VOLUME 2/2: APPENDICES

Reference: D/4271/2021

Document: NS051-EV-REP-000-00021

Appendix A - ENVID 2
Appendix B - Stakeholder Scoping Response 10
Appendix C - Commitments Register 19
Appendix D - Projects For Cumulative Impact Assessment 30
Appendix E - Marine Plans 42
Appendix F - Pipeline Surveys Observed Fauna 59
Appendix G - Coastal Processes Baseline 64
Appendix H - Ornithology Technical Report 178
Appendix I - Archaeological Assessment 212
Appendix J - Underwater Sound 492
Appendix K - Drill Cuttings Dispersion Modelling 568
Appendix L - Pipeline Dispersion Modelling 597
Appendix M - Navigational Risk Assessment 618
Appendix N - Fishing Intensity Study 732
Appendix O - Vessel Emissions 790

Appendix A: ENVID

ID	Project aspect	Description of potential effects	Project phase	Mitigation	Significant environmental impact and/or stakeholder concern	Take forward further in EIA?
Physical Presence and Seabed Disturbance						
PP 1	Disturbance of seabed sediments, increased turbidity and disturbance to sediment transport regime resulting from: - Cuttings mounds; - Footprint of jackup rig on seabed, including possible jetting of seabed to aid penetration and removal; - Scouring of sandbanks due to physical presence of new structures on the seabed; - Piling of subsea infrastructure; - Installation and burial of pipelines and cables; - Spot rock placement for upheaval buckling and at pipeline transitions / crossings; - Mattresses (required for exposed pipeline and spoolpieces between the trench exit and tie-in location and pipeline crossing); - Landfall and shore approach crossing preparation involving excavation, presweeping, dredging, installation (and removal at end of operations) of sheet piling; - Location of cofferdam in the nearshore at Humber - Spoil storage alongside the trench and replaced into the trench, post pipelay; - Anchoring/positioning of vessels and pipeline laybarge; - UXO clearance.	n/a	Drilling	- Discharge of tophole (WBM) cuttings only; - Drill cuttings disperion modelling; - Environmental risk assessment through the MATs/SATs system; - Identification and avoidance of sensitive habitats identified through Environmental Baseline Survey (EBS); - Geotechnical survey; - Minimising rig movements.	Yes	Scoped In
			Construction, installation and decommissioning	- Identification and avoidance of sensitive habitats identified through Environmental Baseline Survey (EBS); - Pre work conditions (seabed samples may be required); - Activities will be appropriately permitted: - Environmental risk assessment through the MATs/SATs system; Requirements in Marine & Coastal Access Act; - MCZ Management Plan; - Route selection: pipeline routing optimisation to minimise impacts on benthic features; - Limited boulder clearance footprint: boulder laydown areas limited to up to 5 m wide either side of the pipeline corridor; - Volumes and locations of rock and mattresses to be used will be refined during detailed design to reduce the footprint on the seabed to the extent practicable; - No rock will be placed landward of 10 m LAT at the Humber landfall; - Lessons learnt from previous pipelines; - Stakeholder consultation including Natural England and JNCC; - Spread of rock placement to be restricted through use of a fall pipe system, where possible; - Anchor plans; - Anchors will not be placed within designated area e.g. Runswick MCZ. - Contractor selection and management; - No storage of cohesive sediments (clay) within MCZs or intertidal zone; - Loss of small proportion of interest features not likely to disrupt overall MCZ functioning - Spoil from seabed sweeping activities will be stored at designated area outwith Holderness Inshore and Offshore MCZs, and outwith Runswick MCZ; - Pipeline corridor will not cross Runswick MCZ; - Re-use of trenched materials wherever possible; - In nearshore section, depth of cover of pipeline to provide protection over lifetime in light of coastal erosion & global warming - 40 year design life; - Archaeological Exclusion Zones (AEZs) around known sites; - Protocol for Archaeological Discoveries; - Mechanically moving accreted sediment from the north to the south side of the Humber cofferdam to minimise interference with the sediment transport regime, for the duration of its presence. - Placement of filter unit rock bags to minimise wave energy at Humber - Beach monitoring and management programme for Humber landfall to be agreed with East Riding Yorkshire Council and Natural England. - Beach at Humber landfall re-instatement to similar conditions as pre-installation.		
			Operations	- Pipeline inspections; - Scheduled surveys of buried cable and pipeline to ensure not becoming uncovered due to erosion;		
			Decommissioning	- Decommissioning philosophy to be included in design phase of the project; - Stakeholder consultation; - Seabed survey; - Subject to option Comparative Assessment and Decomissioning EIA.		
PP 2	Physical presence of: - Jackup drilling rig during 370 day offshore drilling campaign; - Vessels e.g. guard vessels during installation, support vessels, pipelay vessels, cable lay vessel, dredging & well intervention vessels; - The subsea infrastructure (including deposited material) for the life of the development and/or abandoned structures.	- Short term potential obstruction or exclusion from drilling rig and vessel use may impede commercial fishing activities and other sea users. Includes temporary safety zones; - Short term navigational hazard to fishing operations and shipping; - Long term potential obstruction or exclusion from structures laid/fixed on seabed, e.g. pipeline may impede commercial fishing activities (including through snag risk) and other sea users. Includes permanent safety zones established around subsea infrastructure; - Helicopter movements may impact nearby offshore developments (e.g. OWFs, O&G etc.).	Drilling	- Establishment of temporary 500 m safety zone & guard vessel; - UKHO standard communication channels including Kingfisher, Notice to Mariners and radio navigation warnings; - Consultation will be undertaken with relevant authorities and organisations, including fisheries; - Consent to Locate (CTL) SATs; - Inclusion of facilities on navigational charts, marine notices etc.; - Existing fisheries compensation approach from 2020 survey; - Fisheries liaison officer; - Post-drilling seabed survey which will include the requirement to demonstrate safe seabed.	Yes	Scoped In
			Construction, installation and commissioning	- Establishment of temporary 500 m safety zone & guard vessel(s); - Establishment of safety zones around subsea infrastructure (wells, manifolds and SSIV); - UKHO standard communication channels including Kingfisher, Notice to Mariners and radio navigation warnings; - Consultation will be undertaken with relevant authorities, organisations and stakeholders; - CTL SATs; - Navigation risk assessment; - Vessel management plan; - Development and implementation of a fishery liaison strategy and appointment of fisheries liaison officer; - Clay berms to be used for backfill over pipeline so minimal snag risk; - Rock berms designed to be fishing friendly; - Requirement for rock berms to be minimised by design; - Optimised vessel use reducing vessel time spent in field; - Compliance with Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs); - Stakeholder consultation.		
			Operations	- Pre-sweeping of area, specifically sand waves, to ensure pipeline sits on the seabed and less vulnerable to dynamic sediment movement; - Operational surveys to establish pipeline depth as part of the integrity management program; - Design depth in coastal area considers future seabed lowering and cliff erosion for the design life of the pipeline; - Pipeline routes added to admiralty charts, Kingfisher database, etc; - Subsea facilities designed within NORSOK U001 / ISO 13628-1 trawl load standards; - Fishing friendly structures design; - Pipeline fishing protection; - Utilise existing surveys to minimise impact on protected Annex I habitat; - Marine licences required to deploy on the seabed; - Optimisation of pipeline design and routing, inclduing crossings' design; - Infrastructure marked on Admiralty charts and the Fish Safe data base; - Consultation with fisheries organisations, fisheries compensation where applicable; - Consideration of avoidance of survey overlap with fishing activities seasonally.		

ID	Project aspect	Description of potential effects	Project phase	Mitigation	Significant environmental impact and/or stakeholder concern	Take forward further in EIA?
			Decommissioning	- Establishment of 500 m safety zone & guard vessel; - UKHO standard communication channels including Kingfisher, Notice to Mariners and radio navigation warnings); - Consultation will be undertaken with relevant authorities and organisations; - Consent to Locate (CTL) SATs.		
PP 3	Physical presence of (including light emissions): - Jackup drilling rig during 370 day offshore drilling campaign; - Vessels e.g. guard vessels during installation, support vessels, pipelay vessels, dredging & well intervention vessels.	- Disturbance to wildlife (e.g. seabird communities, particularly migrating species and red-throated diver/little tern in nearshore waters, and marine mammals) and designated sites (Southern North Sea SAC (harbour porpoise) & Greater Wash SPA)); - Could lead to exclusion of marine species from an area, or to collision between vessel and animals.	Drilling	- Environmental awareness training; - CTL conditions.	Yes	Scoped In
			Construction, installation and commissioning	- Environmental awareness training; - CTL conditions; - Vessel management plan (within MCZ management plan); - Away from local residential areas; - Stakeholder engagement; - 24 hr working will be exception, not the norm.		
			Operations	- CTL conditions.		
			Decommissioning	- Environmental awareness training; - Stakeholder consultation.		
PP 4	Nearshore construction activities (some 24 hr working but not likely to be extensive).	- Disturbance to local communities and users of the nearshore through noise and visual presence (inc. lights).	Drilling		Yes	Scoped In
			Construction, installation and commissioning	- EIA public consultation process; - Guard vessels; - Local authority engagement; - Stakeholder management plan; - Highest number of vessels would be present during the temporary construction period; - Optimisation of design to lessen impacts.		
			Operations			
			Decommissioning	- Guard vessels; - Local authority engagement; - Stakeholder management plan.		
PP 5	Physical presence of nearshore SSIV - navigational depth reduction	- Disturbance to users of the nearshore	Drilling		Yes	Scoped In
			Construction, installation and commissioning	- Guard vessels; - Local authority engagement; - Stakeholder management plan.		
			Operations	- Marked on marine charts; - Establishment of safety zones around SSIV; - Navigational markings; - Pipeline route selected to avoid high use shipping lanes and fishing grounds.		
			Decommissioning	- Guard vessels; - Local authority engagement; - Stakeholder management plan.		
Underwater Sound						
UW 1	Sound emissions from: - Drilling rig and vessel activities (including. DP noise); - Piling - subsea infrastructure; - Helicopter movements; - Clearance of UXO; - Transponders used to install the subsea infrastructure; - Noise from 4D seismic during operations	- Disturbance and/or injury potential to marine mammals, fish and seabirds - SNS SAC (designated for harbour porpoise) beyond zone of influence of nearshore activities but pipelines located within the SAC on approach to Endurance - Donna Nook is a known haul out and breeding site and is designated as part of the Humber Estuary SAC, it is located 25 km away with land mass in between.	Drilling	- Limit the duration of the noise emitting activities as much as practicable; - Assessment to be refined for drilling permit applications; - Optimisation of vessel use, reducing time in the field; [Noise from helicopter use for crew change on jackup rig considered de-minimis]	Yes	Scoped In
			Construction, installation and commissioning	- Identification and avoidance of sensitive habitats/species through Environmental Baseline Survey (EBS); - Limit the duration of the noise emitting activities; - Account for seasonal sensitivities if possible; - Implement vessel management plan; - Potential for pipeline micro-routing around known UXO; - Use of JNCC guidelines for minimising impact to wildlife (e.g. piling soft start); - Stakeholder consultation; - Habitats Regulations Assessment; - EPS licence requirements; - Marine Mammal Mitigation Plan (MMMP).		
			Operations	- Helicopter movements to be minimal; - Use of JNCC guidelines for minimising impact to wildlife; - Stakeholder consultation; - Habitats Regulations Assessment; - EPS licence requirements; - Seismic survey is a permitted activity; - Minimisation of airguns size where practicable; - Engagement with other operators re-timing of other sound generating activities; - Marine Mammal Mitigation Plan (MMMP).		
			Decommissioning	- Limit the duration of the noise emitting activities; - Account for seasonal sensitivities if possible; - Stakeholder consultation.		

ID	Project aspect	Description of potential effects	Project phase	Mitigation	Significant environmental impact and/or stakeholder concern	Take forward further in EIA?
Discharges to Sea and Formation Water Displacement						
DTS 1	Discharge of drill cuttings to sea from well drilling - 2 top hole section drilled riserless, fluids and cuttings discharged at seabed.	Cuttings, dissolved metals, and chemicals released to sea on cuttings and from cementing may cause detrimental impacts on local water and seabed quality and associated marine flora and fauna.	Drilling	- Permitted activity; - Only discharges to sea are tophole (WBM) cuttings; - LTOBM and associated cuttings to be skipped/shipped; - Drill cuttings dispersion modelling; - Selection of chemicals with less potential for environmental impact; - Contractor selection process; - Environmental risk assessment through the MATs/SATs system (OCR) and discharge permitting; - Chemical Risk Assessment; - Benthic environmental survey; - Cefas approved chemicals; - Majority of PLONOR chemicals used; - Chemicals with SUBs warning will be avoided where appropriate; - All chemical usages and discharges will be recorded and reported.	Yes	Scoped In
			Construction, installation and commissioning			
			Operations			
			Decommissioning			
DTS 2	Chemical use and discharge to sea, from - discharge of WBM; - pipeline hydrostatic pressure testing (including drying); - pipeline valve testing; - downhole safety valve operation; - pipeline isolation valve operation.	Chemicals discharged to sea may cause contamination of seawater and disturbance to aquatic ecosystem.	Drilling	- Selection of chemicals with less potential for environmental impact; - Contractor selection process; - Environmental risk assessment through the MATs/SATs system (OCR).	Yes	Scoped In
			Construction, installation and commissioning	- Volumes to be recorded and reported; - Selection of chemicals with less potential for environmental impact; - Contractor selection process; - Environmental risk assessment through the MATs/SATs system (Offshore Chemicals Regulations); - Commissioning plan with fit for purpose testing and optimised commissioning; - Short-lived exposure to chemicals; - Dispersion modelling undertaken.		
			Operations	- Water wash of wells (freshwater with trace additives and MEG) performed annually - no returns; - Selection of low-toxicity, waterbased hydraulic fluid.		
			Decommissioning	- Wells to be decommissioned to CCS UKCS decommissioning regulations and procedures; - Selection of chemicals with less potential for environmental impact; - Contractor selection process; - Environmental risk assessment through the MATs/SATs system (OCR); - Subject to option Comparative Assessment and Decomissioning EIA.		
DTS 3	Outcrop formation water displacement	Displaced Formation Water at the Bunter Outcrop may be associated with low pH, low oxygen concentration and metals, potentially causing detrimental impacts on local water and seabed quality and associated marine flora and fauna.	Drilling		Yes	Scoped In
			Construction, installation and commissioning			
			Operations	- Monitoring Plan with the following objectives and approach a) Verify the storage and absence of displacement, prepare for effective communication and actioning if required. b) The Monitoring Plan is linked to project/storage risk assessment and addresses corrective measures to the identified risks. - Addressed as part of store development plan - commitments to monitor within this plan; - Sub surface plume migration monitoring through regular seismic surveys; - Landers / AUV monitoring; - Ongoing environmental baselining / surveys.		
			Decommissioning	- Monitoring Plan with the following objectives and approach a) Verify the storage and absence of displacement, prepare for effective communication and actioning if required. b) The Monitoring Plan is linked to project/storage risk assessment and addresses corrective measures to the identified risks; - Addressed as part of store development plan - commitments to monitor within this plan. - Landers / AUV monitoring; - Ongoing environmental baselining / surveys.		
DTS 4	Release of CO_2 into water column from: - Wireline work (intervention); - Testing subsea tree valves; and - Choke changeouts - subsea interventions.	Released CO_2 dissolves in water, causing localised reduction in pH which may cause detrimental impacts on local water quality and associated marine flora and fauna	Drilling		No	Scoped out
			Construction, installation and commissioning			
			Operations	- Wireline work and the testing of subsea tree valves are a de minimis source of CO_2; - Choke changeouts occur infrequently.		
			Decommissioning			
DTS 5	Routine discharge of ballast water and removal/fall-off of fouling growth from ships.	Ballast water and marine growth on ships coming into the Development area may contain non-native organisms. Some species may survive and establish themselves. Non-native species may cause serious ecological impacts, particularly if they become invasive.	Drilling	- Compliance with MARPOL requirements; - Discharge of ballast waters outwith 12 NM of shore; - Marine assurance of vessel and equipment inspection/maintenance; - Rig mobilisation audit.	No	Scoped Out
			Construction, installation and commissioning	- Compliance with MARPOL requirements; - Discharge of ballast waters outwith 12 NM of shore; - Ballast tank cleaning for vessels as required by the consenting authority; - Marine assurance of vessel and equipment inspection/maintenance; - Rig mobilisation audit.		
			Operations	- All vessels to be from UK.		
			Decommissioning	- Compliance with MARPOL requirements; - Discharge of ballast waters outwith 12 NM of shore; - Marine assurance of vessel and equipment inspection/maintenance; - Rig mobilisation audit.		

ID	Project aspect	Description of potential effects	Project phase	Mitigation	Significant environmental impact and/or stakeholder concern	Take forward further in EIA?
DTS 6	Routine blackwater production (i.e. sewage), grey water (i.e. from showers, laundry, hand wash basins and drinking fountains) and food waste (macerated) disposal (from vessels and drilling rig).	Discharge of sewage, grey water and macerated food has an associated BOD and may contribute to organic enrichment in the vicinity of the discharge possibly leading to a small increase in plankton and fish population.	Drilling	- Treatment to IMO (MARPOL) standards; - Vessel assurance programme.	No	Scoped Out
			Construction, installation and commissioning	- Treatment to IMO (MARPOL) standards; - Vessel assurance programme; - All discharges monitored and records maintained.		
			Operations	- Treatment to IMO (MARPOL) standards; - Vessel assurance programme.		
			Decommissioning	- Treatment to IMO (MARPOL) standards; - Vessel assurance programme.		
DTS 7	Routine seawater usage for cooling (e.g. engine cooling).	Discharge may be at a higher temperature than the surrounding water.	Drilling	- Quantities assumed to be low enough so any effect is likely to be minimal due to dilution effects; - Most cooling circuits to be closed loop; - Vessels to be compliant with MARPOL.	No	Scoped Out
			Construction, installation and commissioning	- Quantities assumed to be low enough so any effect is likely to be minimal due to dilution effects; - Vessels to be compliant with MARPOL.		
			Operations	- Quantities assumed to be low enough so any effect is likely to be minimal due to dilution effects; - Vessels to be compliant with MARPOL.		
			Decommissioning	- Quantities assumed to be low enough so any effect is likely to be minimal due to dilution effects; - Vessels to be compliant with MARPOL.		
Atmospheric Emissions						
AE 1	Fuel combustion by drilling rig and vessels	- Resource use; - Emissions of CO_2, CH_4, CO, VOCs, SO_x, NO_x and particles of carbon (soot) may contribute to global warming, acid precipitation, ozone depletion and deterioration of local air quality.	Drilling	- Optimisation of vessel fleet and duration in the field; - Rig subjected to bp marine assurance; - Rig mobilisation audit - Helicopter use for crew change on jackup rig considered de-minimis	Yes	Scoped In
			Construction, installation and commissioning	- Optimisation of vessel fleet and duration in the field; - All vessels subjected to bp marine assurance; - Rig mobilisation audit; - Diesel consumption tracking and reporting; - Rig's power management system; - Vessel / barges MARPOL compliant.		
			Operations	- Diesel consumption tracking and reporting; - Low sulphur fuels; - Contractor selection; - Optimised vessel scheduling/use reducing vessel time spent in field; - Maximise use of autonomous vehicles to avoid vessel use; - Vessels MARPOL compliant. - Vessels subjected to bp marine assurance; - Rig mobilisation audit.		
			Decommissioning	- Low sulphur fuels; - Contractor selection.		
AE 2	Indirect emissions associated with power exported from shore	- Resource use; - Contribution to climate change.	Drilling		Yes	Scoped In
			Construction, installation and commissioning			
			Operations	- Minimisation of power demand via design		
			Decommissioning			

ID	Project aspect	Description of potential effects	Project phase	Mitigation	Significant environmental impact and/or stakeholder concern	Take forward further in EIA?
Accidental Events						
AE 1	LARGE SCALE - Well blowout during operations (will not flow during drilling); - Loss of pipeline containment leading to release of gas; - Damage to third party pipeline and umbilical crossing during installation activities; - Loss of fuel inventory from rig or vessel; - Onstructure 3 legacy wells - could leak brine; - Damage to project infrastructure from dropped objects or from snagging or dragging of pipeline or cable.	- Contamination of surrounding water and atmosphere; - Infrastructure damage; - Impact on seabird populations; - Potential shoreline impact.	Drilling	- Marine assurance of vessel and equipment inspection/maintenance; - Rig mobilisation audit; - Emergency Response Plans - including North Sea IMT support; - Establishment of 500 m safety zone around jackup rig & guard vessel; - Temporary / localised restrictions in vicinity of working vessel(s); - CtL for anchored vessel(s); - Guard vessel(s); - Engagement with key stakeholders e.g. fisheries / port authorities; - Kingfisher Bulletin, NtM, radio navigation warnings; - SOPEPs and OPEPs; - Vessel management plan.	Yes	Scoped In
			Construction, installation and commissioning	- Temporary / localised restrictions in vicinity of working vessel(s); - CtL for anchored vessel(s); - Guard vessel(s); - Engagement with key stakeholders e.g. fisheries / port authorities; - Kingfisher Bulletin, NtM, radio navigation warnings; - Marine assurance of vessel and equipment inspection/maintenance; - SIMOPs; - SOPEPs and OPEPs; - Vessel management plan; - Emergency Response Plan - including bp IMT support.		
			Operations	- Inspection procedures; - SIMOPs plans; - Subsurface safety valve and subsea tree valves - double barrier isolation; - Verified well integrity; - Monitoring plan; - Risk assessment of legacy wells; - Pipeline routes added to admiralty charts, Kingfisher database, etc; - Subsea facilities designed within NORSOK U001 / ISO 13628-1 trawl load standards; - Fishing friendly structures design; - Pipeline fishing protection.		
			Decommissioning	- Wells to be decommissioned to CCS UKCS decommissioning regulations and procedures; - Long term store monitoring; - SIMOPs.		
AE 2	SMALL SCALE Accidental discharge/ release of diesel/chemcials to sea from: - LTOBM and diesel bunkering; - Releases of chemicals associated with cementing and brines. LTOBM, WBM, hydraulic oils, lubricating oils (including cutting).; - Resupply of chemical IBC to rig; - Mechanical failure (e.g. hose failure during bunkering); - Human error; - Corrosion & erosion; - AUV/ROV use; - Release of chemically inhibited water, most likely at pipeline joints.	- Smaller releases may cause localised, short-term contamination of seawater and limited damage to the aquatic ecosystem; - Chemicals discharged to sea may cause contamination of seawater and disturbance to aquatic ecosystem.	Drilling	- Rig piping system to be closed loop; - Operational procedures for bunkering; - Bunkering hoses to be fitted with marine break coupling on hose connections; - Bunkering and mud-handling procedures; - Personnel training; - Maintenance and inspection of bunkering hoses; - Tank level monitoring; - Vessel selection; - Pre-mobilisation audits including spill prevention procedures; - Appropriate chemical storage areas with drip trays and bunding; - Relatively small inventories stored; - All vessels MARPOL compliant; - SOPEPs in place; - Permit to Work, Lock out/Tag out system; - Emergency Response Plans (Vessels and Rig).	Yes	Scoped In
			Construction, installation and commissioning	- Personnel training; - Maintenance procedures; - Vessel selection; - Pre-mobilisation audits including spill prevention procedures; - Appropriate chemical storage areas with drip trays and bunding; - Relatively small inventories stored; - Appropriate chemical/oil storage standards; - Permit to Work, Lock out/Tag out system; - Commissioning plan; - Emergency Response Plans (Vessels). - All vessels MARPOL compliant. - SOPEPs in place.		
			Operations	- Vessel selection; - Pre-mobilisation audits including oil spill prevention procedures; - Appropriate oil/chemical storage areas with drip trays and bunding; - Permit to Work, Lock out/Tag out system; - inspection and maintenance systems; - Standard operating procedures and checks; - Follow standard operating procedures and checks; - Inspection and maintenace systems; - Emergency Response Plans (Vessels); - Cefas approved chemicals; - Majority of PLONOR chemicals used; - Chemicals with SUBs warning will be avoided where appropriated; - Wells SoR; - All chemical usages and discharges will be recorded and reported.		

ID	Project aspect	Description of potential effects	Project phase	Mitigation	Significant environmental impact and/or stakeholder concern	Take forward further in EIA?
			Decommissioning	- Bunkering and mud-handling procedures; - Personnel training; - Maintenance procedures; - Vessel selection; - Pre-mobilisation audits including spill prevention procedures; - Appropriate oil/chemical storage areas with drip trays and bunding; - Permit to Work, Lock out/Tag out system; - Emergency Response Plans (Vessels and Rig).		
AE 3	Accidental release of CO_2: - from CO_2 pipeline (and flowlines) due to corrosion, fatigue and damage; - from CO2 pipeline (and flowlines) due to fugitive weeps and seeps; - from storage due to cement fatigue resulting in leak; - from storage due to the 3 on-structure legacy wells; - from injection induced stress causing unexpected new fractures in store seal.	Effect on: - FOAK future technology development; - Future development; - Stakeholder confidence.	Drilling		Yes	Scoped In
			Construction, installation and commissioning			
			Operations	- Store selection and seal robustness confirmed; - Well design; - In-well monitoring; - Subsurface modelling; - Subsurface characterisation; - Monitoring Plan, including landers / visual inspection; - There are multiple monitoring methods included within the MP; - Pressure sensors; - Fast closing valve and another mechanism nearshore; - Subsurface safety valve and Christmas tree valves; - Double barrier isolation; - Verified well integrity; - Control strategy (will cover all operations); - Monitoring (including visual pipeline inspections at appropriate intervals); - Pipeline spec/design to ensure integrity/containment; - Pipeline protection / stabilisation; - Corrosion management; - Cement design (resistance to temperature and fatigue loading); - Cement testing; - Cement barrier qualification; - Leak repair; - Legacy well management; - Plug and abandonment or relief well; - Corrective Measures Plan (approved by NSTA) which captures all mitigation measures; - Well intervention to address seepage; - Plume migration monitoring through regular seismic surveys; - Tracer injection to determine where the CO_2 is coming from; - There will be defined operating limits for the wells to ensure that pressure in the aquifer stays below cap rock fracture pressure; - The selection of the storage aquifer, in particular the low porosity of the halite layers; - Affected wells can be shut in.		
			Decommissioning	- Subsurface modelling; - Subsurface characterisation; - Monitoring Plan; - Post site-closure monitoring programme.		
AE 4	Accidental deposit of materials on the seabed (e.g. dropped objects, pipelines, ROV etc.).	- Interaction/damage to seabed/species (direct or indirect) and other sea users (e.g. exclusion, snag risk) and infrastructure (e.g. pipeline).	Drilling	- Compliance to Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) including inspection/testing; - Personnel training; - Lift planning, including consideration of prevailing environmental conditions and the use of specialist equipment; - All lifting equipment to be tested and certified; - Record location of lost materials, with significant objects to be recovered where practicable and reported using PON 2 notification; - Debris clearance surveys.	No	Scoped Out
			Construction, installation and commissioning	- Pipeline protected by concrete matresses; - Compliance to LOLER including inspection/testing; - Personnel training; - Lift planning, including consideration of prevailing environmental conditions and the use of specialist equipment; - All lifting equipment to be tested and certified; - Record location of lost materials, with significant objects to be recovered where practicable and reported using PON 2 notification; - Debris clearance surveys; - SIMOP procedures; - Emergency Response Plan.		
			Operations	- Compliance to LOLER including inspection/testing; - Personnel training; - Lift planning, including consideration of prevailing environmental conditions and the use of specialist equipment; - All lifting equipment to be tested and certified; - Record location of lost materials, with significant objects to be recovered where practicable and reported using PON 2 notification; - Wellhead protection structures provided per tree.		
			Decommissioning	- Compliance to LOLER including inspection/testing; - Personnel training; - Lift planning, including consideration of prevailing environmental conditions and the use of specialist equipment; - All lifting equipment to be tested and certified; - Record location of lost materials, with significant objects to be recovered where practicable and reported using PON 2 notification; - Debris clearance surveys.		

ID	Project aspect	Description of potential effects	Project phase	Mitigation	Significant environmental impact and/or stakeholder concern	Take forward further in EIA?
Waste						
W 1	Routine generation and disposal of non-hazardous waste streams.	- Disposal to land of inert waste materials.	Drilling	- bp EMS; - Waste management plan; - Contractor selection / audits; - Use of licensed waste contractors/sites; - Waste transfer notes; - Waste heirarchy.	No	Scoped Out
			Construction, installation and commissioning	- bp EMS; - Waste management plan; - Contractor selection / audits; - Use of licensed waste contractors/sites; - Waste transfer notes; - Waste heirarchy.		
			Operations	- bp EMS; - Waste management plan; - Contractor selection / audits; - Use of licensed waste contractors/sites; - Waste transfer notes; - Waste heirarchy.		
			Decommissioning	- bp EMS; - Waste management plan; - Contractor selection / audits; - Use of licensed waste contractors/sites; - Waste transfer notes; - Waste heirarchy.		
W 2	Routine generation and disposal of special/ hazardous wastes, e.g. solvents, batteries, chemical cans/drums/sacks, contaminated cuttings, cement from cementing operations, completion fluid, sludge & slops.	- Disposal to land of special/ hazardous waste materials.	Drilling	- Contractor selection / audits; - Use of licensed waste contractors/sites; - Waste transfer notes; - Skip and ship of LTOBM and waste cement managed through bp EMS/existing contractors; - Completions stopped if circulation not working - no discharges; - Monitoring pit levels; - bp waste management plan (skip and ship); - Waste Duty of Care; - Treatment and disposal at authorised facilities.	No	Scoped Out
			Construction, installation and commissioning	- bp EMS; - Waste management plan; - Contractor selection / audits; - Use of licensed waste contractors/sites; - Waste transfer notes; - Waste heirarchy; - Proposed drilling fluids to be reviewed as part of the EPC bid evaluation; - FEED documentation to specify management and offshore disposal of arisings.		
			Operations	- bp EMS; - Waste management plan; - Contractor selection / audits; - Use of licensed waste contractors/sites; - Waste transfer notes; - Waste heirarchy.		
			Decommissioning	- bp EMS; - Waste management plan; - Contractor selection / audits; - Use of licensed waste contractors/sites; - Waste transfer notes; - Waste heirarchy.		

Appendix B: Stakeholder Scoping Response

ID	Responses to NEP scoping document	Response	ES section in which addressed
	JNCC		
JNCC_1	Holderness Offshore Marine Conservation Zone (MCZ) The Humber pipeline crosses the Holderness Offshore MCZ, which is designated for subtidal coarse sediment, subtidal sand, subtidal mixed sediments, Arctica islandica and North Sea glacial tunnel valleys. All features within this site are currently in an unfavourable status and all have a recover objective, therefore any impacts to this site must be assessed per feature and not as a whole site. We recommend that any introduction of hard substrate (e.g. rock dump) within Holderness Offshore MCZ be avoided.	The impacts on the site features of the MCZ are assessed in Section 6.8. This has assumed a worst case scenario of rock placement being needed along 10% of the pipeline route through the MCZ.	Chapter 3: Project Description Chapter 6: Seabed Disturbance
JNCC_2	Southern North Sea Special Area of Conservation (SAC) Both pipelines cross, and the Endurance Store area is in, the Southern North Sea Special Area of Conservation (SAC). Conservation Objective 3 for the Southern North Sea SAC, "ensuring that the condition of supporting habitats and processes, and the availability of prey is maintained", should be taken into consideration when assessing seabed impacts on the site. JNCC acknowledge that this may be assessed in terms of any impacts to prey species during a desk-based assessment of potential impacts on fish.	The potential for impacts on the supporting habitats and processes within the SAC, and on the availability of fish prey species, is assessed in Section 6.9.2.1. Consideration is given to the likelihood of significant effects on harbour porpoise using the SAC.	Chapter 6: Seabed Disturbance
JNCC_3	Southern North Sea Special Area of Conservation (SAC) Table 5-1 "Designated sites which intersect with the Development" states that the Humber Pipeline will pass through an area of winter habitat within the Southern North Sea SAC. However, figure 5-4 "designated sites in the vicinity of the Development" shows the Humber Pipeline bypassing the winter habitat area. This should be made clear in the ES.	The use of summer and winter habitat within the Southern North Sea SAC is addressed in Section 4.4.6.2 of the Environmental Description.	Chapter 4: Environment Description
JNCC_4	Southern North Sea Special Area of Conservation (SAC) In order to be able to assess the impact on Southern North Sea SAC, JNCC request that the operator specifically state how much protection/stabilisation material and area of seabed footprint occurs within the site.	The seabed footprint within the SAC is shown in Section 6.4 (Figures 6-1 and 6-2), with full details provided in Section 6.9.2.1.	Chapter 3: Project Description Chapter 6: Seabed Disturbance
JNCC_5	Ornithology JNCC suggest that the operator use distribution maps from Waggit et al (2019) in addition to Kober et al (2010) as these include more recent data and use more sophisticated modelling methods.	Section 4.4.5 on birds utilises the best available information regarding bird distributions throughout the UKCS, inlcuding Kober *et al.* (2010) and Waggit *et al.* (2019).	Chapter 4: Environment Description
JNCC_6	Ornithology JNCC also suggest that the operator assess the cumulative impacts of the potential cable routes for The Crown Estate's round 4 preferred offshore wind projects 1, 2 and 3.	Cumulative project list to be considered within the Environmental Statement (ES) has been agreed with stakeholders and has considered round 4 preferred offshroe wind projects as suggested.	Chapter 3: Project Description Chapter 6: Seabed Disturbance
JNCC_7	*Survey data* JNCC would expect the following site-specific survey to be included: As per BEIS 2021, the environmental description should focus on that of the actual area to be developed and not just provide a generic description of the local environment. Evidence should be presented within the application confirming that the data are still relevant. Any gaps or limitations in environmental information should be acknowledged with, where appropriate, strategies to address these gaps or limitations.	The Environment Description has been split into subsections coving the Endurance Store and pipeline routes so that the information is specific to each area/aspect of the Development. Best available scientific literature has been used to develop an understanding of the area and this has been supported through inclusion of survey environmental baseline reports and habitat assessments commissioned for the Development specifically.	Chapter 4: Environment Description
JNCC_8	Survey data Areas of Sabellaria spinulosa and stony reef habitat have been identified during the Tolmount pipeline site specific surveys. We recommend that where possible, the operator avoids these habitats as much as practically possible during proposed operations.	Figures showing the distribution of *S. spinulosa* reef and rocky reef presence along the pipeline routes has been included in Section 4.4.2 of the Environmental Description.	Chapter 4: Environment Description Appendix C: Commitments Register
JNCC_9	Survey data Sea pens and burrowing megafauna: burrowing megafauna is an essential element of the habitat, but seapens may or not be present. Burrows identified as at least frequent on the SACFOR scale during surveys may be indicative of this OSPAR threatened and declining habitat. Further guidance is available in the JNCC-published report on the UK interpretation of this feature JNCC, 2014. JNCC clarifications on the habitat definitions of two habitat FOCI.	Discussion of 'Seapens and burrowing megafauna' is addressed in Section 4.4.2 of the Environmental Description.	Chapter 4: Environment Description
JNCC_10	*Protective material* Whilst JNCC would encourage the operator to minimise the amount of hard substrate material used, the ES should use the worst case option to enumerate the protection/stabilisation material that will be used, and the area of seabed impacted. Within marine protected areas this should be split by into the feature types impacted.	Chapter 6: Seabed Disturbance identifies and assesses the worst case for rock placement. The worst case area affected is is assessed for each feature type in Section 6.9.	Chapter 3: Project Description Chapter 6: Seabed Disturbance
JNCC_11	*Protective material* The commentary on protective materials should include: • Location of rock protection sites • Size / grade of rock to be used • Tonnage/volume to be used • Contingency tonnage / volume to be used • Method of delivery to the seabed • Footprint of rock • Assessment of the impact	Details regarding rock placement activities and the type and amount of rock to be used are provided in Section 3.2.6. Chapter 6: Seabed Disturbance identifies and assesses the worst case for rock placement.	Chapter 3: Project Description Chapter 6: Seabed Disturbance
JNCC_12	*Protective material* Where the use of protective material cannot be avoided, we recommend using a more targeted placement e.g. fall-pipe vessel rather than using vessel-side discharge methods.	Rock will be deposited by a fall pipe vessel to ensure accurate positioning of the rock (Sections 3.2.6; 6.5.1).	Chapter 6: Seabed Disturbance Appendix C: Commitments Register
JNCC_13	*UXO Clearance* We note that no obstructions with the potential to be a UXO were identified during the site-specific surveys at the Endurance store area; however, should any be found and clearance through detonation be required, low order alternatives to high-order clearance should be given priority when developing clearance protocols. A full impact assessment will also be required to support the marine licence application and a mitigation plan agreed with the regulator and JNCC. We would be happy to provide further guidance at the time should this be needed.	Based on an initial desk-based unexploded ordnance (UXO) assessment it is assumed that it will be possible to avoid any UXO encountered. Should any further mitigation be required, such as clearance or detonation, this would be subject to separate assessment and applications. This is discussed within Chapter 3: Project Description.	Chapter 3: Project Description
JNCC_14	*Cumulative assessment* Assessment of cumulative effects of a project is required under EIA regulations. JNCC suggests that the proposed operations are assessed alongside approved developments under construction, approved developments that have not yet commenced construction, developments submitted for approval but not yet approved, as well as any other significant appropriate development for which some realistic figures are available.	The list of projects for cumulative impact assessment has been circulated to stakeholders, including JNCC to ensure list is sufficiently extensive. Comments have been incorporated into the long list of projects presented in Appendix D.	Chapter 5: EIA Methodology Appendix D: Cumulative Impact Assessment, project list
JNCC_15	*Over-trawl* JNCC's understanding is that over-trawl should only be undertaken after sufficient survey effort has been carried out to review whether it is necessary (in consultation with suitable fishing industry representatives). In addition where over-trawl is agreed to be required, JNCC now request 'gates' are designed as crossing points over pipelines rather than an over-trawl being conducted over the entire length of a pipeline. JNCC also request that where possible all efforts are made to avoid any protected habitats/species in the over-trawl area. JNCC advise that repeated over-trawl sweeps are minimised as much as possible to reduce the impact on the seabed from repeated sweeps. OPRED no longer support the use of chain mats for over-trawl in environmental designated or sensitives sites we would therefore assume that any over-trawl which is required within a protected site is done by non-intrusive means.	Relevant stakeholders will be consulted with on the methodology for overtrawl trials, if these are required following survey effort. Details are included within Chapter 9: Physical Presence.	Chapter 9: Physical Presence Interactions
JNCC_16	*Worst case scenarios* When assessing the environmental impacts of each activity, JNCC considers it best practice to present a realistic worst-case scenario to enable a meaningful assessment of the full environmental impacts of a project.	Realistic worst case scenarios described in Chapter 3: Project Description and assessed in impact assessment chapters (6: Seabed Disturbance - 11: Atmospheric Emissions). Where different worst case scenarios exist for different receptors, receptor-specific worst case scenarios have been defined per impact assessment chapter.	Chapter 3: Project Description Chapters 6 - 11 impact assessment
JNCC_17	*Cumulative impacts list:* Owing to the Endurance Store area being within the Southern North Sea SAC, any projects that have the potential to impact upon the conservation objectives of this site, and are within 40km of the proposed works, should be considered in the cumulative assessment. This includes projects involving impulsive noise and decommissioning projects.	Considered within Chapter 7: Underwater Sound and Appendix D: Cumulative Impact Assessment, project list.	Appendix D: Cumulative Impact Assessment, project list
JNCC_18	*Cumulative impacts list* : We would note that the following works are scheduled to complete by the end of March 2022. However, if they are delayed such that they are concurrent with the Endurance Store works, owing to their proximity to the Endurance works they should also be included in the assessment: • Theddlethorpe Gas Terminal (TGT) to Murdoch MD PL0929/PL0930 – sub-bottom profiler pinger survey along eight short sections of the TGT to Murdoch MD to Viking Bravo pipeline. This survey passes within 30km of the Endurance store area.	Endurance Store works will commence (earliest), January 2025. It is not anticipated that there will be any overlap with these previously consented projects.	Appendix D: Cumulative Impact Assessment, project list
JNCC_19	*Cumulative impacts list:* JNCC note that existing infrastructure with a seabed footprint within the Holderness Inshore MCZ and the Holderness Offshore MCZ have been included as part of the cumulative impact assessment. Both the project's two pipelines and the Endurance Store area are in the Southern North Sea SAC. Therefore, Conservation Objective 3 for the Southern North Sea SAC, "ensuring that the condition of supporting habitats and processes, and the availability of prey is maintained", should be taken into consideration when assessing cumulative seabed impacts on the site.	Cumulative project list to be considered within the ES has been agreed with stakeholders and has considered projects as suggested. Conservation objective 3 of the Southern North Sea SAC has been taken into consideration in the assessment of potential cumulative impacts on the site (Section 6.9.2.1).	Chapter 6: Seabed Disturbance
JNCC_20	*Cumulative impacts list:* JNCC would suggest that all active and planned windfarms within 510km of Flamborough and Filey Coast SPA are included (this is the mean max foraging range for northern gannet, which is a feature of this SPA, and for which site-specific data shows a similar foraging range).	All active and planned windfarms within 510 km of Flamborough and Filey Coast SPA are included have been added to the long list of project in Appendix D. They are screened out as collision risk is not an impact associated with the Development and displacement is temporary, for the duration of vessel activity associated with the Development	Appendix D: Cumulative Impact Assessment, project list
JNCC_21	*Cumulative impacts list* : JNCC propose that existing (constructed and operational) projects should be included in this list; this applies in particular to windfarms where impacts continue to be exerted throughout the operational phase (particularly collision and displacement impacts).	Constructed and operational projects are included in the long list of project in Appendix D. They are screened out as collision risk is not an impact associated with the Development and displacement is temporary, for the duration of vessel activity associated with the Development	Appendix D: Cumulative Impact Assessment, project list
JNCC_22	*Cumulative impacts list:* We propose that any activities within Greater Wash SPA or a 2km buffer of (10km boundary for large infrastructure such as windfarms) should be included within in-combination assessments; red-throated diver and common scoter are susceptible to disturbance and displacement from human activities including vessel traffic (Fliessbach et al. 2019, Schwemmer et al. 2011). It is not clear whether the last bullet point on page 7 would include all such activity.	Cumulative project list to be considered within the ES has been agreed with stakeholders and has considered projects as suggested.	Appendix D: Cumulative Impact Assessment, project list
JNCC_23	*Cumulative impacts list:* New projects with vessel routes north of the Humber only have been selected as these represent those projects with the greatest potential for interaction with the Development; this is considered as a pragmatic solution to enable meaningful assessment of cumulative impacts". JNCC disagree with this statement, see above point; any projects with vessel routes that may intersect with the Greater Wash SPA (plus 2km buffer) may have in-combination effects with the proposed Northern Endurance Partnership Projects.	Cumulative project list to be considered within the ES has been agreed with stakeholders and has considered projects as suggested.	Appendix D: Cumulative Impact Assessment, project list
	Sofia OWF		
SOWF_1	Sofia Offshore Wind Farm ("SOWF") was developed and consented by the Forewind Limited Consortium and previously known as Dogger Bank Teesside B ("Teesside B"). The Dogger Bank Teesside A and B Offshore Wind Farm Order 2015 ("the DCO") was granted on 4 August 2015 and came into force on 26th August 2015. The Forewind Limited consortium disbanded and since August 2017, Innogy Renewables UK Limited ("innogy"), now RWE Renewables, has held 100% ownership of SOWF under a new subsidiary, Sofia Offshore Wind Farm Limited ("SOWFL").	This reference has been updated within Chapter 4: Environment Description.	Chapter 4: Environment Description Chapter 5: EIA Methodology
SOWF_2	Sofia Offshore Wind Farm achieved a positive financial investment decision from RWE in March 2021 and onshore construction commenced in June 2021. Construction activities on the Sofia offshore cable corridor will commence in Q2 2023 and are due to be completed in 2024.	Information incorporated into Cumulative project list.	Appendix D: Cumulative Impact Assessment, project list
SOWF_3	Please note that a commercial crossing agreement will be required to be in place before any Works / activity in connection with the construction of your pipeline within the vicinity of the Sofia Offshore Wind Farm export cables.	Activity managed by bp project team. Not applicable to ES.	N/A
	East Riding of Yorkshire Council		
ERYC_1	Section 5.3 (Table 5.1): Runswick Bay Marine Conservation Zone should also be referenced in the list of designations which intersect the development or are adjacent to it.	All sites which will be directly intersected by the Development in some capacity are listed in Section 4.5 of the Environmental Description; this includes the Runswick Bay MCZ. All other designated sites within 50 km of the Development are also listed.	Chapter 4: Environment Description
ERYC_2	I would also like to share that I found the document quite difficult to read, with the grey text against a white background. It would be appreciated if a more contrasting colour choice could be used next time.	Use of bp template agreed with bp.	Throughout

	Natural England		
NE_1	The Scoping Report includes insufficient detail regarding the size and scale and nature of infrastructure, the methods of installation, and operation and maintenance requirements to enable Natural England to provide specific comment on the scope of the EIA for this proposal. Therefore, we would be unable to support areas being scoped out of the EIA at this stage, and are unable to confirm that the data collection proposed is sufficient to inform the ES.	Meeting held with Natural England during ES development (02/02/22). Discussed ES scope. NE noted that additional justification is required for any elements scoped out. -Particular reference to management processes/procedures/relevant legislation for e.g. waste management, vessel discharges to sea -Provide further clarity on linkage (or absence of linkage) between receptor and impact -Relate scoping out of impacts of underwater sound on seabirds back to designated sites and species Addressed in Chapter 5: EIA Methodology.	Chapter 3: Project Description Chapter 5: EIA Methodology
NE_2	*General Principles* Schedule 6 of The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 sets out the necessary information to assess impacts on the natural environment to be included in an Environmental Statement (ES),	The ES has been developed in line with the requirements of Schedule 6 of The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 and associated guidance	Throughout
NE_3	*General Principles* It will be important for any assessment to consider the potential cumulative effects of this proposal, including all supporting infrastructure, with other similar proposals and a thorough assessment of the 'in combination' effects of the proposed development with any existing developments and current applications. A full consideration of the implications of the whole scheme should be included in the ES. All supporting infrastructure and activities should be included within the assessment.	List of projects for cumulative impact assessment circulated to consultees for review and comment. During meeting (02/02/22), NE noted that the list was comprehensive and had not identified any additional projects. Whole scheme assessment is considered within Chapter 12: Whole Scheme Assessment.	Chapter 5: EIA Methodology Chapters 12: Whole Scheme Assessment
NE_4	*Ecological Aspects of an Environmental Statement* Natural England advises that the potential impact of the proposal upon features of nature conservation interest and opportunities for habitat creation/enhancement should be included within this assessment in accordance with appropriate guidance on such matters. Guidelines for Ecological Impact Assessment (EcIA) have been developed by the Chartered Institute of Ecology and Environmental Management (CIEEM) and are available on their website. EcIA is the process of identifying, quantifying and evaluating the potential impacts of defined actions on ecosystems or their components. EcIA may be carried out as part of the EIA process or to support other forms of environmental assessment or appraisal.	EIA methodology developed by reference to the Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment (CIEEM, 2022).	Chapter 5: EIA Methodology
NE_5	*Internationally Designated Sites* The ES should thoroughly assess the potential for the proposal to affect designated sites. Internationally designated sites (e.g. designated Special Areas of Conservation (SAC) and Special Protection Areas (SPA)) fall within the scope of the Conservation of Habitats and Species Regulations 2017 (as amended). In addition paragraph 176 of the National Planning Policy Framework requires that potential Special Protection Areas, possible Special Areas of Conservation, listed or proposed Ramsar sites, and any site identified as being necessary to compensate for adverse impacts on classified, potential or possible SPAs, SACs and Ramsar sites be treated in the same way as classified sites. Under Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended) and Regulation 28 of the Conservation of Offshore Habitats and Species Regulations 2017 (as amended) an appropriate assessment needs to be undertaken in respect of any plan or project which is (a) likely to have a significant effect on a European site (either alone or in combination with other plans or projects) and (b) not directly connected with or necessary to the management of the site.	All sites which will be directly intersected by the Development in some capacity are listed in Section 4.5 of the Environmental Description. All other designated sites within 50 km of the Development are also listed. Potential impacts on designated sites will be addressed as appropriate within each impact chapter.	Chapter 4: Environment Description Chapters 6 - 11 Impact assessment
NE_6	*Internationally Designated Sites* The ES should include a full assessment of the direct and indirect effects of the development on the features of special interest within these sites, and should identify such mitigation measures as may be required in order to avoid, minimise or reduce any adverse significant effects. The development site is within the following internationally designated nature conservation sites: • Southern North Sea Special Area of Conservation (SAC) • Greater Wash Special Protection Area (SPA) • Teesmouth and Cleveland Coast SPA • Teesmouth and Cleveland Coast Ramsar The development site lies adjacent to the following internationally designated nature conservation sites: • Humber Estuary SAC • Humber Estuary SPA • Humber Estuary Ramsar • Northumbria Coast SPA • Flamborough Head SPA • Flamborough Head SAC • European site conservation objectives are available on our internet site http://publications.naturalengland.org.uk/category/6490068894089216. • And for the Southern North Sea SAC on the JNCC internet site https://jncc.gov.uk/our-work/southern-north-sea-mpa	All sites which will be directly intersected by the Development in some capacity are listed in Section 4.5 of the Environmental Description. All other designated sites within 50 km of the Development are also listed. Potential impacts on designated sites will be addressed as appropriate within each impact chapter.	Chapter 4: Environment Description Chapters 6 - 11 Impact assessment
NE_7	*Habitats Regulations Assessment* If during the EIA process the potential for a Likely Significant Effect on the conservation objectives of the sites cannot be ruled out the competent authority for the licence/consent (MMO / Government Department) should undertake an Appropriate Assessment of the implications for the site in view of its conservation objectives. Noting recent case law (People Over Wind3) measures intended to avoid and/or reduce the likely harmful effects on a European Site cannot be taken into account when determining whether or not a plan or project is likely to have a significant effect on a site, therefore consideration is required at Appropriate Assessment. Natural England wishes to be consulted on the scope of the Habitats Regulations Assessment and the information that will be produced to support it and should be formally consulted on any Appropriate Assessment provided for the proposal (Regulation 63).	With the exception of soft start, no mitigation measures have been taken into account as part of the assessment on the SNS SAC.	Chapters 6 - 11 Impact assessment
NE_8	*Nationally Designated Sites, inc. Sites of Special Scientific Interest (SSSI) and Marine Conservation Zones (MCZ's)* The development site is within the following nationally designated nature conservation sites: • Holderness Inshore Marine Conservation Zone (MCZ) • Holderness Offshore MCZ The development site is adjacent to the following nationally designated nature conservation sites: • Dimlington Cliff Site of Special Scientific Interest (SSSI) • Teesmouth and Cleveland Coast SSSI • Easington Lagoons SSSI • Humber Estuary SSSI • Runswick Bay MCZ Although, as highlighted, the landfall of this proposal lies out with Dimlington Cliff SSSI and Teesmouth and Cleveland Coast SSSI, the onshore infrastructure (Zero Carbon Humber (ZCH) and Net Zero Teeside) lies directly within these sites. It is important that one permission is not predetermining the outcome of another. We would therefore expect to see information relating to the landfall and intertidal infrastructure highlighted within the ES.	Information on the landfall and intertidal infrastructure is presented in Chapter 3: Project Description and any predicted impacts are assessed in Section 6.9.1.	Chapter 3: Project Description Chapter 6: Seabed Disturbance
NE_9	*Nationally Designated Sites, inc. Sites of Special Scientific Interest (SSSI) and Marine Conservation Zones (MCZ's)* Sites of Special Scientific Interest (SSSIs)- Further information on the location of SSSIs and their special interest features can be found at www.magic.gov.uk. The ES should include a full assessment of the direct and indirect effects of the development on the features of special interest within the sites listed above and should identify such mitigation measures as may be required in order to avoid, minimise or reduce any adverse significant effects.	The potential for impacts on SSSIs is assessed in Section 6.9.2.3.	Chapter 6: Seabed Disturbance
NE_10	*Nationally Designated Sites, inc. Sites of Special Scientific Interest (SSSI) and Marine Conservation Zones (MCZ's)* Marine Conservation Zones - Marine Conservation Zones are areas that protect a range of nationally important, rare or threatened habitats and species. You can see where MCZs are located and their special interest features on www.magic.gov.uk. Factsheets that establish the purpose of designation and conservation objectives for each of the MCZ's are available at https://www.gov.uk/government/collections/marine-conservation-zone-designations-in-england The ES should consider including information on the impacts of this development on MCZ interest features, to inform the assessment of impacts on habitats and species of principle importance for this location. Further information on MCZs is available via the following link: http://publications.naturalengland.org.uk/category/1723382	The ES includes an MCZ assessment in Section 6.9.1.	Chapter 6: Seabed Disturbance
NE_11	*Protected Species - Species protected by the Wildlife and Countryside Act 1981 (as amended) and by the Conservation of Habitats and Species Regulations 2017 (as amended)* The ES should assess the impact of all phases of the proposal on protected species (including, for example, pinnipeds (seals), cetaceans (including dolphins, porpoises whales), fish (including seahorses, sharks and skates), marine turtles, birds, marine invertebrates, bats, etc.). Information on the relevant legislation protecting these species can be reviewed on the following link https://www.gov.uk/government/publications/protected-marine-species. Natural England does not hold comprehensive information regarding the locations of species protected by law, but advises on the procedures and legislation relevant to such species. Records of protected species should be sought from appropriate local biological record centres, nature conservation organisations, NBN Atlas, groups and individuals; and consideration should be given to the wider context of the site for example in terms of habitat linkages and protected species populations in the wider area, to assist in the impact assessment.	Relevant protected species have been considered in the Environmental Description section. Species are also discussed within impact chapters as appropriate.	Chapter 4: Environment Description
NE_12	*Protected Species - Species protected by the Wildlife and Countryside Act 1981 (as amended) and by the Conservation of Habitats and Species Regulations 2017 (as amended)* The conservation of species protected by law is explained in Part IV and Annex A of Government Circular 06/2005 Biodiversity and Geological Conservation: Statutory Obligations and their Impact within the Planning System. The area likely to be affected by the proposal should be thoroughly surveyed by competent ecologists at appropriate times of year for relevant species and the survey results, impact assessments and appropriate accompanying mitigation strategies included as part of the ES. In order to provide this information there may be a requirement for a survey at a particular time of year. Surveys should always be carried out in optimal survey time periods and to current guidance by suitably qualified and where necessary, licensed, consultants.	Relevant protected species have been considered in the Environmental Description section. Surveys have been completed to inform the ES. If further surveys are required these will be in line with relevant guidance. Species are also discussed within impact chapters as appropriate.	Chapter 4: Environment Description
NE_13	*Habitats and Species of Principal Importance* The ES should thoroughly assess the impact of the proposals on habitats and/or species listed as 'Habitats and Species of Principal Importance' within the England Biodiversity List, published under the requirements of S41 of the Natural Environment and Rural Communities (NERC) Act 2006. Section 40 of the NERC Act 2006 places a general duty on all public authorities, including local planning authorities, to conserve and enhance biodiversity. Further information on this duty is available here https://www.gov.uk/guidance/biodiversity-duty-public-authority-duty-to-have-regard-to-conserving-biodiversity.	Habitats and species of conservation importance within the Development area are considered throughout the Environmental Description section. Species and habitats will also be discussed within impact chapters as appropriate.	Chapter 4: Environment Description Chapters 6 - 11 Impact assessment
NE_14	*Habitats and Species of Principal Importance* Government Circular 06/2005 states that Biodiversity Action Plan (BAP) species and habitats, 'are capable of being a material consideration…in the making of planning decisions'. Natural England therefore advises that survey, impact assessment and mitigation proposals for Habitats and Species of Principal Importance should be included in the ES. Consideration should also be given to those species and habitats included in the relevant Local BAP.	Habitats and species of conservation importance within the Development area are considered throughout the Environmental Description section. Species and habitats are also discussed within impact chapters as appropriate.	Chapter 4: Environment Description Chapters 6 - 11 Impact assessment
NE_15	*Nationally Designated Landscapes* As the development site is adjacent to Spurn Heritage Coast, consideration should be given to the potential for direct and indirect effects upon this designated landscape and in particular the effect upon its purpose for designation within the environmental impact assessment.	Meeting held with Natural England during ES development (02/02/22). Discussed that the boundary of the EIA is activity seaward of the Mean Low Water Spring (MLWS), activity landward of the MLWS is permitted under the Development Consent Order (DCO) process. Noted that seaward of the MLWS, there will be no permanent infrastructure above the sea surface and no change to the current landscape or seascape and that during the temporary and localised installation phase, construction vessels will be used to install the Humber and Teesside pipelines. Natural England indicated that consideration is required during design evolution but that requirement is likely to fall away longer term.	Chapter 5: EIA Methodology
NE_16	*Landscape/Seascape and visual impacts* Natural England would wish to see details of local landscape character areas mapped at a scale appropriate to the development site as well as any relevant management plans or strategies pertaining to the area. The EIA should include assessments of visual effects on the surrounding area and landscape together with any physical effects of the development, such as changes in topography. The EIA should include a full assessment of the potential impacts of the development on local landscape character using landscape/seascape assessment methodologies. We encourage the use of Landscape and Seascape Character Assessment (LCA/SCA), based on the good practice guidelines produced jointly by the Landscape Institute and Institute of Environmental Assessment in 2013.	Meeting held with Natural England during ES development (02/02/22). Discussed that the boundary of the EIA is activity seaward of the MLWS, activity landward of the MLWS is permitted under the DCO process. Noted that seaward of the MLWS, there will be no permanent infrastructure above the sea surface and no change to the current landscape or seascape and that during the temporary and localised installation phase, construction vessels will be used to install the Humber and Teesside pipelines. Natural England indicated that consideration is required during design evolution but that requirement is likely to fall away longer term.	Chapter 5: EIA Methodology

