" risk hazard does not automatically indicate that the risk is acceptable, the additional risk controls that had been identified also resulted in a reduction of the risk score of all other higher-scoring "medium" hazards. Therefore these have also be considered ALARP.

10.4 Additional factors for consideration

The factors below are highlighted here as they have the potential to influence the risk profile within the port due to the presence and operation of the IERRT. They therefore need to be taken into account when considering the future risk profile of the IERRT development throughout it's through-life operations and further reinforce the need to implement robust risk controls.

1. Future vessel traffic created by the Able Marine Energy Park development would not conform to regular numbers of vessel per week, month or year, due to the intended use of this terminal as an offshore renewable energy construction or installation hub. Offshore renewable energy installation is typically undertaken in high intensity short duration installation schedules to reduce installation costs which makes future vessel traffic patterns highly variable. This is understood to be evident from the already operational Siemens Gamesa terminal at Hull and operation of both renewable energy terminals utilising the same optimum seasonal weather windows for installation could have a compounding effect on volume of traffic on the Humber passing the Port of Immingham.
2. Commercial pressures and time pressures for vessels restricted by tidal access limitations would see higher volumes of traffic accessing the tidally restricted berths of the IOT Finger Pier and transiting the channel past Immingham more frequently on flood tides and over high water. Liner services operating at the same time each day inevitably also require operation over the restricted tidal windows of other vessels – most critically the tidally restricted bunker barge and coastal tanker movements at the IOT Finger Pier. The IERRT proposed operations would introduce an additional three vessel movements each morning and each evening which could result in narrow windows of operation to achieve all berthing required at this time which would cause increased pressure giving rise to increased risk of human error. In situations where this also aligns with other causation factors highlighted in incident reports – such as high winds, dense fog, or hours of darkness during winter months – the potential for error increases further. The limited room for error, limited redundancy and exposed nature of the vulnerable risk receptors (IOT trunkway infrastructure, berth infrastructure and vessels berthed at the Eastern Jetty, IOT Finger Pier) results in the potential for human error to lead to small incidents which would ultimately result in substantial consequences.
3. Removing the ability to use eastern stemming area on ebb tide and the displacement of these vessels to other areas may result in shifting risk from one area to another or causing greater congestion within the port or channel (noting that other areas within the Port of Immingham may not be possible due to other regular running services by DFDS at the IOH terminal).
4. Global warming effects will increase the intensity and prevalence of severe weather spells which could result in either reduced operational windows (further increasing commercial or time pressure, as discussed above), or more rapid onset of severe weather resulting in operating windows outside of the defined berthing / unberthing criteria. This reinforces the need for adequate redundancy when defining an appropriate operational envelope.
5. It is stated that the IERRT is expected to serve purpose for longer than the nominated 50 year lifespan. The extension of the terminal's operational life also extends the potential exposure time for an incident to occur.
6. Details of the design vessels are not provided within the IERRT project documentation or ABPmer NRA, including displacement, windage areas and propulsion characteristic (engine power, steering and thrusters). This leads to uncertainty about the IERRT's maximum design vessel which could increase the risks, such as if the actual vessel using the terminal have less favourable manoeuvrability characteristics than the vessel's simulated.

10.5 Recommendations

10.5.1 Recommended Risk Controls

The Risk Assessment Team reached consensus and agreement that the credible potential for catastrophic consequences resulting from a single hazard involving the IOT trunkway, vessels at the IOT Finger Pier, and/or chemical tankers at the Eastern Jetty, would not be effectively mitigated by procedural Risk Controls alone. This is due to the limitations of each of the identified risk controls (as explained in Section 8). The residual risk assessment outcome resulted in the requirement for adoption of all identified risk controls. Therefore it is recommended to adopt and further define:

1. Risk Control RC01: Berthing / unberthing criteria
2. Risk Control RC02: Standby tug provision
3. Risk Control RC03: Deconfliction plan
4. Risk Control RC04: Mooring equipment and infrastructure
5. Risk Control RC05: Impact protection for IOT trunkway
6. Risk Control RC06: Moving finger pier *

* Note – this risk control assumed the inner berths 8 and 9 of the IOT Finger Pier would be moved, not the entire finger pier. It is based on the assumptions of the ability of the IOT Finger Pier to withstand a moderate impact from the IERRT project vessel (based on an uncalculated assumption that it would be a reasonable drift speed of an IERRT project vessel from a near-berthed position moving with a strong ebb current).