NE_17	*Landscape/Seascape and visual impacts* In order to foster high quality development that respects, maintains, or enhances, local landscape / seascape character and distinctiveness, Natural England encourages all new development to consider the character and distinctiveness of the area, with the siting and design of the proposed development reflecting local design characteristics and, wherever possible, using local materials. The Environmental Impact Assessment process should detail the measures to be taken to ensure the building design will be of a high standard, as well as detail of layout alternatives together with justification of the selected option in terms of landscape impact and benefit.	Meeting held with Natural England during ES development (02/02/22). Discussed that the boundary of the EIA is activity seaward of the MLWS, activity landward of the MLWS is permitted under the DCO process. Noted that seaward of the MLWS, there will be no permanent infrastructure above the sea surface and no change to the current landscape or seascape and that during the temporary and localised installation phase, construction vessels will be used to install the Humber and Teesside pipelines. Natural England indicated that consideration is required during design evolution but that requirement is likely to fall away longer term.	Chapter 5: EIA Methodology
NE_18	*Landscape/Seascape and visual impacts* The assessment should also include the cumulative effect of the development with other relevant existing or proposed developments in the area. In this context Natural England advises that the cumulative impact assessment should include other proposals currently at Scoping stage. Due to the overlapping timescale of their progress through the planning system, cumulative impact of the proposed development with those proposals currently at Scoping stage would be likely to be a material consideration at the time of determination of the planning application.	Meeting held with Natural England during ES development (02/02/22). Discussed that the boundary of the EIA is activity seaward of the MLWS, activity landward of the MLWS is permitted under the DCO process. Noted that seaward of the MLWS, there will be no permanent infrastructure above the sea surface and no change to the current landscape or seascape and that during the temporary and localised installation phase, construction vessels will be used to install the Humber and Teesside pipelines. Natural England indicated that consideration is required during design evolution but that requirement is likely to fall away longer term.	Chapter 5: EIA Methodology
NE_19	*Landscape/Seascape and visual impacts* The assessment should refer to the relevant National Character Areas which can be found on our website. Links for Landscape / Seascape Character Assessment at a local level are also available on the same page. https://www.gov.uk/government/publications/seascape-assessments-for-north-east-north-west-south-east-south-west-marine-plan-areas-mmo1134 https://data.gov.uk/dataset/3fed3362-2279-4645-8aaf-c6b431c94485/mmo1037-marine-character-areas	Meeting held with Natural England during ES development (02/02/22). Discussed that the boundary of the EIA is activity seaward of the MLWS, activity landward of the MLWS is permitted under the DCO process. Noted that seaward of the MLWS, there will be no permanent infrastructure above the sea surface and no change to the current landscape or seascape and that during the temporary and localised installation phase, construction vessels will be used to install the Humber and Teesside pipelines. Natural England indicated that consideration is required during design evolution but that requirement is likely to fall away longer term.	Chapter 5: EIA Methodology
NE_20	*Water Quality* Increases in suspended sediment concentrations (SSC) during construction and operation (e.g. future dredging works) have the potential to smother sensitive habitats. The ES should include information on the sediment quality and potential for any effects on water quality through suspension of contaminated sediments. The EIA should also consider whether increased suspended sediment concentrations resulting are likely to impact upon the interest features and supporting habitats of the designated sites as listed above	Sediment quality in the Development area is described in Section 4.3.3. Potential impacts resulting from the resuspension and resettlement of sediments are addressed in Section 6.4.2.2, with any impacts on features of protected sites addressed in Section 6.9.	Chapter 4: Environment Description Chapter 6: Seabed Disturbance
NE_21	*Water Quality* Natural England notes that there is the potential for a brine solution to be discharged as a result of these proposals. The ES should include full details of this, including the likely composition of the brine the potential effects on water quality.	Composition of the displaced Outcrop Formation Water is included in Section 4.3.7. Potential effects on water quality are assessed within Section 8.4.4.	Chapter 8: Discharges to Sea and Formation Water Displacement
NE_22	*Water Quality* The ES should consider whether there will be an increase in the pollution risk as a result of the construction or operation of the development.	The risk of accidental events is assessed in Chapter 10: Accidental Events.	Chapter 10: Accidental events
NE_23	*Water Quality* For activities in the marine environment up to 1 nautical mile out at sea, a Water Framework Directive (WFD) assessment is required as part of any application. The ES should draw upon and report on the WFD assessment considering the impact the proposed activity may have on the immediate water body and any linked water bodies. Further guidance on WFD assessments is available here: https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters	Communication with NE, OPRED and the EA concluded that as the Net Zero Teesside (NZT) Power and Onshore Humber application WFD Assessments will include the CO_2 export pipeline corridor out to 1 NM, no additional WFD assessment will be included for the Development.	Chapter 5: EIA Methodology
NE_24	Air Quality The assessment should take account of the risks of air pollution and how these can be managed or reduced. Further information on air pollution impacts and the sensitivity of different habitats/designated sites can be found on the Air Pollution Information System (www.apis.ac.uk). Further information on air pollution modelling and assessment can be found on the Environment Agency website.	Air quality has been considered within Chapter 11: Atmospheric Emissions for the localised and temporary emissions associated with the jackup rig and vessel activity.	Chapter 11: Atmospheric Emissions
NE_25	*Climate Change Adaptation* The England Biodiversity Strategy published by Defra establishes principles for the consideration of biodiversity and the effects of climate change. The ES should reflect these principles and identify how the development's effects on the natural environment will be influenced by climate change, and how ecological networks will be maintained. The NPPF requires that the planning system should contribute to the enhancement of the natural environment 'by establishing coherent ecological networks that are more resilient to current and future pressures' (NPPF Para 174), which should be demonstrated through the ES.	An in-combination climate impact assessment has been conducted in Chapter 11: Atmospheric Emissions. The production of the Marine Plans is a key outcome / action for the English Biodiversity Strategy. Alignment with the relevant Marine Plans has been demonstrated.	Chapter 1: Introduction Chapter 11: Atmospheric Emissions Appendix E: Marine Plans: East and North East Marine Plans
NE_26	*Contribution to local environmental initiatives and priorities* Contribution to local environmental initiatives and priorities (e.g. Local Plan objectives for Green/Blue infrastructure, Marine Plan objectives, local initiatives): The ES should present how the proposed development relates to any such initiatives.	Alignment with the relevant Marine Plans has been demonstrated.	Chapter 1: Introduction Appendix E: Marine Plans: East and North East Marine Plans
NE_27	*Cumulative and in-combination effects* A full consideration of the implications of the whole scheme should be included in the ES. All supporting infrastructure should be included within the assessment. The ES should include an impact assessment to identify, describe and evaluate the effects that are likely to result from the project in combination with other projects and activities that are being, have been or will be carried out. The following types of projects should be included in such an assessment, (subject to available information): a. existing completed projects; b. approved but uncompleted projects; c. ongoing activities; d. plans or projects for which an application has been made and which are under consideration by the consenting authorities; and e. plans and projects which are reasonably foreseeable, i.e. projects for which an application has not yet been submitted, but which are likely to progress before completion of the development and for which sufficient information is available to assess the likelihood of cumulative and in-combination effects.	List of projects for cumulative impact assessment circulated to consultees for review and comment. During meeting (02/02/22), NE noted that the list was comprehensive and had not identified any additional projects. Whole scheme assessment is considered within Chapter 12: Whole Scheme Assessment.	Chapter 5: EIA Methodology Chapters 12: Whole Scheme Assessment Appendix D: Cumulative Impact Assessment, project list
	Maritime and Coastguard Agency		
MCA_1	The development area carries a significant amount of through traffic to major ports, with a number of important international shipping routes in close proximity. Attention needs to be paid to changes in vessel routing, particularly in heavy weather ensuring shipping can continue to make safe passage without large-scale deviations, and any reduction in navigable depth referenced to chart datum.	Further engagement held with MCA (meeting on 24/11/21 and subsequent emails) which led to agreement on the approach to Navigational Risk Assessment (NRA) given that the Development comes under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (rather than the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017). The resultant NRA is presented in Appendix M: NRA.	Appendix M: Navigational Risk Assessment
MCA_2	The Environmental Statement (ES) should supply detail on the possible impact on navigational issues for both commercial and recreational craft, specifically: ▪ Collision Risk ▪ Navigational Safety ▪ Visual intrusion and noise ▪ Risk Management and Emergency response ▪ Marking and lighting of site and information to mariners ▪ Effect on small craft navigational and communication equipment ▪ The risk to drifting recreational craft in adverse weather or tidal conditions ▪ The likely squeeze of small craft into the routes of larger commercial vessels.	Further engagement held with MCA (meeting on 24/11/21 and subsequent emails) which led to agreement on the approach to NRA given that the Development comes under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (rather than the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017). The resultant NRA is presented in Appendix M: NRA.	Appendix M: Navigational Risk Assessment
MCA_3	To support the ES, the MCA will expect the project to carry out a Navigation Risk Assessment (NRA) on the impact of the works on shipping and navigation. We note in section 6.5 the applicant's commitment to carry out an NRA, which will be provided to support the DCO application for the project. We would expect a hazard identification workshop to be held to bring together relevant navigational stakeholders for the area to discuss the potential impacts on navigational safety associated with the proposed development. The NRA should establish how the phases of the project are managed to a point where risk is reduced and considered to be 'as low as reasonably practicable' (ALARP). The NRA should be provided in support of the Shipping and Navigation ES chapter.	Further engagement was held with the MCA (including a meeting on 24/11/21 and subsequent emails) which led to agreement on the approach to NRA given that the Development comes under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (rather than the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017). The resultant NRA is presented in Appendix M: NRA.	Appendix M: Navigational Risk Assessment
MCA_4	Safe Under Keel Clearance (UKC) for the maximum drafts of vessel both observed and anticipated, from which a realistic UKC assessment should be undertaken. The MCA's Under Keel Clearance Policy paper can be found at the following link: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/373456/Under_Keel_Clearance_paper_May_14_-_FINAL.pdf	Further engagement was held with the MCA (including a meeting on 24/11/21 and subsequent emails) which led to agreement on the approach to NRA given that the Development comes under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (rather than the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017). The resultant NRA is presented in Appendix M: NRA.	Appendix M: Navigational Risk Assessment
MCA_5	Attention should be paid to cabling routes and where appropriate burial depth for which a Burial Protection Index study should be completed and, subject to the traffic volumes, an anchor penetration study may be necessary. If cable protection measures are required e.g., rock bags or concrete mattresses, the MCA would be willing to accept a 5% reduction in surrounding depths referenced to Chart Datum. This will be particularly relevant where depths are decreasing towards shore and potential impacts on navigable water increase. Where this is not achievable, the licencee must discuss further with the MCA and Trinity House.	Further engagement was held with the MCA (including a meeting on 24/11/21 and subsequent emails) which led to agreement on the approach to NRA given that the Development comes under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (rather than the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017). The resultant NRA is presented in Appendix M: NRA.	Appendix M: Navigational Risk Assessment
MCA_6	The likely cumulative and in combination effects on shipping routes should also be considered.	Further engagement was held with the MCA (including a meeting on 24/11/21 and subsequent emails) which led to agreement on the approach to NRA given that the Development comes under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (rather than the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017). The resultant NRA is presented in Appendix M: NRA.	Appendix M: Navigational Risk Assessment
MCA_7	The MCA would expect no effects to be scoped out of the assessment with regards to shipping and navigation, pending the outcome of the Navigation Risk Assessment and further stakeholder consultation. As a guideline, Marine Guidance Note 654 should be used, which although written for the offshore renewables industry, can be applied to any NRA: https://www.gov.uk/government/publications/mgn-654-mf-offshore-renewable-energy-installations-orei-safety-response	Further engagement was held with the MCA (including a meeting on 24/11/21 and subsequent emails) which led to agreement on the approach to NRA given that the Development comes under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (rather than the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017). The resultant NRA is presented in Appendix M: NRA.	Appendix M: Navigational Risk Assessment
MCA_8	Finally, we would expect emergency response arrangements to be considered as part of this project on the potential impacts to search and rescue (SAR) and emergency response in the area, to ensure there are no impacts on SAR operations.	Further engagement was held with the MCA (including a meeting on 24/11/21 and subsequent emails) which led to agreement on the approach to NRA given that the Development comes under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (rather than the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017). The resultant NRA is presented in Appendix M: NRA.	Appendix M: Navigational Risk Assessment
	Dogger Bank OWF		
DBWF_1	We note that the proposed pipeline routes will cross our Dogger Bank A (DBA) (previously known as Creyke Beck A), Dogger Bank B (DBB) (previously known as Creyke Beck B), and Dogger Bank C (DBC) (previously known as Teesside A), export cable routes. Please see attached the DBA, DBB and DBC export cable corridor shapefiles (the Dogger Bank C export cable corridor is also the Sofia export, see screenshot of the shapefiles below). We have not yet confirmed the exact export cable routeing for these projects. We note your proposed development schedule. DBWF plans to install the DBA export cable in 2022, the DBB export cable in 2023 and the DBC export cable in 2024 when you are planning to commence installation of the pipelines. There may be some overlap in these activities.	Cumulative project list to be considered within the ES has been agreed with stakeholders and has considered projects as suggested.	Appendix D: Cumulative Impact Assessment, project list

	Orsted		
Orsted_1	*NEP's offshore CO2 transport and infrastructure proposals* We note that your proposed offshore development works comprise: the installation, connection to seabed infrastructure and commissioning of two CO2 export pipelines; the installation of seabed infrastructure including manifolds and infield pipelines; the drilling of five CO2 injector wells and one Endurance Store monitoring well; the operation and maintenance of seabed infrastructure and pipelines; and the monitoring and management of the storage reservoir. Specific to the Endurance Store area the Scoping Report confirms the drilling of the wells is expected to commence in 2025, will be developed in one stage and will consist of five CO2 injector wells connected to the injection manifold with up to two wells connected per manifold slot. One monitoring well will be drilled to monitor the Endurance Store. Each well will have a wellhead and control module (tree) for CO2 injection, control and well monitoring, within a fishing friendly integrated frame. We request clarification on whether the above listed infrastructure is the maximum design scenario for the Endurance Store. If not, please clarify the likelihood for the need of additional infrastructure, what this would be and the programme for such installation.	Chapter 3: Project Description outlines the maximum design scenario for the infrastructure which is the subject of this ES. Any subsequent development will be assessed and consented separately. The ES aligns with the design scope presented within the Store Permit application.	Chapter 3: Project Description
Orsted_2	*Likely Significant Effect* We expect your assessment to fully consider the likely significant effect of your project on Hornsea Four. We note that, for consenting purposes the component parts of your project have been split up and are subject to separate applications, in some cases to different decision makers. We would ask you to ensure however that the Environmental Impact Assessment for each component part of the project fully assesses the impact of the whole project (part and parcel) on Hornsea Four.	The ES has been developed in line with the requirements of Schedule 6 of The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 and associated guidance. Interaction of the Development with other sea users is assessed within Chapter 9 Physical Presence Interactions. Whole scheme assessment is considered within Chapter 12: Whole Scheme Assessment.	Chapter 9: Physical Presence Interactions Chapters 12: Whole Scheme Assessment
Orsted_3	*Taking account of available information* You are required to take into account the available results of other relevant assessments. In this regards we would direct you to the Environmental Statement accompanying the Hornsea Four DCO application	The Hornsea Four DCO ES has been reviewed and taken into account in the cumulative impact assessments.	Chapter 6: Seabed Disturbance Chapter 7: Underwater Sound Chapter 9: Physical Presence Interactions
Orsted_4	*Alternatives and mitigation* As part of these processes we would expect you to fully investigate and report on different methodologies to install and monitor your proposed operations. As discussed with you previously we consider that there are methodologies available including some which have been acknowledged by the Oil & Gas Authority which could substantially reduce the adverse effects on Hornsea Four and we are happy to continue to explore these with you.	Chapter 2: Consideration of Alternatives presents the decision making process associated with the Development to arrive at the design scenario assessed within the ES.	Chapter 2: Consideration of Alternatives
	MoD		
MoD_1	I can confirm that the MOD has No Concerns regarding the proposals in the locations specified.	No further action required for the ES	N/A
	UKHO		
UKHO_1	The UKHO requires FIVE WEEKS advance notice of offshore activities to allow preparation of Admiralty Notices to Mariners. We should also be notified of any amendments to the existing installations as offshore work progresses (i.e. structure removal, structure height changes, new/altered aids to navigation) or any installation of new infrastructure. Following completion of offshore work, we require confirmation that the seabed is clear of debris, or details of the remaining debris/structures, before we can fully update our charts. Please send all notifications and correspondence to offshore.energy@ukho.gov.uk and SDR@ukho.gov.uk. The operator should also be advised to contact our Radio Navigation Warnings section 24 hours before offshore work is due to commence, Email: NavWarnings@UKHO.gov.uk, Tel: 01823 353448 (direct line) Fax: 01823 322352.	Activity managed by bp project team. Not directly applicable to ES. Environmental management and regulatory compliance processes considered within Chapter 13: Environmental Management.	Chapter 13: Environmental Management
UKHO_2	In addition to the requirements above can we request that the operator observes and adheres to the guidance outlined in Section 16. Marking of remains and safety zones, from the following document: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760560/Decom_Guidance_Notes_November_2018.pdf	Activity managed by bp project team. Not directly applicable to ES. Environmental management and regulatory compliance processes considered within Chapter 13: Environmental Management.	Chapter 13: Environmental Management
UKHO_3	Please also notify us of any installation, removal or changes to aids to navigation that you may be using.	Activity managed by bp project team. Not directly applicable to ES. Environmental management and regulatory compliance processes considered within Chapter 13: Environmental Management.	Chapter 13: Environmental Management
	The Wildlife Trust		
TWT_1	*Benthic Impacts* TWT is concerned that the proposed Humber Pipeline intersects with Holderness Inshore Marine Conservation Zone (MCZ) and Holderness Offshore MCZ, particularly regarding the impacts from rock dumping or concrete matressing. Our position is that cable and pipeline protection should not be permitted in MPAs. This is because protection such as rock dumping or concrete matressing causes: • Habitat loss, modification and changes in epifauna communities • Impacts for the lifetime of the project, placing the conservation objectives of MPAs at risk. In the case of MCZs, this would be contrary to the Marine and Coastal Access Act. • Impacts that can extend beyond the lifetime of the project, as cable protection can be challenging to decommission. Therefore it is often left in situ, We request that to avoid habitat loss within the two MCZs and consenting risk, pipeline rerouting should take place to avoid the sites. If the pipeline is not re-routed, we expect the Measures of Equivalent Environmental Benefit (MEEB) will be required. As outlined in draft Defra guidance1 on marine compensation, MEEB and compensation are to be treated to the same standard. Therefore, it is essential to develop MEEB which would ensure the coherence of the UK MPA network. TWT highlight that MEEB is extremely difficult to deliver for benthic habitats. We would be happy to engage in a further conversation in this area.	The MCZ assessments (Section 6.9.1) assume the worst case scenarios for rock placement and surface-laid pipeline within the protected sites and conclude that these are not expected to hinder the conservation objectives of either of the MCZs. The base case is that no rock placement will be required in the MCZs. Whilst it cannot be guaranteed that placement of rock placement will not occur within the MCZs, bp,as operator of NEP, has committed to minimising this as far as practically possible (Section 6.5.1).	Chapter 6: Seabed Disturbance
TWT_3	*Benthic Impacts* In terms of an MCZ assessment, TWT highlight that it is now standard practice for assessments to be to the same standard as an HRA assessment. This is further supported by Defra draft guidance which states “equal consideration of the effect of proposals should be given to all MPAs, regardless of the legislation they were designated under”.	This MCZ assessment follows the MMO (2013) Marine conservation zones and marine licensing guidance (Section 6.9.1).	Chapter 6: Seabed Disturbance
TWT_4	*Benthic Impacts* Outside of the MCZs, all efforts should be made to minimise impacts. This should include reduction of rock dumping or concrete mattressing only where necessary. We encourage novel approaches to protect free spanning pipelines which have minimal environmental impacts.	The measures developed to minimise impacts on the seabed are presented in Section 6.5.1.	Chapter 6: Seabed Disturbance
TWT_5	*Benthic Impact* s Micro-siting will also be an important exercise to avoid impacts on sabellaria reef and any areas identified as important to species such as ocean quahog.	Commitments regarding route optimisation and micro-siting are included in Section 6.5.1.	Chapter 6: Seabed Disturbance
TWT_6	*Marine Mammals* We agree that impacts on marine mammals could arise from seismic surveys, UXO clearance, drilling activity and shipping. It will be essential to assess impacts of these activities both alone and in-combination.	Assessment of potential underwater sound (UWS) impacts on marine mammals included within Chapter 7: Underwater Sound. The UWS chapter considers impacts from piling and seismic surveys. Consideration is also given to geophysical surveys. Impacts are considered individully and in combination with other projects, as per the list of projects identified in the cumulative impacts appendix.	Chapter 7: Underwater Sound
TWT_7	*Marine Mammals* We agree with the assessment of impacts against the marine mammals listed in the Scoping Report.	Noted.	N/A
TWT_8	*Marine Mammals* We'd like to highlight that the bottlenose dolphins found along the east coast of England have been identified as the same animals found in the Moray Firth Special Area of Conservation (SAC). This supports that the east coast of England is functionally linked habitat to this SAC. Careful assessment will be required.	Assessment of functionally linked habitat included within Chapter 7: Underwater Sound. The "Protected Sites" section of the UWS chapter reviews impacts on the bottlenose dolphin population from the Moray Firth SAC and provides justification for screening out.	Chapter 7: Underwater Sound
TWT_9	*Marine Mammals* As outlined in the scoping report, the proposed development is located within the Southern North Sea SAC. TWT envisage that mitigation will be required potentially for alone and almost certainly for in-combination underwater noise disturbance impacts. TWT has extensive experience of developing underwater noise mitigation plans with developers and would welcome a further discussion on this area of work.	Assessment of potential UWS impacts on marine mammals included within Chapter 7: Underwater Sound, considers mitigation. A specific assessment on the conservation objectives of the SNS SAC is included in the Underwater Sound chapter.	Chapter 7: Underwater Sound
TWT_10	*Marine Mammals* Finally, it is important that any seismic surveys undertaken as part of the evidence gathering stage must be subject to a HRA assessment. An EPS disturbance licence will also be required. TWT would welcome further engagement in any such assessments.	Environmental management and regulatory compliance processes considered within Chapter 13: Environmental Management.	Chapter 13: Environmental Management
TWT_11	*Other uncertainties* As Carbon Capture and Storage is a relatively new technology, TWT has a number of uncertainties about impacts on the marine environment. These include but are not limited to, disposal of spoils, impact of leaks of chemicals during construction of wells, and any leaks during transport and storage of CO2 during operation.	Disposal of spoils and potential impacts of leaks of chemicals during construction of wells are not novel to carbon capture and storage (CCS) projects, being associated with conventional oil and gas activity. Potential impacts are identified and assessed in Chapter 8: Discharges to Sea and Formation Water Displacement and Chapter 10: Accidental events. Any leaks associated with transport and storage of CO_2 during operation are identified and assessed in Chapter 10: Accidental Events.	Chapter 8: Discharges to Sea and Formation Water Displacement Chapter 10: Accidental Events
	RWE		
RWE_1	Figure 5.5 of the report shows infrastructure proximal to the proposed Northern Endurance Project. We note that the Dogger Bank South Offshore Wind Farm areas are not included in this figure, nor are the proposed developments mentioned in Section 5.4.2.2. It may be useful to reference the proposed developments and mention the cable routes and landfalls that will be required to facilitate grid connection, albeit at yet to be determined locations. I have provided a shapefile of our site boundaries in the hope that they may be of use to you. Further details of these developing projects can be found here: RWE successful in the UK Offshore Wind Leasing Round 4 by The Crown Estate. Given that our projects will be developing in parallel we would welcome the opportunity to maintain a collaborative dialogue with you as our plans develop to ensure that our projects can be delivered as sustainably as possible and with strategic alignment where beneficial.	Cumulative project list to be considered within the ES has been agreed with stakeholders and has considered projects as suggested.	Chapter 4: Environment Description Chapter 5: EIA Methodology Appendix D: Cumulative Impact Assessment, project list
RWE_2	We note that Figure 5.5 of the report and Section 5.4.2.2 makes no mention of the Sofia Offshore Wind Farm project which is presently under construction on the Dogger Bank. Further details of the project can be found here: https://sofiawindfarm.com/construction/. We understand that you are liaising with Sofia Offshore Wind Farm separately.	Cumulative project list to be considered within the ES has been agreed with stakeholders and has considered projects as suggested.	Chapter 4: Environment Description Chapter 5: EIA Methodology Appendix D: Cumulative Impact Assessment, project list
	OPRED		
OPRED_1	OPRED would like to emphasise the importance of the baseline survey data listed in Section 7 of the Scoping Report. The inclusion of the results from the supporting baseline surveys in the Environmental Statement (ES) will be vital to inform OPRED's assessment of the ES and subsequent determination.	Supporting baseline surveys of the Endurance Store area (Gardline, 2021a, 2021b) and the two pipeline routes (Gardline, 2022a, 2022b) have been used to support the environmental understanding of the Development area throughout the Environmental Description section.	Chapter 4: Environment Description
OPRED_2	The Scoping Report does not address the comments or concerns OPRED had communicated to BP in terms of predicted brine seepage (potentially hypersaline) at the Bunter Outcrop. As previously communicated, OPRED remains concerned that the proposed development concept actively considers seepage of brine at the Bunter Outcrop as an inevitable consequence of storing CO2 in the Endurance store. Information on the composition of the formation water which has the potential to seep was to be acquired from the drilling of a borehole at the Bunter Outcrop, however, recent discussions have indicated this will not happen until after submission of the ES. It is not clear from the Scoping Report how BP intend to address the previously communicated concerns in the intended ES submission. Section 6.3 states, 'Formation water displacement to the water column from the upper 300 m of the Bunter Sandstone formation at the Bunter Outcrop (Section 4.3) will be quantified, and its composition assessed,' but it is not clear how or when this work will be carried out.	Chapter 8: Discharges to Sea and Formation Water Displacement provides information on the composition of Outcrop Formation Water, results from the borehole and detailed modelling results.	Chapter 8: Discharges to Sea and Formation Water Displacement
OPRED_3	The ES must also set-out clearly how BP intend to monitor for any potential for seepage at the Bunter Outcrop and any corrective measures that would be put in place to prevent the potential for brine seepage	Chapter 3: Project Description provides a summary of the Monitoring Plan and the associated Corrective Measures Plan.	Chapter 3: Project Description
OPRED_4	The Scoping Report gives a commitment to assess the potential for impact on the conservation objectives of the SNS SAC but no further information is given on how this will be done. The ES must set-out how BP intend to mitigate any potential impacts on the SNS SAC and the other designated sites impacted. Cumulative impacts must also be considered. The use of rock within the SAC is discussed within Section 4, the impact of this should be assessed paying close attention to the following areas: • killing or injuring harbour porpoise (directly or indirectly); • preventing their use of significant parts of the site (disturbance / displacement); • significantly damaging relevant habitats; or • significantly reducing the availability of prey.	The potential impacts, including cumulative impacts, on the SAC and other protected sites are assessed in Section 6.9 and in Chapter 7: Underwater Sound.	Chapter 6: Seabed Disturbance Chapter 7: Underwater Sound
OPRED_5	*Background to the Development* The scope of the development of offshore CO2 transport and storage at Endurance store and associated infrastructure that the assessment and the ES is intending to cover should be clearly set-out including the volume of CO2 that is proposed to be injected and the anticipated store life.	Chapter 3: Project Description provides a summary of the Monitoring Plan and the associated Corrective Measures Plan.	Chapter 3: Project Description

OPRED_6	*Legislative and Policy Framework* BP should note the Offshore Energy Strategic Environmental Assessment is undertaken by the Department for Business, Energy and Industrial Strategy.	Reference made to Offshore Energy Strategic Environmental Assessment in Chapter 4.	Chapter 4: Environment Description
OPRED_7	*Development Description* The Scoping Report indicates that the design and configuration of the development proposal is likely to be refined as the design matures. BP should be aware that any change to the proposal in the storage permit application and the associated ES may trigger the EIA process again under Regulation 12 of the Offshore EIA Regulations.	Chapter 3: Project Description outlines the maximum design scenario for the infrastructure which is the subject of this ES. This maximum design scenario will not be exceeded but will be refined, and typically reduced, during subsequent design. Any subsequent development will be assessed and consented separately.	Chapter 3: Project Description
OPRED_8	*Development Description* The development concept will need to be described in the ES along with a description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) considered by BP and an indication of the main reasons for the option chosen.	Chapter 2: Consideration of Alternatives presents the decision making process associated with the Development to arrive at the design scenario assessed within the ES. Chapter 3: Project Description outlines the maximum design scenario for the infrastructure which is the subject of this ES.	Chapter 2: Consideration of Alternative Chapter 3: Project Description
OPRED_9	*Development Description* The purpose of the monitoring well is briefly discussed within the Scoping Report but not expanded upon. The purpose of the monitoring well, data likely to be gleaned and how it will be used should be clarified within the ES.	Chapter 3: Project Description outlines the maximum design scenario for the infrastructure which is the subject of this ES, including the monitoring well.	Chapter 3: Project Description
OPRED_10	*Operation* It is stated that "A measurement, monitoring and verification (MMV) plan for the Endurance Store will be developed and agreed with the OGA as part of the storage permitting process." The ES should clearly set-out the envisaged MMV plan. Similarly, the ES should set-out the envisaged Corrective Measures Plan and Post-Closure Plan.	Chapter 3: Project Description provides a summary of the Monitoring Plan and the associated Corrective Measures Plan.	Chapter 3: Project Description
OPRED_11	*Physical Environment* The observation of Sabellaria spinulosa, sponges and Arctica islandica needs to be expanded upon within the ES. The Scoping Report states that " Burrows were frequently observed at the Bunter Outcrop but it was determined that the seabed was unlikely to support the 'sea pen and burrowing megafauna communities' habitat". The ES should set-out how this determination was made.	Habitats and species of conservation importance within the Development area are considered throughout the Environmental Description section. This includes reference to the 'Seapens and burrowing megafauna' habitat, which has been determined using the JNCC SACFOR classification system for occurrence of burrows.	Chapter 4: Environment Description
OPRED_12	*Physical Environment* The potential impact of underwater noise on seabirds should not be scoped out of the EIA process due to "general absence of data".	Noise disturbance to seabirds has been assessed within Chapter 9: Physical Presence.	Chapter 9: Physical Presence Interactions
OPRED_13	*Atmospheric Emissions* The Scoping Report refers to different volumes of CO2 proposed to be stored at Endurance. The assessment should be in the context ofconsider the proposed development concept (including volume of CO2 that is proposed to be injected).	The volume of CO2 stored is presented in Chapter 3: Project Description. The Development context is considered in Chapter 1: Introduction and Chapter 11: Atmospheric Emissions.	Chapter 1: Introduction Chapter 3: Project Description Chapter 11: Atmospheric Emissions
OPRED_14	*Atmospheric Emissions* The ES must consider atmospheric emissions arising from operations as part of the development and in line with environmental protection objectives.	Chapter 11: Atmospheric Emissions assesses emissions associated with the life of the Development.	Chapter 11: Atmospheric Emissions
OPRED_15	*General* There are statements made throughout the Scoping Report with no reference or data to support those statements. Please ensure sources are provided in the ES where necessary.	References are included in the ES where required.	Throughout
OPRED_16	*General* There is limited information on site (Store) characterisation in the Scoping Report. The ES should detail the store characterisation. Also, there is limited information on any penetrations through the aquifer, the seal status and assurance process undertaken. These should also be provided in the ES.	Chapter 3: Project Description provides an overview of store characterisation and status of seal. Chapter 10: Accidental Events provides an overview of assurance process undertaken.	Chapter 3: Project Description Chapter 10: Accidental Events
OPRED_17	The salinity at the depth sampled, at the Outcrop, may be lower than at Endurance, however, the salinity of the sample taken at various depths is higher than the seawater average and the highest salinity is still 2.5 times that of average seawater. Whilst it is noted that BP state that this has increased the confidence that residual environmental impact of seepage of the brine at over an area of 1.4 km^2 is 'not significant', we wait to see the environmental assessment that substantiates the assertion.	Chapter 8: Discharges to Sea and Formation Water Displacement	Chapter 8: Discharges to Sea and Formation Water Displacement
OPRED_18	Does the modelling of expected seepage of brine at the Outcrop take account of the brine densities at different salinities and potential changes overtime? It would be beneficial to confirm what parameters and assumptions were made when modelling the expected seepage of brine.	The modelling has been conducted using computational fluid dynamics (CFD) software. The density of the liquids modelled is a key input for this type of software. Changes in this parameter over time affect the behaviour of the discharge.	Chapter 8: Discharges to Sea and Formation Water Displacement
OPRED_19	It is noted that BP believe that the seepage of the brine at the Outcrop would only be from seabed to 140 m TVDSS. What is the basis of that statement?	As CO_2 is injected into the Endurance Store it will increase the pressure within the Bunter Sandstone Formation, which will dissipate into the Greater Bunter Aquifer. As pressure dissipates through the formation, it could ultimately result in an increase in pressure at the Bunter Sandstone Outcrop which lies about 25 km from the Store area. Outcrop Formation Water has been displaced into the sea from the outcrop at this location over geological time, however, the pressure increases in the formation are likely to lead to increased displacement of Outcrop Formation Water into the sea at this location. Such pressure changes at the outcrop will not be instantaneous but will occur gradually over time as pressure dissipates through the formation. Geological modelling of the formation and outcrop anticipates pressure changes and associated Formation Water displacement may first occur at the outcrop approximately four years after first injection of CO_2 into the Endurance Store. If 100 Mt CO_2 is injected at Endurance, the increase in pressure is likely to lead to the ultimate displacement of Formation Water from the upper 140 m TVDss of the outcrop formation. This can be thought of as a simple mass balance. The total volume of Formation Water displaced at the outcrop will be equivalent to the pore volume of brine displaced within the Endurance Store by the injection of CO_2. The formation water column in the outcrop area (subject to potential displacement by Phase 1 injection) has been appraised by a shallow borehole (42/28-NEPBH1) in June 2022 with core, reservoir pressure, and fluid samples taken from depths down to 290 m TVDss.	Chapter 8: Discharges to Sea and Formation Water Displacement
OPRED_20	Could BP confirm the total volume of brine that is expected to seep at the Outcrop per day?	Up to a maximum of 1,600 m^3 per day	Chapter 8: Discharges to Sea and Formation Water Displacement
OPRED_21	Could BP also confirm that this is expected from between 6 to 10 years from first injection as previously indicated?	Dynamic simulation modelling based on seismic and well data for the area indicates that pressure effects will reach the outcrop approximately four years after first injection of CO_2 into the Endurance Store.	Chapter 8: Discharges to Sea and Formation Water Displacement
OPRED_22	We understand that the full water chemistry analysis is underway and note BP state that this has increased the confidence that residual environmental impact of seepage of the brine at over an area of 1.4 km2 is 'not significant'. We wait to see the environmental assessment that substantiates the assertion.	Chapter 8: Discharges to Sea and Formation Water Displacement	Chapter 8: Discharges to Sea and Formation Water Displacement
OPRED_23	In terms of the whole effluent toxicity tests, could BP explain the purpose of the tests, including what samples are being used and how the test results will inform the environmental assessment?	Samples of bore hole water have been collected from the maximum depth that water displacement is expected to occur. As salinity increases with subsurface depth this is considered to represent the worst case displaced brine. In addition a synthetic brine was prepared to replicate the composition of the bore hole water sample. The results presented are from the WET testing on the borehole water only. A range of long-term (chronic) and sensitive life stage tests have been conducted on 5 different phyla of marine organisms to reduce the uncertainty of the understanding of the potential ecotoxicity of the brine to marine species. As such it is possible by following ECHA endpoint guidance to apply an assessment factor of 10 to the lowest EC10 in determining the PNEC. This is the lowest assessment factor possible, and may only be used when the most extensive testing has been conducted.	Chapter 8: Discharges to Sea and Formation Water Displacement
	NFFO		
NFFO_1	The report broadly characterises the nature of the fisheries in the area and potential impacts to be assessed, with which we concur. Beyond ensuring that infrastructure is "fishing friendly" as stated in the report it will be necessary to have place arrangements for managing disruption to fisheries, good practice is applied in achieving pipeline burial and residual seabed marine hazards that remain post installation are appropriately managed.	Management and mitigation measures are in place to manage disruption to fisheries, such as the appointment of a Fisheries Liaison Office (FLO) and the routine monitoring and inspection surveys will identify seabed marine hazards that will be remediated as required. The worst case scenario for the impact on fisheries assumes that the pipelines will be surface laid for 90% of their length and buried and trenched where additional protection is necessary.	Chapter 9: Physical Presence Interactions
NFFO_2	As the report notes shellfisheries are important to the region and these species (crab lobster and scallops) should also be accounted for in the assessment which presently is centred on finfish species.	The assessment of impacts on commercial fisheries in Chapter 9: Physical Presence considers impacts to shell fisheries.	Chapter 9: Physical Presence Interactions
NFFO_3	We will wish to review and comment on the detailed assessment proposals for mitigating fisheries related impact in due course.	Noted.	Chapter 9: Physical Presence Interactions Chapter 13: Environmental Management
	MMO		
MMO_1	*Benthic Ecology* With respect to benthic ecology related receptors scoped in, the MMO agrees with the assessment of the relevant impact types (e.g., seabed disturbance) (Section 6).	Noted.	Chapter 6: Seabed Disturbance
MMO_2	*Benthic Ecology* When identifying the potential impact types to the seabed, the MMO advises that in addition to "seabed disturbance", "habitat loss and/or alteration" should be included as, for example, it is likely that some sediment habitats would change to hard bottom habitats where mattressing is required.	The Seabed Disturbance chapter includes the potential impacts from habitat loss/alteration.	Chapter 6: Seabed Disturbance
MMO_3	*Benthic Ecology* A summary of the outcomes of both desk-based and survey-based approaches are presented with respect to benthic ecology. This appears sufficiently detailed for a scoping report. Notably, information/data gaps have been identified through this process (Section 7) and such gaps are to be addressed through subsequent targeted survey approaches.	Supporting baseline surveys of the Endurance Store area (Gardline, 2021a, 2021b) and the two pipeline routes (Gardline, 2022a, 2022b) have been used to support the environmental understanding of the Development area throughout the Environmental Description section.	Chapter 4: Environmental Description
MMO_4	*Coastal Processes* The scope of the ES for the proposed project appears comprehensive in relation to coastal processes.	Noted.	Chapter 6: Seabed Disturbance
MMO_5	*Coastal Processes* Section 5.1 details the site specific geophysical and benthic surveys of the pipeline routes. This will inform future monitoring plans. Possible sediment transport and movement triggers and directions are also identified.	Noted.	Chapter 6: Seabed Disturbance
MMO_6	*Coastal Processes.* It is noted that the summary of desk-based and other survey outcomes is presented in detail. A preliminary assessment of metocean conditions for the Endurance Store area and Teesside Pipeline route was undertaken in 2020.	Noted.	Chapter 6: Seabed Disturbance
MMO_7	*Coastal Processes.* Modelled surface currents, near-bed current directions and sea-surface temperatures along the Teesside Pipeline route have been used. However, no statistical accuracy assessment is provided. A statistical accuracy assessment of the modelled data should be provided.	The modelled data consists of estimates of extreme wave and current conditions which will be provided as "posterior predicted" values. This means that the extrapolated uncertainty will be included in the design values. An allowance for measurement uncertainty will also be included in the estimates of extreme wave and current conditions.	Chapter 4: Environmental Description
MMO_8	*Coastal Processes.* The Applicant has stated that the Endurance Store is located approximately 105 km from the UK/Dutch median line and any possible transboundary impacts will be considered by the EIA. This should be considered in the ES.	Transboundary impacts have been considered within the impact assessment chapters (Chapters 6: Seabed Disturbance - 11: Atmospheric Emissions).	Chapter 6 - 11 Impact Assessment
MMO_9	*Fish Ecology and Fisheries.* The project description is clearly presented, although it is noted that some aspects of the infrastructure and construction methods have not been finalised at this early stage of the planning process.	Noted. Where there are outstanding decisions to be made, the possible alternatives have been clearly described and the option which represents the worst case impact is assessed within the specific impact assessment chapters.	Chapter 3: Project Description

MMO_10	*Fish Ecology and Fisheries.* Fish will be scoped into the EIA which is appropriate. Section 5.2.3 ('Fish') has identified that the Endurance Store area is within a nursery area for cod, whiting, herring, lemon sole, sandeel, sprat, anglerfish, blue whiting, mackerel, hake, and spurdog. It has also been recognised that the Endurance Store area overlaps spawning grounds for the following species: plaice, sandeel, cod, lemon sole, sprat and whiting. The summary of information presented on fish is very high level but is generally acceptable for a scoping report. The MMO have provided some additional comments on specific fish receptors that require special consideration by the Applicant for the EIA.	Noted.	Chapter 4: Environmental Description
MMO_11	*Fish Ecology and Fisheries.* The MMO has a number of recommendations for additional data sources and impact pathways for the EIA. The NEP study area overlaps the Banks herring spawning grounds near Flamborough head, as shown in Coull et al. (1998) and Ellis et al. (2012). Herring and their eggs and larvae are sensitive to noise and vibration from anthropogenic activities such as piling and dredging. The effects of high levels of noise on fish can include one or more of the following biological, physiological, and morphological impacts: • Swim bladder rupture or tissue damage • Behavioural responses (avoidance of areas affected by increased noise) • Physical injury • Auditory tissue damage (including temporary and permanent hearing loss) • Physiological responses (stress, health and overall wellbeing) • Mortality	Assessment of potential UWS impacts on fish included within Chapter 7: Underwater Sound.	Chapter 7: Underwater Sound
MMO_12	*Fish Ecology and Fisheries.* Therefore, disturbance to herring during their spawning season (August to October inclusive for the Banks herring population) has the potential to impact on the overall health of the stock. On this basis, the MMO recommends that suitable underwater noise modelling for any noisy construction activities is carried out to inform the impact assessment for herring. Underwater noise modelling should be based on a stationary receptor (rather than a fleeing receptor), using the thresholds described in Popper et al. (2014). The impact range noise contours should be presented in mapped form, overlaid onto a 'heatmap' of 10 years of International Herring Larval Survey (IHLS) data in order to provide a visual representation of the extent and therefore likely significant of the impact on the herring spawning ground.	Assessment of potential UWS impacts on fish included within Chapter 7: Underwater Sound. UWS modelling was undertaken to assess impacts on both fish and marine mammals. This is included in an Appendix and a summary of the results are presented in the UWS chapter. Modelling results indicated that impacts on fish will be very limited and thefore impacts on fish have been assessed accordingly within the chapter.	Chapter 7: Underwater Sound
MMO_13	*Fish Ecology and Fisheries.* Herring require a specific substrate on which to spawn, consisting of gravel and similar habitats (e.g. coarse sand, maerl, shell) where there is a low proportion of fine sediment and well-oxygenated water. The seabed area surrounding Flamborough Head is currently considered to be the main site of spawning activity for the Banks herring population and has sediments comprised of coarse sand and gravels that provide a suitable substrate on which herring can lay their eggs. Disturbance to herring spawning habitats caused by construction activities (e.g., dredging, sandwave clearance, and laying of pipelines and subsea cables) has the potential to cause significant impacts to spawning herring and their eggs are larvae due to the direct damage and disturbance to spawning herring and their habitat, and the temporary localised increases in suspended sediment concentrations (SSC) and smothering of spawning habitats arising from seabed disturbance. Increased SSC can affect fish in a number of ways: • Damage to gills as a result of erosion of the mucus coating and abrasion of tissue (Redding and Schreck, 1982). The extent of damage depends on size and shape of particles, suspended sediment concentration, water velocity and gill dimensions (Appleby and Scarratt, 1989). • Disruption of gaseous exchange by fine particles which bind with the gill epithelium and clog gill rakers and filaments. • A reduction in feeding and foraging effort by visual predators as a result of increased turbidity (Henley et al. (2000). • An increase in respiration and heart rate (Redding and Schreck,1982) • Smothering of benthic foraging grounds by settlement of sediment. • Smothering of benthic eggs and larvae by settlement of sediment. • Reduced oxygen levels in water due to release of sediments containing high organic matter. • Exposure to contaminants contained within dredged sediment. • Resuspension of sediments resulting from dredging can smother organisms and hinder growth, feeding and survival rates. (Gilmour 1999).	Information on the herring spawning potential in the Development area is presented from the site-specific surveys and other relevant publications (Section 4.4.3). The potential for direct and indirect impacts on herring spawning is assessed in Section 6.4.2.	Chapter 6: Seabed Disturbance
MMO_14	*Fish Ecology and Fisheries.* The MMO recommends that the Applicant follows the aggregate industry Atlantic herring potential spawning habitat assessment (MarineSpace 2013) as part of the EIA to determine the extent and significance of impact resulting from construction of the NEP project on herring spawning grounds. Using site-specific Particle Size Analysis (PSA) data, the MarineSpace approach can be used to assess herring spawning habitat significance in the NEP storage area and along the pipeline corridor routes. We also recommend that this approach is supplemented with 10 years of IHLS data.	Information on the herring spawning potential in the Development area is presented from the site-specific surveys and other relevant publications (Section 4.4.3).	Chapter 6: Seabed Disturbance
MMO_15	*Fish Ecology and Fisheries.* Cod are also considered to be more sensitive to noise compared to other fishes because they have a swim bladder that terminates close to the ear. Therefore, there is concern that noise from construction activities at the NEP site may disturb spawning aggregations of adult fish. Accordingly, the underwater noise assessment and modelling should also include cod, and the current state of North Sea cod stocks and the importance of the surrounding spawning and nursery grounds require consideration as part of the assessment, to determine the potential impacts of noise on this species.	A review of the primary species of commerical importance across the Development with regards to sensitivity to underwater noise has been provided in Section 4.4.3 of the Environmental Description; this includes details of species swim bladders etc. Assessment of potential UWS impacts on fish included within Chapter 7: Underwater Sound.	Chapter 7: Underwater Sound
MMO_16	Fish Ecology and Fisheries. Sandeels are an ecologically important prey species for other marine fish, marine birds and marine mammals and are also fished commercially in the southern North Sea. The NEP project area is situated within sandeel habitat, and therefore is also within sandeel spawning and nursery grounds as the species generally spawn where they are found. Sandeels lie dormant in the sediment during the autumn/winter period (Beherns et al. 2007, Greenstreet et al. 2010) and will be more vulnerable during this period to disturbance of the sediment through piling, seabed preparation and pipeline laying activities. The MMO recommends that the Applicant follows the aggregate industry sandeel habitat suitability assessment (MarineSpace 2013) as part of the EIA to determine the extent and significant of impact resulting from construction of the NEP project on sandeel habitat. Using site-specific Particle Size Analysis (PSA) data, the MarineSpace approach can be used to assess sandeel habitat significance in the NEP storage area and along the pipeline corridor routes.	A sandeel and herring habitat suitability assessment is described in Chapter 4: Environmental Description.	Chapter 4: Environmental Description.
MMO_17	*Fish Ecology and Fisheries.* Given the high-level nature of scoping reports it is difficult to know whether the EIA will provide adequate and robust assessments of all the potential impacts and specific receptor species that require particular attention in the ES.	A robust impact assessment has been provided in the impacts assessment chapters (Chapters 6: Seabed Disturbance - 11: Atmospheric Emissions).	Chapter 6 - 11 Impact Assessment
MMO_18	*Fish Ecology and Fisheries.* The literature and data sources proposed for use in the desk-based assessment are all appropriate. The MMO has cited a number of additional resources for use in the assessment which are recommended to ensure that the assessment is as robust as possible.	Additional resources cited are incorporated into Chapter 4: Environmental Description.	Chapter 4: Environmental Description.
MMO_19	*Fish Ecology and Fisheries.* The overall approach to EIA for fish receptors will take the form of a desk-based assessment using existing peer-reviewed literature and fisheries data. This approach is acceptable, and no additional fisheries-specific surveys are required as there are adequate suitable data and resources available to inform the characterisation of the environment for fish and the EIA.	Noted.	Appendix N: Fishing Intensity Study
MMO_20	*Fish Ecology and Fisheries.* The overall approach to EIA (Section 3.3) is considered reasonable. However, it is unclear how receptor sensitivity, and the magnitude and significant of impacts will be assessed as this has not been discussed in the report.	Chapter 5: EIA Methodology contains methodology applied for assessment of receptor sensitivity, and the magnitude and significant of impacts.	Chapter 5: EIA Methodology
MMO_21	*Fish Ecology and Fisheries.* According to Section 7 (Supporting Studies), the requirement for an underwater noise modelling assessment is made on a case-by-case basis depending on installation activities and Endurance Store MMV plan activities. It is therefore unclear at this stage whether underwater noise modelling to predict the extent of impact to fish species will be undertaken. However, the MMO considers that underwater noise modelling will be required as part of the EIA process to determine the extent of noise for any piling and seismic surveys required for the project.	Assessment of potential UWS impacts on fish included within Chapter 7: Underwater Sound.	Chapter 7: Underwater Sound
MMO_22	*Fish Ecology and Fisheries.* The scoping report states that transboundary impacts will be considered in the EIA, which is appropriate. While it may be the case that transboundary impacts from general construction and pipeline laying activities are unlikely to result in transboundary impacts, there is potential for impacts of noise from seismic surveys and piling in the offshore area to affect waters of other European nations, therefore the MMO would expect the potential transboundary impacts of noise on fisheries and fish ecology to be considered in the EIA.	Impacts on fish have been assessed in Chapter 7: Underwater Sound. Modelling undertaken indicates that impacts on fish will be highly localised.	Chapter 7: Underwater Sound
MMO_23	*Shellfish.* Further information is required for the baseline characteristics of the proposed site. The Applicant has included data collected from site specific surveys but has only included information on those species with highest abundance, those which use the area as a nursery ground or are on the OSPAR vulnerable/declining list. A list or table should be included detailing all species identified during these surveys. Where site specific surveys are conducted using non shellfish specific gear (e.g., beam trawl/otter trawl), shellfish abundance should not be used; presence/absence data only should be used for shellfish as the gear is not designed to capture shellfish species. This caveat should be included when using this data.	A full list of species observed during surveys across the Development area has been provided as an Appendix to the ES, and is referred to in Section 4.4.3 of the Environmental Description.	Chapter 4: Environmental Description
MMO_24	*Shellfish.* The Applicant has identified species present at the proposed site and has included information on UK landings data from the MMO. Information on landings per species, per year should be included in a table for ease of comparison.	Information on landings per ICES rectangle, per species, per year has been included in Chapter 4: Environmental Description. Per an additional request from the MMO a table of all shellfish species caught across the NEP Development area was included, providing both value and landed weight per species (and as a percentage of the total value and landings of each ICES Rectangle as a whole).	Chapter 4: Environmental Description
MMO_25	*Shellfish.* A combination of scientific literature has been used, together with site specific surveys and landings data to inform the scoping report. This is considered an appropriate evidence base.	Noted.	Chapter 6: Seabed Disturbance Chapter 9: Physical Presence Interactions Appendix N: Fishing Intensity Study
MMO_26	*Shellfish.* Scientific names for species should be used at least once to avoid confusion with species of a similar common name. In instances where common names are used for species, the full common name should be included as a minimum - for example instead of 'Scallop', to refer to 'King Scallop', if that is what is referred to.	Noted.	Throughout
MMO_27	*Shellfish.* Habitat change/habitat loss should be scoped into the ES as a potential impact on shellfish.	Potential impacts on shellfish (direct and indirect) are assessed in Section 6.4.2.	Chapter 6: Seabed Disturbance
MMO_28	*Shellfish.* Underwater noise has been included for assessment in the ES, however it is unclear if this will be assessed in relation to brown crab. Recent literature has found evidence on underwater noise changing the behaviour of brown crabs (Scott et al, 2021), and as such any potential underwater noise impacts on brown crab should be assessed in the ES.	The literature has been reviewed and incorporated to consider potential impacts in relation to underwater sound.	Chapter 7: Underwater Sound
MMO_29	*Shellfish.* A largely complete scoping report in relation to shellfish impacts has been provided. However, further detail is required on identifying the full baseline characteristics of the proposed site and some additions are required to potential impacts scoped into the ES.	Comment addressed within Chapter 4: Environmental Description and Chapter 6: Seabed Disturbance.	Chapter 4: Environmental Description
MMO_30	*Underwater Noise.* Section 6.2 of the Scoping Report details the activities or sources of noise within the scope of the underwater noise assessment in the ES: repeated geophysical/geotechnical surveys to monitor the Endurance Store, installation vessel thrusters, piling, and detonation of unexploded ordnance (UXO) if encountered and required to be removed.	Noted.	Chapter 7: Underwater Sound
MMO_31	*Underwater Noise.* Section 6.2 identifies marine mammals as sensitive marine receptors to be scoped into the underwater noise assessment and states that noise modelling will be employed to characterise the received levels for the sensitive marine receptors under consideration in which potentially significant impacts have been identified (i.e. potential for injury or significant disturbance). This modelled data will then be combined with the functional hearing ranges of sensitive marine receptors, as well as the potential auditory thresholds for disturbance and injury (as detailed in Southall et al., 2007; Southall et al., 2019 and NOAA, 2018) to identify the potential disturbance and injury ranges surrounding the Development's activities.	Noted.	Chapter 7: Underwater Sound

MMO_32	*Underwater Noise.* Impacts on seabirds from underwater noise have been scoped out of the ES due to the general absence of data on underwater hearing in birds (Popper and Hawkins, 2012) and given that the seabirds in the Development area are not expected to rely heavily on underwater hearing for the majority of their behaviours (Section 6.2). The MMO defers to the relevant SNCBs as to whether or not this is appropriate.	Noted - seabirds remain scoped out from the ES UWS chapter.	Chapter 7: Underwater Sound
MMO_33	*Underwater Noise.* Section 5.2.3.1 states that a number of commercially important fish species occur in the vicinity of the Endurance Store area which is located in a nursery area for: herring Clupea harengus, lemon sole Microstomus kitt, sandeel Ammodytes marinus, sprat Sprattus, anglerfish Lophius piscatorius, blue whiting Micromesistius poutassou, mackerel Scomber scombrus, European hake Merluccius merluccius, spurdog Squalus acanthias; and in a high intensity nursery area for: cod Gadus morhua and whiting Merlangius merlangus (Coull et al., 1998; Ellis et al., 2012). The Endurance Store is located within spawning grounds for the following species: cod, lemon sole, sprat, whiting; and overlaps a high intensity spawning location for plaice Pleuronectes platessa and sandeel. Section 7 mentions criteria for fish species groups (Popper et al., 2014) with regards to underwater noise modelling, however it is unclear whether fish receptors have been scoped into the underwater noise assessment. Fish have varying sensitivity to underwater noise; all fishes can detect particle motion and many fishes are also able to detect sound pressure via the gas bladder or other gas-filled structures (Popper et al., 2014). Therefore, the MMO recommends that fish be included as a sensitive marine receptor to be scoped into the underwater noise assessment and the appropriate auditory thresholds within Popper et al. (2014) should be used within the assessment.	A review of the primary species of commerical importance across the Development with regards to sensitivity to underwater noise has been provided in Section 4.4.3 of the Environmental Description; this includes details of species swim bladders etc. Assessment of potential UWS impacts on fish included within Chapter 7: Underwater Sound.	Chapter 7: Underwater Sound
MMO_34	*Underwater Noise.* The appropriate evidence base for marine mammal auditory thresholds contained within Southall et al. (2007), Southall et al. (2019) and NOAA (2018), have been identified. Please see paragraph 4.8.4 above regarding the appropriate evidence base that should be used for fish receptors. Details of any underwater noise modelling and model parameters should be clearly reported within the ES.	UWS modelling reported in Chapter 7: Underwater Sound and supported by Appendix J.	Chapter 7: Underwater Sound
MMO_35	*Underwater Noise.* The methodology for the underwater noise assessment is presented clearly in Sections 6.2 and 7, i.e., that modelled data will be combined with the functional hearing ranges of sensitive marine receptors, as well as the potential auditory thresholds for disturbance and injury to identify the potential disturbance and injury ranges surrounding the proposed development’s activities. The overall EIA assessment methodology needs to be included, i.e., how effects and significance are assessed, including the significance of residual effects.	UWS modelling and assessment reported in Chapter 7: Underwater Sound and supported by Appendix J.	Chapter 7: Underwater Sound
MMO_36	*Underwater Noise.* Section 6.2 states that noise modelling will simulate the source pressure level and frequency ranges of the Development activities, within the conditions of the surrounding environment, to identify how noise will propagate through the water column. Functional hearing ranges along with the potential auditory thresholds for disturbance and injury will be taken from Southall et al. (2007), Southall et al. (2019) and NOAA (2018). These data sources are appropriate for marine mammal receptors.	Noted.	Chapter 7: Underwater Sound
MMO_37	*Underwater Noise.* Section 7 states that relevant criteria for fish species groups will be taken from Popper et al. (2014), which is an appropriate data source for fish receptors (please see paragraph 4.8.4 above regarding the requirement to scope sensitive fish receptors into the underwater noise assessment).	Noted.	Chapter 7: Underwater Sound
MMO_38	*Underwater Noise.* Section 6.8 states that the Endurance Store is located approximately 105 km from the UK/Dutch median line and any possible transboundary impacts (e.g. accidental releases) will be considered by the EIA. Any underwater noise effects that could potentially have transboundary impacts on sensitive marine receptors should be identified and considered in the ES.	UWS modelling and assessment reported in Chapter 7: Underwater Sound and supported by Appendix J.	Chapter 7: Underwater Sound
MMO_39	*Underwater Noise.* In summary regarding underwater noise: - Fish should be included as a sensitive marine receptor to be scoped into the underwater noise assessment and the appropriate auditory thresholds within Popper et al. (2014) should be used within the assessment. - The overall EIA assessment methodology should be included, i.e., how effects and significance are assessed, including the significance of residual effects. - Details of any underwater noise modelling and model parameters should be clearly reported within the ES. - The potential disturbance from increases in underwater noise throughout the water column need to be considered (i.e., not just above MLWS).	UWS modelling and assessment reported in Chapter 7: Underwater Sound and supported by Appendix J.	Chapter 7: Underwater Sound
MMO_40	*Seabed/Land/Soil Quality.* Regardless of the likely method of construction, the MMO would have expected some discussion of sediment quality in the report, both at the proposed landfall sites and throughout the proposed cable routes. Certain trenching methods may require either side-casting, backfilling or other relocation of disturbed sediment. On this basis, we consider that the scope is currently inadequate, and recommend that sediment quality for dredge and disposal be scoped into the EIA if there is likely to be any potential disposal or relocation of disturbed sediment.	Sediment quality, based on the presence of contaminants as described within site specific survey reports, has been described throughout Section 4.3.3 of the Environmental Description.	Chapter 4: Environmental Description
MMO_41	*Seabed/Land/Soil Quality.* It is not clear from the report whether sediment quality for dredge and disposal is being taken forward for assessment. The only reference to contaminants is in section 5.1.6 – Water Quality. Whilst water quality can provide some information relevant to sediment quality, it is not likely to be appropriate to formulate conclusions about sediment quality. It is difficult to ascertain whether sediment quality for dredge and disposal should be scoped into the EIA given that construction methods are as yet not finalised.	Water quality, based on the presence of contaminants as described within site specific survey reports, has been described throughout Section 4.3.3 of the Environmental Description.	Chapter 4: Environmental Description
MMO_42	*Cumulative Impacts & In-Combination Impacts .* Section 6.8 states that the potential for the Development to act cumulatively or in combination with other offshore, nearshore or onshore projects will be considered in the ES – including the NZT and ZCH (Humber Low Carbon Pipelines) projects and other relevant partner projects above the MLWS. Disturbance to wildlife through underwater noise from multiple locations/projects excluding animals from a significant proportion of their foraging range will be considered. The potential disturbance from increases in underwater noise throughout the water column needs to be considered (i.e., not just above Mean Low Water Springs).	UWS modelling and assessment reported in Chapter 7: Underwater Sound and supported by Appendix J.	Chapter 7: Underwater Sound
MMO_43	*Cumulative Impacts & In-Combination Impacts.* The proposed approach to CIA is a desk-based study utilising available consenting documents written for each of the developments, gathering of data sources such as Explore Marine Plans as well as consultation with other developers to understand timelines and potential cumulative interactions. The approach to CIA seems appropriate.	Noted.	Chapter 6 - 11 Impact Assessment Appendix D: Cumulative Projects List
MMO_44	*Mitigation.* No mitigation/monitoring measures have been identified in this report. A separate section detailing the marine physical processes monitoring and schedule would be helpful in identifying potential triggers. Whilst drafting the monitoring plan information should be added on the mitigation strategies to mitigate the potential risks.	Management and mitigation measures with respect to seabed disturbance are presented in Section 6.5.	Chapter 6: Seabed Disturbance
MMO_45	*Mitigation.* Mitigation and monitoring measured for fish have not been proposed at this stage. The requirement for mitigation and monitoring should be determined on the outcomes of the EIA, where adverse impacts to receptor groups or species have been identified.	UWS modelling and assessment reported in Chapter 7: Underwater Sound and supported by Appendix J. Mitigation measures are included in the UWS chapter.	Chapter 7: Underwater Sound
MMO_46	*Mitigation.* There is potential for significant impacts to occur on some fish receptors (e.g. herring and cod) as a result of noise and vibration and disturbance to habitats. If noise impact range contours from underwater noise modelling indicate that noise is likely to overlap the spawning grounds, then suitable mitigation measures will need to be considered such as temporal and or spatial restrictions.	UWS modelling and assessment reported in Chapter 7: Underwater Sound and supported by Appendix J.	Chapter 7: Underwater Sound
MMO_47	*Mitigation.* There are no proposed mitigation and monitoring measures for underwater noise, however the MMO notes in Section 6 that ‘During the EIA and preparation of the ES, the potential for the occurrence of the issues and associated level of significance will be assessed and possible mitigation measures identified’. We consider this to be appropriate.	UWS modelling and assessment reported in Chapter 7: Underwater Sound and supported by Appendix J.	Chapter 7: Underwater Sound
MMO_48	*Conclusion.* The MMO advises that the topics highlighted in this informal scoping advice should be assessed during the EIA process and the outcome of these assessments should be documented in the ES. This statement, however, should not necessarily be seen as a definitive list of all EIA requirements. Given the scale and programme of these planned works other work may prove necessary.	Noted.	Throughout
	MMO comments on fishing intensity study		
MMO_49	More accurate and recent data on the intensity of herring spawning activity can be acquired by downloading International Herring Larval Survey (IHLS) data from ICES. This can be viewed at the following link: https://www.ices.dk/data/data-portals/Pages/Eggs-and-larvae.aspx?msclkid=ffa06b32c6f511ec88725674c1f88417;	Figures illustrating IHLS herring larval abundance data (covering years 2007 – 2018) from Boyle and New (2018) were reviewed and are described in Section 5 of the Fishing Intensity Study report.	Appendix N: Fishing Intensity Study
MMO_50	Figure 3-2 states: “Average annual landings value (£) (2015-2019) by ICES rectangle (MMO, 2020)”. It appears that one of the legends is incorrect and should be “Average landings (£) per ICES rectangle by species (2015-2019)”.	The legend has been amended to “Average landings (£) (2015 to 2019) per ICES rectangle by vessel length, fishing method and species”.	Appendix N: Fishing Intensity Study
	MMO comments on cumulative projects list		
MMO_51	*MMO GIS software search* In reviewing this document, the MMO has undertaken its own searches using an internal Geographic Information System (GIS) software that is not publicly available, to identify active marine licences and various other infrastructure in the area. The results of these searches are set out in Appendix 1 to this letter. The MMO’s searches were confined to projects in the immediate area of the proposed works, or within 2km radius and Appendix 1 is not a full list of projects that should be considered for cumulative assessment. However, given their proximity to the Development, any projects/infrastructure set out in in Appendix 1 which have not been identified in the cumulative assessment document should also be considered for cumulative/in-combination impacts with the Development, in accordance with the precautionary principle. In preparing Appendix 1, the MMO has sought to identify which projects/infrastructure listed in that document have not been identified in the cumulative assessment document.	Appendix 1 has been reviewed and projects screened into the long list of projects presented in Appendix D.	Appendix D: Cumulative Impact Assessment, project list
MMO_52	MMO GIS software search It is noted that some of the infrastructure referred to in Appendix 1 has not been fully identified – for example various pipelines and cables are shown by the MMO’s GIS searches to be within the area but there is insufficient information to identify them fully. It will be NEP’s responsibility to ensure that all such infrastructure is fully identified and considered in the cumulative assessment. If NEP has any difficulty in identifying any of the infrastructure or projects referred to in Appendix 1, please approach the MMO for assistance.	Where it has not been possible to identify infrastructure or projects, the MMO have been approached for assistance.	Appendix D: Cumulative Impact Assessment, project list
MMO_53	*MMO GIS software search* The cumulative assessment should consider any potential impacts at planning and operational stages. Potential impacts from decommissioning should also be considered (if this is proposed). We advise that initially all projects in the relevant study area are initially screened in, before undertaking a screening exercise which identifies the specific nature and timing of the activities at each site	The list of projects for cumulative impact assessment has been circulated to stakeholders, to ensure the list is sufficiently extensive. Comments have been incorporated into the long list of projects presented in Appendix D.	Appendix D: Cumulative Impact Assessment, project list
MMO_54	*MMO GIS software search* In Appendix 1 MMO has identified multiple marine licences in relation to a single large project (such as an offshore windfarm). In such cases it is acceptable to consider cumulative impacts with the large project as a whole rather than considering each marine licence individually, although all relevant elements of the large project must be taken into account in the cumulative assessment.	This is the approach adopted by the Development.	Appendix D: Cumulative Impact Assessment, project list
MMO_55	In identifying oil and gas infrastructure for consideration NEP should seek advice from the BEIS and the Crown Estate (TCE). Similarly, in identifying pipelines, subsea cables, aggregate extraction areas and offshore wind farms and their locations, NEP should make use of the most recent data layers from TCE and seek their advice.	This is the approach adopted by the Development.	Appendix D: Cumulative Impact Assessment, project list
MMO_56	The MMO notes that NEP in identifying which projects to include for cumulative assessment has said: *“New projects with vessel routes north of the Humber only have been selected as these represent those projects with the greatest potential for interaction with the Development; this is considered as a pragmatic solution to enable meaningful assessment of cumulative impacts.”* Given that the Humber Corridor makes landfall immediately to the north of the Humber and given the scope for impacts to travel over significant distances (including in respect of underwater noise and vibration) the MMO does not believe it is appropriate only to consider projects/ vessel routes north of the Humber. Projects/vessel routes south of the Humber should also be considered.	The list of projects for cumulative impact assessment has been circulated to stakeholders, to ensure the list is sufficiently extensive. Comments have been incorporated into the long list of projects presented in Appendix D.	Appendix D: Cumulative Impact Assessment, project list
MMO_57	The criteria listed on page 7 of the Projects for Cumulative Assessment document indicates the types of projects NEP intends to include in the cumulative impacts assessment. However, it is unclear 1) why the focus was placed only on these specific criteria, and 2) what types of projects within the area were excluded. NEP should provide clarification on this. It would be particularly useful if the NEP could provide a list of any projects (or broad categories of projects) in the vicinity of the proposed development that are not proposed to be taken through to the cumulative impacts assessment and indicate why NEP does not consider these projects to be a concern from a cumulative impact perspective. In the absence of suitable justification, the MMO would expect all projects within the relevant study area to be considered for cumulative impact, in accordance with the precautionary principle.	The list of projects for cumulative impact assessment has been circulated to stakeholders, to ensure the list is sufficiently extensive. Comments have been incorporated into the long list of projects presented in Appendix D.	Appendix D: Cumulative Impact Assessment, project list

MMO_58	It is also stated at page 7 that existing infrastructure with a seabed footprint within the Holderness Inshore Marine Conservation Zone (MCZ) and the Holderness Offshore MCZ have been included for cumulative assessment. Infrastructure in other MCZs in the vicinity should also be considered. In particular it is noted that Runswick Bay MCZ overlaps/is immediately adjacent to the Teesside Corridor – any infrastructure in this MCZ should be included in the cumulative assessment. We understand that at this stage the specific nature, scale and timings of the offshore activities at each site is not yet known, and as such it is difficult to reach a clear conclusion on the potential for in-combination impacts with other projects (which may also be in the development stage at this point) but this must be kept under review as the proposals develop.	It is demonstrated in Chapter 6: Seabed Disturbance that there is no potential for the Development to impact within the Runswick Bay MCZ other than some possible minor and temporary indirect impacts from sediment resuspension. There are no direct impacts predicted (the site lies outside of the maximum extent of seabed disturbance from pipelay vessel anchors). Therefore, this MCZ has been screened out from further assessment, including the cumulative impact assessment.	Chapter 6: Seabed Disturbance
MMO_59	NEP makes reference in the Projects for Cumulative Assessment document to having made use of the MMO website to identify up-coming projects of relevance. We expect that the reference to the MMO website here is to the MMO's Public Register, which is a useful resource in viewing marine licences, and also marine licence applications which are being consulted upon. However, we suggest that NEP also makes use of publicly available data on Explore Marine Plans https://explore-marine-plans.marineservices.org.uk/ where there is a large amount of useful data available, interrogating the various layers under the Map Data tab.	The list of projects for cumulative impact assessment has been circulated to stakeholders, to ensure the list is sufficiently extensive. Comments have been incorporated into the long list of projects presented in Appendix D.	Appendix D: Cumulative Impact Assessment, project list
MMO_60	*Fisheries/shellfish and underwater noise* The Projects for Cumulative Assessment document refers to using different search radiuses for different types of project/infrastructure, with the largest search radius used being 50km. Cefas has advised that this may not be sufficient for consideration of underwater noise/vibration impacts. The effects of noise and vibration generated by piling from offshore construction (e.g., ports/harbours and offshore windfarms) are likely to attenuate over large distances greater than 50km and may have impacts and effects on fish during critical life stages - i.e., during spawning or migration. It is recognised that the NEP project is in its early planning stages, therefore the requirements for noise-generating activity such as piling as part of the construction activities may not yet be known. The Projects for Cumulative Assessment document does not set out any detail regarding proposed methodology for the works, although it does refer to drilling. It is noted that the Scoping Report previously submitted to the MMO under case reference EIA/2021/00038 also referred to the potential for piling and detonation of Unexploded Ordnance (UXO). In the event that piling is required for NEP, then the potential for cumulative effects caused by an overlap/concurrent piling activity at other offshore projects in the Central North Sea region should be considered and assessed accordingly.	UWS modelling and assessment reported in Chapter 7: Underwater Sound and supported by Appendix J. Assessment informed by projects identified in Appendix D: Cumulative Impact Assessment, projects list.	Appendix D: Cumulative Impact Assessment, project list Chapter 7: Underwater Sound
MMO_61	*Fisheries/shellfish and underwater noise* It is also noted that the works are proposed to take place within the Southern North Sea Special Area of Conservation (SAC). The SAC is designated for harbour porpoise (Phocoena phocoena), which is sensitive to underwater noise. The Joint Nature Conservation Committee (JNCC) has advised, for the purposes of identifying whether there is an Adverse Effect on Site Integrity (AEOI), that noise disturbance that impacts or is within an SAC from a plan/project, individually or in combination with other plans and projects, is considered to be significant if it excludes harbour porpoises from more than: - 20% of the relevant area of the site in any given day; or - an average of 10% of the relevant area of the site over a season. These are known as daily and seasonal thresholds respectively. Further information can be found in the following guidance document: SACNoiseGuidanceJune2020.pdf (publishing.service.gov.uk) BEIS ORPED should have regard to these thresholds when making a determination on any activity that impacts on or is within the Southern North Sea SAC. In considering this it would be necessary to take into account not only the noise disturbance which would be caused by the Development, but that which would be caused by other projects and proposed projects within or impacting on the SAC, to establish any in-combination impacts. The MMO would intend to draw this to the attention of BEIS ORPED in the event that it is consulted in relation to this application.	UWS modelling and assessment reported in Chapter 7: Underwater Sound and supported by Appendix J. Assessment informed by projects identified in Appendix D: Cumulative Impact Assessment, projects list.	Appendix D: Cumulative Impact Assessment, project list Chapter 7: Underwater Sound
MMO_62	*Coastal processes* It is not currently possible to comment on which projects/infrastructure should be included in the cumulative assessment from a coastal processes perspective, without further detail about the regional sediment transport pathways. The MMO would advise NEP to ensure all projects/infrastructure located within the largest regional sediment transport cell are considered in the cumulative assessment.	Following detailed desk based assessment, justification is provided within the Coastal processes assessment and the Seabed Disturbance chapters for the use of maximum tidal excursion (mean tide) to screen projects into the cumulative assessment for coastal processes.	Chapter 6: Seabed Disturbance Appendix G: Coastal Processes Assessment

Appendix C: Commitments Register

APPENDIX C: NEP COMMITMENTS REGISTER

Section	Issue	Mitigation or management action
EIA METHODOLOGY		
5.5	Water Framework Directive	The Onshore Humber DCO application will include a Water Framework Directive assessment for the CO_2 export pipeline corridor out to 1 NM.
SEABED DISTURBANCE		
6.5.1	Seabed disturbance	Pipeline route optimisation will be conducted where reasonably practical to minimise impacts on potential features of conservation interest.
6.5.1	Seabed disturbance	Pre-installation survey data will be utilised to aid design of an anchor plan for the pipelay vessel, with an objective to avoid potential features of conservation interest, where reasonably practical.
6.5.1	Seabed disturbance	Stakeholder consultation e.g. with fisheries and statutory nature conservation bodies will continue to be conducted as part of detailed design to address areas of stakeholder concern and draw on a wide expertise with regard to potential sensitivities.
6.5.1	Seabed disturbance	The requirement for pre-installation sweeping and dredging will be minimised as far as reasonably practical.
6.5.1	Seabed disturbance	The nearshore trench spoil ridge will be present for as short a time as reasonably practical in order to minimise sediment losses and impacts on southwards longshore sediment transport at Humber. Post-lay survey will confirm the spoil ridge has dispersed.

Section	Issue	Mitigation or management action
6.5.1	Seabed disturbance	Taking into account relevant engineering considerations for pipeline stability and protection, the volume and placement of rock armour and concrete mattresses will be reviewed during detailed design to reduce the seabed footprint to the extent that is reasonably practical.
6.5.1	Seabed disturbance	It cannot be guaranteed that placement of rock will not occur within the MCZs, bp, as operator of NEP, will attempt to minimise this as far as reasonably practical.
6.5.1	Seabed disturbance	Rock will not be placed landward of 10 m LAT at the Humber landfall.
6.5.1	Seabed disturbance	The spread of rock during placement will be reduced through use of a fall-pipe system as far as reasonably practical. Side stone rock dumping vessel may be utilised in shallower water.
6.5.1	Seabed disturbance	Prior to commencement of works, agreement on requirements will be reached with consultees for any pre-installation onshore beach survey at both of the pipeline landfall sites.
6.5.1	Seabed disturbance	A Beach Monitoring and Management Plan will be agreed with the Local Authority and relevant consultees, as required.
6.5.1	Seabed disturbance	Upon completion of construction and installation activities, all landfall installation equipment, including any beach cofferdam, working platform and temporary access route infrastructure at the Humber landfall will be removed and the beach will be reinstated to pre-construction condition, as far as reasonably practical. These activities will be agreed with relevant parties as part of the Beach Monitoring and Management Plan.
6.5.1	Seabed disturbance	Prior to commencement of works, agreement on requirements will be reached with consultees for any post-installation surveys required to assess whether the sites have been returned to their pre-installation state, as far as reasonably practical.
6.5.1	Seabed disturbance	Any spoil generated from seabed sweeping will be deposited at pre-agreed locations outwith the Runswick Bay MCZ, Holderness Inshore MCZ, Holderness Offshore MCZ and Greater Wash SPA.

Section	Issue	Mitigation or management action
6.5.1	Seabed disturbance	Rock armour may be required at certain locations to ensure adequate protection of the pipelines and pipeline stability.
6.5.1	Seabed disturbance	Pipeline depth of cover in the nearshore and landfall zones will be sufficient to provide protection over the Development lifetime in light of coastal erosion and climate change.
6.5.1	Seabed disturbance	Wherever possible and as far as reasonably practical, material removed from trenches will be re-used.
6.5.1	Seabed disturbance	A decommissioning philosophy has been developed during the Front End Engineering Design phase of the Development and will be revised during detailed design. Decommissioning will be performed in line with regulatory requirements at the time.
6.5.2	Seabed disturbance	Temporary Archaeological Exclusion Zones (AEZ) will be implemented as required during installation activities around recorded wreck sites identified within the Development area.
6.5.2	Seabed disturbance	An avoidance strategy will be implemented, where reasonably practical, for any features of possible archaeological interest that are of uncertain origin.
6.5.2	Seabed disturbance	A Protocol for Archaeological Discoveries (PAD) will be put in place for the Development during installation/construction activities.
6.5.2	Seabed disturbance	In any cases where avoidance of archaeological receptors is inappropriate or impossible, any damage will be offset using methods agreed in consultation with the Archaeological Curator (Historic England).
UNDERWATER SOUND		
7.6	Underwater Sound	Activities associated with the Development will align, as required, with: - JNCC guidance for minimising the risk of injury to marine mammals from geophysical surveys (seismic survey guidelines): JNCC, 2017; and

Section	Issue	Mitigation or management action
		- Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise: JNCC, 2010.
DISCHARGES TO SEA AND FORMATION WATER		
8.5	Discharges to sea	WBM will be recycled as far as reasonably practical to reduce discharges.
8.5	Discharges to sea	Only WBM will be discharged for the drilling of the riser-less sections. For the sections drilled with riser in place, and with LTOBM, the drilling fluid will be managed within a contained circulation system.
8.5	Discharges to sea	No discharge of LTOBM or LTOBM contaminated cuttings to sea.
8.5	Discharges to sea	The use and/or discharge of all chemicals offshore will be subject to environmental risk assessment and permitting under the Offshore Chemical Regulations (OCR), with appropriate assessment and identification of relevant measures to reduce risk including chemical selection procedures as part of this process.
8.5	Discharges to sea	Chemicals 'posing little or no risk to the environment (PLONOR) will be selected wherever practical. Where practical, alternatives to chemicals carrying substitution notifications will be sought; if a sub-warning chemical is the only option, technical justifications will be provided in chemical permit applications.
8.5	Discharges to sea	In line with permit requirements, chemical usage and discharge will be recorded and reported.
8.5	Discharges to sea	A pre-drilling audit will be conducted to ensure that the operations are carried out in compliance with all relevant guidelines and legislation.
8.5	Formation water displacement	A Monitoring Plan will include components that monitor formation water displacement at the outcrop and is being submitted as part of the Store Permit Application for Endurance
PHYSICAL PRESENCE		

Section	Issue	Mitigation or management action
9.5.1	Increased vessel traffic and collision risk	Consent to Locate will be in place for the drilling operations.
9.5.1	Increased vessel traffic and collision risk	Standby vessel(s) will operate on site for the duration of drilling operations. Guard vessel(s) will support the pipelay vessels, as required.
9.5.1	Increased vessel traffic and collision risk	Establishment of temporary 500 m safety zone around the drilling rig during drilling operations.
9.5.1	Increased vessel traffic and collision risk	In line with the HSE Operations Notice 54, Establishment of safety zones for sub-sea installations, the Development will apply for safety zones under The Petroleum Act 1987 at the wellheads, manifolds and nearshore SSIV locations. Future applications shall be subject to consultation with interested parties.
9.5.1	Increased vessel traffic and collision risk	As required by subsequent submissions e.g. Pipeline Works Authorisation and Screening Directions, consultation will be undertaken with relevant authorities and organisations, including fisheries.
9.5.1, 9.5.2, and 9.5.3	Increased vessel traffic and collision risk and temporary and long-term exclusion	Information on the drilling and installation operations will be provided to operators of vessels through standard United Kingdom Hydrographic Office (UKHO) communication channels such as Kingfisher Bulletin, Notice to Mariners and radio navigation warnings.
9.5.1	Increased vessel traffic and collision risk	Compliance with Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS).
9.5.1, 9.5.2, and 9.5.3	Increased vessel traffic and collision risk and temporary and long-term exclusion	Appointment of a Fisheries Liaison Officer (FLO) and development of a fisheries liaison strategy.
9.5.1, 9.5.5 and 9.5.6	Increased vessel traffic and collision risk, disturbance and collision risk to marine	A Vessel Management Plan will be in place.

Section	Issue	Mitigation or management action
	mammals and disturbance to birds	
9.5.2, 9.5.3	Temporary and long-term exclusion and snagging risk	Rock berms will be designed to be fishing friendly e.g. 1:3 slide slope.
9.5.2 and 9.5.3	Temporary and long-term exclusion and snagging risk	Subsea infrastructure within the Endurance Store will be designed to industry standards such as NORSOK U001 / ISO 13628-1 trawl load standards.
9.5.2 and 9.5.3	Temporary and long-term exclusion and snagging risk	UKHO and the Kingfisher database will be provided with information on all infrastructure.
9.5.3	Snagging risk	Maintenance and pipeline route survey inspections will be carried out during the Development lifetime to determine the condition of the pipelines and minimise any snagging risks. If overtrawl trials are required along pipelines following survey effort, relevant stakeholders will be consulted on the methodology.
9.5.3	Snagging risk	Standby vessel(s) will operate on site for the duration of drilling operations. Guard vessels will be utilised where a risk assessment indicates that they are required to mitigate the risk of fishing interaction with infrastructure that has been installed but has not yet been protected.
9.5.4	Dropped objects	Potential for dropped objects will be minimised via: - Lift planning will be undertaken to manage risk during lifting activities and all lifting equipment will be tested and certified; - All deck items will be securely stowed; - All equipment and material on vessels will be adequately stowed and seafastened; - Transfers of objects will use specialist equipment and consider environmental conditions; and - Procedures will be put in place to determine and record the location of any lost material and to support recovery of any significant dropped objects.

Section	Issue	Mitigation or management action
9.5.4	Dropped objects	The pipeline spools are to be protected, which minimises the possibility of a dropped object causing damage. Concrete mattresses are the base case method of protection, however rock placement or purpose built structures may be utilised.
9.5.4	Dropped objects	In the vicinity of the subsea infrastructure at the Endurance Store, pre- and post-installation surveys will be undertaken. 'As-built' surveys will be performed along the pipelines, which will include identification of any significant dropped objects along the routes and at the Endurance Store.
9.5.5 and 9.5.6	Disturbance to marine mammals and disturbance to birds	Relevant personnel will receive targeted environmental awareness training.
ACCIDENTAL EVENTS		
10.3.3	Diesel Release Risks	Combined operations of vessels during pipelay and construction are to be expected for a project of this magnitude. These will be carefully coordinated and managed to reduce any risk of collision or allision resulting in a release of hydrocarbons to sea.
10.3.3	Diesel Release Risks	Prior to a vessel mobilizing to work on the Development, vessels will either undergo an Offshore Vessel Inspection Database (OVID) or a Common Marine Inspection Documents (CMID) inspection in line with industry standards. Assurance activities will also be conducted in line with the bp internal vessel assurance system.
10.3.3	Diesel Release Risks	Navigational risk assessments and appropriate notifications to mariners will be made prior to any activities occurring that may cause navigational issues (e.g. pipelay, jackup jacked down offshore).
10.3.3	Diesel Release Risks	The jackup rig (while on location drilling) will have an OPEP in place that has been approved by the relevant UK authorities; all vessels will have similarly approved Shipboard Oil Pollution Emergency Plans (SOPEPs) in place.

Section	Issue	Mitigation or management action
10.3.3	Diesel Release Risks	The OPEPs/SOPEPs will contain actions to be taken in the event of a release and will be scalable to deal with releases of different volumes of diesel.
10.3.3	Diesel Release Risks	Offshore training drills will be conducted to evaluate the response readiness of all staff and equipment to an oil spill event.
10.3.3	Diesel Release Risks	Appropriate contracts will be in place to facilitate a response to a release should an event occur – as is routine for all marine vessel activities.
10.5.6	CO_2 Leakage Risk	The Monitoring Plan proposed for Endurance Store includes targeted monitoring at key locations such as legacy well bores to identify signs of CO_2 releases leaks and this supplements the planned seismic monitoring to detect the presence of CO_2 within the formations.
10.5.6	CO_2 Leakage Risk	The Monitoring Plan will also incorporate periodic environmental surveys of the Endurance Store area using mobile platforms (ships/AUVs) to assess any long-term changes in marine environments or ecosystems.
10.5.6	CO_2 Leakage Risk	A suite of seabed monitoring solutions to detect CO_2 emissions into the water column will be employed.
10.5.6	CO_2 Leakage Risk	The Corrective Measures Plan will detail any measures that would be taken to prevent or stop the leakage of CO_2 from the storage complex. The measures will be described in detail in the Corrective Measures Plan and will be submitted as part of the Store Permit Application.
10.6.4	Hypersaline Store Formation Water Release Leakage Risk	The Monitoring Plan proposed for the Endurance Store includes targeted monitoring at key locations such as legacy well bores. Monitoring will be conducted to identify any indication of brine leakage.
10.6.4	Hypersaline Store Formation Water Release Leakage Risk	The Corrective Measures Plan which will be submitted as part of the Store Permit Application, will describe in detail measures that would be taken to prevent or stop the release of brine.

Section	Issue	Mitigation or management action
ATMOSPHERIC EMISSIONS		
11.6	Atmospheric Emissions	Drilling operations will be carefully planned to optimise the vessel fleet and the duration of operations, which will subsequently reduce the quantity of emissions generated.
11.6	Atmospheric Emissions	All vessels and rigs employed during installation and drilling activities will be required to comply with the Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2014.
11.6	Atmospheric Emissions	Vessel Common Marine Inspection Documents (CMID) or Offshore Vessel Inspection Database (OVID) and HSE assurance audits conducted to confirm whether that contracted vessels meet International Maritime Organisation (IMO)/ The International Convention for the Prevention of Pollution from Ships (MARPOL) and bp marine and HSE standards.
11.6	Atmospheric Emissions	bp to verify vessel use of low sulphur fuels in accordance with applicable UK regulatory requirements.
11.6	Atmospheric Emissions	Prior to a vessel mobilizing to work on the Development, bp marine assurance and mobilisation audit will be completed for all vessels and the jackup rig.
11.6	Atmospheric Emissions	As part of the selection process for the offshore engineering, procure, construct and install (EPCI) tendering, bidders are required to submit Sustainability Plans. These plans should include consideration of opportunities to reduce number of vessels, vessel days and to optimise vessel speeds to improve fuel efficiency and reduce atmospheric emissions where reasonably practical. Bidders will be evaluated, in part, against their plans submitted. There will also be a requirement for selected EPCI contractors to develop a 'Carbon Reduction Plan' that should include strategies for minimising equipment and materials transportation and reducing construction vehicle and vessel emissions, where reasonably practical. This may include green dynamic positioning or economical speeds when operationally appropriate
11.6	Atmospheric Emissions	bp will conduct assurance to verify that any Fluorinated-gases (F-gases) in vessel cooling systems are managed in accordance with applicable legislation (F-gas regulations as amended 2018 SI 98).

Section	Issue	Mitigation or management action
13.4	Environmental Management	A biodiversity enhancement assessment shall be completed for the Development. This assessment shall inform any requirements for a biodiversity enhancement action plan that shall be implemented during execution and operation of the Development as necessary. This assessment is in line with bp's biodiversity position (Sustainability Aim 16) which aims to achieve a net positive impact on biodiversity for new projects.

Appendix D: Projects For Cumulative Impact Assessment

APPENDIX D: LIST OF PROJECTS FOR CUMULATIVE IMPACT ASSESSMENT

To assist the assessment of cumulative and in-combination impacts in the Environmental Statement (ES) for the Development, a review of existing and forthcoming projects (including oil and gas, cables and renewables) that could have the potential to interact with the Development has been undertaken. These projects and associated project details are provided in Appendix D2 and shown on Figure 1 and Figure 2.

The process by which the final cumulative projects list was generated is described in Section 1.1, the layout of the list is described in Section 1.2 and the application of the list within the Environmental Impact Assessment (EIA) is summarised in Section 1.3.

1.1 Generation of the List of Projects for Cumulative Impact Assessment

Rather than considering all activities within the wider Southern North Sea (SNS) area, a decision was initially made to focus the cumulative assessment on projects that have the greatest potential for significant cumulative and/or in-combination interaction with the Development. The first iteration of the cumulative list was circulated amongst stakeholders for comment. Responses were taken into account and comments were incorporated into subsequent iterations of the cumulative list. Stakeholders to whom the initial cumulative list was circulated are as follows:

- Joint Nature Conservation Committee (JNCC);
- Marine Management Organisation (MMO);
- Natural England; and
- Offshore Petroleum Regulator for Environment and Decommissioning (OPRED).

Projects (at any stage of their life cycle, per the categories defined in Section 1.2 (in planning, consented, under construction, active, disused, dormant)) were selected for inclusion within the list if they, together with the Development, were likely to have a cumulative impact on any of the environmental or societal features characteristic of the Development area. These features are detailed in Chapter 4: Environment Description and are addressed within scope of the EIA.

As part of the stakeholder feedback sought on the cumulative list, the MMO requested additional clarification on the justification behind the compilation of the initial list. The following list aims to address this comment and provide a comprehensive outline of the process through which the final list was generated. The final cumulative list incorporates:

- Existing infrastructure with a seabed footprint within the Holderness Inshore Marine Conservation Zone (MCZ), the Holderness Offshore MCZ, and the Runswick Bay MCZ;
- Subsea cables, pipelines and other oil and gas infrastructure, power generation and carbon capture projects (if any) that may have a cumulative impact with the Development;
- Coastal projects within the vicinity of the Humber Estuary and the Tees Estuary and along the Holderness coast and the Teesside coast that may have a cumulative impact with the Development;

- In planning, consented and active offshore windfarms (OWFs) that have the potential to interact with seabirds within 510 km of the Flamborough and Filey Coast Special Protection Area (SPA) (per JNCC feedback, see text below);
- New projects (in planning, consented, or that will be under construction at the same time as the Development's installation activities) that may result in cumulative impacts with the Development due to increased vessel activity;
- Existing and proposed areas used for aggregate and mineral extraction which may have a cumulative impact with the Development;
- Existing areas used by the Ministry of Defence (MoD) which may coincide with the Development construction activities resulting in cumulative impacts; and
- Existing and historic areas used for disposal of spoil and dredged material which may be affected by the Development resulting in cumulative impacts.

The Tees Estuary and Humber Estuary are highly industrialised areas which generate a lot of vessel traffic. Vessels originating from Immingham, Grimsby or Teesport consequently pass through a number of designated sites en route. The Humber forms a high-density vessel route which bisects the Greater Wash SPA and the Humber Estuary Special Area of Conservation (SAC)/SPA and Teesport forms a high-density vessel route which bisects the Teesmouth and Cleveland Coast SPA. The JNCC provided feedback on the initial cumulative list and requested all projects within the Greater Wash SPA, and within a 2 km buffer of the site be included in the list. With regards to "large infrastructure" projects (e.g. OWFs), the JNCC requested that any such projects within 10 km of the SPA be included also. This aimed to capture the impact of vessel activity associated with these projects around the SPA.

The JNCC requested inclusion of all proposed and active OWFs within 510 km of the Flamborough and Filey Coast SPA. This distance is the maximum foraging range of northern gannets, a species for which the SPA is designated. Per this request, all such OWF projects within this distance range were included.

Through the consultation process, a number of operators provided up to date information and shapefiles for their respective projects. The MMO also provided a list of Marine Licence Applications and projects within 2 km of the Development. Review of this list resulted in a number of spoil/disposal sites being added to the list of projects to be considered within the cumulative impact assessment.

While Natural England did not provide a formal response on the cumulative list, they did advise that cumulative assessment was done on a receptor basis, rather than by project. This approach has been adhered to throughout the EIA, see Section 1.3.

1.2 Cumulative Projects List

The reference in the ID column corresponds to a location shown in Figure 1 (of the Teesside Pipeline route) and Figure 2 (of the Endurance Store and Humber Pipeline route). Please note, where "n/a" is listed under ID these projects are not shown on Figure 1 and Figure 2 as, due to distance, the scale of the figures is insufficient to show them.

Within the cumulative list, the project name is provided along with a brief description of the project, as well as the project status, based on the best available information. Project status indicates what stage the project is at within its lifecycle. The categories for project status are listed below with a brief explanation[1]:

- **In planning**: projects which are in the early stages of conception or have submitted applications but are yet to receive consent[2];
- **Consented**: projects which have received consent and/or are in the pre-construction phase;
- **Under construction**;
- **Active**: projects which have completed construction/installation and are in their operational phase;
- **Disused**: projects which are no longer in use or are decommissioned; and
- **Dormant**: projects which have an uncertain status, e.g. having been previously consented with no obvious recent activity/information available.

A high level 'Data Confidence Assessment' was made; this was categorised as low, medium or high. The confidence level reflects the certainty of the data upon which project description, timescales and status were based. Most projects which are at an early phase of development (i.e. the project status is in planning) have been assigned a low data confidence due to the lack of public information and the likelihood of project changes occurring prior to consent, in addition to changes in timescale.

The Development construction period is set to commence in 2024 through to 2026 – these dates are shown in red. The key for the project construction periods is as follows:

No activity on site	(white)
Construction period	(green hatched)
Operational	(green)
Decommissioning period	(yellow)
Decommissioned	(grey)

Finally, the cumulative list includes the distance and direction from each aspect of the Development (Endurance Store, Humber Pipeline, Teesside Pipeline) to each project identified. Instances in red indicate where a project is within 1 km of the Development or interacts/overlaps directly with the Development.

1.3 Consideration of Cumulative Impacts Within EIA

Once the cumulative list (Appendix D2) was generated, individual EIA chapter authors identified projects to be considered for inclusion as part of the cumulative impact assessment. Within each EIA chapter, the process and justification for the inclusion/exclusion of projects is presented under the respective cumulative impact section.