10.5.2 Recommended Further Assessments

It is also recommended that further assessment is undertaken on:

1. Review of the existing ABP Humber MSMS baseline risk assessment to ensure alignment of the risks identified within this risk assessment is consistent with the risks already identified by ABP Humber.
2. Incorporation of the hazard identification and risk assessment findings of this risk assessment within the ABP Humber baseline risk assessment.
3. Review of potential congestion caused by the vessel movement restrictions required for the six IERRT vessel movements per day, the displacement of vessels from the stemming area or the extended berthing manoeuvres of an aborted approach. This should be considered for nearby berths at the IOT Finger Pier and the Eastern Jetty, and should be separately assessed for congestion / capacity to safely handle all tidally restricted vessel movements during times of peak demand.
4. IERRT construction and simultaneous construction + operation phases should be undertaken using a similar structured, informed, justified and transparent risk assessment methodology.
5. Tug resourcing to ensure there is sufficient number and size of tugs to support additional vessel requirements (including demands from future developments like Able Marine Energy Park). Consideration should also be made for triggers requiring high tug resource demand, for example, adverse weather conditions resulting in additional push up tugs or exceedance of safe berthing limits across multiple terminals.
6. Related to Risk Control RC06 and *note above: Further review and confirmation, in consultation with IOT, on the impact resistance of the IOT Finger Pier and the potential for catastrophic consequences from an IERRT project vessel making contact with IOT Finger Pier infrastructure. This should be based on design impact energy of the berth structure, existing fender capability and existing fendering arrangement to ensure that the assumption applied in this NRA (of the adequacy of RC06 being limited to moving the inner berths 8 and 9 only) is appropriate. In the event that this further review would result in catastrophic consequences of the IOT Finger Pier, this may require additional impact protection.

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Annex A: Hazard Log – Inherent Risk Assessment

HAZ ID	Inherent Risk Rank	Residual Risk Rank	Hazard Name	Hazard Scenario	Inherent Risk Assessment										Inherent Risk Scores by Consequence Category								Inherent Risk Scores	
					Most Likely Scenario					Worst Credible Scenario					Most Likely Risk Score				Worst Credible Risk Score				Calculated Risk Score	Calculated Risk Classifications
					Frequency	People	Property	Environment	Port Business	Frequency	People	Property	Environment	Port Business	People	Property	Environment	Port Business	People	Property	Environment	Port Business		
1	25	17	Collision - Project Vessel (Passenger / Driver) ICW Project Vessel (Passenger / Driver)	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in loss of a vessel.	**2**	2	2	1	1	**1**	4	3	2	3	3.0	3.0	2.0	2.0	5.0	4.0	3.0	4.0	3.63	Medium
2	4	4	Collision - Project Vessel (Passenger / Driver) ICW Coastal Tanker	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in loss of vessel and loss of cargo.	**4**	2	2	2	2	**2**	4	4	4	4	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.00	Significant
3	7	4	Collision - Project Vessel (Passenger / Driver) ICW Bunker Barge	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in loss of vessel and loss of cargo.	**4**	2	2	2	2	**1**	4	4	4	4	6.0	6.0	6.0	6.0	5.0	5.0	5.0	5.0	5.50	Medium
4	14	15	Collision - Project Vessel (Passenger / Driver) ICW Cargo	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in puncture of cargo vessel hull and loss of cargo.	**3**	2	2	1	1	**2**	4	3	3	3	4.0	4.0	2.0	2.0	6.0	5.0	5.0	5.0	4.56	Medium
5	15	10	Collision - Project Vessel (Passenger / Driver) ICW Tanker	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in puncture of tanker hull and loss of cargo.	**2**	2	2	1	1	**2**	4	4	4	4	3.0	3.0	2.0	2.0	6.0	6.0	6.0	6.0	4.38	Medium
6	21	14	Collision - Project Vessel (Passenger / Driver) ICW Tug, Service and Other Small Vessel	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in loss of small craft.	**3**	2	1	1	1	**2**	3	2	2	2	4.0	2.0	2.0	2.0	5.0	3.0	3.0	3.0	3.75	Medium
7	23	15	Collision - Project Vessel (Passenger / Driver) ICW Passenger	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in loss of vessel.	**2**	2	2	1	1	**1**	4	3	2	4	3.0	3.0	2.0	2.0	5.0	4.0	3.0	5.0	3.69	Medium
8	17	24	Contact (Allision) - Coastal Tanker with IOT Trunkway	**Most Likely:** light contact with IOT Trunkway resulting in superficial damage to vessel and trunkway. **Worst Credible:** high impact contact at relative high speed resulting in puncture of tanker hull and rupture of IOT Trunkway pipeline(s).	**2**	2	2	1	2	**1**	3	4	4	4	3.0	3.0	2.0	3.0	4.0	5.0	5.0	5.0	3.88	Medium