---

[1] *ES submission to OPRED is targeting September 2023 therefore the assessment considers projects which fulfil the criteria up to the end of May 2023.*

[2] *For completeness, all projects which are in planning have been included in the cumulative list. For projects which have not yet undertaken scoping, a high level cumulative assessment has been conducted as less information is available in the public domain.*

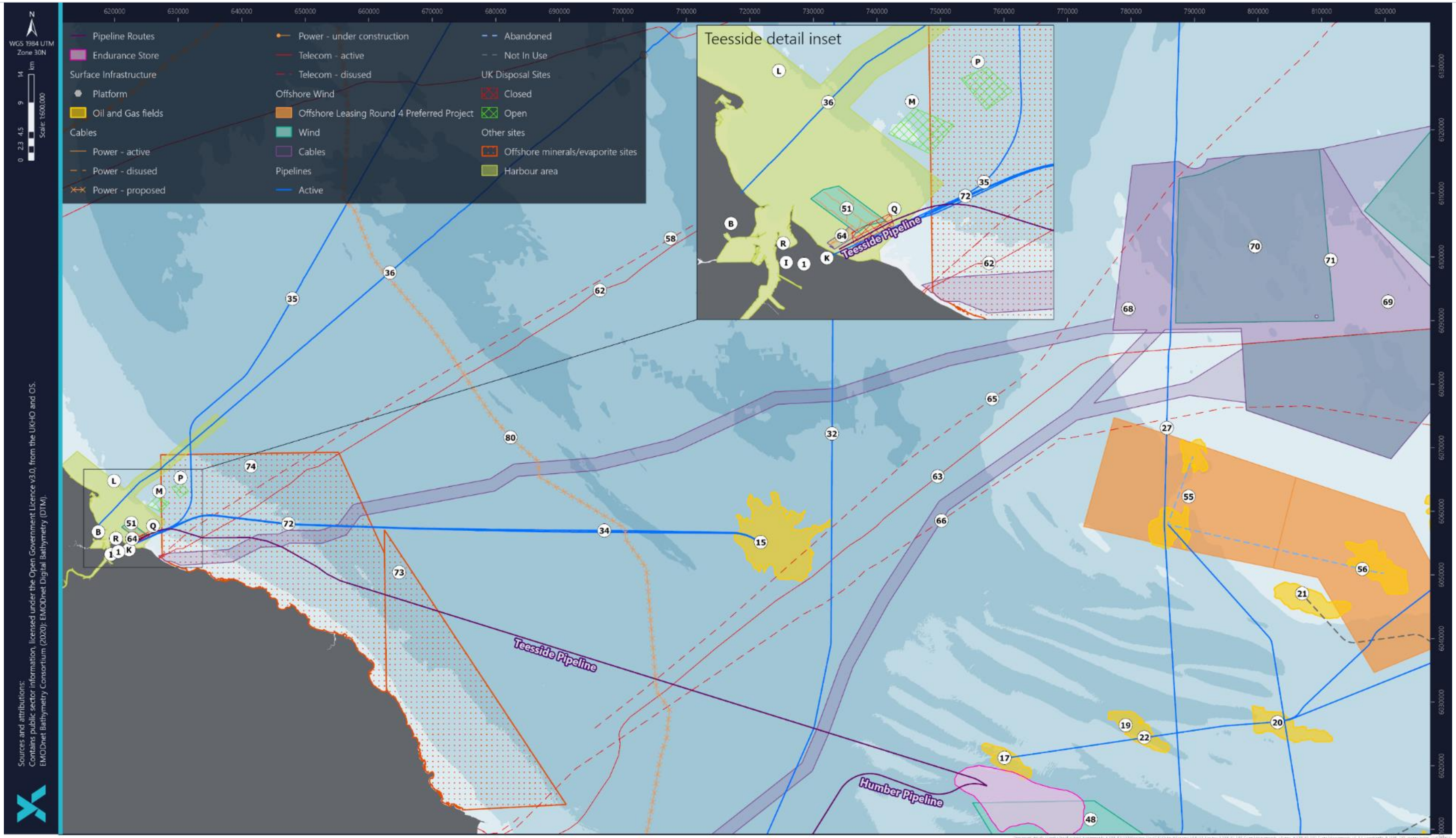


Figure 1 Projects for consideration of cumulative and in-combination impacts in the vicinity of the Teesside Pipeline and north of the Endurance Store

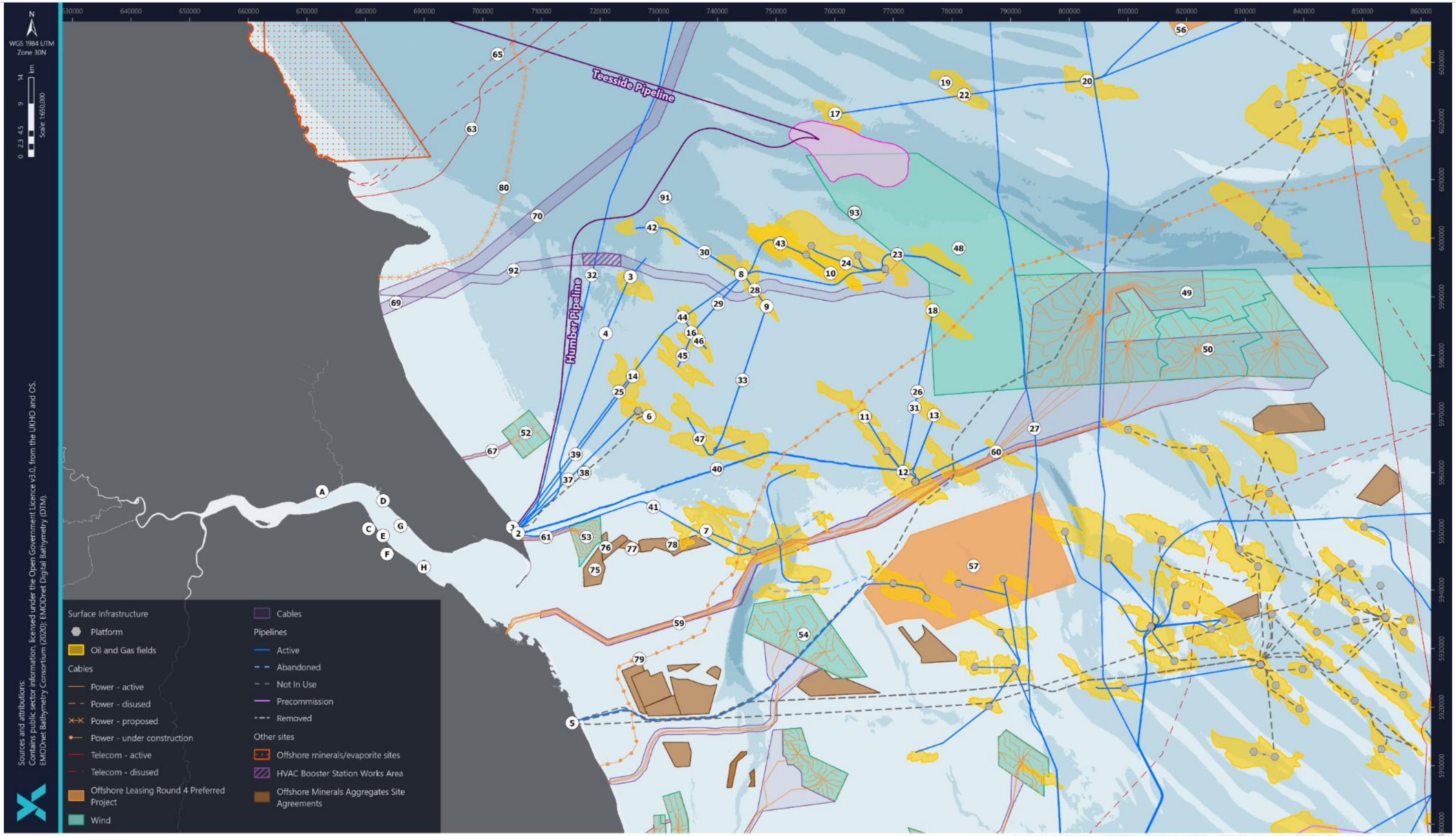


Figure 2 Projects for consideration of cumulative and in-combination impacts in the vicinity of the Humber Pipeline and south of the Endurance Store

Appendix D: Cumulative Projects List [Key in Section 1.2 of Appendix]

ID	Project	Data Confidence Assessment	Developer/Operator	Country	High Level Description	Status of Project	2024	2025	2026	2027	2028-2053	Distance and direction from the Endurance Store	Distance and direction from the Teesside Pipeline	Distance and direction from the Humber Pipeline
Oil and Gas Surface Infrastructure														
1	Teesside Terminal (onshore)	High	ConocoPhillips	UK	The Teesside Terminal is a major crude oil reception, processing, storage and export facility in Middlesbrough. It receives and processes crude oil delivered by the subsea NORPIPE pipeline from the Norwegian Ekofisk field and the UK Fulmar and J-Block fields.	Active						136 km WNW	2 km WSW	109 km WNW
2	Easington/Dimlington Gas Terminal (onshore)	High	Perenco	UK	The Gas Terminal is made up of four plants which are run by and gas is produced by Perenco, Gassco and Centrica Storage Ltd.	Active						80 km SSW	80 km SSW	<1 km SSW
3	Humber Gathering System (HGS) Tolmount	High	Harbour Energy	UK	The HGS Tolmount platform was successfully installed in October 2020. First gas is scheduled for 2021. The Tolmount gas export pipeline is labelled separately as 4.	Active						36 km WSW	32 km SSW	10 km ESE
5	Theddlethorpe Gas Terminal (onshore)	High	Harbour Energy	UK	The former gas terminal processed gas from a number of SNS assets until 2018. Demolition started in 2020 and is expected to take 18 months to complete. Land remediation and restoration will follow through to 2023.	Disused						102 km SSW	108 km SSW	35 km SSE
6	Rough	High	Centrica	UK	Two offshore platforms (Alpha and Bravo) are located in the Rough gas field. Gas processing occurs at the Easington Terminal. The Bravo complex is made up of three separate bridge-linked platforms. Alpha is currently in cold suspension, shut down and unmanned.	Active						51 km SSW	54 km SSW	15 km ESE
7	Amethyst	High	Perenco	UK	Production ceased in 2020. The topsides DP was issued in 2020 with a schedule aiming for completion of decommissioning in 2026.	Disused						62 km SSW	69 km SSW	29 km ESE
8	Cleeton	High	Perenco	UK	Production has ceased here however the facility remains as a hub for other fields in the vicinity. Gas from Cleeton is exported to the Dimlington Gas Terminal.	Active						22 km SSW	27 km SSW	20 km ESE
9	Neptune	High	Perenco	UK	A NUI tied back to Cleeton. Gas has been produced since 1999.	Active						24 km SSW	30 km SSW	27 km ESE
10	Ravenspurn	High	Perenco	UK	Surface infrastructure in the Ravenspurn field is comprised of seven installations (Ravenspurn North, ST2, ST3, CCW, CC, Ravenspurn South A, B and C). Gas is exported via Cleeton to the Dimlington Gas Terminal	Active						12 km SSW	18 km SSW	16 km SSE
11	Hyde	High	Perenco	UK	A NUI tied back to West Sole. Gas has been produced since 1993.	Active						39 km SSW	48 km SSE	48 km SSE
12	West Sole	High	Perenco	UK	West Sole is comprised of three installations which produce gas directly back to the Bacton Terminal, having done so since 1967.	Active						45 km SSE	59 km SSE	54 km SSE
13	Hoton	High	Perenco	UK	A NUI tied back to the West Sole pipeline. Gas has been produced since 2001.	Active						40 km SSE	51 km SSE	51 km SSE
14	York	High	Spirit Energy	UK	The York facility is a NUI installed in 2012. The platform is a four-legged, jacket-type fixed installation, with three platform wells in production. Gas has been exported to the Easington Gas Terminal since production commenced in 2013.	Active						47 km SSW	49 km SSW	12 km ESE
15	Breagh Alpha	High	INEOS UK SNS	UK	The Breagh Alpha installation is in the Breagh field. Production began in 2013 and gas is exported back to the Teesside Terminal.	Active						48 km NNW	25 km NNE	40 km NNW
16	Minerva	High	Perenco	UK	A NUI tied back to Cleeton. Gas has been produced since 2003.	Active						35 km SSW	38 km SSW	21 km ESE
17	Garrow	High	Alpa Petroleum	UK	The Tors development consists of two gas fields, Kilmar and Garrow. The Garrow Normally Unmanned Installation (NUI) was installed in 2008. Gas is exported via Trent to the Bacton Terminal.	Active						2 km NNE	5 km NNE	5 km NNE
18	Babbage	High	NEO Energy	UK	The Babbage field has produced gas from 5 horizontal wells since 2010. Gas from the Babbage NUI is exported back to the Dimlington Gas Terminal.	Active						22 km SSE	35 km SSE	35 km SSE
19	Kilmar	High	Alpa Petroleum	UK	The Tors development consists of 2 gas fields, Kilmar and Garrow. The Kilmar NUI was installed in 2005 with production from the field commencing in 2006. The gas is exported via Trent to the Bacton Terminal.	Active						14 km NNE	26 km ENE	26 km ENE
20	Trent	High	Perenco	UK	The Trent platform has been producing since 1996. Produced gas is exported back to the Bacton Terminal.	Active						33 km ENE	46 km ENE	47 km ENE
21	Cavendish	High	INEOS UK SNS	UK	Cavendish RM platform tied back to Murdoch MD installation since 2007. Production ceased in 2018. Decommissioning Programme (DP) was issued in 2019 with the main in-field decommissioning activities scheduled for 2021-2022 and final surveys expected to occur in 2023.	Disused						47 km ENE	58 km ENE	58 km ENE
91	Tolmount East Development	Medium	Harbour Energy	UK	The development comprises a single well development, installation of subsea infrastructure, and a 4 km, 12" pipeline tied back to the HGS Tolmount minimum facilities platform. Public consultation concluded June 2021. Drilling of the Tolmount East development well commenced in the fourth quarter of 2022 and was successfully completed. Tolmount East is expected to be tied into production in 2024.	Consented						32 km WSW	29 km SSW	8 km SSE
93	Kumatage Field	Low	Bridge Petroleum	UK	The Kumatage gas field comprises UKCS blocks 42/30d and 43/26c. The plan is to develop the gas reservoir either through a platform or subsea development and associated pipeline(s) and umbilical(s) (if required) to tie into existing gas export infrastructure.Final apprisal well location will be subject to seabed survey and detailed design findings. The project is currently at the concept select work stage, an early stage of project engineering. The current timeline of activities is as follows: commitment to appraisal well by 30th September 2022; drilling of appraisal well by 30th September 2024; first gas production by 30th September 2028.	In planning						5 km SSW	13 km SSE	13 km SSE
Pipelines														
4	Tolmount export pipeline	High	Harbour Energy	UK	Gas export pipeline from Tolmount to Dimlington Terminal. The pipeline is part of the Humber Gathering System (HGS). The offshore installation associated with the HGS development is labelled separately as 3.	Active						36 km WSW	32 km SSW	<1 km SSE
22	Garrow to Kilmar export (PL2160, PL2161)	High	Alpha Petroleum	UK	8" gas export pipeline between Garrow and Kilmar and associated 3" service line.	Active						2 km NNE	5 km NNE	5 km NNE
23	Johnston to Ravenspurn North export pipeline, and in-field lines (PL898, PL990, PLU991, PL2501, PLU2508, PL2105, PLU2106)	High	Harbour Energy	UK	12" gas export pipeline tied back to Ravenspurn North and associated methanol line and umbilical. A number of other in-field pipelines are associated with the Johnston field.	Active						11 km SSE	23 km SSE	23 km SSE
24	Ravenspurn North in-field lines (PL729/PL730, PL670, PL450. PL451, PL669)	High	Perenco	UK	There are a number of in-field pipelines within the Ravenspurn North area. PL729/PL730 is closest to the Development.	Active						12 km SSW	18 km SSW	18 km SSE
25	Cleeton to Dimlington export pipeline (PL447)	High	Perenco	UK	36" gas export pipeline back to Dimlington. A number of other in-field pipelines are associated with the Johnston field. PL447 is closest to the Development.	Active						22 km SSW	27 km SSW	<1 km ESE
26	Kilmar to Trent export, and in-field lines (PL2162, PL2163)	High	Alpha Petroleum	UK	12" gas export pipeline between Kilmar and Trent and associated 3" service line.	Active						14 km NNE	26 km ENE	26 km ENE
27	Shearwater to Bacton export (PL1570)	High	Shell	UK	34" gas export pipeline from Shearwater, in the Central North Sea (CNS), to Bacton Terminal.	Active						15 km ENE	30 km ENE	30 km ENE
28	Neptune to Cleeton (PL1684)	High	Perenco	UK	16" gas export pipeline between Neptune and Cleeton.	Active						22 km SSW	27 km SSW	20 km ESE
29	Minerva to Cleeton (PL1934, PL1936, PLU1939)	High	Perenco	UK	16" gas export pipeline between Minerva and Cleeton and associated 3" service line and umbilical.	Active						22 km SSW	27 km SSW	20 km ESE
30	Whittle to Cleeton (PL1928, PLU1930)	High	Perenco	UK	12" production pipeline between Whittle and Cleeton and associated umbilical.	Active						22 km SSW	23 km SSW	6 km ESE
31	Babbage export (PL2612)	High	NEO Energy (owner), ODE (pipeline operator)	UK	12" gas export pipeline between Babbage and West Sole.	Active						22 km SSE	35 km SSE	35 km SSE
32	Langeled export (PL2071)	High	Gassco	UK	44" gas export pipeline from the Sleipner Riser platform to Easington Terminal. This 1,166 km long pipeline originates in Norway and travels across the North Sea via the Sleipner Riser platform. The pipeline section from Sleipner Riser platform to Easington Terminal is the largest submarine pipeline in the North Sea.	Active						24 km WNW	Both the Teesside Pipeline and Humber Pipeline will cross the Langeled export pipeline.	Both the Teesside Pipeline and Humber Pipeline will cross the Langeled export pipeline.
33	Neptune to Mercury (PL1707, PL1708)	High	Perenco	UK	10" gas export pipeline between Mercury and Neptune and associated umbilical.	Active						24 km SSW	30 km SSW	27 km ESE
34	Breagh export (PL2769.1, PL2768.1, PL2769.2, PL2768.2)	High	INEOS UK SNS	UK	20" gas export pipeline between Breagh and shore and associated 3" monoethylene glycol pipeline. Both pipelines have been split into two sections (indicated by the PL numbers), the .2 sections are closest to shore.	Active						48 km NNW	The Teesside Pipeline will cross the PL2769.2 and PL2768.2 sections of pipeline.	40 km NNW
35	CATS export (PL774)	High	CATS	UK	36" gas export pipeline from Everest, in the CNS, to Teesside.	Active						128 km WNW	The Teesside Pipeline will cross the CATS export pipeline.	103 km WNW
36	Ekofisk export (PL19)	High	Conoco Phillips	UK/Nor	34" oil export pipeline from Ekofisk 2/4J to Teesside. The 354 km long pipeline originates in the Norwegian sector of the CNS.	Active						118 km NNW	6 km WNW	108 km NNW
37	Rough export (PL150, PL151)	High	Centrica	UK	36" gas export pipeline from Rough 47/3B to Easington Terminal, and in-field 18" export from Rough 8A to Rough 3B. The PL150 is closest to the Development.	Active						51 km SSW	54 km SSW	<1 km SSE
38	Rough export (PL26)	High	Centrica	UK	16" gas export pipeline from Rough 47/8A to Easington Terminal.	Disused						51 km SSW	54 km SSW	<1 km SSE
39	York export (PL2917, PL2918)	High	Spirit Energy	UK	16" gas export pipeline from York to Easington Terminal, and associated methanol pipeline.	Active						48 km SSW	49 km SSW	<1 km ESE
40	West Sole export (PL28, PL145)	High	Perenco	UK	24" and 16" gas export pipelines from West Sole to Easington Terminal.	Active						47 km SSW	54 km SSW	1 km SSE
41	Amethyst export (PL649)	High	Perenco	UK	30" gas export pipeline from Amethyst A2D to Easington Terminal. Amethyst A2D (amongst other platform assets) is in the process of being decommissioned with the intention to finish activities in 2026.	Disused						62 km SSW	68 km SSW	2 km SSE
42	Wollaston to Whittle (PL1929, PLU1931)	High	Perenco	UK	8" condensate production pipeline from Wollaston to Whittle and associated umbilical.	Active						26 km WSW	23 km SSW	2 km SSE
43	Cleeton to Ravenspurn (PL448)	High	Perenco	UK	16" gas export in-field pipeline from Cleeton CP to Ravenspurn A.	Active						13 km SSW	19 km SSW	16 km SSW
44	M5 to Minerva (PL1932, PLU1941)	High	Perenco	UK	Export pipeline from M5 to Minerva and associated umbilical.	Disused						34 km WSW	39 km SSW	18 km SSE

45	Apollo to Minerva (PL1937, PLU1942)	High	Perenco	UK	Condensate export pipeline from Apollo to Minerva and associated umbilical.	Active						35 km SSW	38 km SSW	20 km ESE
46	M1 to Minerva (PL1933, PLU1940)	High	Perenco	UK	6" condensate export pipeline from M1 to Minerva and associated umbilical.	Active						35 km SSW	38 km SSW	22 km ESE
47	Eris and Ceres to Mercury (PL2598, PL2597, PL2596, PL2595)	High	Spirit Energy	UK	6" gas export pipeline from Eris and Ceres to Mercury, and associated umbilical.	Active						47 km SSW	53 km SSW	22 km ESE
Offshore Windfarms (within 510 km of the Development)														
48	Hornsea Project Four	Low	Ørsted	UK	The windfarm could cover up to 492 km^2 and contain up to 180 wind turbines. This windfarm will be adjacent to Hornsea Two. Construction is set to commence in 2026 prior to first power in 2028. Consent has not yet been granted.	In planning						The Endurance Store area overlaps with The Crown Estate (TCE) Lease area for the Hornsea Project Four windfarm (now in examination phase for a Development Consent Order (DCO)) and as a result, a Statement of Common Ground is under development between bp and Hornsea Project Four. On 17th June 2023, a commercial agreement was reached with Orsted (the developer of Hornsea Four) to avoid construction of Hornsea Four infrastructure within the area of overlap with the Endurance Store.	3 km NNW	3 km SSE
49	Hornsea Two	High	Ørsted	UK	Hornsea Two comprises 165 turbines with a total capacity of 1.4 GW, covering an area of 462 km^2. Became fully operational in 2022.	Operational						25 km ESE	41 km ESE	41 km ESE
50	Hornsea One	High	Ørsted	UK	The Hornsea One windfarm became fully operational in 2021. Covering approximately 407 km^2, it has 174 wind turbines with a total capacity of 1.2 GW.	Active						41 km ESE	57 km ESE	57 km ESE
51	Teesside	High	Teesside Windfarm Ltd (operated by EDF Renewables)	UK	The windfarm is located 1.5 km from the coast. It contains 27 turbines with a total capacity of 62 MW. It has been operational since 2014.	Active						135 km WNW	2 km NNW	109 km WNW
52	Westermost Rough	High	Westermost Rough Limited	UK	The windfarm contains 35 turbines each of 6 MW capacity, covering a total area of 35 km^2.	Active						64 km SSW	59 km SSW	<1 km WNW
53	Humber Gateway	High	E.ON Climate & Renewables UK Humber Wind Limited (operated by E.ON Energy)	UK	The windfarm became fully operational in 2015 and consists of 73 turbines with a total capacity of 219 MW of energy.	Active						69 km SSW	73 km SSW	7 km ESE
54	Triton Knoll	High	Triton Knoll Offshore Wind Farm Limited (operated by RWE)	UK	As of June 2021, half of the 90 turbines were installed. The windfarm will have a total capacity of 857 MW. Became fully operational in 2022.	Operational						71 km SSW	78 km SSW	41 km ESE
55	Dogger Bank South West	Low	RWE Renewables	UK	1500 MW capacity area of seabed which has been awarded Preferred Project status through the Round 4 leasing process. Lease agreements for Round 4 projects will be awarded in spring 2022. As the project is in its early stages, timsecales are highly indicative and based on the current proposed timeline working towards consent being approved in 2025.	In planning						42 km NNE	43 km NNE	43 km NNE
56	Dogger Bank South East	Low	RWE Renewables	UK	1500 MW capacity area of seabed which has been awarded Preferred Project status through the Round 4 leasing process. Lease agreements for Round 4 projects will be awarded in spring 2022. As the project is in its early stages, timsecales are highly indicative and based on the current proposed timeline working towards consent being approved in 2025.	In planning						52 km ENE	57 km ENE	57 km ENE
57	Outer Dowsing	Low	Green Investment Group – Total Energies	UK	1500 MW capacity area of seabed which has been awarded Preferred Project status through the Round 4 leasing process. Lease agreements for Round 4 projects will be awarded in spring 2022. The project is currently in its early planning stages, therefore timescales are unknown.	In planning						69 km SSE	71 km SSE	60 km SSE
n/a	Hornsea Project Three	High	Ørsted	UK	The site occupies an area of 695.83 km^2 and has a capacity of 3000 MW. Scoping work has commenced and construction is planned for 2024.	Consented						95 km ESE	112 km ESE	112 km ESE
n/a	Dudgeon	High	Equinor ASA	UK	The 316.8 MW caacity site covers an area of 34.97 km^2 and contains 88 tubines.The windfarm has been fully commissioned since 2013.	Active						101 km SSE	112 km SSE	94 km ESE
n/a	Dudgeon Extension	Medium	Equinor ASA	UK	A 402 MW extension to the existing Dudgeon OWF. Current timescales assume consent will be authorised in 2023 with a view to first power in 2026. Consent is being sought for extension to the Dudgeon and Sheringham Shoal offshore wind farms. While the extensions are being developed in tandem, construction of the two sites may be separate. Pre-construction activities are expected to commence in 2024. If the sites are constructed at the same time, construction is expected to last two years in total. If the sites are built at different times, there may be up to a four year gap between the completion of both projects, spanning a total of eight years.	In planning						99 km SSE	110 km SSE	95 km ESE
n/a	Sheringham Shoal	High	Equinor ASA	UK	The 402 MW capacity site covers an area of 55.13 km^2 and contains 67 tubines. Constuction was completed in 2017 and the windfarm has been fully commissioned since.	Active						114 km SSE	123 km SSE	91 km ESE
n/a	Sheringham Shoal Extension	Medium	Equinor ASA	UK	A 317 MW extension to the existing Sheringham Shoal OWF. Current timescales assume consent will be authorised in 2024 with a view to first power in 2026. As for the Dudgeon Extension, construction may last up to eight years.	In planning						110 km SSE	120 km SSE	89 km ESE
n/a	Greater Gabbard	High	RWE Renewables	UK	A 504 MW capacity site covers an area of 146.13 km^2 and became fully commissioned in 2013.	Active						259 km SSE	270 km SSE	233 km SSE
n/a	North Falls (Greater Gabbard Extension)	Medium	RWE Renewables	UK	A 504 MW extension to the Greater Gabbard OWF. The current timescales allow for submission of the consent application in 2023 with a view to being authorised in 2024. The intention is for the windfarm to be fully commissioned by 2030.	In planning						272 km SSE	283 km SSE	245 km SSE
n/a	Galloper	High	RWE Renewables	UK	The 353 MW site is adjacent to the Greater Gabbard OWF. The site became fully commissioned in 2018.	Active						259 km SSE	271 km SSE	236 km SSE
n/a	Five Estuaries (Galloper Extension)	Medium	RWE Renewables	UK	A 353 MW extension to the Galloper OWF. Offshore construction is due to commence in 2028 with a view to first power in 2030.	In planning						260 km SSE	272 km SSE	240 km SSE
n/a	Rampion	High	E.ON Climate & Renewables UK Rampion Offshore Wind Limited	UK	The 400.2 MW capacity site is currently the only active OWF along the south coast of England In UK waters. The site covers an area of 74.14 km^2.	Active						399 km SSW	405 km SSW	334 km SSW
n/a	Rampion 2 (Rampion Extension)	Medium	RWE Renewables	UK	A 1200 MW extension to the Rampion OWF. Consent application submission is set for 2022 with the intention of offshore construction commencing in 2026.	In planning						404 km SSW	411 km SSW	339 km SSW
n/a	Dunkerque	Medium	Eoliennes en mer de Dunkerque (EMD)	Fr	A 598 MW capacity windfarm off the French coast. At present, construction is planned for 2026 with full commissioning following in 2027.	In planning						345 km SSE	357 km SSE	320 km SSE
n/a	Global Tech I	High	Ørsted	Ger	The site has a capacity of 400 MW and is located in German offshore waters. The site was fully commissioned in 2018.	Active						339 km ENE	354 km ENE	354 km ENE
n/a	Global Tech II	Low	Northern Energy Global Tech II GmbH	Ger	The German site was initially up for development by Northern Energy Global Tech II GmbH in 2013 but since the project has remained dormant. In February 2022 the site has been made available for bidding once more with the closure of the bidding window set to occur in September 2022.	Dormant						330 km ENE	344 km ENE	344 km ENE
n/a	GICON® SOF 6-8MW Test Turbine	Low	Grossmann Ingenieur Consult (GICON) GmbH	Ger	A test area in German waters for a new floating offshore foundation technology. The area is being developed by a number of universities and developers. The prototype has yet to be installed offshore.	In planning						347 km ENE	363 km ENE	362 km ENE
n/a	Nordsea 2	Low	Nordsee Two GmbH	Ger	The project will have 300 MW installed capacity and €800 million planned investment. The project is scheduled to begin operations in 2026.	In planning						374 km ENE	390 km ENE	390 km ENE
n/a	N-3.7	Low	RWE Renewables Offshore Development Two GmbH	Ger	Tender results were won by RWE Renewables Offshore Development Two GmbH for German site N-3.7 which will have a capacity of 225 MW.	In planning						386 km ENE	401 km ENE	401 km ENE
n/a	Caledonia	Low	Moray Offshore Renewable Power	UK	The site has a capacity of 1000 MW and was won as part of the Scotwind round.	In planning						467 km NNW	382 km NNW	467 km NNW
n/a	Plan Option area NE3	Low	Falck Renewables Wind	UK	The floating site has a capacity of 1000 MW and was won as part of the Scotwind round.	In planning						500 km NNW	424 km NNW	500 km NNW
n/a	Plan Option area NE6	Low	Falck Renewables Wind	UK	The floating site has a capacity of 500 MW and was won as part of the Scotwind round.	In planning						464 km NNW	391 km NNW	464 km NNW
n/a	Plan Option area NE8	Low	BayWa r.e. UK	UK	The floating site has a capacity of 960 MW and was won as part of the Scotwind round.	In planning						466 km NNW	433 km NNW	466 km NNW
n/a	MarramWind	Medium	Scottish Power Renewables	UK	The floating site has a capacity of 3000 MW and was won as part of the Scotwind round. The Scoping Report for the project was submitted in early 2023. Construction is expected to commence in 2025 and last 8 years.	In planning						430 km NNW	477 km NNE	430 km NNW
n/a	Green Volt	Low	Floatation Energy/CNOOC	UK	The 480 MW site will be built with the aim of electirfying offshore oil and gas assets, specifically the Buzzard field, as part of the Innovation and Targeted Oil and Gas (INTOG) leasing round, to be launched by Crown Estate Scotland in early 2022.	In planning						421 km NNW	366 km NNE	417 km NNW
n/a	Plan Option area E2	Low	Vattenfall	UK	The floating site has a capacity of 798 MW and was won as part of the Scotwind round.	In planning						359 km NNW	306 km NNE	359 km NNW
n/a	CampionWind	Low	Shell	UK	The floating site has a capacity of 2000 MW and was won as part of the Scotwind round.	In planning						420 km NNW	286 km NNE	420 km NNW
n/a	Plan Option area E1	Low	Falck Renewables Wind	UK	The floating site has a capacity of 1200 MW and was won as part of the Scotwind round.	In planning						287 km NNW	246 km NNE	287 km NNW

n/a	Ossian	Medium	SSE Renewables	UK	The floating site has a capacity of 2610 MW and was won as part of the Scotwind round. The Scoping Report for the project was submitted in early 2023. No date is given for the start of construction however the Scoping Report assumes a decision regarding consent will be reached in 2025. Construction is expected to take approximately 9 years. Here it has been assumed that construction will commence within a year of consent.	In planning						264 km NNW	213 km NNE	264 km NNW
n/a	Morven	Low	bp	UK	The fixed site has a capacity of 2907 MW and was won as part of the Scotwind round.	In planning						266 km NNW	203 km NNE	266 km NNW
n/a	Cluaran Deas Ear	Low	DEME Concessions Wind NV	UK	The fixed site has a capacity of 1008 MW and was won as part of the Scotwind round.	In planning						328 km NNW	253 km NNW	328 km NNW
n/a	Cenos Offshore Wind Farm	Medium	Flotation Energy and Vårgrønn	UK	Development of a floating offshore wind farm (70 to 100 turbines) to connect to oil and gas installations, as part of the INTOG leasing process. The Scoping Report for the Project was submitted in early 2023. Construction expected to occur between 2027 and 2030.	In planning								
n/a	Salamander	Medium	Ørsted and Simply Blue Group	UK	Development of a floating offshore wind farm. The Scoping Report for the Project was submitted in early 2023. Construction is expected to indicatively begin in 2026 and take approximately 3 years.	In planning								
n/a	Berwick Bank	Low	SSE Renewables	UK	4100 MW capacity site in the former Firth of Forth Zone. Scoping has been conducted for the site and scoping opinions are being submitted. Earliest constrcution may begin in 2027 with full commissioning in 2029.	In planning						280 km NNW	191 km NNW	271 km NNW
n/a	East Anglia ONE	High	East Anglia One Ltd	UK	Fixed-bottom offshore wind farm off East Anglia consisting of 102 turbines. The site became fully operational in 2020.	Active						233 km SSE	246 km SSE	226 km ESE
n/a	East Anglia Hub - ONE North	High	East Anglia Offshore Wind Ltd	UK	The 950 MW site will occupy an area of 207.96 km^2 approximately 36 km from the Suffolk coast.	Consented						216 km SSE	229 km SSE	211 km ESE
n/a	East Anglia Hub - TWO	High	East Anglia Offshore Wind Ltd	UK	The 950 MW site will occupy an area of 218.41 km^2 approximately 40 km from the Suffolk coast.	Consented						237 km SSE	249 km SSE	221 km SSE
n/a	East Anglia Hub - THREE	High	East Anglia Offshore Wind Ltd	UK	The 1480 MW site will occupy an area of 305.23 km^2 approcimately 74 km from the Suffolk coast. Construction is planned to commence in 2024 for the park to be fully commissioned in 2027.	Consented						201 km SSE	216 km SSE	214 km ESE
n/a	Norfolk Boreas	High	Vattenfall	UK	Fixed-bottom offshore wind farm off Norwich, consented for up to 129 turbines and associated transmission infrastructure. Consent was granted in December 2021. The site may be constructed either in one or two phases. Construction is due to commence in 2024 and may last until late 2028.	Consented						172 km ESE	187 km ESE	187 km ESE
n/a	Norfolk Vanguard	High	Vattenfall	UK	Consent is being sought for the Norfolk Vanguard offshore wind farm off the coast of Norwich. Consent was originally authorised in 2020, however, this was withdrawn at the beginning of 2021. Following re-determination, consent was awarded in 2022. Construction is planned to commence in 2023.	Consented						177 km SSE	191 km SSE	191 km SSE
n/a	Inch Cape	High	Inch Cape Offshore Wind Farm Limited	UK	Fixed-bottom offshore wind farm within the Firth of Forth and Tay region, consisting of up to 72 turbines. Offshore construction is expected to commence in 2023 and will be completed by 2025.	Consented						316 km NNW	219 km NNW	307 km NNW
n/a	Seagreen	High	RWE Renewables	UK	Fixed-bottom offshore wind farm within the Firth of Forth and Tay region, consisting of up to 72 turbines. Offshore construction is expected to commence in 2023 and will be completed by 2025.	Under construction						308 km NNW	222 km NNW	300 km NNW
n/a	Seagreen 1A	High	SSE Renewables	UK	Fixed-bottom offshore wind farm of 36 turbines. The turbines were already consented within the Seagreen project; however, an additional export cable route was consented in 2021. It is anticipated that construction of the offshore export cable will begin in 2023.	Consented						310km NNW	220 km NNW	301 km NNW
n/a	Moray West	High	Moray Offshore Windfarm (East) Ltd	UK	Fixed-bottom offshore wind farm of up to 85 wind turbines, consented in early 2019, with construction planned in 2022/2023 - lasting to 2024/2025.	Consented						491 km NNW	403 km NNW	483 km NNW
n/a	Moray East	High	Moray Offshore Renewables Ltd (MORL)	UK	Fixed-bottom offshore wind farm (295 km^2) within the Moray Firth. Construction began in 2018. Installation of the turbines was completed in September 2021, with the site expected to be operational in 2022.	Operational						491 km NNW	409 km NNW	484 km NNW
n/a	EnBW He Dreiht	High	EnBW He Dreiht	Ger	The EnBW He Dreiht offshore wind farm is located off the north east coast of Germany. The site will consist of up to 60 fixed-bottom turbines and associated transmission infrastructure. Construction is due to commence in 2024 with the site being fully operational in 2025.	Consented						327 km ENE	342 km ENE	342 km ENE
n/a	Dieppe - Le Tréport	High	Les Eoliennes en mer de Dieppe-Le Tréport (EMDT)	Fr	The OWF is located on off the coast of Normandie and is consented for up to 62 turbines. The site was consented in 2019 and and construction is due to commence in 2024 with the site becoming fully operational in 2025.	Consented						446 km SSE	455 km SSE	398 km SSE
n/a	Dogger Bank A	High	Dogger Bank Wind Farms	UK	Dogger bank offshore wind farm, off the east coast of England, is being developed in three phases across Dogger Bank A, B and C. The first phase is Dogger Bank A which will consist of up to 95 turbines. Construction is expected to commence in 2022 with Dogger Bank A being operational in 2023.	Under construction						78 km NNE	86 km NNE	86 km NNE
n/a	Dogger Bank B	High	Dogger Bank Wind Farms	UK	Dogger bank offshore wind farm, off the east coast of England, is being developed in three phases across Dogger Bank A, B and C. The second phase is Dogger Bank b which will consist of up to 95 turbines. Construction is expected to commence in 2023 with Dogger Bank B is expected to be be operational in 2024.	Consented						91 km NNE	95 km NNE	95 km NNE
n/a	Dogger Bank C	High	Dogger Bank Wind Farms	UK	Dogger bank offshore wind farm, off the east coast of England, is being developed in three phases across Dogger Bank A, B and C. The third phase is Dogger Bank C which will consist of up to 87 turbines. Construction is expected to commence in 2024 with Dogger Bank C is expected to be be operational in 2025.	Consented						141 km NNE	151 km ENE	151 km ENE
n/a	Sofia	High	Sofia Offshore Wind Farm Limited	UK	Sofia offshore wind farm is located off the east coast of England and will consist of up to 100 fixed-bottom turbines. Offshore construction is expected to commence in 2023 and completed in 2026.	Consented						110 km NNE	118 km NNE	118 km NNE
n/a	Fécamp	High	Eolien Maritime France	Fr	Fécamp is an offshore wind farm in the French waters of the English channel, consented for up to 71 fixed-bottom turbines. Construction of the export cable began in 2021, with construction of the turbines expected in 2023. The site is expected to be fully operational in December 2023.	Consented						479 km SSW	486 km SSW	420 km SSE
n/a	Hollandse Kust Noord	High	CrossWind CV	Ned	The 93.72 km^2 OWF is located in the Dutch sector of the North Sea. The project is expected to be delivered a year early in 2023. TNO, the Dutch organization for applied scientific research, will work on research and demonstration of offshore solar energy. The offshore solar demo will have a minimum size of 0.5 MWp and will be constructed in 2025.	Consented						262 km ESE	278 km ESE	278 km ESE
n/a	Borkum Riffgrund 1	High	Borkum Riffgrund I Offshore Windpark	Ger	The OWF occuppies an area of 35.97 km^2 and was fully commissioned in 2015.	Active						353 km ESE	369 km ENE	369 km ENE
n/a	Borkum Riffgrund 2	High	Ørsted	Ger	The OWF occuppies an area of 35.45km^2 and was fully commissioned in 2018.	Active						349 km ENE	364 km ENE	364 km ENE
n/a	Borkum Riffgrund 3	High	Ørsted	Ned	The Borkum Riffgrund 3 site is located off the coast of Germany and is consented for up to 81 fixed-bottom turbines and associated transmisison infrastructure. Construction is due to commence in August 2023 with the site being fully operational by 2025.	Under construction						329 km ENE	344 km ENE	344 km ENE
n/a	Gode Wind 1 and 2	High	Ørsted	Ger	The 582 MW site was fully commissioned in 2016.	Active						381 km ENE	396 km ENE	396 km ENE
n/a	Gode Wind 3	High	Ørsted	Ger	The Gode Wind 3 offshore wind farm is located off the coast of Germany and is consented for up to 23 fixed-bottom turbines and associated transmission infrastructure. Construction is due to commence in 2023 with the site being fully operational by 2023.	Under construction						389 km ENE	404 km ENE	404 km ENE
n/a	Kaskasi	High	RWE Renewables	Ger	The Kaskasi offshore wind farm is located off the coast of north east Germany and is consented for up to 38 fixed-bottom turbines. Construction of the site commenced at the beginning of 2022 and the site is expected to be fully operational by the end of 2022.	Operational						426 km ENE	440 km ENE	440 km ENE
n/a	Hollandse Kust Zuid Holland I and II	High	Chinook CV	Ned	Construction of the Hollandse Kust Zuid Holland I and III offshore wind farm commenced in July 2021. The site is expected to be fully operational by June 2023.	Under construction						279 km ESE	294 km ESE	294 km ESE
n/a	Hollandse Kust Zuid Holland III and IV	High	Vattenfall	Ned	Construction of the OWF is set to commence in January 2023 in time for full commissioning in 2024.	Under construction						287 km ESE	302 km ESE	302 km ESE
n/a	Windpark Fryslân	High	Ventolines BV	Ned	The fixed foundation OWF is located in the Ijselmeer closed-off inland bay within the Netherlands. Installation was completed in 2021.	Active						305 km ESE	315 km ESE	315 km ESE
n/a	Neart na Gaoithe	High	Neart na Gaoithe Offshore Wind Limited	UK	Fixed-bottom offshore wind farm within the Firth of Forth and Tay region, consisting of up to 54 turbines. Construction commenced in 2020 and the site is expected to be fully operational in 2022.	Under construction						300 km NNW	196 km NNW	289 km NNW
n/a	ForthWind Offshore Wind Demonstration Project	High			Consent has been granted for a single demonstrator turbine within the Firth of Forth. The site was originally consented in 2016, however, a new design is being pursued, subject to a new application. Consent was awarded in March 2023. Construction is expected to commence and be completed in 2024.	Consented								
n/a	Beatrice	High	SSE	UK	The 588 MW site is located in the north of Scotland and occupies an area of 131.33 km^2. The site was fully commissioned in 2019.	Active						502 km NNW	418 km NNW	495 km NNW
n/a	Hywind Scotland Pilot Park	High	Equinor ASA	UK	The 30 MW site is located in the northeast of Scotland and occupies an area of 15.14 km^2. The project was a floating pilot project.	Active						386 km NNW	317 km NNW	380 km NNW

n/a	Aberdeen (EOWDC)	High	Vattenfall Wind Power Ltd	UK	The 93.2 MW site is located off the coast of Aberdeen in Scotland. The project occupies an area of 19.97 km^2.	Active	377 km NNW	294 km NNE	369 km NNW
n/a	Kincardine (phase 1)	High	Cobra Wind International Ltd	UK	This project involved the installation of a single turbine as a prelimiary phase of the project. This was then expanded under phase 2.	Active	352 km NNW	268 km NNW	344 km NNW
n/a	Kincardine (phase 2)	High	Cobra Wind International Ltd	UK	The 48 MW project occupies an area of 24.18 km^2.	Active	351 km NNW	268 km NNW	344 km NNW
n/a	Levenmouth demonstration turbine	High	Offshore Renewable Energy Catapult	UK	This project consists of a single demonstation turbine located in the Firth of Forth. The operational life of the project expires in 2029, when it will be decommissioned.	Active	327 km WNW	211 km NNW	312 km NNW
n/a	Blyth Offshore Demonstrator (phase 1)	High	EDF Energy Renewables	UK	Offshore wind farm off Northumberland using float and submerge gravity base foundations. The Blyth offshore demonstrator site was consented in 2013 for up to 15 turbines across 3 arrays. Phase 1 consisted of 5 turbines which became operational in 2017.	Active	176 km WNW	59 km NNW	158 km WNW
n/a	Blyth Offshore Demonstrator (phase 2)	High	EDF Energy Renewables	UK	Phase 2 of the Blyth offshore demonstrator project is expected to involve floating offshore wind technology. Phase 2 is expected to be operational by 2025.	Consented	177 km WNW	64 km NNW	161 km NNW
n/a	Inner Dowsing	High	Ørsted	UK	Fixed-bottom offshore wind farm off the coast of the Wash, consisting of 27 turbines. The site was developed with the adjacent Lynn offshore Wind Farm and became fully operational in 2009.	Active	115 km SSW	121 km SSW	58 km SSE
n/a	Race Bank	High	Ørsted	UK	Fixed-bottom offshore wind farm off the coast of the Wash consisting of 91 turbines. The site became fully operational in 2018 after construction commenced in 2016.	Active	100 km SSW	107 km SSW	65 km ESE
n/a	Lincs	High	Ørsted	UK	Fixed-bottom offshore wind farm off the coast of the Wash, consisting of 75 turbines. Construction commenced in 2011 and the site became fully operational in 2013.	Active	114 km SSW	120 km SSW	59 km SSE
n/a	Lynn	High	Green Investment Group	UK	Fixed-bottom offshore wind farm off the coast of the Wash, consisting of 27 turbines. The site was developed with the adjacent Inner Dowsing offshore Wind Farm and became fully operational in 2009 after construction commenced in 2007.	Active	120 km SSW	127 km SSW	63 km SSE
n/a	Scroby Sands	High	RWE Renewables	UK	Fixed-bottom offshore wind farm off the coast of Norwich with 30 turbines. The site was consented in 2002 and became fully operational in 2004.	Active	174 km SSE	186 km SSE	160 km ESE
n/a	Gunfleet Sands	High	Gunfleet Sands Ltd	UK	Fixed-bottom offshore wind farm off the south east coast of England, consisting of 48 turbines. Construction at the site began in 2008 and the site became fully operational in 2010.	Active	270 km SSE	279 km SSE	228 km SSE
n/a	Gunfleet Sands 3 - Demonstration Project	High	Ørsted	UK	Fixed-bottom demonstrator site off the South East coast of England, adjacent to the Gunfleets offchsore wind farm site. The site consists of two turbines. Construction at the site commenced in 2012 and the site was fully opertional in 2013.	Active	273 km SSE	292 km SSE	230 km SSE
n/a	London Array	High	RWE Renewables	UK	Fixed-bottom offshore wind farm off the south east coast of England, consisting of 175 turbines. Construction commenced in 2011 and the site was fully operational by 2013.	Active	283 km SSE	293 km SSE	246 km SSE
n/a	Kentish Flats	High	GREP UK	UK	Fixed-bottom offshore wind farm off the north coast of Kent, consisting of 30 turbines. The site became fully operational in 2005 after construction commenced in 2004.	Active	300 km SSE	309 km SSE	254 km SSE
n/a	Kentish Flats Extension	High	Vattenfall	UK	The Kentish Flats Extension offshore wind farm is an extension to the Kentish Flats offshore windfarm. The extension consists of 15 turbines and became fully operational in December 2015 after construction commenced in April 2015.	Active	301 km SSE	310 km SSE	255 km SSE
n/a	Thanet	High	Thanet Offshore Wind Ltd	UK	Fixed-bottom offshore wind farm off the coast of Kent, consisting of 100 turbines. The site became fully operational in 2010 after construction commenced in 2009.	Active	305 km SSE	316 km SSE	269 km SSE
n/a	Seamade (Mermaid)	High	Otary RS NV	Be	The OWF has a capacity of 235 MW and was fully commissioned in 2020.	Active	292 km SSE	305 km SSE	280 km SSE
n/a	Northwester 2	High	Parkwind NV	Be	The OWF has a capacity of 219 MW and was fully commissioned in 2020.	Active	296 km SSE	309 km SSE	284 km SSE
n/a	Belwind	High	Belwind NV	Be	The 165 MW capacity OWF was fully commissioned in 2010.	Active	299 km SSE	312 km SSE	287 km SSE
n/a	Nobelwind	High	Nobelwind	Be	The 165 MW capacity OWF was fully commissioned in 2017.	Active	300 km SSE	313 km SSE	288 km SSE
n/a	Belwind Alstom Haliade Demonstration	High	Belwind NV	Be	The single 6 MW turbine was installed within the Belwind area and was the largest offshore wind turbine installed in sea waters at the time with a better yield than previous existing offshore wind turbines.	Active	298 km SSE	311 km SSE	287 km SSE
n/a	Seamade (Seastar)	High	Otary RS NV	Be	The OWF has a capacity of 252 MW and was fully commissioned in 2020.	Active	304 km SSE	317 km SSE	293 km SSE
n/a	Northwind	High	Nobelwind	Be	The OWF has a capacity of 216 MW and was fully commissioned in 2014.	Active	307 km SSE	320 km SSE	296 km SSE
n/a	Rentel	High	Rentel NV	Be	The OWF has a capacity of 309 MW and was fully commissioned in 2018.	Active	311 km SSE	324 km SSE	300 km SSE
n/a	Thornton Bank (phase i)	High	C-Power NV	Be	The 30 MW site was fully commissioned in 2009.	Active	315 km SSE	328 km SSE	304 km SSE
n/a	Thornton Bank (phase ii)	High	C-Power NV	Be	The 184.5 MW site was fully commissioned in 2013.	Active	315 km SSE	328 km SSE	304 km SSE
n/a	Thornton Bank (phase iii)	High	C-Power NV	Be	The 110.7 MW site was fully commissioned in 2013.	Active	315 km SSE	328 km SSE	304 km SSE
n/a	Norther	High	Northe NV	Be	The OWF has a capacity of 369.6 MW and was fully commissioned in 2018.	Active	319 km SSE	332 km SSE	309 km SSE
n/a	Borssele Site V -Leeghwater - Innovation Plot	High	Two Towers BV	Ned	The 19 MV pilot project was fully commissioned in 2021.	Active	300 km SSE	313 km SSE	293 km ESE
n/a	Borselle 1 and 2	High	Ørsted Borselle 1 BV	Ned	The 752 MW site was fully commissioned in 2020.	Active	305 km SSE	318 km SSE	298 km ESE
n/a	Borssele 3 and 4 - Blauwwind	High	Blauwwind II Consortium	Ned	The 731.5 MW site was fully commissioned in 2021.	Active	299 km SSE	312 km SSE	290 km SSE
n/a	Eneco Luchterduinen	High	Eneco Wind BV	Ned	The 129 MW site was fully commissioned in 2015.	Active	208 km ESE	296 km ESE	296 km ENE
n/a	Prinses Amaliawindpark	High	Offshore Windpark Q7	Ned	The 120 MW site was fully commissioned in 2008.	Active	269 km ESE	285 km ESE	285 km ESE
n/a	Egmond aan Zee	High	NordzeeWind	Ned	The 108 MW site was fully commissioned in 2007. The OWF has an expected life of 20 years, therefore may be ready for decommissioning in 2027.	Active	278 km ESE	294 km ESE	294 km ESE
n/a	Irene Vorrink	High	Nuon	Ned	The 16.8 MW site was fully commissioned in 1996. Decommissioning is set to commence in Q1 2022. New turbines will be installed in the area with an increased capacity of 132 MW as part of a project by Windplanblau. This new development is expected to be operational from 2023.	Active	343 km ESE	359 km ESE	359 km ESE
n/a	Westermeerwind	High	Ventolines BV	Ned	The 144 MW site was fully commissioned in 2016.	Active	334 km ESE	350 km ESE	350 km ESE
n/a	ENOVA Offshore Project Ems Emden	High	ENOVA Energieanlagen	Ger	The ENOVA Offshore Project became operational in 2004 and was intended to have an opertaional lifespan of approximately 20 years before requiring decommissioning, therefore decommissioning may occur in 2024.	Active	410 km ESE	426 km ESE	426 km ESE
n/a	Gemini	High	Northland Power Inc	Ned	The 600 MW site was fully commissioned in 2017.	Active	314 km ENE	329 km ENE	329 km ENE
n/a	Riffgat	High	Offshore Windpark RIFFGAT	Ger	The 108 MW site was fully commissioned in 2014.	Active	353 km ESE	368 km ESE	368 km ESE
n/a	Trianel Windpark Borkum I	High	Trianel Windkraftwerk Borkum	Ger	The 200 MW site was fully commissioned in 2015.	Active	346 km ENE	361 km ENE	361 km ENE
n/a	Trianel Windpark Borkum II	High	Trianel Windkraftwerk Borkum II	Ger	The 203 MW site was fully commissioned in 2020.	Active	346 km ENE	362 km ENE	362 km ENE
n/a	Merkur	High	Merkur Offshore	Ger	The 396 MW site was fully commissioned in 2019.	Active	352 km ENE	368 km ENE	368 km ENE
n/a	Alpha Ventus	High	Deutsche Offshore Testfield und Infrastruktur	Ger	The 60 MW site was fully commissioned in 2010.	Active	356 km ENE	371 km ENE	371 km ENE
n/a	Nordsee One	High	Nordsee One	Ger	The 332.1 MW site was fully commissioned in 2017.	Active	370 km ENE	386 km ENE	386 km ENE
n/a	Deutsche Bucht	High	Northland Deutsche Bucht	Ger	The 252 MW site was fully commissioned in 2019.	Active	301 km ENE	316 km ENE	316 km ENE
n/a	Veja Mate	High	Veja Mate Offshore Project	Ger	The 402 MW site was fully commissioned in 2017.	Active	307 km ENE	321 km ENE	321 km ENE
n/a	BARD Offshore 1	High	Bard Engineering	Ger	The 400 MW site was fully commissioned in 2013.	Active	314 km ENE	328 km ENE	328 km ENE
n/a	Albatros	High	EnBW Albatros	Ger	The 112 MW site was fully commissioned in 2020.	Active	332 km ENE	346 km ENE	346 km ENE
n/a	Hohe See	High	EnBW Hoh See	Ger	The 497 MW site was fully commissioned in 2019.	Active	337 km ENE	351 km ENE	351 km ENE
n/a	Meerwind Süd/Ost	High	WindMW	Ger	The 288 MW site was fully commissioned in 2015.	Active	426 km ENE	441 km ENE	441 km ENE
n/a	Nordsee Ost	High	Essent Wind Nordsee Ost	Ger	The 295.2 MW site was fully commissioned in 2015.	Active	425 km ENE	349 km ENE	439 km ENE
n/a	Amrumbank West	High	Arumbank West	Ger	The 302 MW site was fully commissioned in 2015.	Active	427 km ENE	441 km ENE	441 km ENE
n/a	Dan Tysk	High	DanTysk Offshore Wind	Ger	The 288 MW site was fully commissioned in 2015.	Active	403 km ENE	416 km ENE	416 km ENE
n/a	Sandbank	High	Sandbank Offshore Wind	Ger	The 288 MW site was fully commissioned in 2017.	Active	383 km ENE	396 km ENE	396 km ENE
Subsea Cables									
58	CANTAT 3	High	Faroese Telecom	UK	Disused telecommunications cable.	Disused	95 km NNW	2 km SSW	88 km NNW
59	Hornsea One Transmission Asset	High	Hornsea 1 Limited	UK	Export cable connecting the OWF to shore Horseshoe Point, Lincolnshire.	Under construction	44 km ESE	60 km ESE	15 km SSE
60	Hornsea Two Transmission Asset	High	Optimus Wind	UK	Export cable connecting the OWF to shore, close to Horseshoe Point, Lincolnshire. Schedule assumed to be within the windfarm timeframe.	Under construction	39 km ESE	55 km ESE	15 km SSE
61	Humber Gateway OFTO	High	Humber Gateway OFTO Limited	UK	Export cable connecting the OWF to shore, at Easington, East Riding of Yorkshire.	Active	74 km SSW	2 km SSE	2 km SSE
62	Pangea North	High	ASN	Den/UK	The submarine telecommunications cable system transited the North Sea, connecting UK with Denmark and Netherlands. As of 2018 it is no longer in service.	Disused	93 km NNW	The Teesside Pipeline will cross the cable	86 km NNW
63	TGN Northern Europe (formerly TATA North Europe)	High	TATA Communications	Ned/UK	The fibre optic submarine telecommunications cable system came into service in 2002. The cable consists of four fibre pair(s).	Active	39 km NNW	The Teesside Pipeline will cross the cable	25 km WNW
64	Teesside	High	Teesside Windfarm Ltd	UK	Export cable connecting the OWF to shore, at South Gare, North Yorkshire.	Active	136 km WNW	<1 km NNW	124 km WNW
65	UK-Denmark 4	High	BT	Den/UK	Disused telecommunications cable.	Disused	42 km NNW	The Teesside Pipeline will cross the cable	32 km NNW
66	UK-Germany 6	High	BT	Ger/UK	Disused telecommunications cable.	Disused	34 km NNW	<1 km SSW	26 km NNW
67	Westermost Rough OFTO	High	TC Westermost Rough OFTO Limited	UK	Export cable connecting the OWF to shore, at Tunstall, East Riding of Yorkshire.	Active	70 km SSW	65 km SSW	6 km WNW
68	Dogger Bank C Transmission Asset	Medium	Doggerbank Offshore Wind Farm Project 3 Projco Limited	UK	Export cable connecting the OWF to shore, close to Redcar, North Yorkshire. This transmission asset is shared between Dogger Bank C and Sofia therefore appears as 68 and 71 in Figure 2.1. Consent has been granted. Schedule assumed to be within the windfarm timeframe.	Consented	61 km NNW	The Teesside Pipeline will cross the (currently proposed) cable.	58 km NNW
69	Dogger Bank A Transmission Asset	Medium	Doggerbank Offshore Wind Farm Project 1 Projco Limited	UK	Export cable connecting the OWF to shore near Cottingham, East Yorkshire, UK. This transmission asset is shared between Dogger Bank A and B therefore appears as 69 and 70 in Figure 2.1. Consent has been granted. Schedule assumed to be within the windfarm timeframe.	Consented	21 km WNW	The Teesside Pipeline will cross the (currently proposed) cable.	5 km WNW