HAZ ID	Inherent Risk Rank	Residual Risk Rank	Hazard Name	Hazard Scenario	Inherent Risk Assessment										Inherent Risk Scores by Consequence Category								Inherent Risk Scores	
					Most Likely Scenario					Worst Credible Scenario					Most Likely Risk Score				Worst Credible Risk Score				Calculated Risk Score	Calculated Risk Classifications
					Frequency	People	Property	Environment	Port Business	Frequency	People	Property	Environment	Port Business	People	Property	Environment	Port Business	People	Property	Environment	Port Business		
9	17	24	Contact (Allision) - Bunker Barge with IOT Trunkway	**Most Likely:** light contact with IOT trunkway resulting in superficial damage to vessel and trunkway. **Worst Credible:** high impact contact at relative high speed resulting in puncture of Project Vessel hull and rupture of IOT Trunkway pipeline(s).	**2**	2	2	1	2	**1**	3	4	4	4	3.0	3.0	2.0	3.0	4.0	5.0	5.0	5.0	3.88	Medium
10	2	21	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Trunkway	**Most Likely:** high impact contact resulting rupture of IOT Trunkway pipeline(s). **Worst Credible:** high impact contact at relative high speed resulting in puncture of hull and rupture of IOT Trunkway pipeline(s).	**3**	3	4	4	4	**2**	4	4	4	4	6.0	7.0	7.0	7.0	6.0	6.0	6.0	6.0	6.44	Significant
11	10	6	Contact (Allision) - Coastal Tanker with IOT Finger Pier (or moored vessel)	**Most Likely:** light contact with IOT Finger Pier resulting in superficial damage vessel and Finger Pier infrastructure. **Worst Credible:** high impact contact at relative high speed resulting in puncture of tanker hull, rupture of IOT Finger Pier pipeline(s) and damage to berth infrastructure.	**3**	2	2	1	3	**2**	3	3	4	3	4.0	4.0	2.0	6.0	5.0	5.0	6.0	5.0	5.31	Medium
12	10	6	Contact (Allision) - Bunker Barge with IOT Finger Pier (or moored vessel)	**Most Likely:** light contact with IOT Finger Pier resulting in superficial damage vessel and Finger Pier infrastructure. **Worst Credible:** high impact contact at relative high speed resulting in puncture of tanker hull, rupture of IOT Finger Pier pipeline(s) and damage to berth infrastructure.	**3**	2	2	1	3	**2**	3	3	4	3	4.0	4.0	2.0	6.0	5.0	5.0	6.0	5.0	5.31	Medium
13	2	2	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Finger Pier (or moored vessel)	**Most Likely:** light contact with Coastal tanker / Bunker Barge moored alongside resulting in moderate damage to both vessels, IOT Finger Pier, breakaway of Coastal tanker / Bunker Barge and ruptured loading arm(s). **Worst Credible:** high impact contact with Coastal tanker / Bunker Barge moored alongside resulting in multiple vessel breakaway puncture of tanker / barge hull, rupture of IOT Finger Pier pipeline(s) and significant damage to IOT Finger Peir infrastructure (with extension of breakaway causing impact to IOT trunkway).	**4**	2	3	3	3	**2**	4	4	4	4	6.0	7.0	7.0	7.0	6.0	6.0	6.0	6.0	6.44	Significant
14	13	3	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT River berths (or moored vessel)	**Most Likely:** light contact with tanker moored alongside resulting in moderate damage to both vessels and river berth infrastructure. **Worst Credible:** high impact contact with terminal infrastructure and Tanker moored alongside resulting in ruptured loading arms and river berth pipelines, multiple vessel breakaway and damage to vessels and berth infrastructure. Or, high direct impact contact with Tanker moored alongside resulting in puncture of tanker hull, rupture of river berth pipeline(s) and damage to vessels and berth infrastructure.	**2**	2	3	3	3	**1**	4	4	4	4	3.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.88	Medium

HAZ ID	Inherent Risk Rank	Residual Risk Rank	Hazard Name	Hazard Scenario	Inherent Risk Assessment										Inherent Risk Scores by Consequence Category								Inherent Risk Scores	
					Most Likely Scenario					Worst Credible Scenario					Most Likely Risk Score				Worst Credible Risk Score					
					Frequency	People	Property	Environment	Port Business	Frequency	People	Property	Environment	Port Business	People	Property	Environment	Port Business	People	Property	Environment	Port Business	Calculated Risk Score	Calculated Risk Classifications
15	6	12	Contact (Allision) - Coastal Tanker with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in moderate damage to both vessels. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in puncture of tanker hull and major damage to project vessel and project infrastructure.	**4**	2	2	1	2	**2**	3	4	4	3	6.0	6.0	3.0	6.0	5.0	6.0	6.0	5.0	5.69	Medium
16	10	20	Contact (Allision) - Bunker Barge with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in moderate damage to both vessels. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in puncture of barge hull and damage to project vessel.	**4**	2	2	1	2	**2**	3	3	3	3	6.0	6.0	3.0	6.0	5.0	5.0	5.0	5.0	5.31	Medium
17	20	12	Contact (Allision) - Tanker with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in moderate damage to both vessels and IERRT infrastructure. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in puncture of tanker hull and major damage to project vessel and IERRT infrastructure.	**2**	2	2	1	2	**1**	3	4	4	3	3.0	3.0	2.0	3.0	4.0	5.0	5.0	4.0	3.81	Medium
18	27	27	Contact (Allision) - Tug, Service and Other Small Vessel with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in minor damage to both vessels. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in moderate damage to tug / service vessel.	**3**	1	1	1	1	**2**	2	2	2	2	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	2.50	Low
19	16	23	Contact (Allision) - Project Vessel (Passenger / Driver) with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in minor damage to both vessel or IERRT infrastructure. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in major damage to both vessels and IERRT infrastructure.	**4**	1	1	1	1	**2**	2	4	2	3	3.0	3.0	3.0	3.0	3.0	6.0	3.0	5.0	4.06	Medium
20	1	1	Contact (Allision) - Project Vessel (Passenger / Driver) with Eastern Jetty (or moored vessel)	**Most Likely:** light contact with tanker moored alongside resulting in moderate damage to vessels, breakaway of tanker and ruptured loading arm. **Worst Credible:** high impact contact with tanker moored alongside (or bunkering barge alongside tanker) resulting in puncture of tanker hull or bunker barge hull, rupture of Eastern Jetty pipeline(s), loss of bunker barge moored alongside major and damage to berth infrastructure.	**4**	2	2	4	3	**2**	4	4	4	4	6.0	6.0	8.0	7.0	6.0	6.0	6.0	6.0	6.69	Significant
21	8	8	Breakaway - Coastal Tanker at IOT Finger Pier	**Most Likely:** mooring lines part from wash and current resulting in breakaway from berth, minor loss of cargo from loading arm, vessel engines restarted and vessel secured alongside. **Worst Credible:** mooring lines part from wash and current resulting in breakaway from berth, vessel engines cannot be restarted and contact is made with IOT Trunkway resulting in rupture to IOT trunkway pipeline(s).	**4**	2	2	2	2	**1**	3	4	4	4	6.0	6.0	6.0	6.0	4.0	5.0	5.0	5.0	5.44	Medium