70	Dogger Bank B Transmission Asset	Medium	Doggerbank Offshore Wind Farm Project 2 Projco Limited	UK	Export cable connecting the OWF to shore near Cottingham, East Yorkshire, UK. This transmission asset is shared between Dogger Bank B and A therefore appears as 70 and 69 in Figure 2.1. Consent has been granted. Schedule assumed to be within the windfarm timeframe.	Consented						21 km WNW	The Teesside Pipeline will cross the (currently proposed) cable.	5 km WNW
71	Sofia Transmission Asset	Medium	Sofia Offshore Wind Farm Limited	UK	Export cable connecting the OWF to shore, close to Redcar, North Yorkshire. This transmission asset is shared between Sofia and Dogger Bank C therefore appears as 71 and 68 in Figure 2.1. Consent has been granted. Schedule assumed to be within the windfarm timeframe.	Consented						61 km NNW	The Teesside Pipeline will cross the (currently proposed) cable	58 km NNW
72	Breagh Fibre Optic Cable (PL2770)	High	INEOS UK SNS	UK	Fibre optic cable link between Breagh platform and shore.	Active						48 km NNW	The Teesside Pipeline will cross the cable	40 km NNW
79	Viking Link	High	NationalGrid and EnergiNet	Den/UK	The 760 km 1400 MW high voltage direct current (DC) electricity link will connect the British and Danish transmission systems at Bicker Fen substation in Lincolnshire and Revsing substation in southern Jutland, Denmark. Onshore construction commenced in 2020. The ES assumed construction would take 2-3 years.	Under construction						24 km ESE	39 km ESE	30 km SSE
80	Scotland to England Green Link – SEGL2	Low	NationalGrid	UK	The project proposes to construct a High Voltage Direct Current (HVDC) Link from Peterhead in Aberdeenshire to Drax in North Yorkshire. Landfall in England is at Wilsthorpe on the Holderness coast. Construction is currently due to commence in 2024 and be completed in 2029. However, consent has not yet been granted.	In planning						46 km WNW	The (currently proposed) cable will cross the Teesside Pipeline.	14 km WNW
92	Hornsea Four Transmission Asset	Medium	Ørsted	UK	Export cable connecting the OWF to shore, close to Bridlington, East Riding of Yorkshire. The HVAC Booster Station works area (shown on Figure 2.2) will be located <2 km from the Humber Pipeline. DCO process is ongoing. Schedule assumed to be within the windfarm timeframe.	In planning						13 km SSW	25 km SSW	The (currently proposed) cable will cross the Humber Pipeline.
n/a	Triton Knoll Export	High	Triton Knoll Offshore Windfarm Limited	UK	Transmission asset associated with theTriton Knoll OWF. Assume that the the schedule of installation will fall within the proposed timeline for the OWF.	Operational						85 km SSW	177 km SSE	47 km ESE
n/a	Hornsea 3 Transmission Asset	Medium	Ørsted	UK	Transmission asset associated with the Hornsea 3 OWF. Consent has been granted. Assume that the the schedule of installation will fall within the proposed timeline for the OWF.	Consented						83 km SSE	227 km ESE	93 km SSE
n/a	Norfolk Vanguard and Boreas Transmission Asset	Medium	Norfolk Vanguard Ltd and Norfolk Boreas Ltd	UK	The Norfolk Vanguard and Boreas OWFs chare the same tranmission asset. Consent has been granted. Assume that installation of the transmission asset will fall within the proposed timeline for the OWF.	Consented						167 km SSE	300 km SSE	134 km SSE
Aggregate and Mineral Extraction														
73	Hundale/Woodsmith Potash Mine	High	Anglo American plc	UK	The area contains the world's largest, highest grade polyhalite resource. The project began in 2010 with construction commencing in 2017. Anglo American plc acquired the project in early 2021. 1st production targeting 2024.	Under construction						61 km WSW	The Teesside Pipeline passes through the area licensed by TCE to the mine.	28 km WNW
74	Boulby Potash Mine	High	ICL	UK	Boulby is the deepest mine in the UK which mines salt, potash and most recently has become the first mine in the world to mine polyhalite, a fertiliser. Tunnels stretch far out, deep below the North Sea. Current planning permission requires minerals extraction to cease by 6 May 2023 with restoration to be completed by 6 May 2025. As of 2019, a new planning application was put forth to seek consent to continue the current mining operations for polyhalite and salt. The planning application seeks to retain a surface mine with operational area plant, equipment and supporting buildings for an additional 25 years from 2023, with a view to decommissioning at the end of the 25 year period.	Active						90 km WNW	The Teesside Pipeline passes through the area licensed by TCE to the mine.	62 km WNW
75	Humber 1	High	CEMEX UK Marine Ltd	UK	The marine aggregate extraction area supplies various grades of marine aggregates ranging from sand to coarse gravel, utilised in the construction industry. Area licensed until 2029.	Active						73 km SSW	77 km SSW	13 km ESE
76	Humber 2	High	CEMEX UK Marine Ltd	UK	The marine aggregate extraction area supplies various grades of marine aggregates ranging from sand to coarse gravel, utilised in the construction industry. Area licensed until 2029.	Active						70 km SSW	75 km SSW	12 km ESE
77	Humber 3	High	CEMEX UK Marine Ltd	UK	The marine aggregate extraction area supplies various grades of marine aggregates ranging from sand to coarse gravel, utilised in the construction industry. Area licensed until 2029.	Active						70 km SSW	74 km SSW	16 km ESE
78	Humber 4	High	CEMEX UK Marine Ltd	UK	The marine aggregate extraction area supplies various grades of marine aggregates ranging from sand to coarse gravel, utilised in the construction industry. Area licensed until 2029.	Active						65 km SSW	70 km SSW	19 km ESE
Other (within 50 km of the Development)														
B	Able Seaton Port	High	Able UK	UK	A facility for handling all types of offshore construction vessels, with significant crane capacity and quays, to serve the heavy fabrication industry. Potential for further quays to be added at a later date.	Active						99 km WSW	83 km SSW	32 km WNW
C	North Killingholme Power Project	Medium	C.GEN	UK	Construction of a new 470 MWe combined cycle gas turbine (CCGT) plant. Consent was granted in September 2014. Development set to commence by October 2026.	Consented						98 km WSW	87 km SSW	24 km WSW
E	Able Humber Port	Medium	Able UK Ltd	UK	Includes construction of a bespoke port facility for the renewable energy sector, particularly offshore wind. Development will feature approx. 1,300 m of new deep-water quays. Consent was granted in December 2013. Construction scheduled to begin in June 2022, completed by March 2025.	Consented						98 km WSW	88 km SSW	23 km WSW
F	VPI Immingham OCGT	Medium	VPI Immingham B Ltd	UK	Construction and operation of a new Open Cycle Gas Turbine Power Station of up to 299 MW gross output and associated development including gas and electrical connections. Consent was granted in August 2020.	Consented						99 km SSW	89 km SSW	21 km WSW
G	V-Net Zero Project	Medium	Harbour Energy	UK	A project which aims to store and transport CO_2 from the Immingham cluster on Humberside to an offshore depleted reservoir. Repurposing of Theddlethorpe Gas Terminal and LOGGS 36" offshore pipeline. A feasability study was announced in September 2021. CCS storage licence granted October 2021. Current timelines anticipate project completion for 2026/2027.	Consented						95 km WSW	86 km SSW	21 km WSW
H	South Humber Bank Energy Centre	Medium	EP Waste Management Limited	UK	Construction, operation and maintenance of an energy from waste power station with a gross electrical output of up to 95 MW. Consent was granted in November 2021. Construction was planned to commence during 2021 and last 3 years.	Consented						97 km WSW	91 km SSW	19 km WSW
I	York Potash Harbour Facilities Order	Medium	York Potash Limited	UK	The installation of wharf/jetty facilities with two ship loaders capable of loading bulk dry material at a rate of 12m tons per annum (dry weight). Associated dredging operations to create berth. Associated storage building with conveyor to wharf/jetty. Including a materials handling facility (if not located at Wilton) served by a pipeline (the subject of a separate application) and conveyor to storage building and jetty. Consent was granted in July 2016.	Consented						79 km WSW	3 km SW	110 km WNW
J	Net Zero Teeside	Medium	Net Zero Teesside	UK	The Net Zero Teesside Development comprises the construction and operation of a Carbon Capture Usage and Storage (CCUS) facility comprising a gas-fired generating station, together with equipment required for the capture and compression of CO_2 emissions from the power generating station. Supporting infrastructure and connections to facilitate the development of a wider industrial carbon capture network on Teesside also forms part of the Development. The Development also includes the onshore section of a pipeline to export the captured CO_2 for off-shore storage. This pipeline will connect to the Teesside Pipeline. The DCO for the project had been submitted. Assuming a DCO is granted for the project, construction is anticipated to commence in 2024 with a view to operation in 2027.	In planning						135km WNW	The Teesside Pipeline will interface with the Net Zero Teesside Development.	108 km WNW
K	Onshore Humber	Low	Zero Carbon Humber	UK	The project involves the creation of an onshore network of underground pipelines to transport captured CO_2. The pipelines are intended to connect major industrial emitters and power stations in the Humber region, before continuing to a landfall point on the Holderness coast. Here the captured carbon will be transported offshore to the Endurance Store via the Humber Pipeline. Subject to the ongoing sale process, and building on previous submissions, DCO submission is anticipated in 2024. The schedule for project completion aligns with enabling 10 million tonnes of CO2 injection per year by 2030.	Reasonably forseeable						80 km SSW	79 km SSW	The Humber Pipeline will interface with Onshore Humber
L	Harbour Area -Tees and Hartlepool Port Authority	High	PD Ports	UK	12 mile stretch of the River Tees, which includes a section three miles out into the North Sea: vessel traffic management, ensuring safe navigation, maintaining channel depths	Active						130 km NW	The Teesside Pipeline will cross the Teesport (collective name for Tees and Hartlepool harbours) port authority area.	110 km NW
M	Disposal site – Tees Bay A	High	Pd Teesport Limited	UK	Historically used for the disposal of both capital and maintenance dredged material. In general, Tees Bay A is used for the disposal of maintenance dredged material. Over the period 2000 to 2015, the site has been used every year for the disposal of either capital or maintenance dredged material. The average annual volume of maintenance dredged material deposited over this period was 1.7 million wet tonnes, with a peak disposal quantity of 2.4 million wet tonnes in 2006. The average annual volume of capital dredged material deposited over this period was approximately 0.1 million wet tonnes (over the six years when capital dredged material was deposited); with a peak of over 300,000 wet tonnes in 2008. PDT currently holds a 10 year licence (L/2015/00427/1) for the disposal of maintenance dredged material from the Tees estuary into the Tees Bay A site.	Active						130 km NW	2.8 km N	107 km NW
R	Port location & Harbour facility – Redcar Bulk Terminal	High	Redcar Bulk Terminal Ltd	UK	320 m long continuous quay which can accommodate vessels up to 17 m draft and is fitted with 2 x Ship Unloaders which can operate on grab or hook for bulk or conventional cargoes respectively.	Active						138 km WNW	3.4 km W	111 km WNW

P	Disposal site - Tees Bay C	High	Unknown	UK	Capital offshore dredged material disposal siteal. Over 1 million tonnes of material was deposited in Tees Bay C in 1999, but since then it has received only 74,903 tonnes of material in total. The site is used only occasionally.	Active						128 km WNW	5 km NNW	101 km WNW
Q	Disposal site - Amoco CATS Pipeline trench	High	Amoco	UK	2.3 km long disposal site associated with the CATS pipeline trench. Found on the north side of the CATS pipeline.	Disused						133 km WNW	<1 km NNW	107 km WNW

Appendix E: Compliance with Relevant Marine Plans

E. 1 East Inshore and East Offshore Marine Plans

The following table outlines how the Development aligns with relevant East Marine Plan policies.

Table E-1 - Alignment between the Development and the East Inshore and East Offshore Marine Plans

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
EC1	Proposals that provide economic productivity benefits which are additional to Gross Value Added currently generated by existing activities should be supported.	The Development will support local and UK employment during construction, operation and decommissioning phases.
EC2	Proposals that provide additional employment benefits should be supported, particularly where these benefits have the potential to meet employment needs in localities close to the marine plan areas.	The Development provides new pipeline infrastructure that may facilitate future CCS developments in the area, i.e. there is potential longer term economic benefit. The Development will support local and UK employment during construction, operation and decommissioning phases.
ECO1	Cumulative impacts affecting the ecosystem of the East Marine Plans and adjacent areas (marine and terrestrial) should be addressed in decision-making and plan implementation.	Cumulative impacts have been considered for each potential impact assessment carried out for the Development (see Chapters 6 – 11). No significant cumulative impacts are anticipated, including to the ecosystems of the East Marine Plans.
ECO2	The risk of release of hazardous substances as a secondary effect due to any increased collision risk should be taken account of in proposals that require an authorisation.	The potential for collision risk has been considered in Appendix M and accidental spills have been considered in Chapter 10: Accidental Events. Measures are proposed to minimise the collision risk between third-party vessels and vessels associated with the Development. No significant impacts are anticipated as a result from collision risk or accidental spills.
BIO1	Appropriate weight should be attached to biodiversity, reflecting the need to protect biodiversity as a whole, taking account of the best available evidence including on habitats and species that are protected or of conservation concern in the East Marine Plans and adjacent areas (marine and terrestrial).	The Development has undertaken environmental surveys and used the baseline information to inform the proposed Development footprint. For example, seabed survey data have been used to inform pipeline routing work, in order to limit potential interaction with seabed areas of conservation concern. Further details on the potential for interaction with protected habitats and species and the measures that have or will be taken to limit potential impact is described in each impact assessment (see Chapters 6 – 11). As outlined in Chapter 13: Environmental Management (Section 13.4), to align with bp's aim to achieve a net positive impact in new projects[1], a biodiversity enhancement assessment shall be completed for the Development. This assessment shall inform any requirements for a biodiversity enhancement action plan that shall be implemented during execution and operation of the Development as necessary.

[1] *https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/our-biodiversity-position-2020.pdf*

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
BIO2	Where appropriate, proposals for development should incorporate features that enhance biodiversity and geological interests.	Where necessary, mitigation measures have been implemented to protect biodiversity and geology. Impacts on biodiversity will be minimised as far as practicable. As outlined in Chapter 13: Environmental Management (Section 13.4), to align with bp's aim to achieve a net positive impact in new projects[2], a biodiversity enhancement assessment shall be completed for the Development. This assessment shall inform any requirements for a biodiversity enhancement action plan that shall be implemented during execution and operation of the Development as necessary.
CC1	Proposals should take account of: 1. How they may be impacted upon by, and respond to, climate change over their lifetime; and 2. How they may impact upon any climate change adaptation measures elsewhere during their lifetime. Where detrimental impacts on climate change adaptation measures are identified, evidence should be provided as to how the proposal will reduce such impacts.	A climate change resilience review is provided in Chapter 11: Atmospheric Emissions, which assesses the Development's ability to withstand, respond to and adapt to climate change. This assessment concluded that Development is able to withstand the predicted changes in climate. As a carbon capture and storage project, the Development will contribute towards the UK decarbonisation targets.
CC2	Proposals for development should minimise emissions of greenhouse gases as far as is appropriate. Mitigation measures will also be encouraged where emissions remain following minimising steps. Consideration should also be given to emissions from other activities or users affected by the proposal.	An impact assessment for atmospheric emissions has been carried out and is presented in Chapter 11: Atmospheric Emissions. This chapter also outlines opportunities to minimise emissions. Detailed emissions reduction reviews will form part of the detailed design and installation process.
CCS2	Carbon Capture and Storage proposals should demonstrate that consideration has been given to the re-use of existing oil and gas infrastructure rather than the installation of new infrastructure (either in depleted fields or in active fields via enhanced hydrocarbon recovery).	Consideration to the re-use of existing oil and gas infrastructure was considered and the rationale for not progressing this option is presented within the consideration of alternatives in Chapter 2.
DD1	Proposals within or adjacent to licensed dredging and disposal areas should demonstrate, in order of preference 1. That they will not adversely impact dredging and disposal activities 2. How, if there are adverse impacts on dredging and disposal, they will minimise these; and	There are no active disposal sites immediately adjacent to the Development. Chapter 9: Physical Presence outlines the mitigation measures in place to reduce any disruption to other sea users, including promulgation of information to ensure there would be no impact on disposal activities of other projects.

[2] *https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/our-biodiversity-position-2020.pdf*

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	3. How, if the adverse impacts cannot be minimised	
FISH1	Within areas of fishing activity, proposals should demonstrate in order of preference: 1. That they will not prevent fishing activities on, or access to, fishing grounds; 2. How, if there are adverse impacts on the ability to undertake fishing activities or access to fishing grounds, they will minimise them; 3. How, if the adverse impacts cannot be minimised, they will be mitigated; and 4. The case for proceeding with their proposal if it is not possible to minimise or mitigate the adverse impacts.	An assessment into the potential impacts to fisheries has been undertaken in Chapter 9: Physical Presence. Whilst it is acknowledged that there could be some temporary access restrictions during pipeline installation and drilling at the Endurance Store, any long-term exclusion will be localised to any permanent 500 m safety zones at the manifolds, wellheads and the SSIV locations that are applied for. Mitigation measures are proposed to minimise any disturbance to the fishing industry. bp, as operator of NEP, will continue to consult the fishing industry throughout the Development to minimise any potential impacts. As noted in the impact assessment in Chapter 9: Physical Presence, temporary and long-term exclusion is not expected to significantly impact the fishing industry.
FISH2	Proposals should demonstrate, in order of preference: 1. That they will not have an adverse impact upon spawning and nursery areas and any associated habitat; 2. How, if there are adverse impacts upon the spawning and nursery areas and any associated habitat, they will minimise them; 3. How, if the adverse impacts cannot be minimised they will be mitigated; and 4. The case for proceeding with their proposals if it is not possible to minimise or mitigate the adverse impacts.	The potential impact on nursery and spawning areas has been considered in the seabed impacts impact assessment (See Chapter 6: Seabed Disturbance). Although the Development area is considered to be within spawning and nursery grounds for some species, as discussed in the environmental baseline (see Chapter 4: Environment Description), the greatest potential for impact is during installation of the pipelines. These activities will be short-lived and cover only a small area of the available spawning habitat. The Development is not expected to have any long term impacts.
GOV1	Appropriate provision should be made for infrastructure on land which supports activities in the marine area and vice versa.	Separate consent applications are being made for the onshore infrastructure, as described in Chapter 1: Introduction.
GOV2	Opportunities for co-existence should be maximised wherever possible.	Chapter 9: Physical Presence has assessed the impacts from the Physical Presence of the Development on other users of the area and indicates that the Development can co-exist alongside other sea users such as shipping and navigation, fisheries and other sea users. Mitigation measures have been presented to reduce any potential disturbance to other sea users. Consultation has been undertaken with third parties and will continue through the lifetime of the Development.
GOV3	Proposals should demonstrate in order of preference:	The site selection process and consideration of alternative for the Development is described in Chapter 2. This details the considerations for selecting the Endurance Store, including the number of pipeline / cable crossings. The

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	1. That they will avoid displacement of other existing or authorised (but yet to be implemented) infrastructure; 2. How, if there are adverse impacts resulting in displacement by the proposal, they will minimise them; and 3. How, if the adverse impacts resulting in displacement by the proposal, cannot be minimised, they will be mitigated against; or 4. The case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts of displacement.	pipeline route selection also considered nearby infrastructure / activities. The Endurance Store area overlaps with The Crown Estate (TCE) Lease area for the Hornsea Project Four windfarm. On 17th June 2023, a commercial agreement was reached with Orsted (the developer of Hornsea Four) to avoid construction of Hornsea Four infrastructure within the area of overlap with the Endurance Store. The pipelines will also cross existing pipelines and cables and the crossing of these assets will be designed to minimise damage or disruption. bp, as operator of NEP, will remain in consultation with other third parties in the vicinity of the Development to minimise any potential displacement.
MPA1	Any impacts on the overall Marine Protected Area network must be taken account of in strategic level measures and assessments, with due regard given to any current agreed advice on an ecologically coherent network.	As part of each impact assessment (see Chapter 6 – 11) the potential for impacts to Marine Protected Areas is considered. As described in the assessment chapters, interaction with protected features in some protected sites is expected. For example, there will be pipeline installation in the Teesmouth and Cleveland Coast SPA, designated for several seabird species. Considering the scale of Development activities and the mitigation measures planned, significant impacts to MPAs are not expected and therefore impacts on the overall network are not expected.
SOC2	Proposals that may affect heritage assets should demonstrate, in order of preference: 1. That they will not compromise or harm elements which contribute to the significance of the heritage asset; 2. How, if there is compromise or harm to a heritage asset, this will be minimised; 3. How, where compromise or harm to a heritage asset cannot be minimised it will be mitigated against; or 4. The public benefits for proceeding with the proposal if it is not possible to minimise or mitigate compromise or harm to the heritage asset.	The seabed impact assessment (see Chapter 6: Seabed Disturbance) considers potential impacts to cultural heritage assets in the vicinity of the Development. No significant impacts have been identified for cultural heritage receptors. Temporary Archaeological Exclusion Zones (AEZ) (during installation) around known and potential features of archaeological interest will be implemented as required to ensure there are no impacts. A Procedure for Archaeological Discoveries (PAD) will be put in place for the Development, which will report finds of archaeological interest and mitigate against damage to unexpected and unrecorded archaeological assets.
SOC3	Proposals that may affect the terrestrial and marine character of an area should demonstrate, in order of preference:	Potential impacts to the current condition of the marine and terrestrial (in this case, coastal) environment have been given due consideration throughout the EIA process. There will be no permanent surface infrastructure associated with

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	1. That they will not adversely impact the terrestrial and marine character of an area; 2. How, if there are adverse impacts on the terrestrial and marine character of an area, they will minimise them; 3. How, where these adverse impacts on the terrestrial and marine character of an area cannot be minimised they will be mitigated against; or 4. The case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts.	the Development, and thus, any impact on the terrestrial (coastal) and marine character will be minimal. The majority of Development activities will be offshore and will not have a significant impact on the character, quality and distinctiveness of the character, quality and distinctiveness of the seascape and landscape. Any nearshore activities will be temporary and are also not expected to result in significant impacts on the character, quality and distinctiveness of the seascape and landscape.
OG1	Proposals within areas with existing oil and gas production should not be authorised except where compatibility with oil and gas production and infrastructure can be satisfactorily demonstrated.	The Development is within an area of past and present oil and gas exploration and production. Given the nature of the Development, which will involve the drilling of wells, installation of subsea facilities and the installation of two pipelines, it is deemed to be wholly compatible with oil and gas activity in the area. bp, as operator of NEP, will remain in consultation with oil and gas developers in the vicinity of the Development to minimise any potential impacts.
WIND1	Developments requiring authorisation, that are in or could affect sites held under a lease or an agreement for lease that has been granted by TCE for development of an offshore wind farm, should not be authorised unless: 1. They can clearly demonstrate that they will not compromise the construction, operation, maintenance, or decommissioning of the offshore wind farm; 2. The lease/agreement for lease has been surrendered back to TCE and not been re-tendered; 3. The lease/agreement for lease has been terminated by the Secretary of State; or 4. In other exceptional circumstances.	A number of offshore windfarm developments occur in the vicinity of the Development. The main way the Development could impact on these operations are disruption to shipping activities associated with the developments. Potential impacts to shipping is considered in the Physical presence impact assessment (see Chapter 9: Physical Presence). As described in the impact assessment chapter, the short-term nature of potential interaction means that no significant impact is anticipated. On 17th June 2023, a commercial agreement was reached with Orsted (the developer of Hornsea Four) to avoid construction of Hornsea Four infrastructure within the area of overlap with the Endurance Store.
PS2	Proposals that require static sea surface infrastructure that encroaches upon important navigation routes should not be authorised unless there are exceptional circumstances. Proposals should: 1. Be compatible with the need to maintain space for safe navigation, avoiding adverse economic impact;	No permanent static sea surface infrastructure will be in place for the Development. However, the drilling rig will be present at the Endurance Store for 370 days during the drilling operations. There will also be slow moving vessels on site for the duration of the pipeline installation. The area of the Development is known to be within a relatively busy shipping area. A collision risk assessment and consideration of potential impacts to navigation have been carried out (see Appendix M) and it is considered that

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	2. Anticipate and provide for future safe navigational requirements where evidence and/or stakeholder input allows; and 3. Account for impacts upon navigation in-combination with other existing and proposed activities.	through employment of the proposed mitigation and management there will be no significant impact to navigation in the area. Chapter 9: Physical Presence also considers the potential for cumulative impacts to arise with other existing and proposed activities. No significant cumulative impacts were identified.
PS3	Proposals should demonstrate, in order of preference: 1. That they will not interfere with current activity and future opportunity for expansion of ports and harbours; 2. How, if the proposal may interfere with current activity and future opportunities for expansion, they will minimise this; 3. How, if the interference cannot be minimised, it will be mitigated; and 4. The case for proceeding if it is not possible to minimise or mitigate the interference	During the life of the Development, port/harbour facilities will be required, and therefore, would support opportunities for port and harbour expansion. No direct impacts on ports and harbours are anticipated. However, Appendix M assesses the potential for disruption to established routes and areas, including vessels transiting to and from ports and harbours. It is considered that through employment of the proposed mitigation and management there will be no significant impact.
TR1	Proposals for development should demonstrate that during construction and operation, in order of preference: 1. They will not adversely impact tourism and recreation activities; 2. How, if there are adverse impacts on tourism and recreation activities, they will minimise them; 3. How, if the adverse impacts cannot be minimised, they will be mitigated; or 4. The case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts.	Recreation and tourism in the area is described as part of the baseline (see Chapter 4: Environment Description). The only potential impact to tourism and recreation is predicted to be temporary exclusion from the nearshore Development area during pipeline installation, since many of the activities will be occurring offshore, away from areas known for use as bathing waters or for recreational sailing. Any exclusion during pipeline installation is anticipated to be temporary in nature and not significant (see Chapter 9: Physical Presence).
TR2	Proposals that require static objects in the East Marine Plan areas, should demonstrate, in order of preference: 1. That they will not adversely impact on recreational boating routes; 2. How, if there are adverse impacts on recreational boating routes, they will minimise them; 3. How, if the adverse impacts cannot be minimised, they will be mitigated; or 4. The case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts.	Recreational boating activities in the area are presented as part of the Navigational Risk Assessment Baseline (see Appendix M). The only potential impact to recreational boating is predicted to be temporary exclusion from the nearshore Development area during pipeline installation, since many of the activities will be occurring offshore, away from areas known for use for recreational sailing. Any exclusion during pipeline installation is anticipated to be temporary in nature and not significant (see Chapter 9: Physical Presence).

E. 2 North East Inshore and North East Offshore Marine Plans

The following table outlines how the Development aligns with relevant North East Marine Plan policies.

Table E-2 - Alignment between the Development and the North East Inshore and North East Offshore Marine Plans

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
NE-INF-1	Proposals for appropriate marine infrastructure which facilitates land-based activities, or land-based infrastructure which facilitates marine activities (including the diversification or regeneration of sustainable marine industries), should be supported.	The Development is critical to the delivery of the wider East Coast Cluster by providing the onshore and offshore pipelines for transporting CO_2 from Teesside and Humber to the Endurance Store. The East Coast Cluster will decarbonise industrial clusters in Teesside and Humberside. In addition, the Development will provide economic benefits and local employment opportunities.
NE-CO-1	Proposals that optimise the use of space and incorporate opportunities for co-existence and co-operation with existing activities will be supported. Proposals that may have significant adverse Impacts on, or displace, existing activities must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse impacts so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals must state the case for proceeding.	Chapter 9: Physical Presence has assessed the impacts from the Physical Presence of the Development on other users of the area and indicates that the Development can co-exist alongside other sea users such as shipping and navigation, fisheries and other sea users. Mitigation measures have been presented to reduce any potential disturbance to other sea users. Consultation has been undertaken with third parties and will continue through the lifetime of the Development.
NE-OG-1	Proposals in areas where a licence for oil and gas has been granted or formally applied for should not be authorised unless it is demonstrated that the other development or activity is compatible with the oil and gas activity.	The Development is within an area of past and present oil and gas exploration and production. Given the nature of the Development, which will involve the drilling of wells, installation of subsea facilities and the installation of two pipelines, it is deemed to be wholly compatible with oil and gas activity in the area. bp, as operator of NEP, will remain in consultation with oil and gas developers in the vicinity of the Development to minimise any potential impacts.
NE-OG-2	Proposals within areas of geological oil and gas extraction potential demonstrating compatibility with future extraction activity will be supported.	bp, as operator of NEP, will remain in consultation with oil and gas developers in the vicinity of the Development to minimise any potential impacts.
NE-PS-1	In line with the National Policy Statement for Ports, sustainable port and harbour development should be supported. Only proposals demonstrating compatibility with current port and harbour activities will be	During the life of the Development, port/harbour facilities will be required, and therefore, would support opportunities for port and harbour expansion.

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	supported. Proposals within statutory harbour authority areas or their approaches that detrimentally and materially affect safety of navigation, or the compliance by statutory harbour authorities with the Open Port Duty or the Port Marine Safety Code, will not be authorised unless there are exceptional circumstances. Proposals that may have a significant adverse impact upon future opportunity for sustainable expansion of port and harbour activities, must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate – adverse impacts so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding.	No direct impacts on ports and harbours are anticipated. However, Appendix M assesses the potential for disruption to established routes and areas, including vessels transiting to and from ports and harbours. It is considered that through employment of the proposed mitigation and management there will be no significant impact.
NE-PS-3	Proposals that require static sea surface infrastructure or that significantly reduce under-keel clearance which encroaches upon high-density navigation routes, strategically important navigation routes, or that pose a risk to the viability of passenger services, must not be authorised unless there are exceptional circumstances.	There will be slow moving vessels on site for the duration of the pipeline installation. The area of the Development is known to be within a relatively busy shipping area. A collision risk assessment and consideration of potential impacts to navigation have been carried out (see Appendix M). and it is considered that through employment of the proposed mitigation and management there will be no significant impact to navigation in the area. Appendix M also includes an Under-Keel Clearance (UKC) assessment to support the NRA. It was concluded that there was adequate UKC for the SSIV. Recommendations were made to maximum UKC for the manifolds at the Endurance Store.
NE-HER-1	Proposals that demonstrate they will conserve and enhance the significance of heritage assets will be supported. Where proposals may cause harm to the significance of heritage assets, proponents must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate – any harm to the significance of heritage assets.	The seabed impact assessment (see Chapter 6) considers potential impacts to cultural heritage assets in the vicinity of the Development. No significant impacts have been identified for cultural heritage receptors. Temporary AEZ (during installation) will be implemented as required for known and potential features of archaeological interest to ensure there are no impacts. A PAD will also be put in place for the Development, which will report finds of archaeological interest and mitigate against damage to unexpected and unrecorded archaeological assets.

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	If it is not possible to mitigate, then public benefits for proceeding with the proposal must outweigh the harm to the significance of heritage assets.	
NE-REN-2	Proposals for new activity within areas held under a lease or an agreement for lease for renewable energy generation should not be authorised, unless it is demonstrated that the proposed development or activity will not reduce the ability to construct, operate or decommission the existing or planned energy generation project.	A number of offshore windfarm developments occur In the vicinity of the Development. The Endurance Store area also overlaps with TCE Lease area for the Hornsea Project Four windfarm. On 17th June 2023, a commercial agreement was reached with Orsted (the developer of Hornsea Four) to avoid construction of Hornsea Four infrastructure within the area of overlap with the Endurance Store. The main way the Development could impact on these operations are disruption to shipping activities associated with the developments. Potential impacts to shipping is considered in the Physical presence impact assessment (see Chapter 9: Physical Presence). As described in the impact assessment chapter, the short-term nature of potential interaction means that no significant impact is anticipated. The pipelines will also cross existing offshore wind export cables and the crossing of these assets will be designed to minimise damage or disruption.
NE-FISH-2	Proposals that enhance access for fishing activities should be supported. Proposals that may have significant adverse impacts on access for fishing activities must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate–- adverse impacts so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding.	An assessment into the potential impacts to fisheries has been undertaken in Chapter 9: Physical Presence. Whilst it is acknowledged that there could be some temporary access restrictions during pipeline installation and drilling operations, any long-term exclusion will be localised to permanent 500 m safety zones at the manifolds, wellheads and the SSIV locations that are applied for. As noted in the impact assessment in Chapter 9: Physical Presence, temporary and long-term exclusion is not expected to significantly impact on the fishing industry.
NE-FISH-3	Proposals that enhance essential fish habitat, including spawning, nursery and feeding grounds, and migratory routes, should be supported. Proposals that may have significant adverse impacts on essential fish habitat, including spawning, nursery and feeding grounds, and migratory routes, must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or	The potential impact on nursery and spawning areas has been considered in the seabed impacts impact assessment (Chapter 6). Although the Development area is considered to be within spawning and nursery grounds for some species, as discussed in the environmental baseline (see Chapter 4: Environment Description), the greatest potential for impact is during installation of the pipelines. These activities will be short-lived and cover only a small area

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	3. Mitigate–- adverse impacts so they are no longer significant.	of the available spawning habitat. The Development is not expected to have any long term impacts.
NE-EMP-1	Proposals that result in a net increase in marine related employment will be supported, particularly where they meet one or more of the following: 1. Are aligned with local skills strategies and support the skills available; 2. Create a diversity of opportunities; 3. Create employment in locations identified as the most deprived; or 4. Implement new technologies–- in, and adjacent to, the north east marine plan areas.	The Development provides new pipeline infrastructure that may facilitate future CCS developments in the area, i.e. there is potential longer term economic benefit. The Development will support local and UK employment during construction, operation and decommissioning phases
NE-CC-1	Proposals that conserve, restore or enhance habitats that provide flood defence or carbon sequestration will be supported. Proposals that may have significant adverse impacts on habitats that provide a flood defence or carbon sequestration ecosystem service must demonstrate that they will, in order of preference. 1. Avoid; 2. Minimise; 3. Mitigate – adverse impacts so they are no longer significant; or 4. Compensate for significant adverse impacts that can be mitigated	An assessment of the impact of the Development on blue carbon is provided in the seabed impacts chapter (Chapter 6: Seabed Disturbance). The Development is located in an area of sediment with low-moderate carbon value. Other habitats with blue carbon potential in the Development area include biogenic *Sabellaria spinulosa* reef along the Teesside Pipeline route, and seagrass restoration efforts may also take place at both Humber and Teesside. Nevertheless, the assessment has concluded that the Development is unlikely to impact carbon sequestration potential. The seabed disturbance assessment (Chapter 6: Seabed Disturbance) and the coastal processes assessment (Appendix G) has assessed the impact of the Development on the benthic and intertidal habitats and coastal processes. No significant impacts are predicted.
NE-CC-2	Proposals in the north east marine plan areas should demonstrate for the lifetime of the project that they are resilient to the impacts of climate change and coastal change.	A climate change resilience review is provided in Chapter 11: Atmospheric Emissions, which assesses the Development's ability to withstand, respond to and adapt to climate change. This assessment concluded that Development is able to withstand the predicted changes in climate.
NE-CC-3	Proposals in the north east marine plan areas, and adjacent marine plan areas, that are likely to have significant adverse impacts on coastal change, or on climate change adaptation measures inside and outside of the proposed project areas, should only be supported if they can demonstrate that they will, in order of preference: 1. Avoid;	The coastal processes assessment is provided in Appendix G which concludes that the impact of the Development on the coastal environment is not significant. The in-combination impact of coastal erosion and the Development on the coastal environment is considered in the in-combination climate change impact assessment in Chapter 11: Atmospheric Emissions. This

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	2. Minimise; or 3. Mitigate - adverse impacts so they are no longer significant.	has concluded that the impact of the Development in-combination with projected changes in climate is not likely to be significant.
NE-CCUS-2	Carbon capture, usage and storage proposals incorporating the re-use of existing oil and gas infrastructure will be supported.	Consideration to the re-use of existing oil and gas infrastructure was considered and the rationale for not progressing this option is presented within the consideration of alternatives in Chapter 2: Consideration of Alternatives.
NE-CCUS-3	Proposals associated with the deployment of low carbon infrastructure for industrial clusters should be supported.	The Development will facilitate the development of the proposed East Coast Cluster that will decarbonise industrial clusters in Teesside and Humberside.
NE-ACC-1	Proposals demonstrating appropriate enhanced and inclusive public access to and within the marine area, including the provision of services for tourism and recreation activities, will be supported. Proposals that may have significant adverse impacts on public access should demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse impacts so they are no longer significant.	Where necessary, mitigation measures have been implemented to reduce the adverse impacts on public access and is presented in Chapter 9: Physical Presence. The only potential impact to tourism and recreation is predicted to be temporary exclusion from the nearshore Development area during pipeline installation, since many of the activities will be occurring offshore, away from areas known for use as bathing waters or for recreational sailing. Any exclusion during pipeline installation is anticipated to be temporary in nature and not significant (see Chapter 9: Physical Presence).
NE-TR-1	Proposals that promote or facilitate sustainable tourism and recreation activities, or that create appropriate opportunities to expand or diversify the current use of facilities, should be supported. Proposals that may have significant adverse impacts on tourism and recreation activities must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse impacts so they are no longer significant.	Recreation and tourism in the area is described as part of the baseline (see Chapter 4: Environment Description). The only potential impact to tourism and recreation is predicted to be temporary exclusion from the nearshore Development area during pipeline installation, since many of the activities will be occurring offshore, away from areas known for use as bathing waters or for recreational sailing. Any exclusion during pipeline installation is anticipated to be temporary in nature and not significant (see Chapter 9: Physical Presence).
NE-MPA-1	Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network will be supported. Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: 1. Avoid;	As part of each impact assessment (see Chapter 6 - 11) the potential for impacts to Marine Protected Areas is considered. As described in the assessment chapters, interaction with protected features in some protected sites is expected. For example, there will be trenching activities in the Holderness Inshore MCZ and Holderness Offshore MCZ, which are designated for seabed features. Considering the scale of Development

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	2. Minimise; or 3. Mitigate – adverse impacts, with due regard given to statutory advice on an ecologically coherent network.	activities and the mitigation measures planned, significant impacts to MPAs are not expected and therefore impacts on the overall network are not expected.
NE-MPA-2	Proposals that enhance a marine protected area's ability to adapt to climate change, enhancing the resilience of the marine protected area network, will be supported. Proposals that may have adverse impacts on an individual marine protected area's ability to adapt to the effects of climate change, and so reduce the resilience of the marine protected area network, must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse impacts.	As part of each impact assessment (see Chapter 6 - 11) the potential for impacts to Marine Protected Areas is considered. As described in the assessment chapters, interaction with protected features in some protected sites is expected. For example, there will be trenching activities in the Holderness Inshore MCZ and Holderness Offshore MCZ, which are designated for seabed features. Considering the scale of Development activities and the mitigation measures planned, significant impacts to MPAs are not expected and therefore impacts on the overall network are not expected. The in-combination impact of the Development and climate change is considered in the in-combination climate change impact assessment in Chapter 11: Atmospheric Emissions. This has concluded that the impact of the Development in-combination with projected changes in climate is not likely to be significant.
NE-MPA-4	Proposals that may have significant adverse impacts on designated geodiversity must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse impacts so they are no longer significant.	A number of coastal Sites of Special Scientific Interest (SSSI's) are situated onshore of the landfall locations, which are designated for geological features. The Teesmouth and Cleaveland SSSI is landward of the Teesside Pipeline landfall. The coastal processes assessment (Appendix G) considers the potential impact of the Development on coastal features. This concluded that no significant impacts are expected.
NE-BIO-1	Proposals that enhance the distribution of priority habitats and priority species will be supported. Proposals that may have significant adverse impacts on the distribution of priority habitats and priority species must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; 3. Mitigate – adverse impacts so they are no longer significant; or	Chapters 6 – 11 consider the potential impacts from the Development to marine ecology receptors. Mitigations measures have been proposed to reduce the risk of adverse impacts on priority habitats and species where appropriate. As outlined in Chapter 13: Environmental Management (Section 13.4), to align with bp's aim to achieve a net positive impact in new projects[1], a biodiversity enhancement assessment shall be completed for the Development. This assessment shall inform any requirements for a biodiversity enhancement action

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	4. Compensate for significant adverse impacts that cannot be mitigated	plan that shall be implemented during execution and operation of the Development as necessary.
NE-BIO-2	Proposals that enhance or facilitate native species or habitat adaptation or connectivity, or native species migration, will be supported. Proposals that may cause significant adverse impacts on native species or habitat adaptation or connectivity, or native species migration, must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; 3. Mitigate - adverse impacts so they are no longer significant; or 4. Compensate for significant adverse impacts that cannot be mitigated.	Chapters 6 – 11 consider the potential impacts from the Development to marine ecology receptors. Where necessary, mitigation measures have been implemented to reduce the risk of adverse impacts on native species or habitat adaptation or connectivity. As outlined in Chapter 13: Environmental Management (Section 13.4), to align with bp's aim to achieve a net positive impact in new projects[3], a biodiversity enhancement assessment shall be completed for the Development. This assessment shall inform any requirements for a biodiversity enhancement action plan that shall be implemented during execution and operation of the Development as necessary.
NE-BIO-3	Proposals that conserve, restore or enhance coastal habitats, where important in their own right and/or for ecosystem functioning and provision of ecosystem services, will be supported. Proposals must take account of the space required for coastal habitats, where important in their own right and/or for ecosystem functioning and provision of ecosystem services, and demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; 3. Mitigate; or 4. Compensate for net habitat loss.	Where necessary, mitigation measures have been implemented to protect biodiversity and geology, however it is not deemed necessary for the Development to incorporate features that enhance these interests. Impacts on biodiversity will be minimised as far as practicable. As outlined in Chapter 13: Environmental Management (Section 13.4), to align with bp's aim to achieve a net positive impact in new projects[1],a biodiversity enhancement assessment shall be completed for the Development. This assessment shall inform any requirements for a biodiversity enhancement action plan that shall be implemented during execution and operation of the Development as necessary.
NE-INNS-1	Proposals that reduce the risk of introduction and/or spread of invasive non-native species should be supported. Proposals must put in place appropriate measures to avoid or minimise significant adverse impacts that would arise through the introduction and transport of invasive non-native species, particularly when: 1. Moving equipment, boats or livestock (for example fish or shellfish) from one water body to another; or	The introduction and spread of invasive non-native species will be reduced through compliance with relevant legislation and guidance, including MARPOL requirements and IMO Ballast Water Management Convention guidelines. Through compliance with these measures the discharges of ballast waters and biofouling of vessels will be controlled.

[3] *https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/our-biodiversity-position-2020.pdf*

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	2. Introducing structures suitable for settlement of invasive non-native species, or the spread of invasive non-native species known to exist in the area.	
NE-DIST-1	Proposals that may have significant adverse impacts on highly mobile species through disturbance or displacement must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse impacts so they are no longer significant.	The impact of the Development on highly mobile species is considered in Chapter 6, 7 and 9. The impacts from the Development are mainly expected to occur in the construction phase and will be short-term. Therefore, disturbance to highly mobile species is not expected to be significant. Where necessary, mitigation measures have been implemented to protect highly mobile species.
NE-UWN-1	Proposals that result in the generation of impulsive sound must contribute data to the UK Marine Noise Registry as per any currently agreed requirements. Public authorities must take account of any currently agreed targets under the Marine Strategy Part One Descriptor 11.	Data will be added to the UK Marine Noise Registry as required.
NE-UWN-2	Proposals that result in the generation of impulsive or non-impulsive noise must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse impacts on highly mobile species so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals must state the case for proceeding.	An impact assessment for underwater sound has been carried out and is presented in Chapter 7: Underwater Sound. The impact from underwater sound was not considered to be significant with the implementation of proposed management and mitigation measures.
NE-CE-1	Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse cumulative and/or in-combination effects so they are no longer significant.	As part of the Cumulative Impact Assessment for the Development, consideration has been given to all projects in the area including those already in operation and those with consent in place but not yet constructed within each assessment chapter (Chapter 6 – 11).
NE-SCP-1	Proposals should ensure they are compatible with their surroundings and should not have a significant adverse	There will be no permanent surface infrastructure associated with the Development, and thus, any impact on the terrestrial (coastal) and marine character will be minimal. The majority of Development activities will be

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	impact on the character and visual resource of the seascape and landscape of the area. The location, scale and design of proposals should take account of the character, quality and distinctiveness of the seascape and landscape. Proposals that may have a significant adverse impact on the seascape and landscape of the area should demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate – adverse impacts so they are no longer significant. If it is not possible to mitigate, the public benefits for proceeding with the proposal must outweigh significant adverse impacts to the seascape and landscape of the area. Proposals within or relatively close to nationally designated areas should have regard to the specific statutory purposes of the designated area. Great weight should be given to conserving and enhancing landscape and scenic beauty in National Parks and Areas of Outstanding Natural Beauty.	offshore and will not have a significant impact on the character, quality and distinctiveness of the character, quality and distinctiveness of the seascape and landscape. Any nearshore activities will be temporary and are also not expected to result in significant impacts on the character, quality and distinctiveness of the seascape and landscape.
NE-AIR-1	Proposals must assess their direct and indirect impacts upon local air quality and emissions of greenhouse gases. Proposals that are likely to result in increased air pollution or increased emissions of greenhouse gases must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - air pollution and/or greenhouse gas emissions in line with current national and local air quality objectives and legal requirements.	An assessment of the impacts of the Development on air quality is provided in Chapter 11: Atmospheric Emissions. The impact on local air quality was assessed as not significant with the consideration of proposed management and mitigation measures.
NE-ML-2	Proposals that facilitate waste re-use or recycling to reduce or remove marine litter will be supported. Proposals that could potentially increase the amount of marine litter in the marine plan areas must include measures to, in order of preference: 1. Avoid; 2. Minimise; or	The potential impact of accidental spills is assessed in Chapter 10: Accidental Events. Plans will be in place for accidental spills and contaminant releases. Procedures will be put in place to ensure that the location of any lost material is recorded and that significant objects are recovered, as detailed in Chapter 9: Physical Presence.

Policy	Objective/policy	Details of how the Development meets the requirements of the Objective / Policy
	3. Mitigate - adverse cumulative and/or in-combination effects so they are no longer significant.	
NE-WQ-1	Proposals that protect, enhance and restore water quality will be supported. Proposals that cause deterioration of water quality must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse cumulative and/or in-combination effects so they are no longer significant.	The potential impact of the Development on water quality is considered in Chapter 8: Discharges to Sea and Formation Water Displacement and Chapter 10: Accidental Events. With the implementation of the proposed management and mitigation measures, no significant impacts are expected.
NE-AGG-1	Proposals in areas where a licence for extraction of aggregates has been granted or formally applied for should not be authorised, unless it is demonstrated that the proposal is compatible with aggregate extraction.	The Teesside Pipeline overlaps with the offshore subsurface mining lease area for the Boulby and Hundale Potash Mines. The mining activities are undertaken under the sea. Hence, there are no impacts expected from the Development.
NE-DD-2	Proposals that cause significant adverse impacts on licensed disposal sites should not be supported. Proposals that may have significant adverse impacts on licensed disposal sites must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate - adverse impacts so they are no longer significant. If it is not possible to mitigate the significant adverse impacts, proposals must state the case for proceeding.	The are no active disposal sites immediately adjacent to the Development. Chapter 9: Physical Presence outlines the mitigation measures in place to reduce any disruption to other sea users, including promulgation of information to ensure there would be no impact on disposal activities of other projects.