HAZ ID	Inherent Risk Rank	Residual Risk Rank	Hazard Name	Hazard Scenario	Inherent Risk Assessment										Inherent Risk Scores by Consequence Category								Inherent Risk Scores	
					Most Likely Scenario					Worst Credible Scenario					Most Likely Risk Score				Worst Credible Risk Score				Calculated Risk Score	Calculated Risk Classifications
					Frequency	People	Property	Environment	Port Business	Frequency	People	Property	Environment	Port Business	People	Property	Environment	Port Business	People	Property	Environment	Port Business		
22	8	8	Breakaway - Bunker Barge at IOT Finger Pier	**Most Likely:** mooring lines part from wash and current resulting in breakaway from berth, minor loss of cargo from loading arm, vessel engines restarted and vessel secured alongside. **Worst Credible:** mooring lines part from wash and current resulting in breakaway from berth, vessel engines cannot be restarted and contact is made with IOT Trunkway resulting in rupture to IOT trunkway pipeline(s).	**4**	2	2	2	2	**1**	3	4	4	4	6.0	6.0	6.0	6.0	4.0	5.0	5.0	5.0	5.4	Medium
23	5	21	Breakaway - Project Vessel (Passenger / Driver) at IERRT Jetty	**Most Likely:** mooring lines part resulting in breakaway from berth, vessel engines cannot be restarted in time and contact is made with IOT Finger Pier resulting in damage to finger pier, rupture to finger pier pipelines, breakaway of vessel at finger pier. **Worst Credible:** mooring lines part resulting in breakaway from berth, vessel engines cannot be restarted and contact is made with IOT Finger Peir (as above), loss of life on finger pier and further contact with IOT Trunkway resulting in rupture to IOT Trunkway pipeline(s).	**3**	2	4	4	4	**1**	4	4	4	4	4.0	7.0	7.0	7.0	5.0	5.0	5.0	5.0	5.81	Medium
24	17	10	Breakaway - Tanker at Eastern Jetty	**Most Likely:** mooring lines part resulting in breakaway from berth, vessel engines cannot be restarted in sufficient time and light contact with IERRT vessel or IERRT infrastructure. **Worst Credible:** mooring lines part resulting in breakaway from berth, vessel engines cannot be restarted and contact is made with Project Vessel moored alongside IERRT or IERRT infrastructure, Tanker hull ruptured, IERRT vessel breakaway.	**2**	2	2	2	2	**1**	3	3	4	4	3.0	3.0	3.0	3.0	4.0	4.0	5.0	5.0	3.88	Medium
25	26	24	Grounding - Project Vessel (Passenger / Driver)	**Most Likely:** vessel makes light contact with river bed and is able to free, negligible damage. **Worst Credible:** vessel makes contact with river bed and requires assistance to navigate free**,** moderate damage to vessel.	**3**	1	1	1	1	**1**	2	2	2	3	2.0	2.0	2.0	2.0	3.0	3.0	3.0	4.0	2.81	Low
26	23	18	Fire - Project Vessel (Passenger / Driver) at IERRT Jetty	**Most Likely:** fire contained by crew resulting in moderate damage to vessel **Worst Credible:** crew are unable to contain fire resulting to serious damage to vessel and multiple loss of life.	**1**	2	2	1	2	**1**	4	3	3	3	3.0	3.0	1.0	3.0	5.0	4.0	4.0	4.0	3.69	Medium
27	21	18	Foundering / Swamping - Tug, Service and Other Small Vessel from Project Vessel thrust	**Most Likely**: Wash from vessel floods the deck of the tug. Tug has water tight doors closed and remains afloat **Worst Credible:** Wash from vessel floods the deck of the tug. Tug has not water tight doors closed, takes on water, loses stability and sinks.	**4**	1	1	1	1	**2**	3	2	3	2	3.0	3.0	3.0	3.0	5.0	3.0	5.0	3.0	3.75	Medium

Annex B: Hazard Log – Residual Risk Assessment

HAZ ID	Inherent Risk Rank	Residual Risk Rank	Hazard Name	Hazard Scenario	Additional Risk Controls Black = applicable Red = not applicable	Residual Risk Assessment										Residual Risk Scores by Consequence Category								Residual Risk Scores	
						Most Likely Scenario					Worst Credible Scenario					Most Likely Risk Score				Worst Credible Risk Score					
						Frequency	People	Property	Environment	Port Business	Frequency	People	Property	Environment	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business	Calculated Risk Score	Calculated Risk Classifications
1	25	17	Collision - Project Vessel (Passenger / Driver) ICW Project Vessel (Passenger / Driver)	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in loss of a vessel.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	1	1	**1**	4	3	2	3	3.0	3.0	2.0	2.0	5.0	4.0	3.0	4.0	3.63	Medium
2	4	4	Collision - Project Vessel (Passenger / Driver) ICW Coastal Tanker	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in loss of vessel and loss of cargo.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**3**	2	2	2	2	**1**	4	4	4	4	4.0	4.0	4.0	4.0	5.0	5.0	5.0	5.0	4.50	Medium
3	7	4	Collision - Project Vessel (Passenger / Driver) ICW Bunker Barge	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in loss of vessel and loss of cargo.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**3**	2	2	2	2	**1**	4	4	4	4	4.0	4.0	4.0	4.0	5.0	5.0	5.0	5.0	4.50	Medium
4	14	15	Collision - Project Vessel (Passenger / Driver) ICW Cargo	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in puncture of cargo vessel hull and loss of cargo.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	1	1	**1**	4	3	3	3	3.0	3.0	2.0	2.0	5.0	4.0	4.0	4.0	3.69	Medium
5	15	10	Collision - Project Vessel (Passenger / Driver) ICW Tanker	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in puncture of tanker hull and loss of cargo.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	1	1	**1**	4	4	4	4	3.0	3.0	2.0	2.0	5.0	5.0	5.0	5.0	3.88	Medium
6	21	14	Collision - Project Vessel (Passenger / Driver) ICW Tug, Service and Other Small Vessel	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision occurrence at relative high speed resulting in loss of small craft.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**3**	2	1	1	1	**2**	3	2	2	2	4.0	2.0	2.0	2.0	5.0	3.0	3.0	3.0	3.75	Medium
7	23	15	Collision - Project Vessel (Passenger / Driver) ICW Passenger	**Most Likely:** light touch, low speed contact between two project vessels whilst underway. **Worst Credible:** heavy contact collision	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and	**2**	2	2	1	1	**1**	4	3	2	4	3.0	3.0	2.0	2.0	5.0	4.0	3.0	5.0	3.69	Medium

HAZ ID	Inherent Risk Rank	Residual Risk Rank	Hazard Name	Hazard Scenario	Additional Risk Controls Black = applicable Red = not applicable	Residual Risk Assessment										Residual Risk Scores by Consequence Category								Residual Risk Scores	
						Most Likely Scenario					Worst Credible Scenario					Most Likely Risk Score				Worst Credible Risk Score				Calculated Risk Score	Calculated Risk Classifications
						Frequency	People	Property	Environment	Port Business	Frequency	People	Property	Environment	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business		
				occurrence at relative high speed resulting in loss of vessel.	infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier																				
8	17	24	Contact (Allision) - Coastal Tanker with IOT Trunkway	**Most Likely:** light contact with IOT Trunkway resulting in superficial damage to vessel and trunkway. **Worst Credible:** high impact contact at relative high speed resulting in puncture of tanker hull and rupture of IOT Trunkway pipeline(s).	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	1	1	1	**1**	2	2	2	2	3.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	2.81	Low
9	17	24	Contact (Allision) - Bunker Barge with IOT Trunkway	**Most Likely:** light contact with IOT trunkway resulting in superficial damage to vessel and trunkway. **Worst Credible:** high impact contact at relative high speed resulting in puncture of Project Vessel hull and rupture of IOT Trunkway pipeline(s).	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	1	1	1	**1**	2	2	2	2	3.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	2.81	Low
10	2	21	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Trunkway	**Most Likely:** high impact contact resulting rupture of IOT Trunkway pipeline(s). **Worst Credible:** high impact contact at relative high speed resulting in puncture of hull and rupture of IOT Trunkway pipeline(s).	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	1	2	**1**	2	3	2	3	3.0	3.0	2.0	3.0	3.0	4.0	3.0	4.0	3.31	Medium
11	10	6	Contact (Allision) - Coastal Tanker with IOT Finger Pier (or moored vessel)	**Most Likely:** light contact with IOT Finger Pier resulting in superficial damage vessel and Finger Pier infrastructure. **Worst Credible:** high impact contact at relative high speed resulting in puncture of tanker hull, rupture of IOT Finger Pier pipeline(s) and damage to berth infrastructure.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	1	3	**1**	3	3	4	3	3.0	3.0	2.0	5.0	4.0	4.0	5.0	4.0	4.38	Medium
12	10	6	Contact (Allision) - Bunker Barge with IOT Finger Pier (or moored vessel)	**Most Likely:** light contact with IOT Finger Pier resulting in superficial damage vessel and Finger Pier infrastructure. **Worst Credible:** high impact contact at relative high speed resulting in puncture of tanker hull, rupture of IOT Finger Pier pipeline(s) and damage to berth infrastructure.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	1	3	**1**	3	3	4	3	3.0	3.0	2.0	5.0	4.0	4.0	5.0	4.0	4.38	Medium
13	2	2	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT Finger Pier (or moored vessel)	**Most Likely:** light contact with Coastal tanker / Bunker Barge moored alongside resulting in moderate damage to both vessels, IOT Finger Pier, breakaway of Coastal tanker / Bunker Barge and ruptured loading arm(s). **Worst Credible:** high impact contact with Coastal tanker / Bunker Barge moored	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**3**	2	3	3	3	**1**	4	4	4	4	4.0	6.0	6.0	6.0	5.0	5.0	5.0	5.0	5.38	Medium