Appendix F: Pipeline Surveys Observed Fauna

Note: this appendix is directly extracted from Northern Endurance Partnership Integrated Site Survey – 2021: Gardline Report Ref: 11711.E02, where it formed Appendix D of the report.

APPENDIX D FAUNAL OBSERVATION SUMMARY

Station	NEP21-ENV-CAM-02	NEP21-ENV-DC-01	NEP21-ENV-DC-02	NEP21-ENV-DC-04	NEP21-ENV-DC-05	NEP21-ENV-DC-06	NEP21-ENV-DC-08	NEP21-ENV-DC-10	NEP21-ENV-DC-11	NEP21-ENV-DC-12	NEP21-ENV-DC-13	NEP21-ENV-DC-14	NEP21-ENV-DC-15	NEP21-ENV-DC-16	NEP21-ENV-DC-17	NEP21-ENV-DC-18	NEP21-ENV-DC-19	NEP21-ENV-DC-20	NEP21-ENV-DC-21	NEP21-ENV-DC-22	NEP21-ENV-DC-23	NEP21-ENV-DC-24	NEP21-ENV-DC-24A	NEP21-ENV-DC-25	NEP21-ENV-DC-26	NEP21-ENV-DC-27	NEP21-ENV-DC-28	NEP21-ENV-DC-29	NEP21-ENV-DC-30	NEP21-ENV-DC-31	NEP21-ENV-DC-32	NEP21-ENV-DC-33	NEP21-ENV-DC-34	NEP21-ENV-DC-35	NEP21-ENV-DC-36	NEP21-ENV-DC-37	NEP21-ENV-DC-38	NEP21-ENV-DC-39	NEP21-ENV-DC-40	NEP21-ENV-DC-41	NEP21-ENV-DC-42	NEP21-ENV-DC-43	NEP21-ENV-DC-44	NEP21-ENV-DC-45
Number of Images Assessed	106	23	57	40	52	54	40	35	94	42	34	21	33	36	33	32	30	31	34	37	48	95	78	72	51	50	57	49	41	50	51	58	46	52	49	63	53	60	55	46	152	39	45	42
Phylum - Taxon	Present in number of Stills per Station																																											
Animalia indet.	10	0	1	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	0	1	1	6	2	1	0	0	0	1	4	2	0	0	0	1	4	6	3	3	0	2	1	7	2	0
Animalia tube	11	0	0	0	0	1	1	3	1	2	0	1	0	11	0	4	0	1	0	3	0	45	16	17	18	12	12	7	8	3	15	4	1	20	7	2	1	3	0	2	2	0	5	2
Annelida - *Ampharete falcata*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida - *Hyalinoecia tubicola*	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3	0	0	0	0	0	0	4	0	0	0	2	0	0	0
Annelida - Myxicola 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Annelida - *Oxydromus flexuosus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida - Pectinariidae msp0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0
Annelida - Sabellidae 01	0	0	0	0	0	0	0	0	0	6	8	0	0	0	0	0	0	0	0	0	31	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida - Sabellidae 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Annelida - Sabellidae 03	4	0	0	0	0	0	0	0	1	0	0	0	1	1	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	2	0
Annelida - Serpulidae msp0001	2	0	0	0	0	0	0	13	33	32	3	0	15	26	10	13	14	19	14	23	9	63	46	61	37	45	51	42	31	41	43	34	15	46	39	60	44	57	38	45	72	1	40	16
Annelida - Sipuncula 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Annelida - Terebellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Arthropoda - Brachyura 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	6	7	4	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	2	0
Arthropoda - Brachyura 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Arthropoda - Brachyura 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Arthropoda - Brachyura 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Arthropoda - Brachyura 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0
Arthropoda - Brachyura 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Arthropoda - Brachyura 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Arthropoda - Brachyura 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Arthropoda - *Cancer pagurus*	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1	1	0	1	0	0	2	0	0	0	0	0	0	1	2	1	2	0	0	0
Arthropoda - Caridea msp0001	0	0	0	0	0	0	0	10	1	9	10	0	1	4	2	2	4	1	2	3	9	58	19	19	2	16	23	24	5	16	3	1	0	3	1	1	0	0	0	0	5	0	11	0
Arthropoda - Cirripedia	0	0	0	0	0	0	0	0	0	0	1	0	19	16	22	19	25	23	18	31	1	0	2	1	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda - *Corystes cassivelaunus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Arthropoda - *Ebalia* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	1	0	1	0
Arthropoda - Galatheidae	1	0	0	0	0	0	0	5	5	15	6	0	0	0	0	1	0	1	1	5	4	38	14	19	4	13	36	22	11	28	26	20	6	15	10	17	0	0	0	0	61	0	4	1
Arthropoda - *Homarus gammarus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda - Inachidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Arthropoda - *Inachus* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	5	1	0	0	0
Arthropoda - *Liocarcinus depurator*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0
Arthropoda - Majidae 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	1	1	1	2	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Arthropoda - *Munida rugosa*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	9	1	5	0	2	13	9	3	10	3	0	4	4	7	5	20	17	11	2	14	0	1	0
Arthropoda - *Necora puber*	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Arthropoda - Paguroidea msp0001	1	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	4	6	12	6	9	3	1	2	4	2	4	1	5	3	0	1	2	1	1	0	1	0	0
Arthropoda - *Pagurus bernhardus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda - *Pagurus prideaux*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	3	4	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Arthropoda - Pycnogonida	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0
Brachiopoda 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bryozoa - *Alcyonidium diaphanum*	11	0	0	0	0	0	0	0	0	0	0	0	1	5	3	3	8	13	7	2	2	10	4	3	4	9	6	12	5	11	2	16	3	1	8	7	13	10	19	20	23	4	8	4
Bryozoa - *Cellaria* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	4	0	2	8	0	0	0	0	0	0	2	2	2	1	1	0	0	1	0	0	1	5	1	8	13	0	2	0
Bryozoa - Flustridae 01	47	0	0	0	0	0	0	20	1	2	21	0	5	11	10	19	14	11	17	11	28	47	31	9	16	31	40	32	20	32	33	25	18	31	25	34	32	19	40	10	136	5	21	7
Chlorophyta 01	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Chlorophyta 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Chlorophyta 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii 04	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	9	0	0	0	3	3	1	1	1	2	1	1	0	0	0	3	1	0	0	0	1	0
Chordata - Actinopterygii 05	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0

APPENDIX D FAUNAL OBSERVATION SUMMARY

Station	NEP21-ENV-CAM-02	NEP21-ENV-DC-01	NEP21-ENV-DC-02	NEP21-ENV-DC-04	NEP21-ENV-DC-05	NEP21-ENV-DC-06	NEP21-ENV-DC-08	NEP21-ENV-DC-10	NEP21-ENV-DC-11	NEP21-ENV-DC-12	NEP21-ENV-DC-13	NEP21-ENV-DC-14	NEP21-ENV-DC-15	NEP21-ENV-DC-16	NEP21-ENV-DC-17	NEP21-ENV-DC-18	NEP21-ENV-DC-19	NEP21-ENV-DC-20	NEP21-ENV-DC-21	NEP21-ENV-DC-22	NEP21-ENV-DC-23	NEP21-ENV-DC-24	NEP21-ENV-DC-24A	NEP21-ENV-DC-25	NEP21-ENV-DC-26	NEP21-ENV-DC-27	NEP21-ENV-DC-28	NEP21-ENV-DC-29	NEP21-ENV-DC-30	NEP21-ENV-DC-31	NEP21-ENV-DC-32	NEP21-ENV-DC-33	NEP21-ENV-DC-34	NEP21-ENV-DC-35	NEP21-ENV-DC-36	NEP21-ENV-DC-37	NEP21-ENV-DC-38	NEP21-ENV-DC-39	NEP21-ENV-DC-40	NEP21-ENV-DC-41	NEP21-ENV-DC-42	NEP21-ENV-DC-43	NEP21-ENV-DC-44	NEP21-ENV-DC-45
Number of Images Assessed	106	23	57	40	52	54	40	35	94	42	34	21	33	36	33	32	30	31	34	37	48	95	78	72	51	50	57	49	41	50	51	58	46	52	49	63	53	60	55	46	152	39	45	42
Phylum - Taxon	Present in number of Stills per Station																																											
Chordata - Actinopterygii 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Chordata - Actinopterygii 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Actinopterygii indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - *Agonus cataphractus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Chordata - Ascidiacea 01	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0
Chordata - Ascidiacea 02	0	0	0	0	0	0	0	0	0	0	0	0	1	24	17	25	26	28	22	25	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	6	0	0	0
Chordata - Ascidiacea 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - *Buglossidium luteum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Chordata - *Callionymus lyra*	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - cf. *Melanogrammus aeglefinus*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - *Chelidonichthys cuculus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Gadidae msp001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	5	6	11	9	4	4	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Chordata - Labridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - *Limanda limanda*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - *Merlangius merlangus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - *Microstomus kitt*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	0	2	1	0	1	0	0	0	0	0
Chordata - *Pholis gunnellus*	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	1	0	1	3	0	0	0
Chordata - *Pleuronectes platessa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Pleuronectiformes indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Pleuronectiformes 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Chordata - Pleuronectiformes 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Pleuronectiformes 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Pleuronectiformes 04	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Pleuronectiformes 05	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Pleuronectiformes 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Chordata - Scorpaeniformes 01	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Chordata - *Solea solea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata - Trachinidae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Actiniaria 01	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	1	2	0	0	4	1	1	2	1	3	3	1	0	2	3	4	1	9	0	0	0
Cnidaria - Actiniaria 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Actiniaria 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Actiniaria 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - *Adamsia palliata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	3	4	0	0	2	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Cnidaria - *Alcyonium digitatum*	88	0	0	0	0	0	0	10	15	25	10	0	0	0	0	0	0	0	0	0	12	57	30	35	28	27	41	36	18	40	47	50	32	34	45	46	37	47	50	14	37	2	33	3
Cnidaria - Cerianthiidae 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cnidaria - Cerianthiidae 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - *Corymorpha nutans*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Cnidaria - *Hydractinia echinata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Cnidaria - Hydrozoa 01	9	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	2	0	1	1	0	5	2	1	2	2	1	5	1	0	2	7	2	2	0	0	67	0	0	0
Cnidaria - Hydrozoa 02	3	0	0	0	0	0	0	0	0	2	0	0	0	4	1	2	3	0	0	1	0	0	3	3	0	3	2	1	1	9	3	7	4	8	6	3	9	5	15	0	84	0	3	6
Cnidaria - Hydrozoa 03	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	0	0
Cnidaria - Hydrozoa 04	4	0	0	0	0	0	0	0	0	0	1	0	1	0	2	20	4	2	1	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	2	1	0	2	2	0	0	0
Cnidaria - Hydrozoa 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	1	0	0	0	0	3	0	0	1
Cnidaria - Hydrozoa 06	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	1	0	0	0	0	0	0	0	1	1	6	2	1	0	0	0	0	1	9	2	10	18	0	0	0
Cnidaria - Hydrozoa 07	1	0	0	0	0	0	0	0	0	1	0	0	0	4	5	12	4	3	1	1	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	7	2	3	0	5	0	0	1
Cnidaria - Hydrozoa 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cnidaria - Hydrozoa 09	0	0	0	0	0	0	0	0	0	0	0	0	3	21	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Gardline

APPENDIX D FAUNAL OBSERVATION SUMMARY

Station	NEP21-ENV-CAM-02	NEP21-ENV-DC-01	NEP21-ENV-DC-02	NEP21-ENV-DC-04	NEP21-ENV-DC-05	NEP21-ENV-DC-06	NEP21-ENV-DC-08	NEP21-ENV-DC-10	NEP21-ENV-DC-11	NEP21-ENV-DC-12	NEP21-ENV-DC-13	NEP21-ENV-DC-14	NEP21-ENV-DC-15	NEP21-ENV-DC-16	NEP21-ENV-DC-17	NEP21-ENV-DC-18	NEP21-ENV-DC-19	NEP21-ENV-DC-20	NEP21-ENV-DC-21	NEP21-ENV-DC-22	NEP21-ENV-DC-23	NEP21-ENV-DC-24	NEP21-ENV-DC-24A	NEP21-ENV-DC-25	NEP21-ENV-DC-26	NEP21-ENV-DC-27	NEP21-ENV-DC-28	NEP21-ENV-DC-29	NEP21-ENV-DC-30	NEP21-ENV-DC-31	NEP21-ENV-DC-32	NEP21-ENV-DC-33	NEP21-ENV-DC-34	NEP21-ENV-DC-35	NEP21-ENV-DC-36	NEP21-ENV-DC-37	NEP21-ENV-DC-38	NEP21-ENV-DC-39	NEP21-ENV-DC-40	NEP21-ENV-DC-41	NEP21-ENV-DC-42	NEP21-ENV-DC-43	NEP21-ENV-DC-44	NEP21-ENV-DC-45
Number of Images Assessed	106	23	57	40	52	54	40	35	94	42	34	21	33	36	33	32	30	31	34	37	48	95	78	72	51	50	57	49	41	50	51	58	46	52	49	63	53	60	55	46	152	39	45	42
Phylum - Taxon	Present in number of Stills per Station																																											
Cnidaria - Hydrozoa 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Hydrozoa 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Hydrozoa 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Hydrozoa 13	0	0	0	0	0	0	0	0	0	0	0	0	5	25	14	27	29	25	19	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Hydrozoa 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Hydrozoa 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	10	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Hydrozoa 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	5	1	15	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Hydrozoa 17	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	7	10	2	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Hydrozoa 18	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Hydrozoa 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - *Metridium senile*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - Nemertesia 01	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	4	3	2	0	0	1	2	0	0	0	0	1	0	2	0	0	0
Cnidaria - Nemertesia 02	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	1	1	2	1	0	0	2	3	1	0	1	2	0	98	0	0	0
Cnidaria - Nemertesia 03	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	1	3	2	0	16	0	0	0
Cnidaria - Sagartia 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	3	2	0	0	0	0	1	0	0	0	0	0	0
Cnidaria - *Thuiaria thuja*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	2	6	4	5	7	3	7	11	3	0	0	11	1	3	2	1	0	1	5	0	1	0
Cnidaria - *Tubularia* sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	2	1	2	16	1	2	18	0	12	3	6	8	11	13	10	5	11	10	1	10	7	1	2	2	3	21	4	5	0	0	2
Cnidaria - *Urticina eques*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
Cnidaria - *Urticina felina*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria - *Urticina* sp.	8	0	0	0	0	0	0	1	0	0	2	0	0	0	0	4	0	0	1	1	0	4	1	3	0	0	0	1	0	0	0	0	0	0	0	2	1	0	0	1	0	0	0	0
Echinodermata - *Asterias rubens*	4	0	0	0	0	0	0	1	2	1	3	0	0	0	0	0	0	0	0	0	6	2	2	6	1	0	3	1	1	0	3	0	0	1	4	2	3	2	1	3	4	0	8	0
Echinodermata - Asteroidea 01	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	17	6	3	5	0	2	4	2	3	1	1	1	0	2	0	3	0	0	0	0	0	1
Echinodermata - Asteroidea 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata - Asteroidea 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Echinodermata - Asteroidea 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Echinodermata - Asteroidea 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata - Asteroidea indet.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata - *Astropecten irregularis*	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	1	0	1	0	2
Echinodermata - *Crossaster papposus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	4	0	2	1	1	0	0	1	1	1	2	0	0	1	0	1	0
Echinodermata - *Echinoidea* sp.	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Echinodermata - *Echinus esculentus*	0	0	0	0	0	0	0	4	4	2	1	0	0	0	0	0	0	1	2	1	2	11	0	2	2	5	11	5	2	5	5	1	2	7	7	6	4	2	1	0	22	0	0	0
Echinodermata - *Henricia* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	1	0	2	0	1	3	4	1	1	0	1	1	1	0	1	1	0	0	2	7	0	3	0
Echinodermata - *Luidia ciliaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Echinodermata - *Luidia sarsii*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata - *Ophiothrix fragilis*	2	0	0	0	0	0	0	10	0	2	0	0	0	0	0	0	0	0	0	0	0	15	0	21	0	1	2	1	0	8	0	19	0	0	2	0	8	18	10	0	65	0	1	0
Echinodermata - *Ophiura albida*	4	0	0	0	0	0	0	7	5	6	0	0	0	0	0	0	0	0	0	0	0	10	2	35	12	8	0	4	4	0	1	2	0	6	5	2	13	20	4	0	18	0	9	0
Echinodermata - Ophiuroidea	2	0	0	0	0	1	0	23	11	6	13	0	0	0	0	0	0	0	0	0	17	43	5	25	11	9	34	14	9	8	3	7	2	2	7	11	6	5	1	0	49	0	3	1
Faunal turf	20	0	0	0	1	0	0	12	4	12	31	0	0	0	0	0	0	0	1	0	37	83	49	69	46	48	56	37	33	41	40	39	16	9	9	59	12	2	0	0	1	2	37	12
Foraminifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laminaria 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Lebenspurren - Faecal cast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca - Anomiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca - *Arctica islandica* dead shells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca - *Arctica islandica* siphons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0
Mollusca - Bivalvia 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca - Bivalvia 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	1	0	0	0	0
Mollusca - Bivalvia 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Mollusca - Bivalvia siphons	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	1	0	2	1	0	0	0	2	1	1	0	0	0
Mollusca - *Calliostoma zizyphinum*	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	1	2	0	2	2	1	3	0	3	1	1	1	0	2	3	0	5	0	0	1
Mollusca - cf. *Neptunea antiqua*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	3	1	0	2	1	0	4	1	0	0	0
Mollusca - Gastropoda 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	1

APPENDIX D FAUNAL OBSERVATION SUMMARY

Station	NEP21-ENV-CAM-02	NEP21-ENV-DC-01	NEP21-ENV-DC-02	NEP21-ENV-DC-04	NEP21-ENV-DC-05	NEP21-ENV-DC-06	NEP21-ENV-DC-08	NEP21-ENV-DC-10	NEP21-ENV-DC-11	NEP21-ENV-DC-12	NEP21-ENV-DC-13	NEP21-ENV-DC-14	NEP21-ENV-DC-15	NEP21-ENV-DC-16	NEP21-ENV-DC-17	NEP21-ENV-DC-18	NEP21-ENV-DC-19	NEP21-ENV-DC-20	NEP21-ENV-DC-21	NEP21-ENV-DC-22	NEP21-ENV-DC-23	NEP21-ENV-DC-24	NEP21-ENV-DC-24A	NEP21-ENV-DC-25	NEP21-ENV-DC-26	NEP21-ENV-DC-27	NEP21-ENV-DC-28	NEP21-ENV-DC-29	NEP21-ENV-DC-30	NEP21-ENV-DC-31	NEP21-ENV-DC-32	NEP21-ENV-DC-33	NEP21-ENV-DC-34	NEP21-ENV-DC-35	NEP21-ENV-DC-36	NEP21-ENV-DC-37	NEP21-ENV-DC-38	NEP21-ENV-DC-39	NEP21-ENV-DC-40	NEP21-ENV-DC-41	NEP21-ENV-DC-42	NEP21-ENV-DC-43	NEP21-ENV-DC-44	NEP21-ENV-DC-45
Number of Images Assessed	106	23	57	40	52	54	40	35	94	42	34	21	33	36	33	32	30	31	34	37	48	95	78	72	51	50	57	49	41	50	51	58	46	52	49	63	53	60	55	46	152	39	45	42
Phylum - Taxon	Present in number of Stills per Station																																											
Mollusca - Gastropoda 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca - Gastropoda 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0
Mollusca - Gastropoda 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
Mollusca - Gastropoda 05	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	8	2	0	5	5	0	0	0
Mollusca - Gastropoda 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Mollusca - Gastropoda 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Mollusca - Naticidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca - Naticidae eggs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	4	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mollusca - Nudibranchia 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	1	0	0	2	0	0	0	5	0	0	0
Mollusca - Nudibranchia 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	1	0	0	0
Mollusca - Nudibranchia 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca - Nudibranchia 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Mollusca - Pectinidae msp0001	5	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	5	2	7	4	8	2	3	5	2	5	2	1	2	3	6	3	3	6	24	10	2	20	0
Mollusca - Scaphopoda msp0001	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	4	0	0	1	1	0	1	1	1	0	0	1	0	0	0	0	0
Porifera 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta 01	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix G: Coastal Processes Baseline

BP Exploration Operating Company Ltd

Offshore Environmental Statement for the Northern Endurance Partnership

Coastal Processes Baseline

ASSIGNMENT A200540-S00
DOCUMENT A-200540-S00-REPT-013

XODUS

Aberdeen

Xodus House
50 Huntly Street . Aberdeen
AB10 1RS . UK

T +44 (0)1224 628300

www.xodusgroup.com

REVISIONS & APPROVALS

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A01	04/07/2023	Issued for Use	JL	MD	MD	
R02	27/09/2022	Issued for Review	CM	JL	MD	
R01	10/06/2022	Issued for Review	CM	JL	WM/MD	

CONTENTS

EXECUTIVE SUMMARY		5
1	INTRODUCTION	7
1.1	**Project Description**	**7**
1.2	**Scope of Work**	**7**
1.2.1	Study Objectives	7
1.2.2	Study Area	8
1.3	**Stakeholder Consultation**	**10**
1.4	**Local Shoreline Management Plans**	**10**
1.4.1	Teesside	12
1.4.2	Humber	13
2	BASELINE ENVIRONMENT	16
2.1	**Regional Context**	**16**
2.2	**Teesside**	**22**
2.2.1	Key Data Sources	22
2.2.2	Designated Sites	22
2.2.3	Geology and Surficial Sediment	25
2.2.4	Bathymetry and Morphology	28
2.2.5	Metocean	30
2.2.6	Sediment Transport Regime	35
2.2.7	Coastline	37
2.2.8	Climate Change and Sea Level Rise	39
2.2.9	Teesside Site Visit	40
2.3	**Humber**	**42**
2.3.1	Key Data Sources	42
2.3.2	Designated Sites	42
2.3.3	Geology and Surficial Sediment	46
2.3.4	Bathymetry and Morphology	50
2.3.5	Metocean	52
2.3.6	Sediment Transport Regime	56
2.3.7	Coastline	60
2.3.8	Climate Change and Sea Level Rise	63
2.3.9	Coastline Projections	64
2.3.10	Humber Site Visit	65
2.3.11	Sediment Transport Modelling	67
3	IMPACT ASSESSMENT	70
REFERENCES		71

APPENDIX 1 COASTAL MODELLING REPORT 76

PAGE LEFT INTENTIONALLY BLANK

EXECUTIVE SUMMARY

The purpose of this report is to provide a standalone summary of the baseline data and assessment methodology for the coastal processes aspects of the Northern Endurance Partnership (NEP) Development ('the Development'), to support the offshore Environmental Statement,

The Development is one component of the proposed East Coast Cluster strategic initiative that aims to deliver the UK's first zero carbon industrial cluster. The East Coast Cluster consists of a diverse mix of low-carbon projects including industrial carbon capture, low-carbon hydrogen production, negative emissions power, and power with carbon capture. The Development consists of offshore CO_2 transport and storage infrastructure in the UK SNS and will route CO_2 from industrial clusters in the Teesside and Humber regions to the offshore geological storage site, the Endurance Store ('the Store') located approximately 63 km from the nearest coastline in the SNS.

The introduction presents information on the Development area of assessment at both the Teesside and Humber landfalls, the local Shoreline Management Plans, the design envelope and a summary of the scoping and consultation undertaken to date. The baseline section then presents general background on the geology, bathymetry, metocean conditions and coastline behaviour at each of the Teesside and Humber landfalls. It describes the net southward longshore sediment transport along the coast and the key role the Dimlington cliffs play in the supply of sediments to sites further south, and sets the Development within the context of the Dimlington Site of Special Scientific Interest (SSSI) and Holderness Inshore Marine Conservation Zone (MCZ).

At Teesside, the key impact to coastal processes is likely to be the permanent presence of the SSIV, which will cause local scour, although the impact is not considered to be significant.

At Humber, the key impact to coastal processes from pipeline construction works is likely to be the potential barrier to net longshore sediment transport caused by the cofferdam, which may be in place for around six months, although the impact is not considered to be significant and can be fully mitigated against.

This report will be included as an Appendix in the full offshore NEP Environmental Statement, and sections of it have fed directly into the Seabed Disturbance Chapter 6.

1 INTRODUCTION

1.1 Project Description

The Northern Endurance Partnership (NEP) Development ('the Development'), is one component of the proposed East Coast Cluster strategic initiative that aims to deliver the UK's first zero carbon industrial cluster. The East Coast Cluster consists of a diverse mix of low-carbon projects including industrial carbon capture, low-carbon hydrogen production, negative emissions power, and power with carbon capture. The Development consists of offshore CO_2 transport and storage infrastructure in the UK SNS and will route CO_2 from industrial clusters in the Teesside and Humber regions to the offshore geological storage site, the Endurance Store ('the Store') located approximately 63 km from the nearest coastline in the SNS.

The infrastructure required as part of the Development is entirely subsea in nature and will include two CO_2 pipelines, one each running from Humber and Teesside compression/pumping systems to a common subsea manifold and well injection site at the Endurance Store. These pipelines are henceforth referred to as the Teesside Pipeline and the Humber Pipeline. CO_2 from both pipelines will be combined and distributed for injection into the Store via well injection facilities on the seabed. The Humber Pipeline landfall is in the Easington area, north of the Perenco Dimlington terminal and the Teesside Pipeline landfall is at Coatham Sands, to the southeast of the mouth of the River Tees.

A full description of the project, including details on the proposed installation activities, can be found in Chapter 3 of the Offshore Environmental Statement for the Northern Endurance Partnership.

1.2 Scope of Work

1.2.1 Study Objectives

During the construction of the Development there will be a physical disturbance of the seabed associated with installation of the pipelines, in particular activities occurring at the coast in relation to pipeline landfall. During the installation and future maintenance phases of the Development, activities may cause localised changes to the hydrodynamic regime, which in turn could modify the sediment dynamics of the area.

This report aims to summarise the data sources available for EIA, provide a baseline characterisation of the areas around the two pipeline landfall sites, and determine the potential impacts of the Development on local coastal processes.

This study is not part of the main ES but will act as a supporting document to the ES. In particular, this study will inform the Seabed Disturbance chapter of the ES (Chapter 6) which will synthesise the information presented throughout the study within the context of the wider implications of the Development on the seabed. This study forms an Appendix to the main ES. Consequently, this study will be available to regulators and stakeholders as part of the overall framework of documents in support of the Development.

1.2.2 Study Area

The study area for this report is focussed on pipeline landfalls at Humber and Teesside (Figure 1-1.). The nature of coastal processes means that it is necessary to have a broader understanding of the regional coastal cell and offshore environment associated with the landfall locations, so at times we describe the offshore region for context, but the consideration of Development impacts is focussed on the landfall locations. This means that the Endurance Store area of the Development is out of scope, but the nearshore sections of the pipelines are included. Some impacts further offshore are also included for completeness, but they will be covered in full detail in the Seabed Disturbance chapter (Chapter 6).

At the Humber Pipeline landfall, the study area encompasses a few kilometres either side of the landfall location, and as far to the south as Spurn Head, which is included because of its importance as a feature of the Humber Estuary. The presence of Spurn Head is integral to the protection of the Humber Estuary from extreme weather events; this allows the area to continue as an industrial hub and busy port location.

At the Teesside Pipeline landfall, the study area extends from the south bank of the Tees Estuary to Redcar, encompassing South Gare breakwater and Coatham Sands where the Teesside Pipeline will reach landfall. The spatial extent of the study area was chosen on the basis that it encompasses the region of the coast along which the proposed landfall and pipeline installation activities may have the greatest impact on coastal processes.

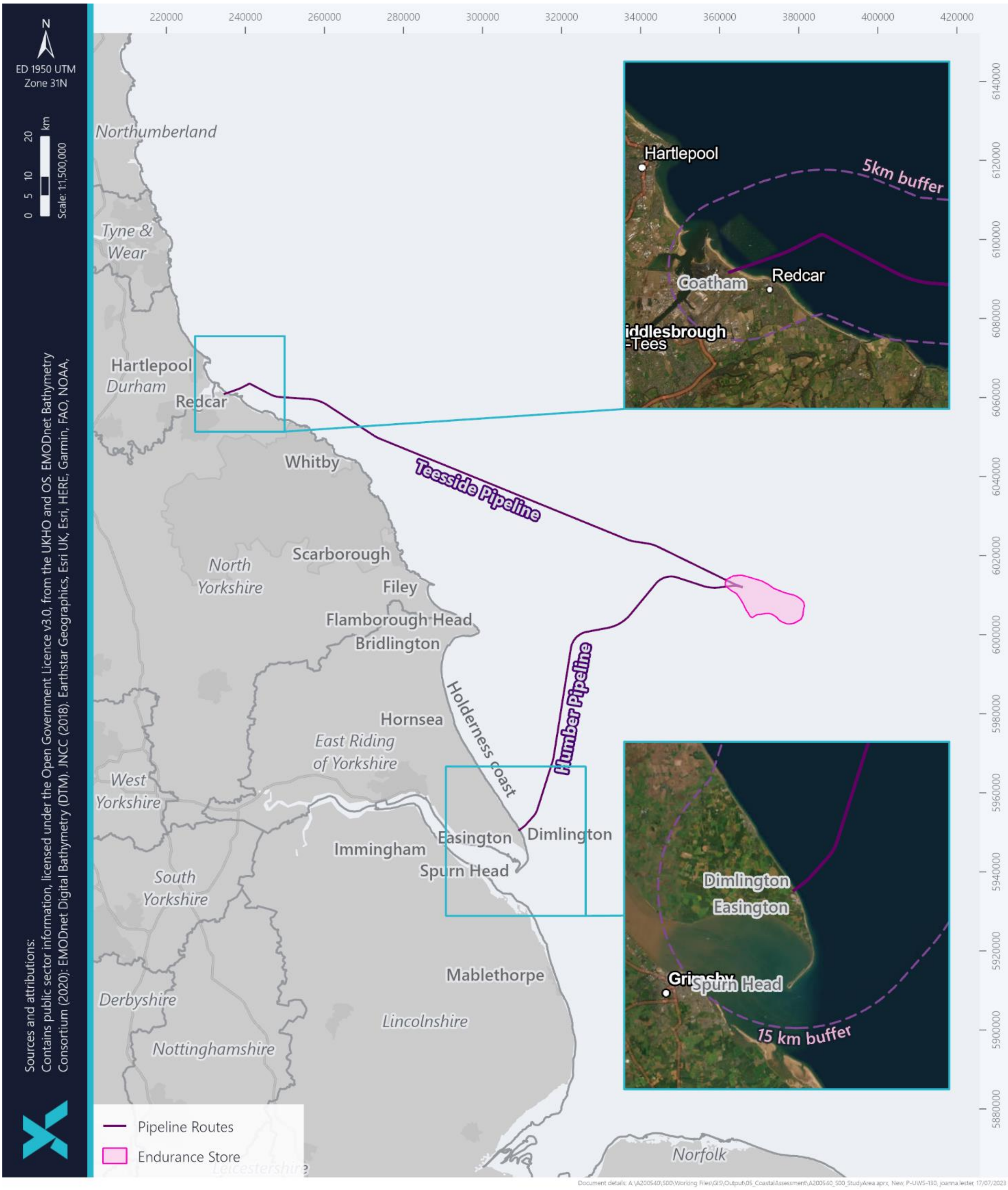


Figure 1-1 – Coastal processes landfall study areas and relevant placenames

1.3 Stakeholder Consultation

Scoping and consultation have been ongoing throughout since the early planning stages of the Development. This has played an important role in ensuring the scope of the baseline characterisation work and impact assessment methodology are aligned with the requirements of regulators and their advisors and are appropriate to the nature and scale of the Development. Table 1-1 below summarises all consultee comments regarding coastal processes.

Table 1-1 - Stakeholder consultee comments pertaining to coastal processes

NAME OF ORGANISATION	KEY CONCERNS	RESPONSE	SECTION WITHIN WHICH THIS SPECIFIC ISSUE IS ADDRESSED
Marine Management Organisation	Modelled surface currents, near-bed current directions and sea-surface temperatures along the Teesside Pipeline route have been used. However, no statistical accuracy assessment is provided. A statistical accuracy assessment of the modelled data should be provided.	Estimates of extreme wave and current conditions have been provided as “posterior predicted” values, which means that the extrapolation uncertainty will be included in the design values. An allowance has also been made for measurement uncertainty in the estimates. (bp, 2022)	The currents are used in Section 2.2.5 and 2.3.5
Marine Management Organisation	The Applicant has stated that the Endurance Store is located approximately 105 km from the UK/Dutch median line and any possible transboundary impacts will be considered by the EIA. This should be considered in the ES.	Transboundary impacts for coastal processes will be considered in the ES.	Transboundary impacts are not anticipated as part of the Development; addressed in Chapter 6, Seabed Disturbance.

1.4 Local Shoreline Management Plans

Shoreline Management Plans (SMP) exist for the entire length of the coastline of England and Wales (Environment Agency, 2022). Their purpose is to develop a sustainable management approach for the shoreline that takes account of issues like coastal erosion and water quality, and to achieve the best possible balance of all the values and features that occur around the shoreline for the longer term (currently 2105). The four SMP objectives which have been determined for each section of coastline are:

- Hold the existing defence line;
- Advance the existing defence line;
- Managed realignment; and
- No active intervention.

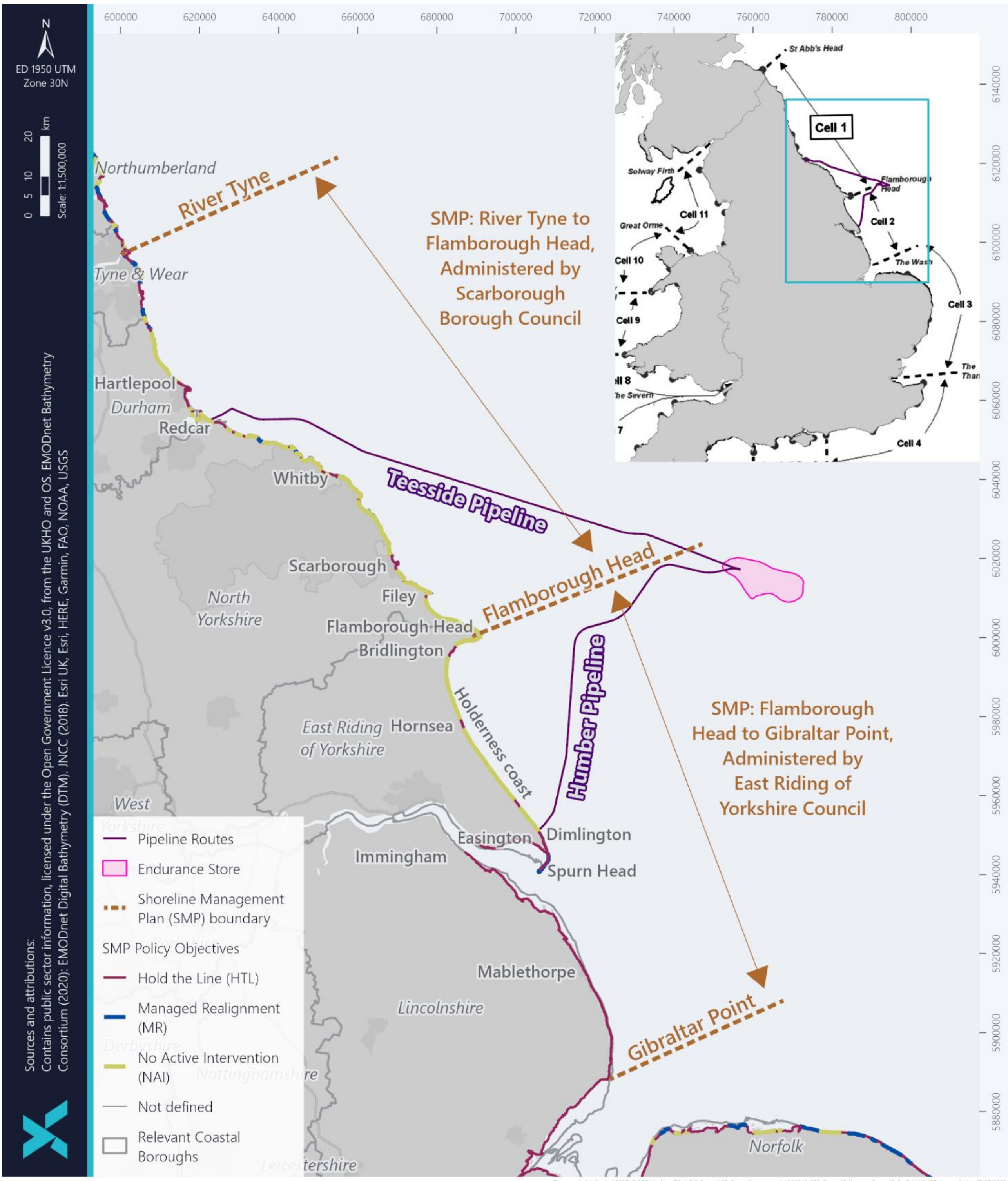


Figure 1-2 – England and Wales coastal cells (inset panel) and relevant SMP boundaries (main panel)

The SMP boundary divisions have been chosen based on regions which exhibit similar coastal processes, known as "Coastal Cells" (Motkya and Brampton, 1993), combined with the location of administrative boundaries which allow the policies to be implemented by regional councils. The relevant coastal cells and subsetted SMP boundaries are shown in Figure 1-2, then a breakdown of the regionally relevant policy status for each landfall is presented below.

1.4.1 Teesside

The Teesside landfall is located in the SMP for the shore section between the River Tyne and Flamborough Head (North East Coastal Authorities Group, 2007). Located within Coastal Cell 1, it is managed by Scarborough Borough Council as shown in Figure 1-2. Looking more locally, the pipeline landfall comes ashore at a section of SMP policy objective of "No active intervention", as shown in Figure 1-3 and summarised in more detail in Table 1-2, meaning there are no plans to defend the coast at the pipeline landfall. The neighbouring region to the east at Redcar has the "Hold the Line" policy, meaning the coastal defences there will be maintained.

Table 1-2 - Summary of preferred SMP policies at Teesside landfall site (North East Coastal Authorities Group, 2007)

EPOCH	PREFERRED POLICY TO IMPLEMENT - LITTLE SCAR TO COATHAM SANDS	PREFERRED POLICY TO IMPLEMENT - COATHAM SANDS TO MILL HOWE
From present day to 2025	Hold the line to Seaton Carew, while allowing natural roll back of the Seaton Sands Dunes and the North Gare Dunes. Allow the natural development of the Bran Sands and Coatham Dunes, within the strategic control of maintaining the South Gare.	Hold the Line at Redcar and to the development planned between Redcar and Coatham Sands. Maintain the line of defence to the East of Redcar with possible improved defence to low lying area behind.
Medium term 2025 – 2055	As above but to consider retreat of the Seaton Carew sea front. Detailed consideration of flood risk to the area to the south of the North Gare Breakwater. Land use management plan for the area behind Seaton Dunes.	As above but realigning the eastern flank of Redcar, while maintaining flood defence to low lying area behind.
Long term 2055 – 2205	As above but ultimately maintain defence to Seaton Carew.	As above but adapt defence to the western end of the Coatham defence to ensure a suitable transition to Coatham Sands.

Figure 1-3 – Teesside Shoreline Management Plan policy objectives

1.4.2 Humber

The Humber landfall is located in the SMP for the shore section between Flamborough Head and Gibraltar Point (HECAG, 2010), also known as Coastal Cell 2, which is manged by the East Riding of Yorkshire Council and is shown in Figure 1-2. The Holderness cliffs are eroding rapidly in this coastal cell, so the SMP had to make some difficult decisions about which sections of coast to protect and which to allow to evolve naturally. Looking more locally, the pipeline landfall comes ashore at a section of SMP policy objective of "No active intervention", as shown in Figure 1-4 and summarised in more detail in Table 1-3, meaning there are no plans to defend the coast at the pipeline landfall.

The neighbouring region at nearby Dimlington and Easington has the "Hold the Line" policy, meaning the coastal defences there will be maintained.

Table 1-3 - Summary of preferred SMP policies at Humber landfall site (HECAG, 2010)

EPOCH	PREFERRED POLICY TO IMPLEMENT - SOUTH WITHERNSEA TO DIMLINGTON CLIFFS	PREFERRED POLICY TO IMPLEMENT - DIMLINGTON AND EASINGTON GAS TERMINALS
From present day to 2025	There will be no management intervention or defences constructed.	The defences will be held in their current position, subject to a review of planning status for the Gas Terminals in 2020. No Active Intervention elsewhere, however management of outflanking may be permitted, subject to necessary approvals, in order to protect the nationally important gas supplies.
Medium term 2025 – 2055	There will be no management intervention or defences constructed. Assessment of options for maintaining a strategic north-south transport link is likely to be necessary.	Future decisions will need to be made in regard to the protection of the site. No Active Intervention for currently undefended areas, however management of outflanking may be permitted, subject to necessary approvals, in order to protect the nationally important gas supplies, while there is a strategic need for the site.
Long term 2055 – 2205	There will be no management intervention or defences constructed.	Future decisions will need to be made in regard to the protection of the site. No Active Intervention for currently undefended areas, however management of outflanking may be permitted, subject to necessary approvals, in order to protect the nationally important gas supplies while there is a strategic need for the site.

Figure 1-4 – Humber Shoreline Management Plan policy objectives

2 BASELINE ENVIRONMENT

2.1 Regional Context

The landfall points span the coast of the historical county of Yorkshire, bounded by the Tees Estuary in the North and the Humber Estuary in the South. This is a dynamic and complex region of coastline, encompassing rocky cliffs, low glacial cliffs, urban areas and sandy beaches, parts of which are undergoing large scale erosion. The offshore environment relevant to coastal processes is broadly summarised in Figure 2-1 to Figure 2-4 (showing bathymetry, metocean conditions and seabed sediments), to give an initial regional context. Each of the two landfall sites are then described in more detail in the subsequent baseline sections.

The water depths heading from shore out to the Endurance Store along each pipeline are shown in Figure 2-1. Along the route of the Teesside Pipeline, the water depth increases relatively steeply from the shore down to 30 m LAT within the first 10 km, and then deepens gently, undulating between 50 m LAT and 60 m LAT out to the Endurance Store. Along the route of the Humber Pipeline, the bathymetry deepens relatively uniformly, at first dropping around 10 m in the first 500 m or so, then deepening more gradually beyond this point. A prominent deep channel (up to 90 m LAT) is present east of the mouth of the Humber.

The general wind, wave and tidal conditions along both pipeline routes are shown in Figure 2-2. Average wind speeds and mean significant wave heights increase with distance from shore. Average wind speeds range 6 m/s nearshore, to upwards of 11 m/s at the Endurance Store, and mean significant wave heights range from 0.1 m near shore to up to 3 m at the Endurance Store. The lower right panel of Figure 2-2 shows the tidal excursion ellipses across the Development. Each ellipse shows the distance and pattern of flow that a single particle would follow in the water column at various points across the seabed. The pattern of flow is dependent on the water depth, seabed substrate, coastline and tidal dynamics. As seen in Figure 2-2, the shortest excursion distances are generally in the north, and longer distances are experienced in the south and around prominent headlands (Scarborough Borough Council, 2013). Further offshore, tidal currents run in a north-south alignment.

The broad scale seabed sediment distribution in the study area is shown in Figure 2-4. The majority of the pipeline routes cover sand or coarser substrate, with some mud and muddy sands evident near the Teesside landfall. The seabed energy available to mobilise seabed sediments is highest along the Holderness coast, and generally reduces offshore direction in an easterly direction. Sand ripples are present at the eastern end of each pipeline route. Seabed surveys conducted for the Development (Gardline, 2022a, 2022b), found evidence of scattered boulders nearer the landward section of both pipeline routes, diminishing in number out towards the Endurance Store.

In the furthest offshore sections of each pipeline, sandwaves are present (Figure 2-4 and Figure 2-5). In Figure 2-5, the survey bathymetry shows that the sandwaves in the presence of the Langeled pipeline have not yet returned to their pre-installation form, 15 years after installation.