HAZ ID	Inherent Risk Rank	Residual Risk Rank	Hazard Name	Hazard Scenario	Additional Risk Controls Black = applicable Red = not applicable	Residual Risk Assessment										Residual Risk Scores by Consequence Category								Residual Risk Scores	
						Most Likely Scenario					Worst Credible Scenario					Most Likely Risk Score				Worst Credible Risk Score					
						Frequency	People	Property	Environment	Port Business	Frequency	People	Property	Environment	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business	Calculated Risk Score	Calculated Risk Classifications
				alongside resulting in multiple vessel breakaway puncture of tanker / barge hull, rupture of IOT Finger Pier pipeline(s) and significant damage to IOT Finger Peir infrastructure (with extension of breakaway causing impact to IOT trunkway).																					
14	13	3	Contact (Allision) - Project Vessel (Passenger / Driver) with IOT River berths (or moored vessel)	**Most Likely:** light contact with tanker moored alongside resulting in moderate damage to both vessels and river berth infrastructure. **Worst Credible:** high impact contact with terminal infrastructure and Tanker moored alongside resulting in ruptured loading arms and river berth pipelines, multiple vessel breakaway and damage to vessels and berth infrastructure. Or, high direct impact contact with Tanker moored alongside resulting in puncture of tanker hull, rupture of river berth pipeline(s) and damage to vessels and berth infrastructure.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	3	3	3	**1**	4	4	4	4	3.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.88	Medium
15	6	12	Contact (Allision) - Coastal Tanker with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in moderate damage to both vessels. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in puncture of tanker hull and major damage to project vessel and project infrastructure.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	1	2	**1**	3	4	4	3	3.0	3.0	2.0	3.0	4.0	5.0	5.0	4.0	3.81	Medium
16	10	20	Contact (Allision) - Bunker Barge with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in moderate damage to both vessels. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in puncture of barge hull and damage to project vessel.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	1	2	**1**	3	3	3	3	3.0	3.0	2.0	3.0	4.0	4.0	4.0	4.0	3.44	Medium
17	20	12	Contact (Allision) - Tanker with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in moderate damage to both vessels and IERRT infrastructure. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in puncture of tanker hull and major damage to project vessel and IERRT infrastructure.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	1	2	**1**	3	4	4	3	3.0	3.0	2.0	3.0	4.0	5.0	5.0	4.0	3.81	Medium

HAZ ID	Inherent Risk Rank	Residual Risk Rank	Hazard Name	Hazard Scenario	Additional Risk Controls Black = applicable Red = not applicable	Residual Risk Assessment										Residual Risk Scores by Consequence Category								Residual Risk Scores	
						Most Likely Scenario					Worst Credible Scenario					Most Likely Risk Score				Worst Credible Risk Score				Calculated Risk Score	Calculated Risk Classifications
						Frequency	People	Property	Environment	Port Business	Frequency	People	Property	Environment	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business		
18	27	27	Contact (Allision) - Tug, Service and Other Small Vessel with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in minor damage to both vessels. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in moderate damage to tug / service vessel.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	3	1	1	1	1	2	2	2	2	2	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	2.50	Low
19	16	23	Contact (Allision) - Project Vessel (Passenger / Driver) with IERRT Jetty (or moored vessel)	**Most Likely:** light contact with Project Vessel moored alongside resulting in minor damage to both vessel or IERRT infrastructure. **Worst Credible:** high impact contact with Project Vessel moored alongside resulting in major damage to both vessels and IERRT infrastructure.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	3	1	1	1	1	1	2	4	2	3	2.0	2.0	2.0	2.0	3.0	5.0	3.0	4.0	3.19	Medium
20	1	1	Contact (Allision) - Project Vessel (Passenger / Driver) with Eastern Jetty (or moored vessel)	**Most Likely:** light contact with tanker moored alongside resulting in moderate damage to vessels, breakaway of tanker and ruptured loading arm. **Worst Credible:** high impact contact with tanker moored alongside (or bunkering barge alongside tanker) resulting in puncture of tanker hull or bunker barge hull, rupture of Eastern Jetty pipeline(s), loss of bunker barge moored alongside major and damage to berth infrastructure.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	3	2	2	4	3	1	4	4	4	4	4.0	4.0	7.0	6.0	5.0	5.0	5.0	5.0	5.56	Medium
21	8	8	Breakaway - Coastal Tanker at IOT Finger Pier	**Most Likely:** mooring lines part from wash and current resulting in breakaway from berth, minor loss of cargo from loading arm, vessel engines restarted and vessel secured alongside. **Worst Credible:** mooring lines part from wash and current resulting in breakaway from berth, vessel engines cannot be restarted and contact is made with IOT Trunkway resulting in rupture to IOT trunkway pipeline(s).	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	2	2	2	2	2	1	3	4	4	4	3.0	3.0	3.0	3.0	4.0	5.0	5.0	5.0	3.94	Medium
22	8	8	Breakaway - Bunker Barge at IOT Finger Pier	**Most Likely:** mooring lines part from wash and current resulting in breakaway from berth, minor loss of cargo from loading arm, vessel engines restarted and vessel secured alongside. **Worst Credible:** mooring lines part from wash and current resulting in breakaway from berth, vessel engines cannot be restarted and contact is made with IOT Trunkway resulting in rupture to IOT trunkway pipeline(s).	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	2	2	2	2	2	1	3	4	4	4	3.0	3.0	3.0	3.0	4.0	5.0	5.0	5.0	3.94	Medium
23	5	21	Breakaway - Project Vessel (Passenger / Driver) at IERRT Jetty	**Most Likely:** mooring lines part resulting in breakaway from berth, vessel engines cannot be restarted in time and contact is	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan	2	2	2	1	2	1	2	3	2	3	3.0	3.0	2.0	3.0	3.0	4.0	3.0	4.0	3.31	Medium