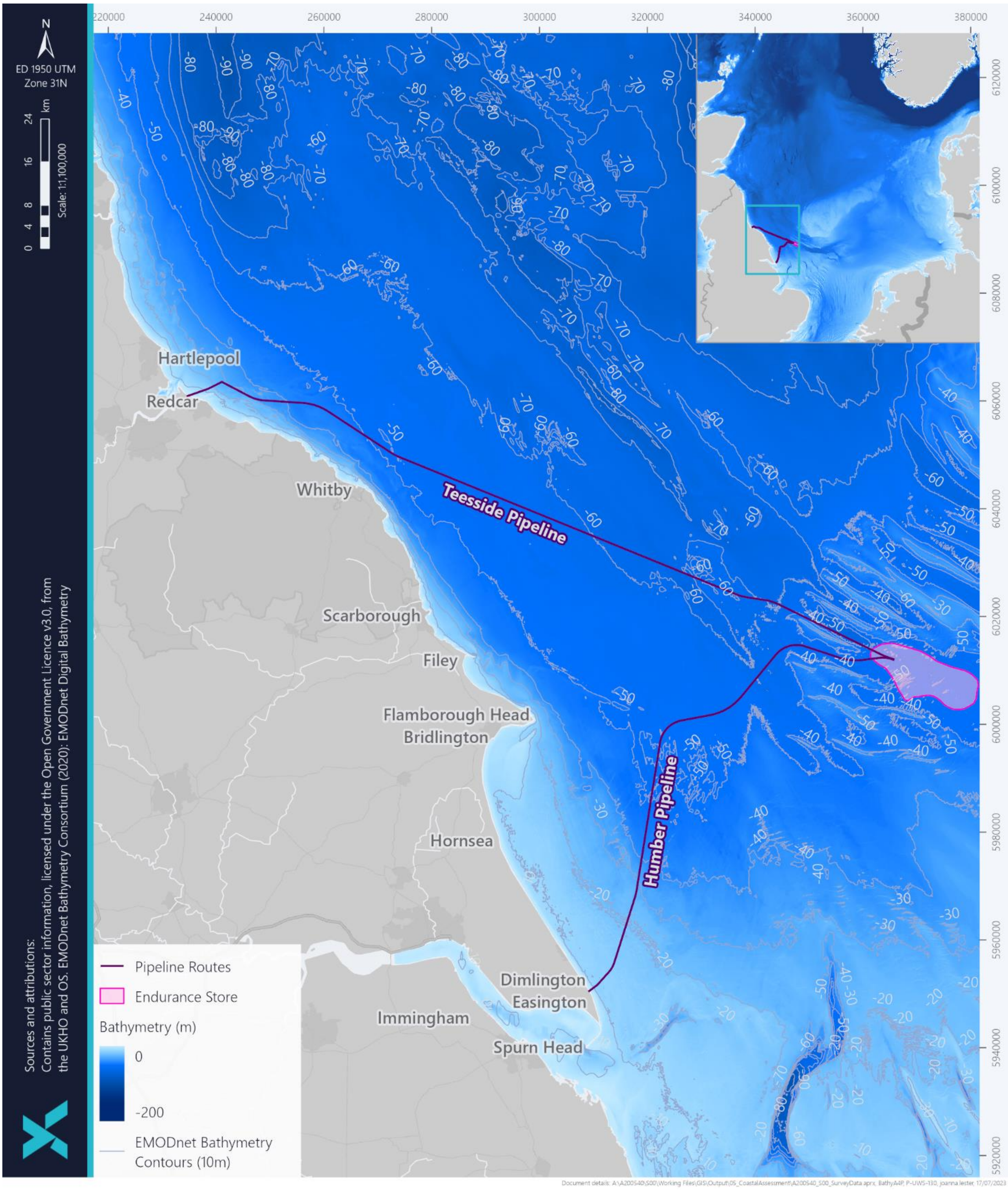


Figure 2-1 – Bathymetry along pipeline routes

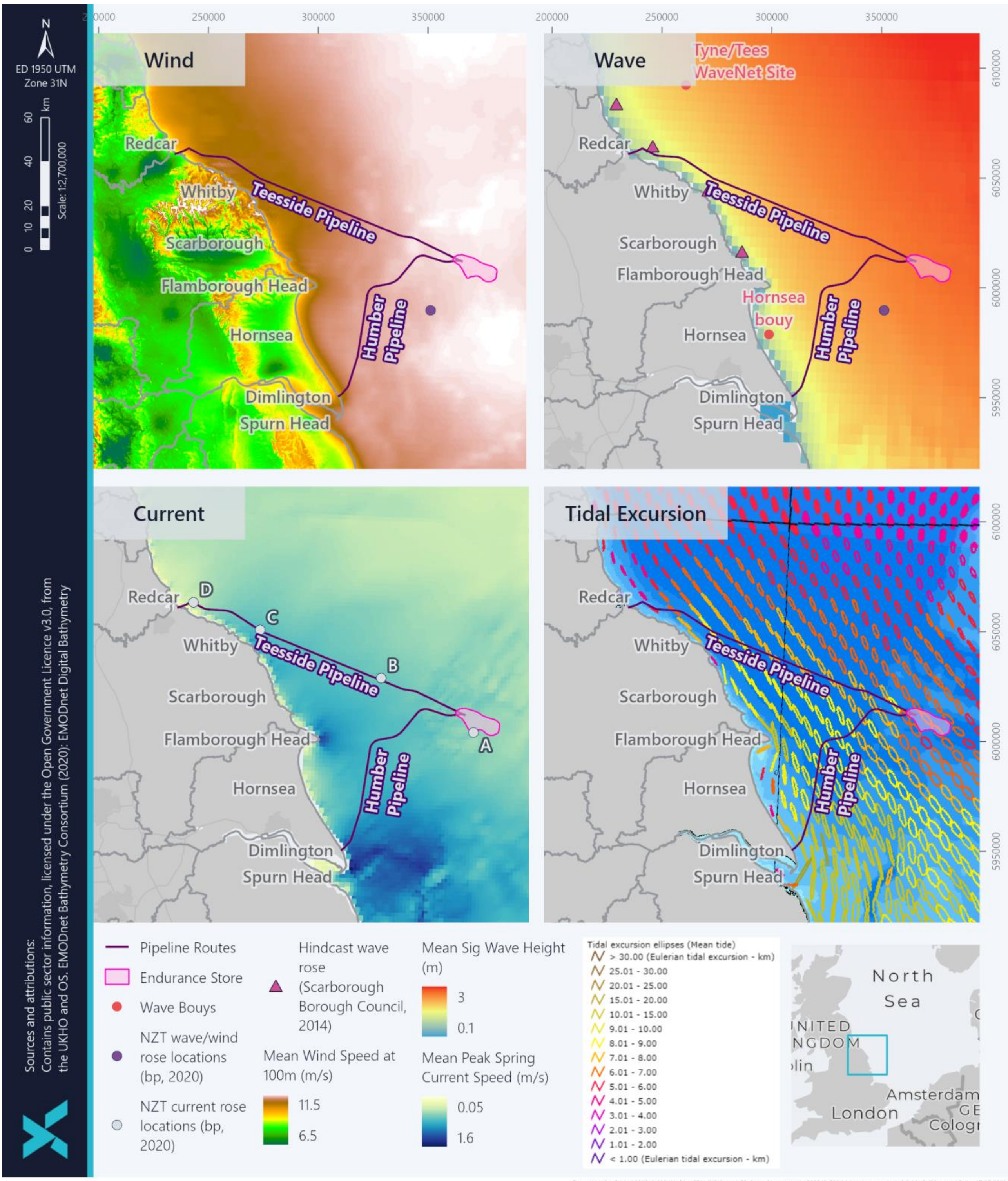


Figure 2-2 – Offshore metocean context (Global Wind Atlas (2022), Bangor (2020) and ABPmer (2017))

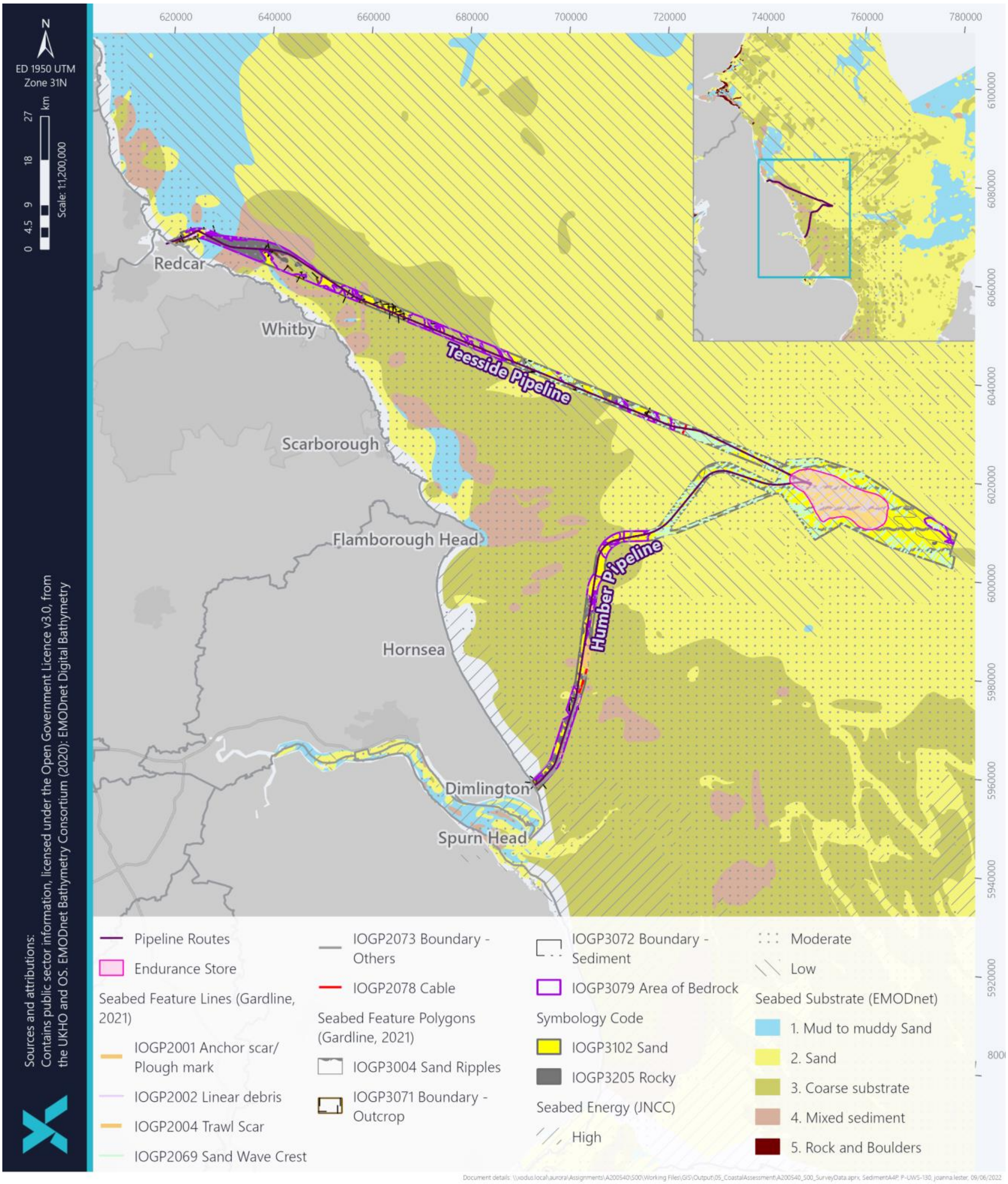


Figure 2-3 – Seabed sediments across the pipeline routes

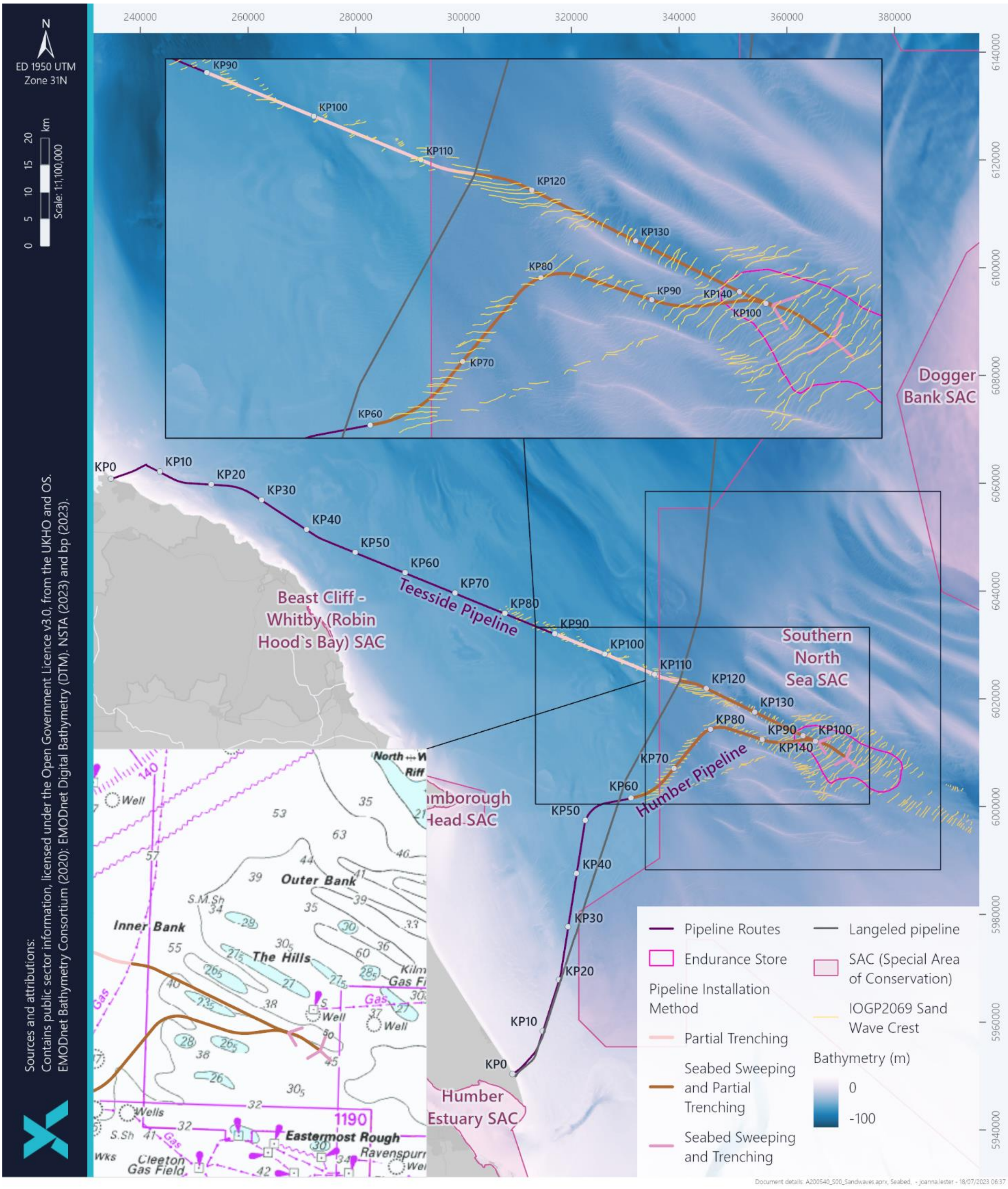


Figure 2-4 – Overview of sandwaves in the offshore region

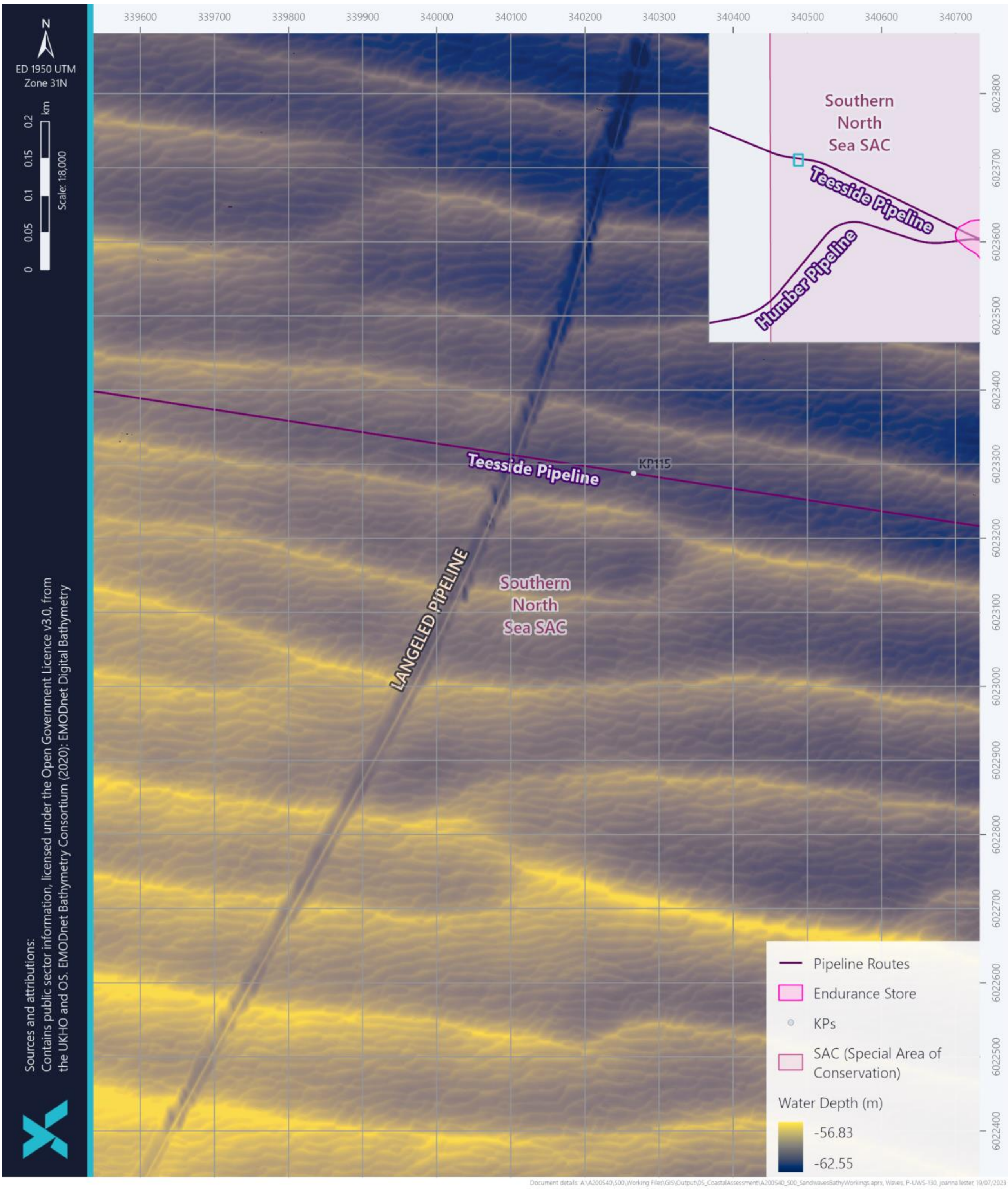


Figure 2-5 – Sandwave detail where the Teesside pipeline crosses the Langeled pipeline (Gardline, 2021))

2.2 Teesside

2.2.1 Key Data Sources

A number of primary and secondary data sources have been used to inform the baseline understanding of the physical environment along the Teesside Pipeline route. Project specific information used to develop this understanding includes:

- bp Metocean Report for the Endurance Store and Teesside Pipeline (bp, 2020);
- NEP Integrated Site Survey – 2021 Environmental Baseline Report (Gardline, 2022a);
- NEP Integrated Site Survey – 2021 Environmental Survey Habitat Assessment (Gardline, 2022b); and
- A site visit to the coast around Coatham Sands, undertaken on 8th March 2022.

Reports and data produced for the wider Teesside area that have contributed significantly to this assessment are as follows:

- Shoreline Management Plan 2: River Tyne to Flamborough Head (North East Coastal Authorities Group, 2007);
- Cell 1 Sediment Transport Study Scoping Report and Main Report (Scarborough Borough Council 2013, 2014);
- Tees Maintenance Dredging Annual Review 2019 (PD Teesport, 2019);
- Cell 1 Regional Coastal Monitoring Programme Walkover Inspection Surveys 2020 (Scarborough Borough Council, 2020);
- Cell 1 Regional Coastal Monitoring Programme Analytical Report 13: 'Full Measures' Survey 2020 (Scarborough Borough Council, 2021);
- Cell 1 Regional Coastal Monitoring Programme Wave and Tide Data Analysis Report 2020/21 (Scarborough Borough Council, 2021a); and
- Seabed Mapping: HI1543 Sunderland to Redcar (Channel Coastal Observatory, 2021a).

A number of other site-specific studies and publicly available reports which have informed this work are as follows:

- Atlas of UK Marine Renewable Energy Resources (ABPmer, 2017);
- Northeast Coastal Monitoring Programme Seabed Mapping: Sunderland to Redcar (Scarborough Borough Council, 2021b); and
- Teesside Offshore Wind Farm Environmental Statement: Coastal Processes Chapter (EDF Energy, 2004).

2.2.2 Designated Sites

There are a number of designated sites close to or intersected by the Teesside Pipeline. Nearby designated sites are shown in Figure 2-6, and summarised in Table 2-1.

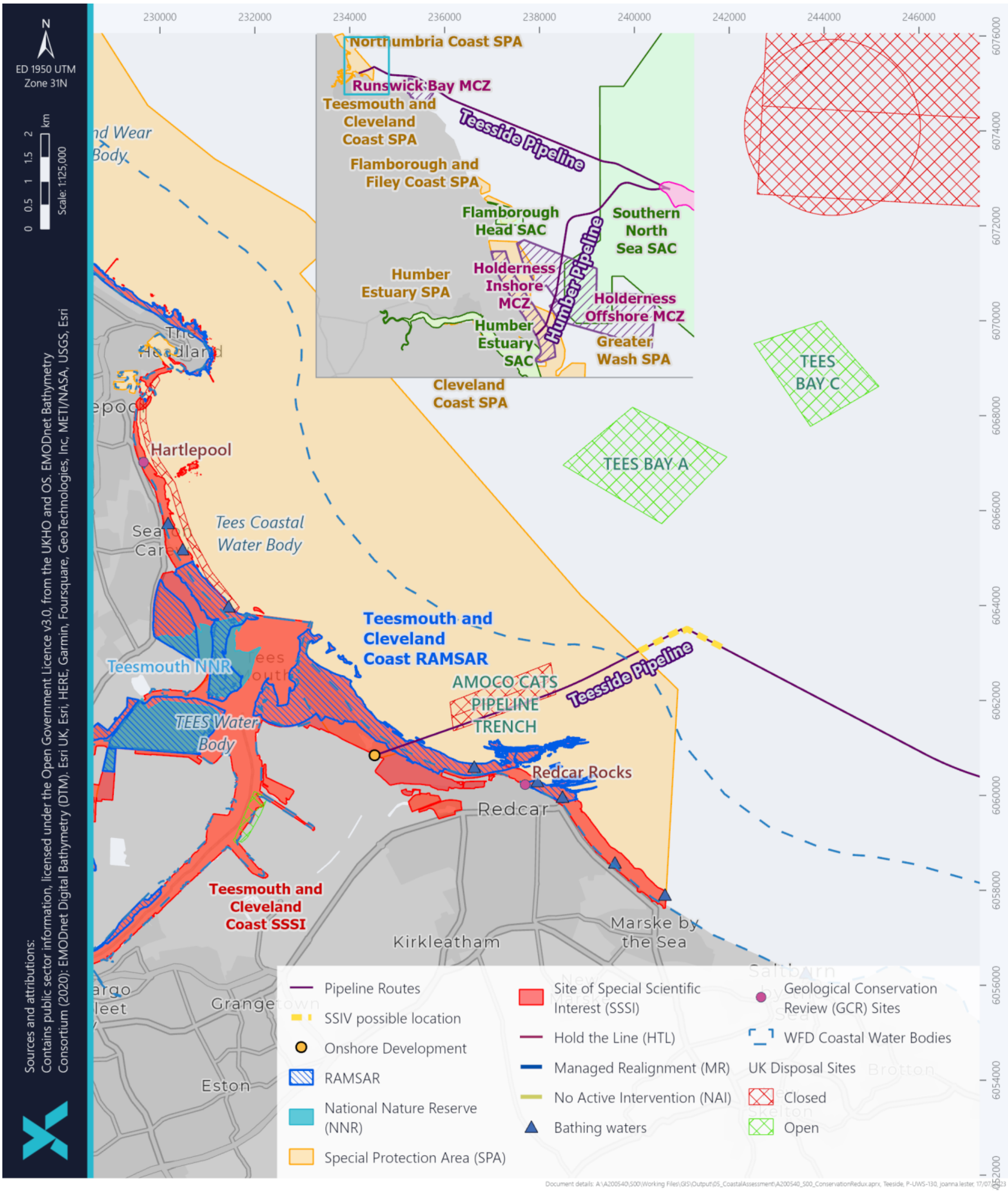


Figure 2-6 - Conservation sites and disposal sites near the Teesside Pipeline

As in Section 2.3.2, indicative tidal excursion ellipses as shown in Figure 2-2 (ABPmer, 2017) were used to determine the range from the Teesside Pipeline within which designated sites could be impacted by Development activities. The tidal excursion extent was approximately 5 km in the Teesside area. Table 2-1 outlines all coastal sites within 5 km of the Teesside Pipeline. Impacts to protected sites associated with the Teesside Pipeline are addressed in Chapter 6, Seabed Disturbance.

Table 2-1 - Coastal designated sites within 5 km of the Teesside Pipeline

Site	Description	Distance/direction from Teesside Pipeline
Teesmouth and Cleveland Coast SPA	The Teesmouth and Cleveland Coast SPA boasts significant areas of intertidal sand and mudflat, saltmarsh and freshwater grazing marsh, saline lagoon, sand dune, shingle, rocky shore and shallow coastal waters. The site was first classified for a number of breeding bird species, but in 2020 the list was extended resulting in the site being designated for the following: breeding little tern, passage Sandwich tern, wintering red knot and passage common redshank. The 2020 extension to the site includes additional areas of coastal and wetland habitats, the River Tees channel and the shallow coastal waters of Tees Bay (Natural England, 2020).	Intersects
Runswick Bay MCZ	The inshore boundary of the site lies along a stretch of shoreline and extends seawards to a distance of approximately 7 km. This site is of particular interest as it contains a matrix of broad-scale habitats, each supporting diverse and unique communities. These habitats include subtidal sand, subtidal mud, mixed sediment and coarse sediments, as well as rocky intertidal and subtidal features. It is also designated for the presence of ocean quahog (*Arctica islandica*; Natural England, 2021).	1 km SSW
Teesmouth and Cleveland Coast Ramsar	The site includes a range of coastal habitats, including sand-flats and mud-flats, rocky shore, saltmarsh, freshwater marsh and sand dunes which are situated in and around an estuary which has been considerably modified by human activities. The Teesmouth and Cleveland Coast site is designated for bird assemblages of international importance and the presence of populations of common (representing an average of 0.7% of the British population) and wintering red knot (representing an average of 0.9% of the British population; JNCC, 2008b).	Intersects
Teesmouth and Cleveland Coast SSSI	The site is designated for both geological and biological features, including sand dune and saltmarshes habitats, breeding harbour seals, breeding bird species and an	Intersects

Site	Description	Distance/direction from Teesside Pipeline
	assemblage of more than 20,000 waterfowl during the non-breeding season (Natural England, 2018).	
Tees Bay A Disposal Site	In operation since the 1980s, typically this site is used for the disposal of maintenance dredging from the River Tees and adjoining river entrance. Deposited material ranges from riverine silt to fine sands. Approximately 1,000,000 m^3 of material is dredged per year (PD Teesport, 2019)	2 km N
Tees Bay C Disposal Site	In operation since the 1980s, typically this site is used for the disposal of capital dredged material. Deposited material ranges from riverine silt to fine sands. (EDF Energy, 2004). Small scale usage. Peak volume deposited was 1.9 million wet tonnes in 1999, associated with the construction of the downstream Ro-Ro berths. Typical annual volume is 0.1 million wet tonnes. Some years show no usage at all (PD Teesport, 2019).	5 km N

2.2.3 Geology and Surficial Sediment

The bedrock along the coast of the north of England sequentially transitions from Carboniferous to Upper Cretaceous, becoming progressively younger southwards. This area was covered by an ice sheet during the last glaciation, which left a layer of boulder clay deposits in its wake, extending out into the offshore area. Since then, much of the deposited boulder clay has been eroded away and only patches of these deposits remain (Balson, 2002, referenced in Scarborough Borough Council, 2013).

Much of the coastline consists of cliffs of relatively resistant rock formations, which are unlikely to have receded considerably over the last 6,000 years, including outcrops of hard Permian Magnesian Limestone. However, in areas of unprotected coastline, cliffs cut in areas of glacially deposited sediment have formed small landslides (Scarborough Borough Council, 2013).

Offshore, the main surface sediments consist predominantly of sand and muddy sand with areas of mixed sediment (Scarborough Borough Council, 2021b). Much of the sand and mud originates from coastal erosion, with the added contribution of mud from historic colliery spoil (Scarborough Borough Council, 2013). Additionally, as seen in Figure 2-7, there are bands of coarse sediment that extend perpendicular to the coast. Boulders are present throughout the surveyed corridor. An analysis of boulder density within the 40 m wide boulder clearance corridor shows that no more than three boulders are present with any 100 m by 40 m stretch along the pipeline (Figure 2-6).

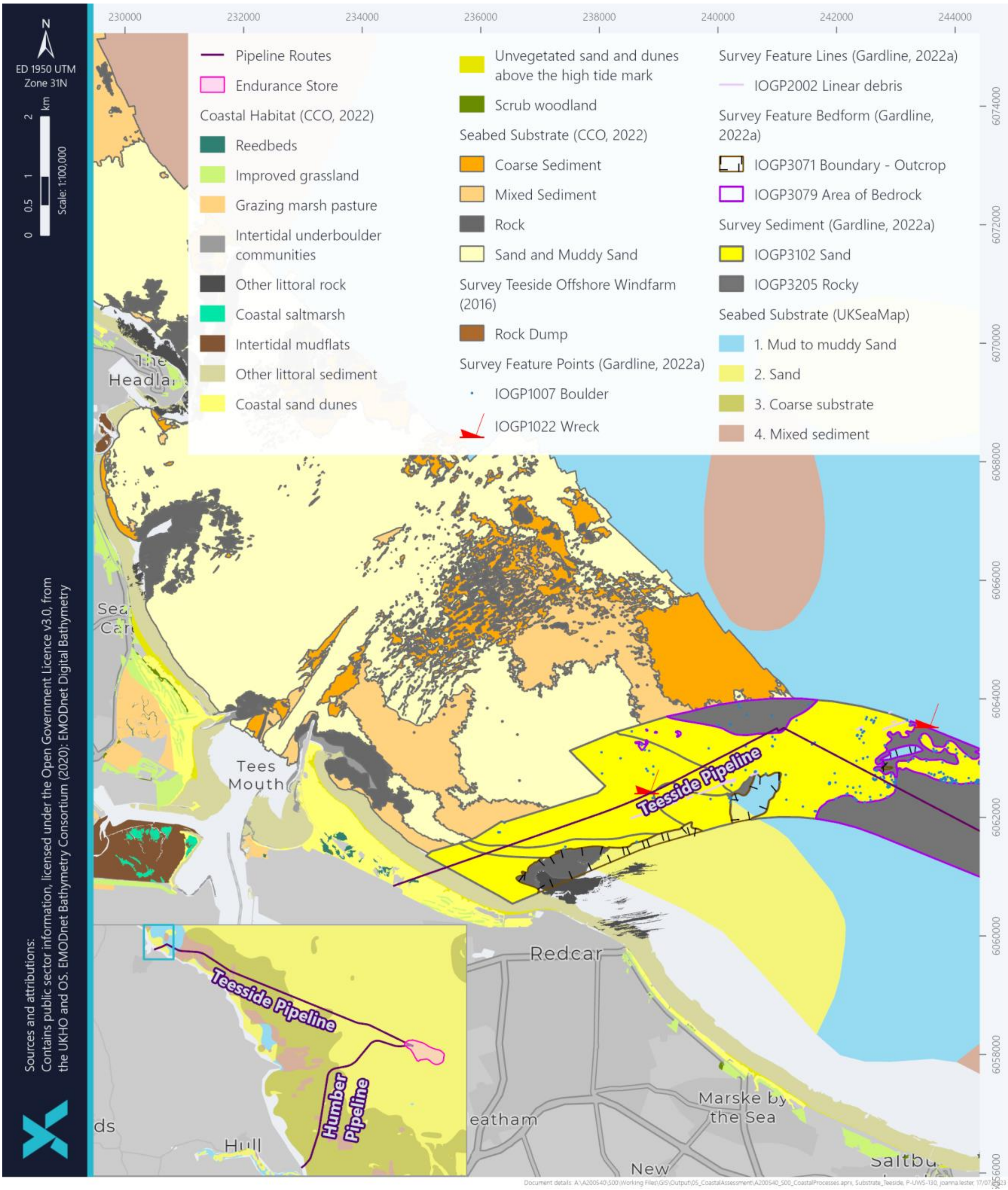


Figure 2-7 – Seabed substrate at the Teesside Pipeline landfall

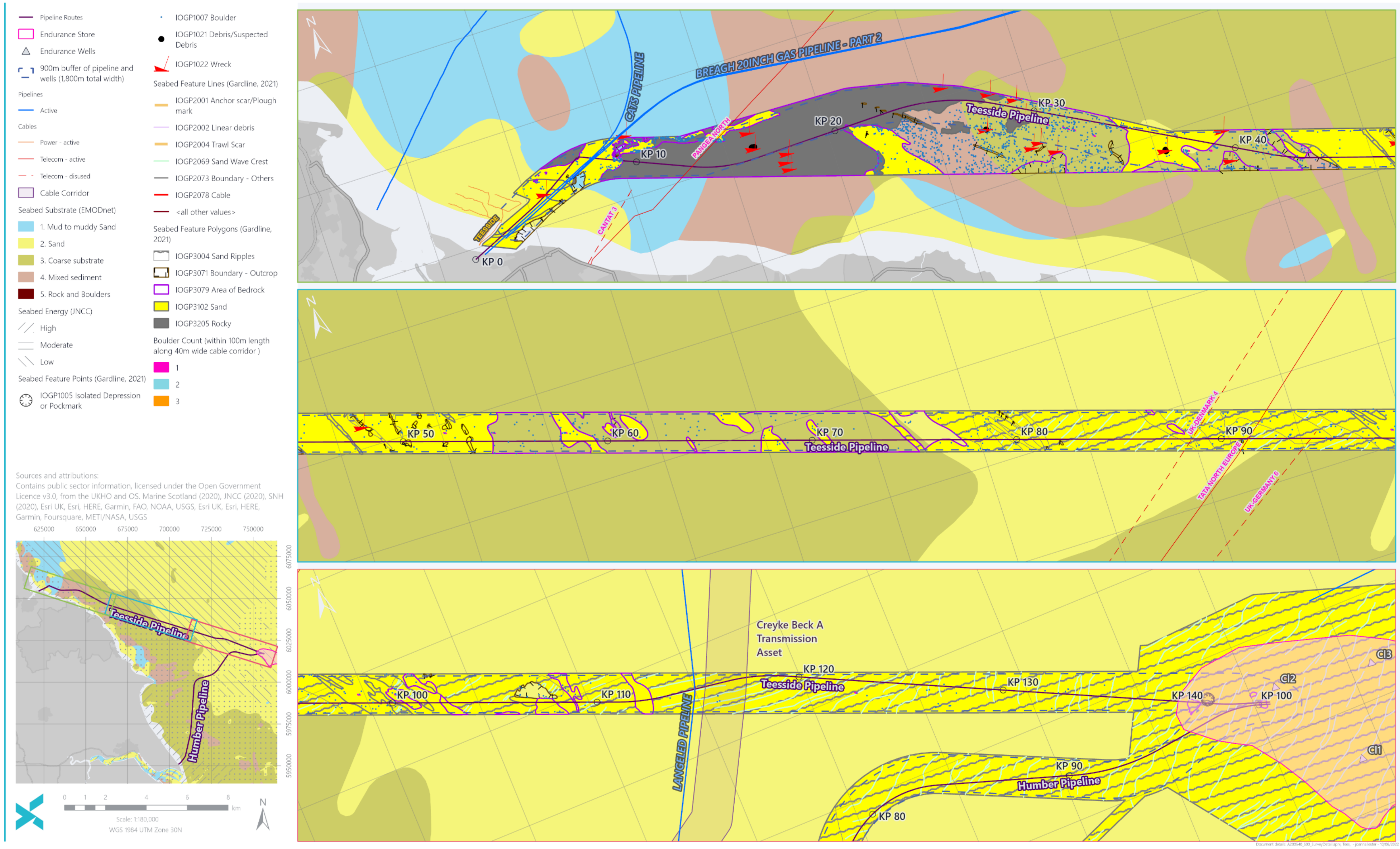


Figure 2-8 – Seabed substrate length of the Teesside Pipeline

As part of the ES undertaken for NZT Power, intertidal surveys were undertaken (AECOM, 2021a). The results showed that there was little variation between sediment samples taken along the Coatham Sands frontage where the Teesside Pipeline will come ashore. All of the sample stations were dominated by sandy sediments (>90%) and a low mud content. All samples were classified as medium or fine sand under the Folk classification system (1954). Across all 16 samples, the average mean sediment particle size was 277.4 µm (AECOM, 2021a).

2.2.4 Bathymetry and Morphology

The proposed Teesside Pipeline comes ashore at Coatham Sands, just to the east of the Tees Estuary. The Tees estuary is a long narrow estuary that, though extensively dredged, has developed from a fairly wide embayment. At either side of the mouth, it is enclosed with spits and constructed breakwaters, and sandbanks and extensive intertidal areas are present just inside the mouth (Scarborough Borough Council, 2021b). As seen in Figure 2-7, each side of the river mouth is sheltered by outcrops of rock that do not extend into deeper water. The dredged channel in the mouth of the River Tees can also be seen.

At either end of Tees Bay, there are two clear geological formations (Figure 2-9). To the north, the formation consists of a large sandstone outcrop that breaks the surface (on the left of Figure 2-9). The southern formation is larger and comprised of layers of Redcar Mudstone and Staithes Sandstone (on the right of Figure 2-9). The southern formation only just breaks the surface on spring lows (Scarborough Borough Council, 2021b). In the general offshore area there are few bedforms that might indicate sediment transport movement and pathways (Scarborough Borough Council, 2013).

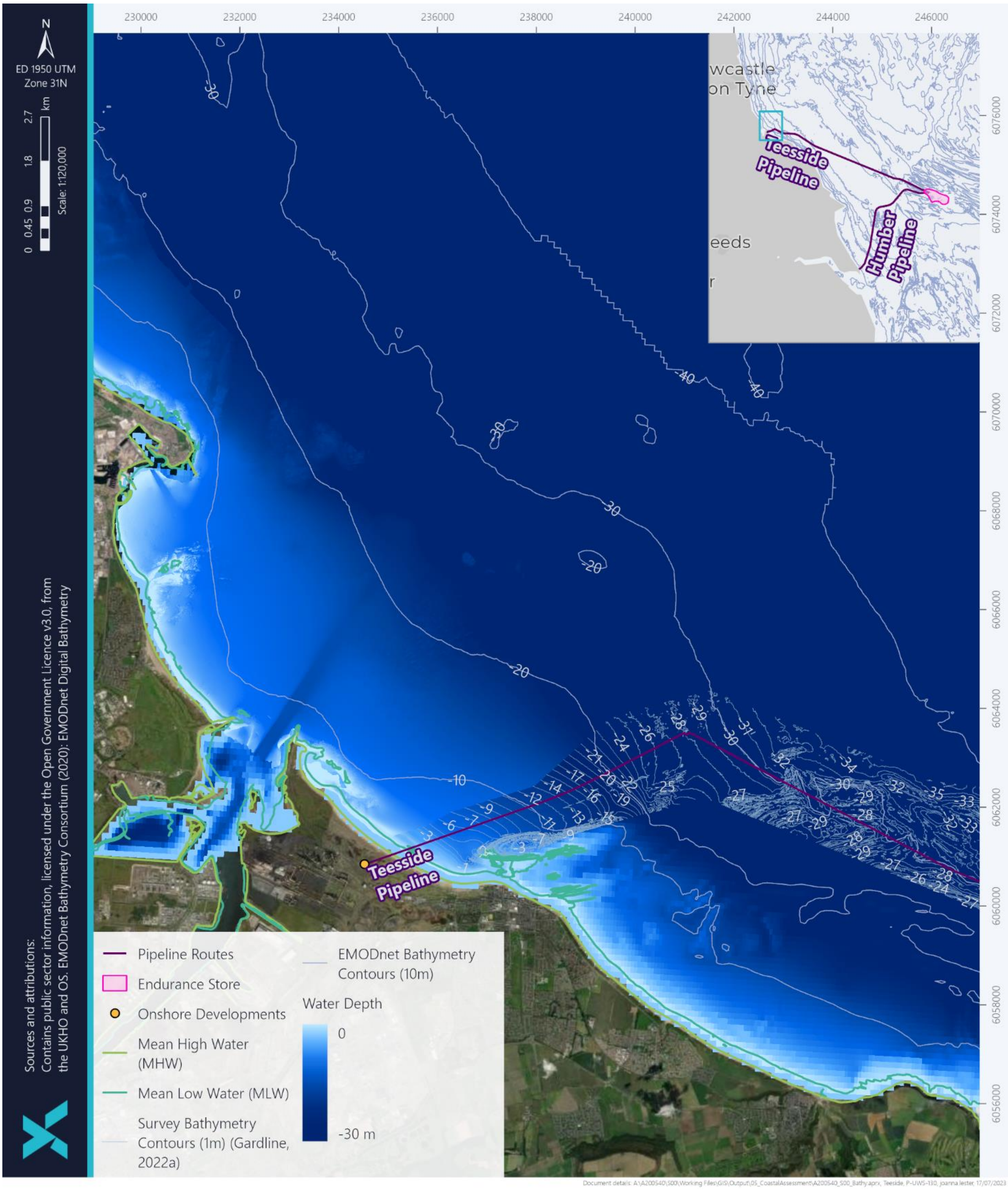


Figure 2-9 - Bathymetry of Tees Bay

2.2.5 Metocean

Tide

The UK Hydrographic Office publishes Admiralty Tidal Tables at a series of standard ports around the coastline of the UK. Within Cell 1 there are two standard ports, the River Tees (Entrance) port is located closest to the Teesside Pipeline. The recorded tidal levels for 2013 are shown in Table 2-2.

Table 2-2 - Astronomical tidal levels at the entrance to the River Tees in 2013 (Scarborough Borough Council, 2013)

Tidal State	Level (m Ordnance Datum)
HAT	3.3
MHWS	2.7
MHWN	1.5
MLWN	-0.9
MLWS	-2.0
LAT	-2.9

The spring tidal range varies from between 4.1 to 4.3 m towards the north of Cell 1 (Eyemouth to Blyth), through around 4.3 to 4.6 m towards the centre (North Shields to the River Tees entrance) to between 4.6 and 4.8 m in the south (Whitby to Filey). This increase in tidal range with southerly progression is partly due to the constriction produced in the North Sea by the land masses of Britain and mainland Europe (Scarborough Borough Council, 2013). This southward increase in water levels can also be seen in predicted extreme water levels across a variety of return periods; Table 2-3 shows the predicted extreme water levels for North Shields and Whitby.

Table 2-3 - Extreme water levels for various return periods (from Scarborough Borough Council, 2013)

Return Period (Years)	Level (m ODN)	
	North Shields	Whitby
1	3.20	3.37
2	3.27	3.46
5	3.38	3.58
10	3.46	3.68
25	3.58	3.81
50	3.67	3.92
100	3.76	4.02

Currents

Off the coast of North Yorkshire, the tide generally floods to the south and the ebbs to the north. Tidal currents are generally greatest towards the south, with the peak values measured offshore of Flamborough Head (Scarborough Borough Council, 2013).

The nearshore current speeds are generally weak, but they can become locally influenced by coastal topography and increase in the proximity of headlands and islands (Scarborough Borough Council, 2013). Nearshore tidal currents are weakest within the most deeply-embayed frontages, such as Tees Bay. These areas consequently act as sediment sinks.

Modelled surface currents under operational conditions along the Teesside Pipeline route increase with distance from shore. In terms of frequency of occurrence, currents at the shore are most likely to be between 0.1 and 0.4 m/s, compared to speeds of 0.3 to 0.5 m/s nearer the Store (bp, 2020). Figure 2-10 shows the near-bed currents at four points along the Teesside Pipeline, with Figure 2-10a being representative of a point furthest offshore, Figure 2-10b being a mid-point along the pipeline and Figure 2-10c showing currents at the point of landfall. Near-bed current directions are predominantly southeast and northwest along the pipeline route.

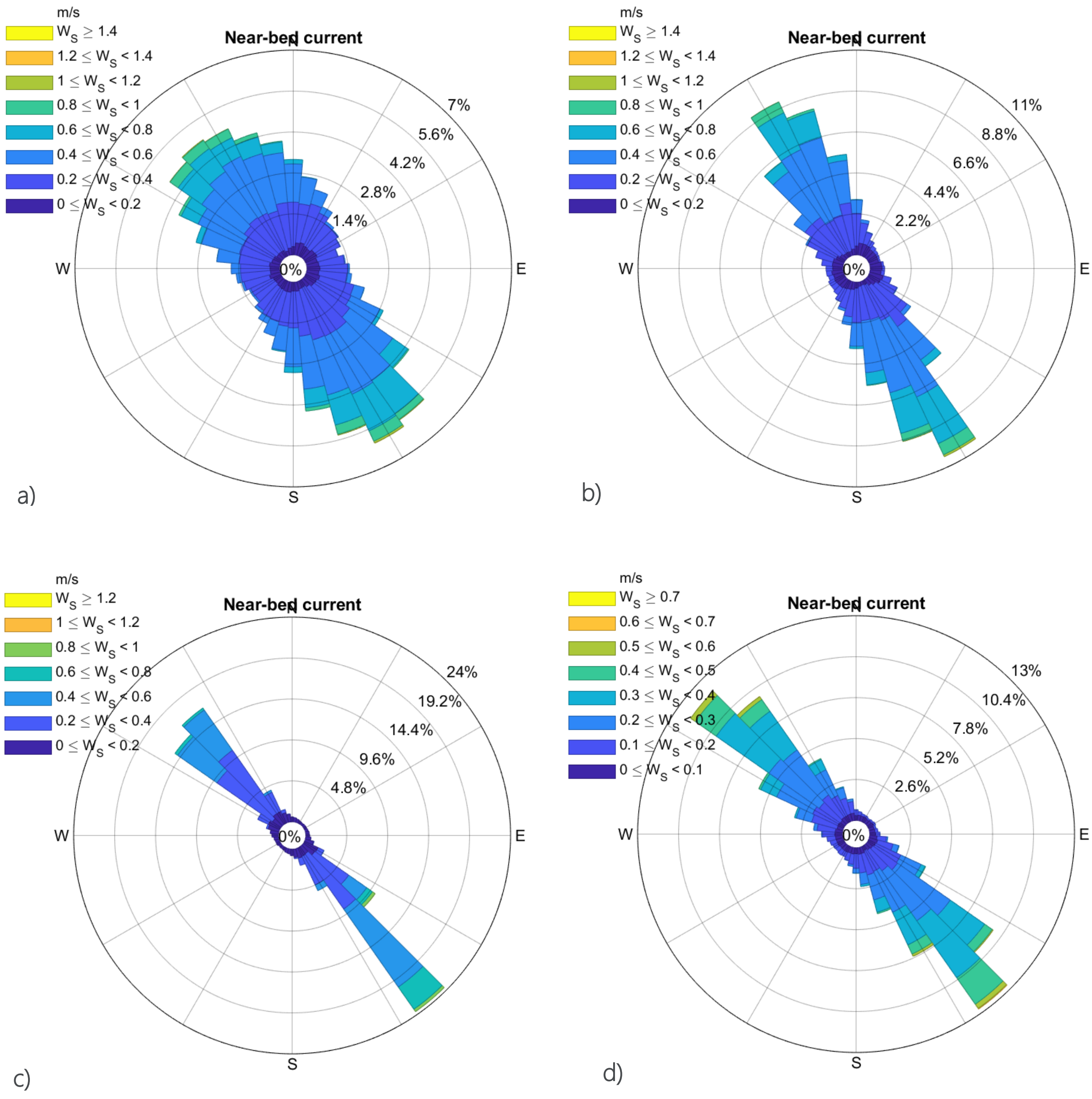


Figure 2-10 – Near-bed annual current speeds along the Teesside Pipeline (a) close to the Endurance Store (b) at a mid-point along the pipeline (c) closer to shore, and (d) close to shore (bp, 2020) (locations shown in Figure 2-2)

Wind

A preliminary assessment of metocean conditions for the Endurance Store area, Teesside and Humber Pipeline routes was undertaken in 2020 (bp, 2020). Figure 2-11 shows the annual wind direction modelled for the Endurance Store, at the location shown in Figure 2-2 (wind). Winds occur from all directions but winds from the south-west and west predominate. The maximum annual wind speed is 25 m/s (bp, 2020).

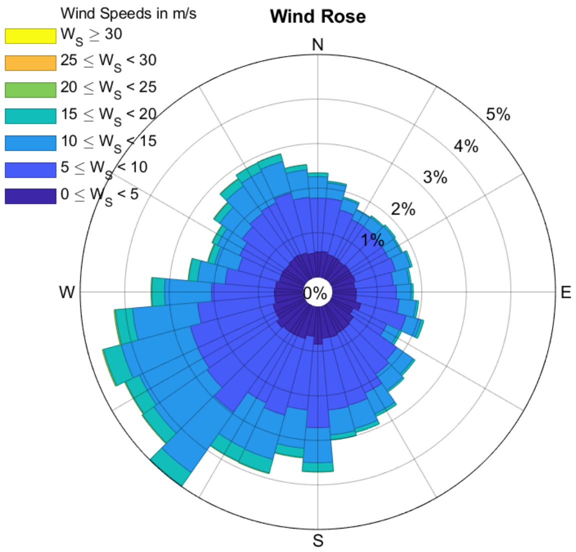


Figure 2-11 - Mean wind direction and speed (coming from) at the Endurance Store area (bp, 2020)

Wave

The Tyne/Tees wave buoy was deployed by Cefas in 2006 and continues to operate as part of WaveNet. The wave buoy is located 35 km offshore in around 65 m water depth, and lies approximately 33 km north of the Teesside Pipeline.

During 2020/21, some long period swell waves with heights of 0.5 to 1.5 m and periods over 20 s were observed. Maximum storm wave heights of typically about 7 m are associated with peak periods of 8 to 9 s (Scarborough Borough Council, 2021a). The largest significant wave height recorded in the 2020/21 dataset of 6.6 m (with an associated zero crossing period of 8.2s) was on 25th September 2020. The longest zero crossing wave period in the 2020/21 dataset of 10.9 s (with an associated significant wave height of 2.2 m) was recorded on the 7th March 2021 (Scarborough Borough Council, 2021a).

Wave direction recorded by the Tyne/Tees wave buoy is shown in Figure 2-12 (location of buoy shown on Figure 2-2, wave). The majority of the waves approach from the north to north-northeast sector (0-30 degrees). There is a small secondary peak in approach direction for waves from the south east sector (120-150 degrees). Other waves approach from easterly directions (30-120 degrees) located between the primary and secondary peaks (Scarborough Borough Council, 2021a).

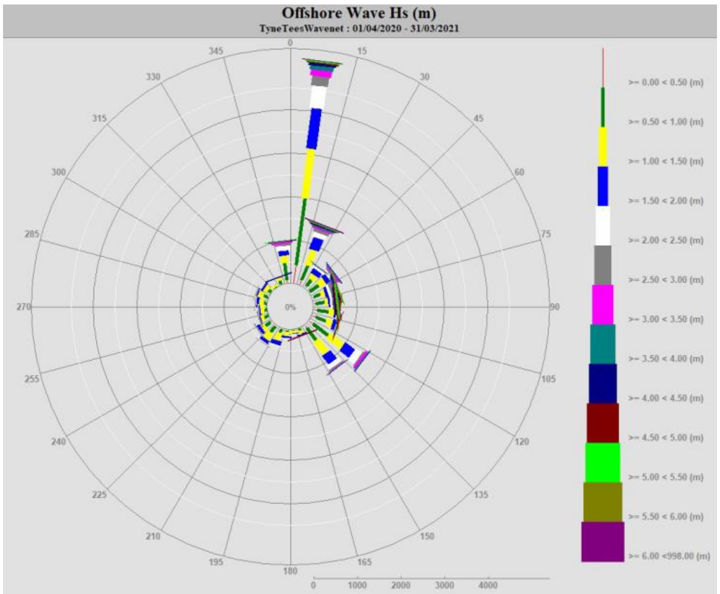


Figure 2-12 - Wave rose for the Tyne/Tees wave buoy (Scarborough Borough Council, 2021a)

Storm associated waves picked up by the Tyne/Tees wave buoy mostly arrive from the north to northeast direction, 0 to 40 degrees, which has the longest fetch, but there are also a significant number of storms from other directions, particularly 80 to 140 degrees (Figure 2-12; Scarborough Borough Council, 2021a).

Hindcast wave data from each of the six Met Office model points has been used to create a wave rose at each location, as shown in Figure 2-13 (Scarborough Borough Council, 2014). The landfall of the Teesside Pipeline lies within Zone 4.

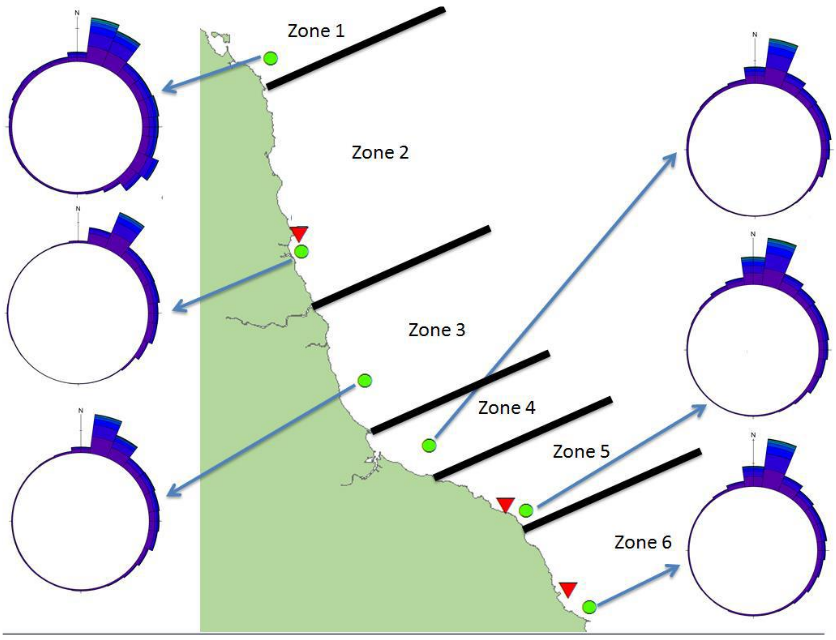


Figure 2-13 - Hindcast wave roses along the northeast coast of England (Scarborough Borough Council, 2014)

The Endurance Store is further offshore and northwest of the Tyne/Tees wave buoy location and, comparing Figure 2-25 and Figure 2-13, there are differences in observed wave directionality; further offshore at the Endurance Store waves are more common from the north-northwest as opposed to north-northeast at the Tyne/Tees buoy location.

2.2.6 Sediment Transport Regime

The shoreline of the northeast coast of England is heavily influenced by the controls exerted by its underlying geology. The area is characterised by a series of typically sandy bays between harder rock headlands. Often, sediment transport remains relatively contained within these bays, moving in the prevailing direction of the residual tidal currents or predominant waves. However, during storm events, material is often drawn down the beaches to the nearshore zone before returning to the beaches when sea states become calmer (Scarborough Borough Council, 2014). In addition to natural geological features influencing the transport of sediment, processes in the area have also been heavily influenced by human activities, namely the historic legacy of colliery spoiling and the construction of coastal defences (Scarborough Borough Council, 2014). Only short stretches of cliff are subject to erosion so only provided a limited supply of beach building material. As such, it is likely that there is a strong dependence on adjoining coastal areas providing a material source. Therefore, any changes or alterations to the coastline could have consequences for the shoreline further afield (Scarborough Borough Council, 2013).

The net longshore transport of sediment along this section of the coast is to the south. Transects along the coastal frontage of this section of coast were analysed for sediment transport potential under MHWS and MLWS water levels, as part of a Sediment Transport Study (Scarborough Borough Council, 2014). Figure 2-14 shows the net potential movement of sediment (in m^3 per year) along transects at various locations from Bamburgh in the north to Scarborough in the south. Net positive drift is representative of movement south and net negative drift indicates movement north. The Hartlepool North and Saltburn locations are both within the Tees Bay area, therefore closest to the Teesside Pipeline landfall, and exhibit low magnitude net drift overall (Scarborough Borough Council, 2014).

Sediment transport in this region is primarily governed by movement at times of high water (shown in blue in Figure 2-14), therefore much of the sediment movement occurs within the inter-tidal zone (Scarborough Borough Council, 2014).