HAZ ID	Inherent Risk Rank	Residual Risk Rank	Hazard Name	Hazard Scenario	Additional Risk Controls Black = applicable Red = not applicable	Residual Risk Assessment										Residual Risk Scores by Consequence Category								Residual Risk Scores	
						Most Likely Scenario					Worst Credible Scenario					Most Likely Risk Score				Worst Credible Risk Score				Calculated Risk Score	Calculated Risk Classifications
						Frequency	People	Property	Environment	Port Business	Frequency	People	Property	Environment	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business		
				made with IOT Finger Pier resulting in damage to finger pier, rupture to finger pier pipelines, breakaway of vessel at finger pier. **Worst Credible:** mooring lines part resulting in breakaway from berth, vessel engines cannot be restarted and contact is made with IOT Finger Peir (as above), loss of life on finger pier and further contact with IOT Trunkway resulting in rupture to IOT Trunkway pipeline(s).	RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier																				
24	17	10	Breakaway - Tanker at Eastern Jetty	**Most Likely:** mooring lines part resulting in breakaway from berth, vessel engines cannot be restarted in sufficient time and light contact with IERRT vessel or IERRT infrastructure. **Worst Credible:** mooring lines part resulting in breakaway from berth, vessel engines cannot be restarted and contact is made with Project Vessel moored alongside IERRT or IERRT infrastructure, Tanker hull ruptured, IERRT vessel breakaway.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	2	2	2	2	**1**	3	3	4	4	3.0	3.0	3.0	3.0	4.0	4.0	5.0	5.0	3.88	Medium
25	26	24	Grounding - Project Vessel (Passenger / Driver)	**Most Likely:** vessel makes light contact with river bed and is able to free, negligible damage. **Worst Credible:** vessel makes contact with river bed and requires assistance to navigate free, moderate damage to vessel.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**2**	1	1	1	1	**1**	2	2	2	3	2.0	2.0	2.0	2.0	3.0	3.0	3.0	4.0	2.81	Low
26	23	18	Fire - Project Vessel (Passenger / Driver) at IERRT Jetty	**Most Likely:** fire contained by crew resulting in moderate damage to vessel **Worst Credible:** crew are unable to contain fire resulting to serious damage to vessel and multiple loss of life.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**1**	2	2	1	2	**1**	4	2	2	3	3.0	3.0	1.0	3.0	5.0	3.0	3.0	4.0	3.56	Medium
27	21	18	Foundering / Swamping - Tug, Service and Other Small Vessel from Project Vessel thrust	**Most Likely**: Wash from vessel floods the deck of the tug. Tug has water tight doors closed and remains afloat **Worst Credible:** Wash from vessel floods the deck of the tug. Tug has not water tight doors closed, takes on water, loses stability and sinks.	RC01 Berthing / unberthing criteria RC02 Standby tug provision RC03 Deconfliction plan RC04 Mooring equipment and infrastructure RC05 Impact protection for IOT Trunkway RC06 Moving finger pier	**1**	2	2	1	2	**1**	4	2	2	3	3.0	3.0	1.0	3.0	5.0	3.0	3.0	4.0	3.56	Medium