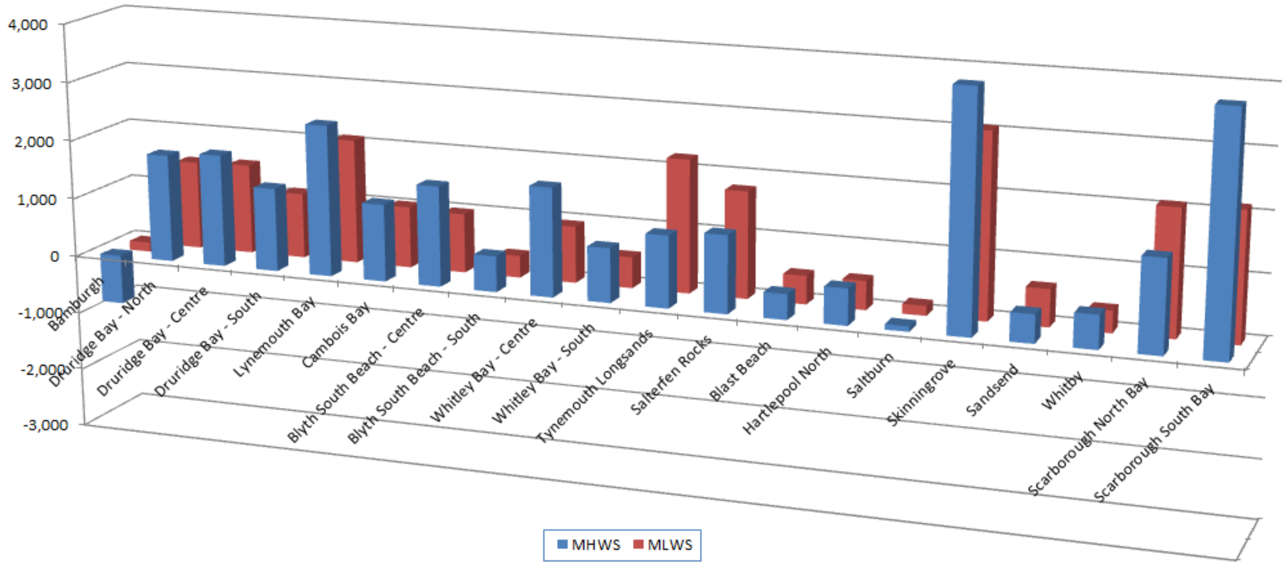


Figure 2-14 – Sediment net drift (m^3/year) at transects within Cell 1, where Coatham Sands sits between Hartlepool North and Saltburn (Scarborough Borough Council, 2014)

Tees Bay is primarily a sediment sink. Although net sediment transport is to the south along the North Yorkshire coast, Tees Bay is sufficiently well set back within the influence of the Hartlepool Headland and the larger overall general headland of the North York Moor, that current speeds are reduced in the Bay, so sediment previously held in suspension settles out and accumulates (North East Coastal Authorities Group, 2007). The Tees estuary is flanked on either side by the North and South Gare breakwaters, stable solid structures which allow beach sediment to accumulate in their lee.

The Tees estuary is regularly dredged to depths of between 10 and 15 m to maintain navigable channels within the river mouth (Scarborough Borough Council, 2013; 2014). Between 800,000 and 1,500,000 m^3 of sediment has been dredged from the channel every year from 2001 to 2016 (Figure 2-15), but dredge volumes have decreased in recent years, with only 550,000 m^3 of sediment dredged in 2019 (PD Teesport, 2019). Dredging takes place six days a week, and can increase to seven days per week following high deposition storm events. Dredged material is deposited at dredge disposal site Tees Bay A (Figure 2-6) throughout the year.

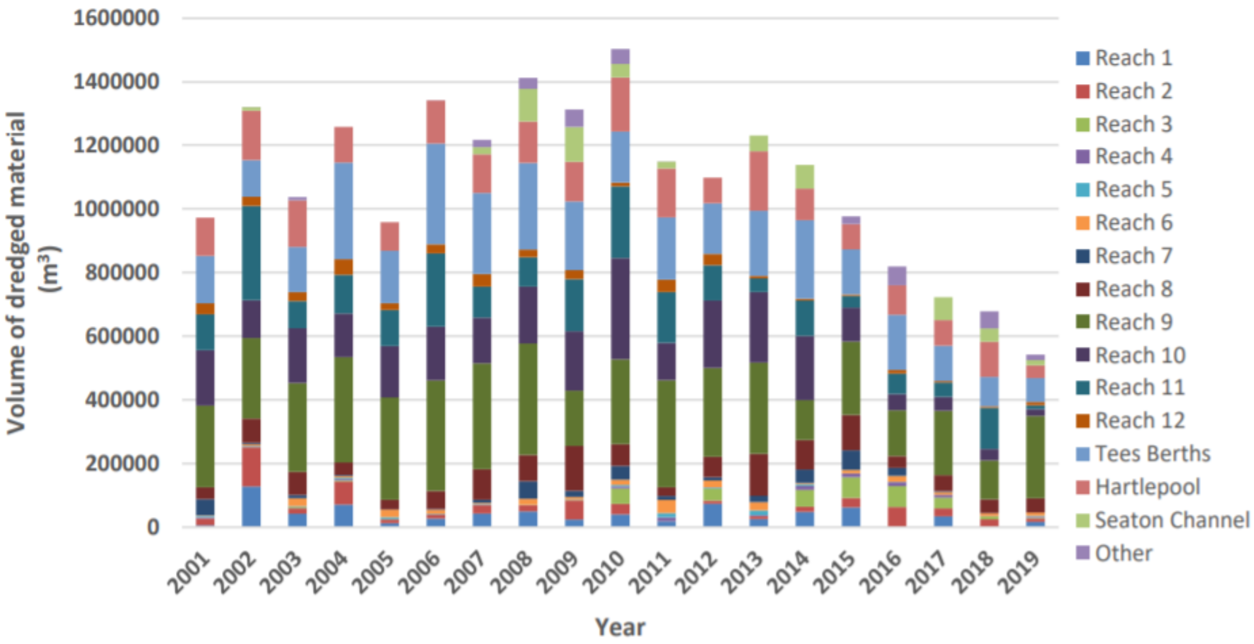


Figure 2-15 – Summary of volumes (m^3) dredged from the Tees River (and Hartlepool) and deposited offshore during the period 2001 to 2019 (PD Teesport, 2019). "Reach" in the legend refers to different sections of the Tees River.

2.2.7 Coastline

The Teesside Pipeline comes ashore at Coatham Sands, a beach which extends between the South Gare Breakwater at the mouth of the River Tees estuary, and Coatham Rocks further to the southeast (Figure 1-3). These features help retain a wide sandy beach that is initially backed by low sand dunes forming links and then boulder clay coastal slopes extending further southeast. Three nearshore slag banks (human-made structures constructed from concrete and slag, a by-product of the steel smelting) are exposed at low water east of South Gare Breakwater. They are known as the "German Charlies" and they provide further shelter to the beach (Figure 1-3). Loss of beach material typically only occurs under storm conditions. The beach and backing dunes form part of the Teesmouth and Cleveland Coast SSSI (Figure 2-6).

The dunes backing Coatham Sands are stable and well vegetated in the north, showing a notable increase in the extent of dune vegetation in recent years (Scarborough Borough Council, 2018). However, there is extensive ongoing erosion of the dune crest at the southern end of the beach near the caravan park (Figure 1-3), where the continuing roll-back of the dunes is now encroaching significantly into the caravan park and former site compound areas. This is evidenced by the loss of pitches along the seaward facing row of caravans in recent years (Scarborough Borough Council, 2020). However, overall, the dune activity status at Coatham Sands has been recorded as inactive or dormant since surveys began in 2012, suggesting a degree of stability (Scarborough Borough Council, 2020). The evolution in beach profiles at Coatham Sands from 2008 to 2020 are shown in Figure 2-16, showing the beach is accreting in the west, and stable in the east.

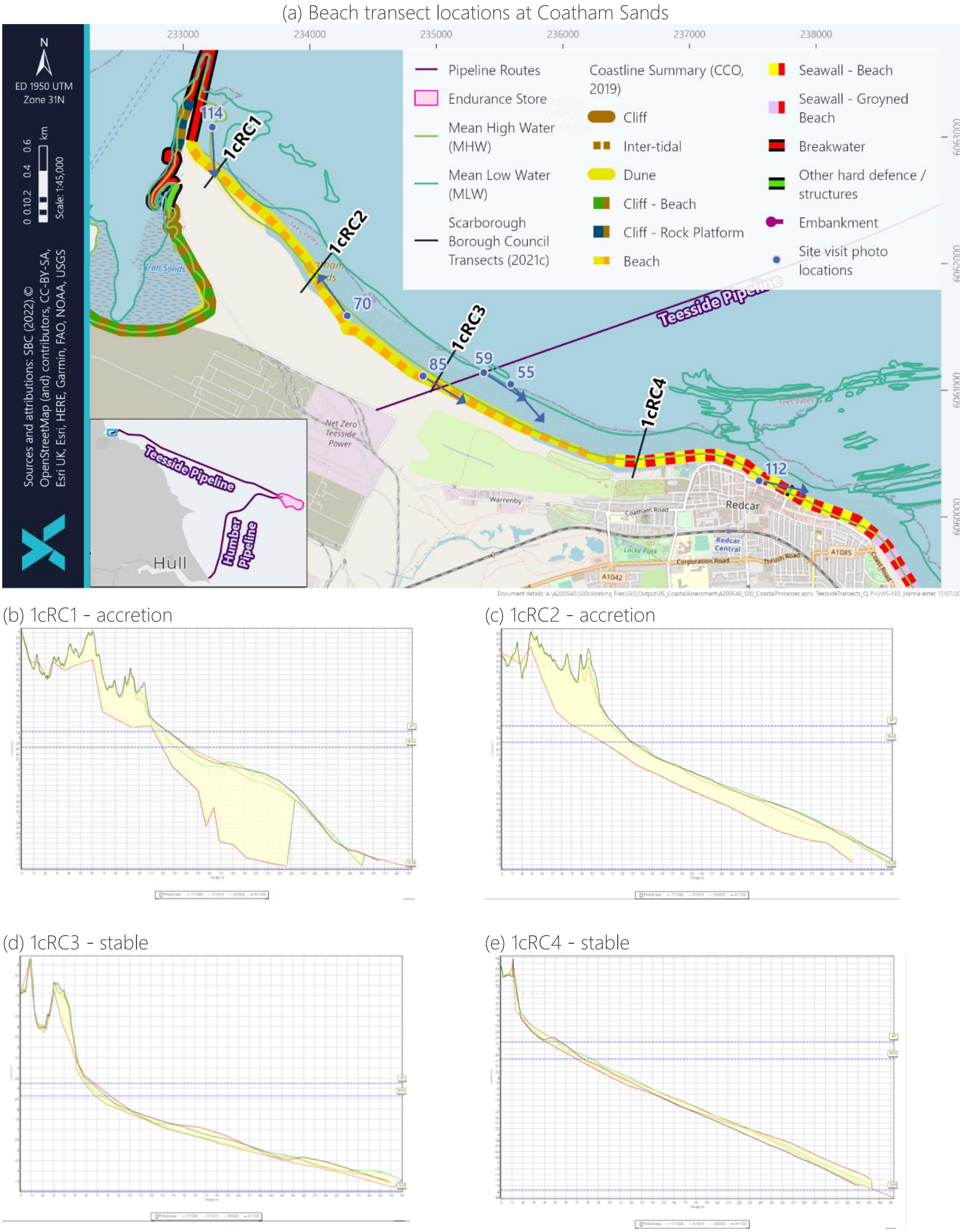


Figure 2-16 – Beach profile evolution at Coatham Sands from 2008 to 2020 (Scarborough Borough Council, 2021c)

Further south along the coast near Saltburn, the dunes are partially or totally active and in particular during the summer of 2018 a number of erosion events occurred. Since then, there have been a number of further rockfall incidents reported (Scarborough Borough Council, 2014; 2020).

Further to east, the coastline fronting Redcar headland comprises a sandy beach which is backed by a sea wall and revetments. Behind the sea wall is a variable width land-claimed sand dune fronting a boulder clay hinterland. Seaward of the beach is a well-defined rock shore platform of Coatham Rocks and Redcar Rocks, which are composed of Redcar Mudstone Formation and control the position of the headland. The beach appears to be fairly volatile and sensitive to wave conditions with loss over short periods followed by recovery over periods of a few years (Scarborough Borough Council, 2013).

A recent survey determined that the South Gare breakwater is currently in poor condition and is comprised of numerous ad hoc repairs particularly along its northern flank (Scarborough Borough Council, 2018). The shoreline management plan objective for the breakwaters indicate the intention is to “Hold the line”, so repairs will be made in due course. At Redcar to the east, coastal defences were repaired in 2013 and remain in good condition.

2.2.8 Climate Change and Sea Level Rise

Isostatic readjustment will affect future changes in sea level, with the north of Great Britain uplifting in the wake of glacial ice melt and the south sinking. The supposed axis upon which this process hinges is thought to follow a line between the north of Tees Bay in the east and the Dee Estuary (between Wales and England) in the west. The existing literature suggests that the rate of uplifting of northern England is beginning to demonstrably slow. This means that the eustatic components of global sea level rise will start to become more pronounced (Scarborough Borough Council, 2013).

Sea level rise projections for the years between 2014 and 2070 present an average of 0.35 m relative sea level rise under the maximum emissions scenario (Scarborough Borough Council, 2013), which is roughly in keeping with the Environment Agency sea level rise allowance estimates. The Environment Agency upper end sea level rise allowance in the Northumbria basin (which captures the Teesside area) for the years 2000-2035 is 5.8 mm per year and 203 mm over the whole time period. The allowance for 2036-2065 is 10 mm per year and 300 mm overall. The cumulative rise from 2000 to 2125 is 1.42 m (Environment Agency, 2021).

Under the Met Office future UK Climate Projections 2018 (UKCP18) for the Stockton-on-Tees area, which are based on a 1981-2000 baseline, a range of possible scenarios called Representative Concentration Pathways (RCPs), have been devised to inform future emissions trends. RCP 8.5 is the worst-case scenario with regards to emissions. Based on RCP 8.5, there is a 50% probability that sea levels will have risen 8 cm by 2022 and 11 cm by 2026; these dates are key in the commencement of construction and initial operation of the Net Zero Teesside Development. By 2051 (i.e. the end of the Net Zero Teesside Development operational lifespan) this may increase further to 26 cm above 1981-2000 baseline (AECOM, 2021b). Sea level projections for the Teesside region, based on models that were used to inform the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (Palmer *et al.*, 2018) are available in ES Chapter 4 Section 4.7.1.

2.2.9 Teesside Site Visit

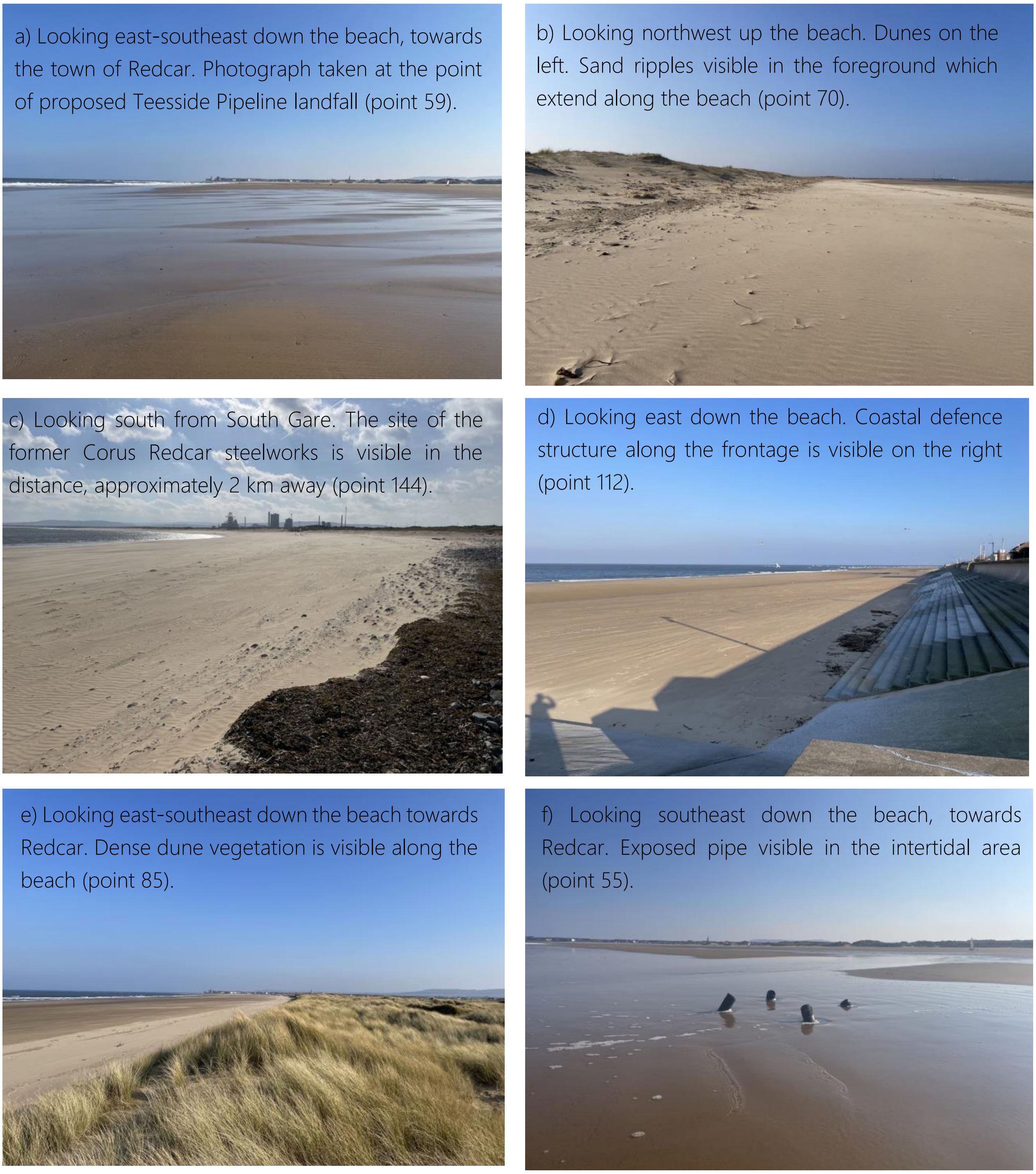
bp conducted the site visit to the Teesside Pipeline landfall location on 8th March 2022. The site visit was carried out on the days just after the lowest spring tide. The weather was fair and clear for the duration of the visit. The timing of visit on the designated day was planned to coincide with low tide, which occurred at 13:10. A description of the site visit is provided here with some photographs (Figure 2-17), while photo locations are shown in Figure 2-16.

Overall, there was no noticeable variation in beach profile along coast, with the whole beach having a relatively gentle gradient (Figure 2-17a). Where the sea wall/defences begin at the Majuba car park and southwards along the Redcar seafront there is a visible change in beach sediment with increased patches of gravel and pebbles along the beach. These were not observed northwards of the car park. However, sandwaves and ripples were present extensively across the intertidal area north of the car park (Figure 2-17b and Figure 2-17c). Figure 2-17d shows the coastal defence approximately 1.2 km south of the Majuba car park and 2.3 km south of the Teesside Pipeline landfall.

At South Gare the height of coastal defences in front of the dunes visibly decreases moving south along the beach. This could be a possible indication of sediment accretion in the area south of the defences. The view looking south from South Gare along the length of the Redcar beach frontage is in Figure 2-17c.

At the Teesside Pipeline landfall, the dunes are more established than elsewhere along the beach. Vegetation cover is dense and more mature here than elsewhere along the coastline (Figure 2-17e). To the north of the landfall location, dunes are less developed (Figure 2-17b).

A number of exposed pipelines, including possible effluent pipe, were identified at a number of locations along the beach. One instance of exposed pipe is shown in Figure 2-17f; these exposed pipe ends are located in the intertidal area, just to the south of the CATS pipeline landfall.



a) Looking east-southeast down the beach, towards the town of Redcar. Photograph taken at the point of proposed Teesside Pipeline landfall (point 59).

b) Looking northwest up the beach. Dunes on the left. Sand ripples visible in the foreground which extend along the beach (point 70).

c) Looking south from South Gare. The site of the former Corus Redcar steelworks is visible in the distance, approximately 2 km away (point 144).

d) Looking east down the beach. Coastal defence structure along the frontage is visible on the right (point 112).

e) Looking east-southeast down the beach towards Redcar. Dense dune vegetation is visible along the beach (point 85).

f) Looking southeast down the beach, towards Redcar. Exposed pipe visible in the intertidal area (point 55).

Figure 2-17 - Teesside site visit photos (point numbers are shown on Figure 2-16)

2.3 Humber

2.3.1 Key Data Sources

A number of data sources have been used to inform the baseline understanding of the physical environment along the Humber Pipeline route. Project specific information used to develop this understanding includes:

- bp Metocean Report for the Humber Pipeline;
- NEP Integrated Site Survey – 2021 Environmental Baseline Report (Gardline, 2022a);
- NEP Integrated Site Survey – 2021 Environmental Survey Habitat Assessment (Gardline, 2022b);
- Humberside landfall investigation for the NEP: Coastal Erosion Study (Resilient Coasts, 2022); and
- A site visit to the coast around Dimlington, undertaken by bp on 7th March 2022.

Reports and data produced for the wider Humber area which have contributed significantly to this assessment are as follows:

- Southern North Sea Sediment Transport Study (HR Wallingford *et al.*, 2002), and Appendix 11: Report on Southern North Sea longshore sediment transport (Sutherland *et al.*, 2002);
- Flamborough Head to Gibraltar Point Shoreline Management Plan Appendix C: Assessment of Coastal Behaviour and Baseline Scenarios (Humber Estuary Coastal Authorities Group, 2010); and
- East Riding of Yorkshire Council Coastal Explorer beach profiles and cliff erosion data (ERYC, 2021a, b).

A number of other site-specific studies and publicly available reports that have informed this work are as follows:

- Atlas of UK Marine Renewable Energy Resources (ABPmer, 2017);
- Hornsea Wave Report 2021 (Channel Coastal Observatory, 2021b);
- The East Riding Coastline: Past, Present and Future (Boyes, Barnard and Elliott, 2016);
- The Tolmount ES (Premier, 2018);
- Coastal Processes Assessment for renewal of planning permission for the Easington Coastal Defences (ERYC, 2019); and
- East Riding Coastal Monitoring Programme, Seabed Mapping: Flamborough Head to Spurn Point (ERYC, 2014).

2.3.2 Designated Sites

The Humber Pipeline intersects a number of designated sites along its length, a number of which are designated for seabed features and/or their geological value. Figure 2-18 shows the protected sites which are close to the Humber Pipeline.

The pipeline passes through the Holderness Offshore MCZ and the Holderness Inshore MCZ, which are both predominantly designated for seabed features. The Holderness Offshore MCZ is designated for Subtidal coarse sediment; Subtidal sand; Subtidal mixed sediments; part of a North Sea glacial tunnel valley; and the presence of ocean quahog *Arctica islandica*, a slow growing mollusc species (JNCC, 2020b). The Holderness Inshore MCZ is designated for Intertidal sand and muddy sand; Moderate energy and High energy circalittoral rock; Subtidal coarse sediment; Subtidal mixed sediments; Subtidal sand; and Subtidal mud. The site also protects a geological feature, Spurn Head, located at the southern end of the MCZ. This is a unique example of an active spit system, extending across the mouth of the Humber Estuary (Defra, 2016). Both MCZs are subject to an MCZ Assessment (Chapter 6, Seabed Disturbance), within which the potential impacts to the two MCZs will be assessed and quantified.

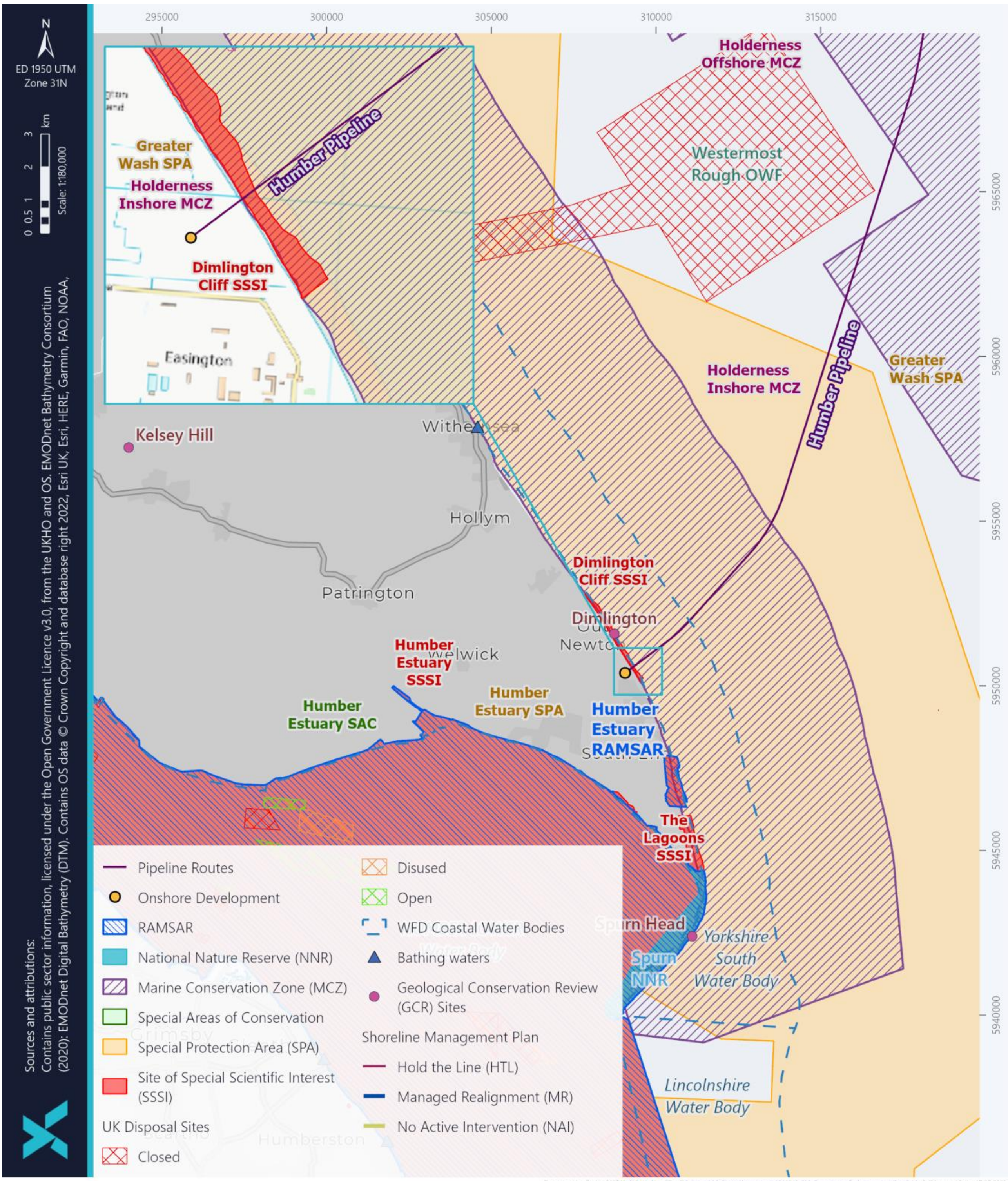


Figure 2-18 - Conservation sites and disposal sites near the Humber Pipeline

A number of other coastal sites proximal to the Humber Pipeline potentially stand to be affected by the proposed Development activities. The radius of search from the Humber Pipeline was informed by indicative tidal excursion ellipses from Atlas of UK Marine Renewable Energy Resources (ABPmer, 2017), which provide the indicative extent of sediment transport within a tidal cycle (see Figure 2-2). The tidal excursion extent north of the Humber Estuary in the region of pipeline landfall was approximately 15 km, so this distance was used to determine what sites could be potentially affected by the Development, see Table 2-4 for the complete list of coastal sites within 15 km of the Humber Pipeline. Impacts to protected sites associated with the Humber Pipeline are addressed in Chapter 6, Seabed Disturbance.

Table 2-4 - Coastal designated sites within 15 km of the Humber Pipeline

Site	Description	Distance/direction from Humber Pipeline
Greater Wash SPA	The extensive coastal site is designated for supporting nationally and internationally significant populations of seabirds. The seabed within the site includes areas of coarse sediment, sand, mud and mixed sediments subtidal sandbanks and occasional Annex I reefs (JNCC, 2020a).	Intersected by pipeline
Humber Estuary SPA	The range of habitats within the Humber Estuary, and by extension within the SPA, support a variety of wintering, passage and breeding birds, including internationally important populations of a number of species. Birds are widely distributed throughout the site, the distribution of individual species reflecting habitat distribution and species ecology (Natural England, 2019).	3 km SSE
Humber Estuary SAC	Designated for the Annex I habitats 'Estuaries' and 'Mudflats and sandflats not covered by seawater at low tide'. Other Annex I habitats and species are present in the site as qualifying features but not the primary reason for the designation of the site, including a number of terrestrial habitats, grey seal, sea lamprey and river lamprey (JNCC, 2022).	3 km SSE
Humber Estuary Ramsar	The inner estuary supports extensive areas of reedbeds and saltmarsh. At other places within the estuary the saltmarsh is backed by sand dunes and marshy slacks. This varied habitat supports internationally important populations of waterfowl in winter and nationally important breeding populations in summer (JNCC, 2008a).	3 km SSE
Dimlington Cliffs SSSI	Dimlington Cliff is the highest point on the Holderness coast. The site is considered to be in favourable condition and is the location of ongoing rapid coastal erosion. Good examples of rotational landslip can be seen within the site. Landslips have covered exposures in the cliffs but these will be re-exposed as natural coastal erosion progresses (Natural England, 2022a).	Intersected by pipeline (underground)

Site	Description	Distance/direction from Humber Pipeline
The Lagoons SSSI	The site lies approximately 2 km north of the Spurn peninsula. It comprises a variety of coastal habitats including saltmarsh, shingle, sand dune, swamp and most significantly, saline lagoons and pools which represent the only extant example in North Humberside of this nationally rare habitat. These habitats support a number of dune flora communities and breeding bird aggregations (Natural England, 2022b).	3 km SSE
Humber Estuary SSSI	The Humber Estuary is a nationally important site with a series of nationally important habitats. These are the estuary itself and its associated habitats. The site is also of national importance for the geological interest at South Ferriby Cliff and for the coastal geomorphology of Spurn. It is also nationally important for a number of bird, seal and lamprey species, and vascular plant and invertebrate assemblages (Natural England, 2022c).	4 km SSW

2.3.3 Geology and Surficial Sediment

The location of the Humber Pipeline landfall lies on the southern end of the Holderness coast, a coastal region around 60 km in length bounded by the chalk cliffs at Flamborough Head to the north and the sand and shingle spit of Spurn Head to the south (Figure 1-1). The Holderness coast is composed of glacially deposited 'soft' Quaternary sediments, which form cliffs with an average height of 15 m but range from less than 3 m near Easington to up to 40 m at Dimlington, within the Dimlington Cliff SSSI (Humber Estuary Coastal Authorities Group, 2010). The sediments deposited in the cliffs vary in age, thickness and character, both vertically and laterally, and include (Eyles *et al.*, 1994) Basement Till (deposited c.130,000 to 300,000 years ago), Skipsea Till (deposited 13,000 to 18,000 years ago), and Withernsea Till (deposited 11,000 to 13,000 years ago; Humber Estuary Coastal Authorities Group, 2010).

Boreholes taken by Fugro in 2003 as part of the OLT (Ormen Lange Transport) Pipeline – Easington Landfall ground investigation, recorded the composition of sediment layers in the intertidal and offshore environments. The OLT Pipeline project is located approximately 600 m from the present Humber Pipeline landfall (Waterman Infrastructure & Environment, 2021). The Fugro (2003) boreholes identified the top ~1 m of sediment in the intertidal zone to be sand of varying levels of compaction and density. Beyond this, to a depth of 15 m, the sediment comprised stiff to very stiff dark grey sandy gravelly clay, identified as part of the aforementioned Basement Till. Cone penetration testing undertaken in the fully offshore environment identified the first 0.9-1.75 m of sediment to be sand, underpinned by stiff to very stiff clay with gravels (Waterman Infrastructure & Environment, 2021).

More recent survey work, synthesised in a report by HR Wallingford (2016), was conducted as part of the installation of the Tolmount pipeline which reaches landfall at the Dimlington Terminal. According to the findings, which can be applied to the Humber Pipeline, the nearshore section of the pipeline route (within the first 1 km) passes through an area of seabed characterised by a considerable variety of clay strengths. The clays are also of considerable depth variations below the surface silt-sand-gravel layer (HR Wallingford, 2016). Sediment samples taken 25 m from the revetement at the terminal frontage underwent particle size analysis as part of this same study. These sediments are considered to be representative of the mobile beach sediment. The median grain diameter is D_{50} = 1.77 mm, representing coarse sand. The range of values for D_{10} and D_{90} were 0.295 mm to 10.402 mm, respectively. Particles of such a size represent fine-medium sand to medium gravel (HR Wallingford, 2016).

The distribution of seabed sediments is shown in Figure 2-19. The results of the survey conducted along the Humber Pipeline route are transposed on top of the wider seabed classification (Gardline, 2022a). The substrate nearest the landfall is sand, extending through a patch of rocky substrate, then comprising sand coarse sediments further offshore. Boulders are present throughout the surveyed corridor. An analysis of boulder density within the 40 m wide boulder clearance corridor shows that no more than three boulders are present with any 100 m by 40 m stretch along the pipeline (Figure 2-20).

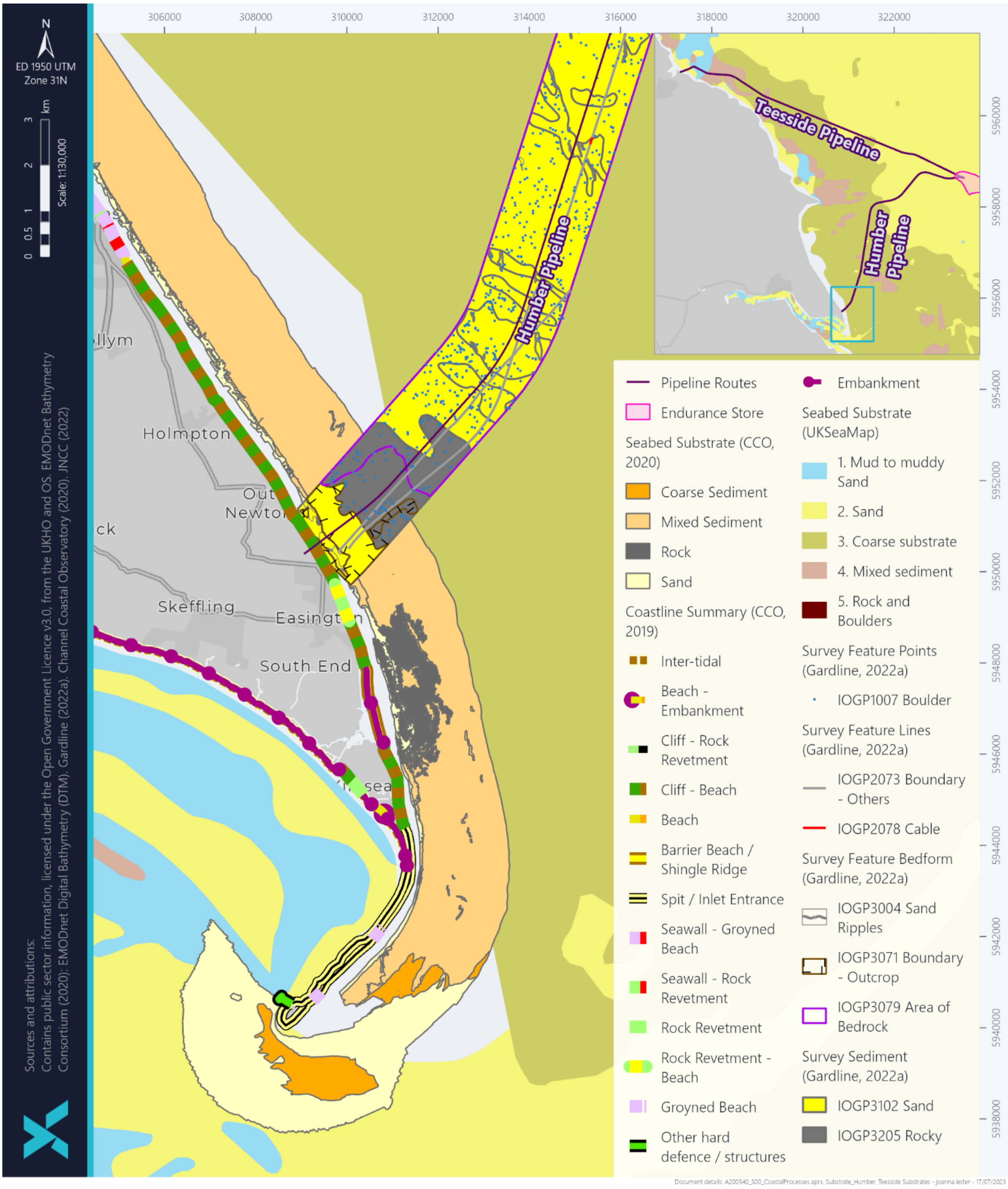


Figure 2-19 – Seabed substrate at the Humber Pipeline landfall

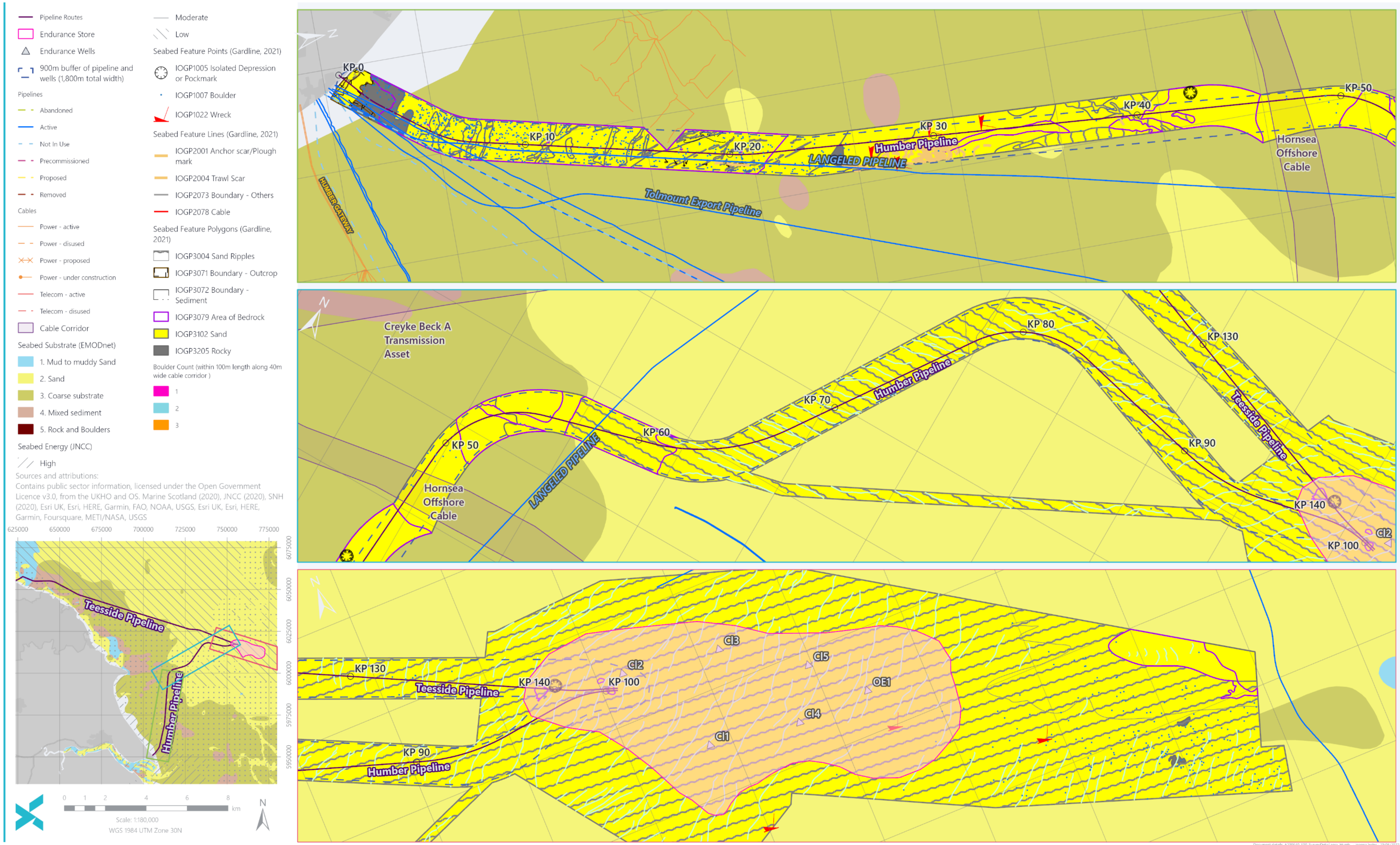


Figure 2-20 – Seabed substrate length of the Humber Pipeline (Gardline, 2022a)

2.3.4 Bathymetry and Morphology

The bathymetry along the Holderness coast deepens relatively uniformly, at first dropping around 10 m in the first 500 m or so, then deepening more gradually beyond this point. A gently sloping (<1°) shore platform comprised of till, with occasional lag boulders remaining, extends offshore from the Holderness coast for several kilometres; until a marked break in slope occurs at about 9 to 12 m below LAT forming the shoreline platform (Humber Estuary Coastal Authorities Group, 2010). There are no distinct bathymetric features that are likely to disrupt or influence net southward sediment transport along the coast. Figure 2-18 shows the 1 m and 10 m bathymetry contours along the coast as far as Spurn Head, as well as the bathymetry within the Humber Pipeline route corridor.

The seabed contours are aligned parallel with, and close to the coastline. However, with progression further south of the gas terminals, the alignment of the coastline changes and the 10 m seabed contour is considerably further offshore, with wider sand deposits in the nearshore (ERYC, 2019). Discontinuous sand sheets with low sandy bedforms (1-4 m high and generally less than 50 m in extent) and spreads of gravels occur on the submerged platform (IECS 1988, cited in Humber Estuary Coastal Authorities Group, 2010; ERYC, 2014). Nearshore, the underlying till bedrock is covered with sand, which makes way for largely mixed sediments further offshore (ERYC, 2014), as described in Section 2.3.5.

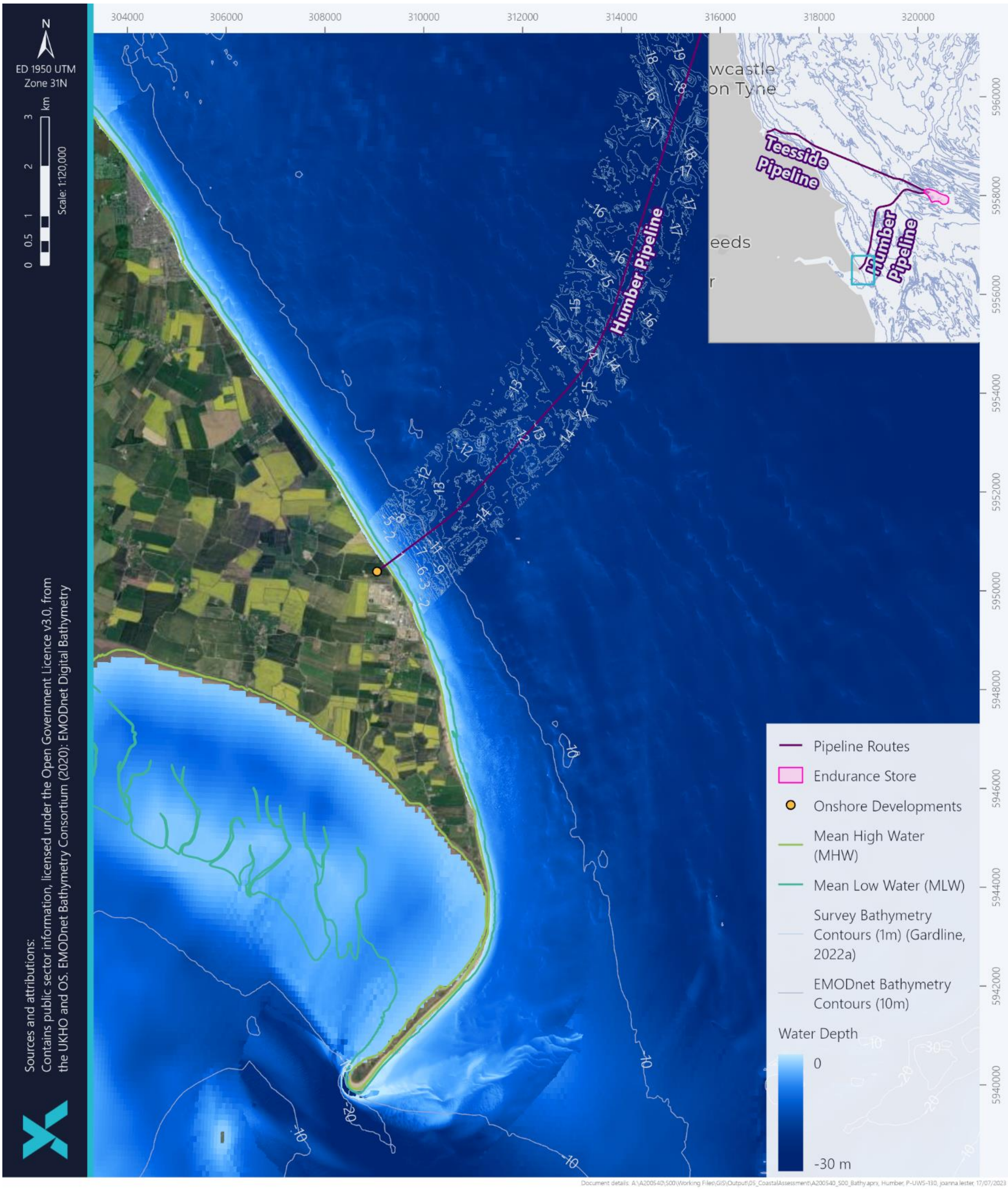


Figure 2-21 – Bathymetry along the Holderness coast and Spurn Head

2.3.5 Metocean

Tide

The tide along the Holderness coast floods southwards and ebbs northwards. At Bridlington, just south of Flamborough, and Spurn Head the mean ranges of the spring tide are 5.0 m and 5.7 m respectively, and mean neap tidal ranges are 2.4 m and 2.8 m (HR Wallingford *et al.*, 2002). The spring tidal range at the shore within 1 km of pipeline landfall is approximately 5.27 m with an associated tidal power of 0.89 kW/m^2. The neap tidal range is approximately 2.34 m (ABPmer, 2017). The tidal power is particularly strong at the entrance to the Humber Estuary and peaks just off the coast of Spurn Head, south of the pipeline landfall.

The Humber Estuary itself is macro-tidal. Mean High Water Spring (MHWS) levels at Goole, which is inland and upstream at the start of the estuary, are 1.3 m above levels at the estuary mouth by Spurn Head; high water levels increase further upstream as tidal flows are constricted by the narrowing estuary (Able UK Ltd, 2011).

Water levels along the east coast are also influenced by tidal surges, experienced when low pressure weather systems move southward in the North Sea. Extreme water levels associated with positive surges have been predicted for a range of return periods for the Easington area in Table 2-5.

Table 2-5 - Extreme waters levels and their associated return period for the Easington area (from ERYC, 2019)

Return Period (years)	Water Level (m ODN)
1	3.63
5	3.87
50	4.23
100	4.33
200	4.46

Currents

Peak spring currents along the Holderness and Lincolnshire coasts are directed southward (Figure 2-22; HR Wallingford *et al*., 2002). Tidal currents in this region are generally uniform, except further north where tidal streams run off prominent headlands like Flamborough Head, giving rise to turbulence and eddies on both sides of the promontory (Barne *et al.*, 1995). Close to the Holderness coast, mean spring near-surface tidal currents range between 0.75 and 1.25 m/s. Near-bottom velocities are lower than those at the surface but only by a small amount due to the relatively shallow water depths (Tappin *et al.*, 2011). The maximum flood flow velocity is generally equal to or greater than the maximum ebb flow and also lasts longer, resulting in a net residual water movement to the south (DTI, 2001).

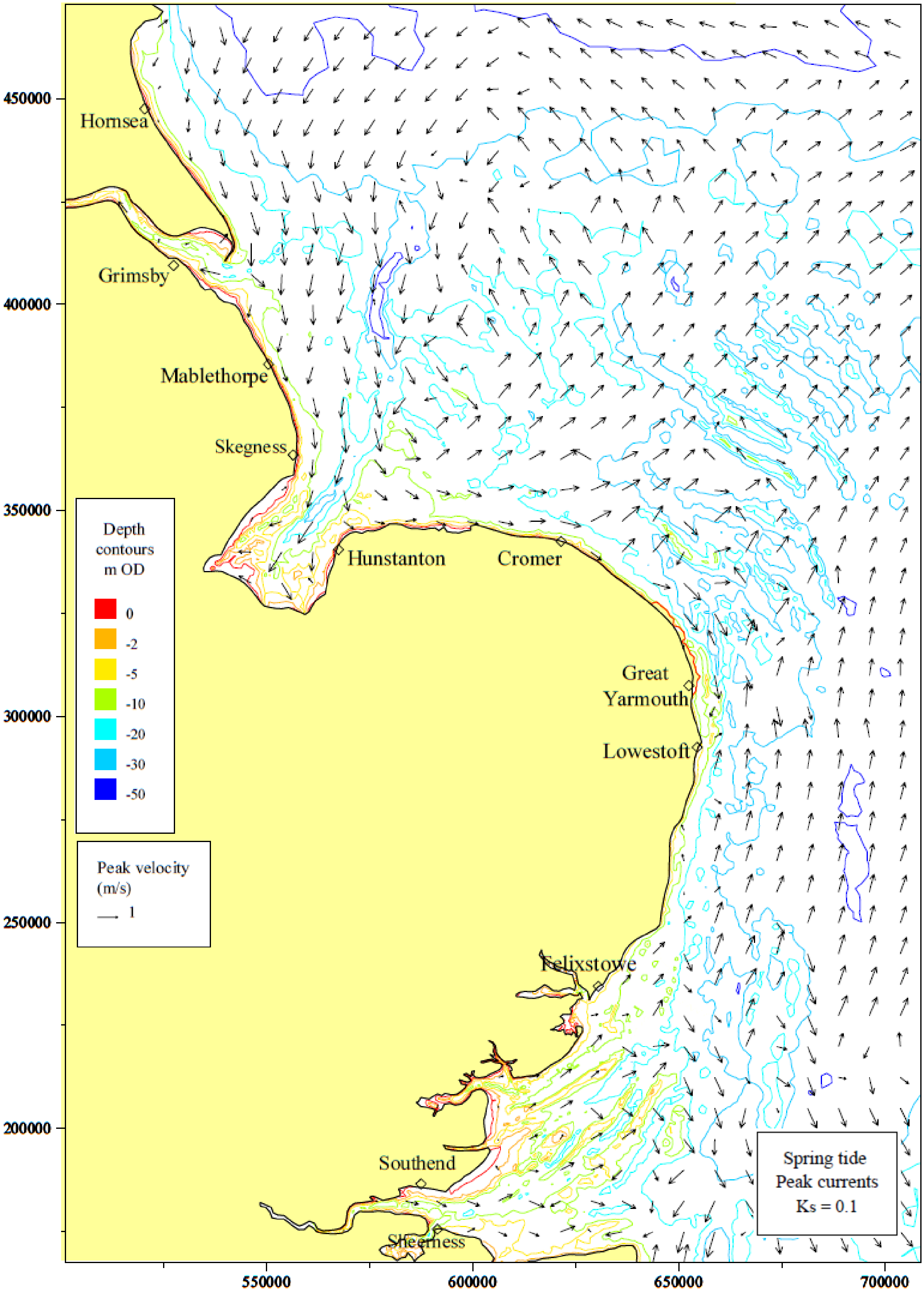


Figure 2-22 - Spring tide peak depth-averaged currents along the east coast of England (HR Wallingford et al., 2002)

Wind

A preliminary assessment of metocean conditions for the Endurance Store area and Teesside Pipeline route was undertaken in 2020 (bp, 2020). Figure 2-23 shows the annual wind direction modelled for the Endurance Store (location shown on Figure 2-2). Winds occur from all directions but winds from the south-west and west predominate. The maximum annual wind speed is 25 m/s (bp, 2020).

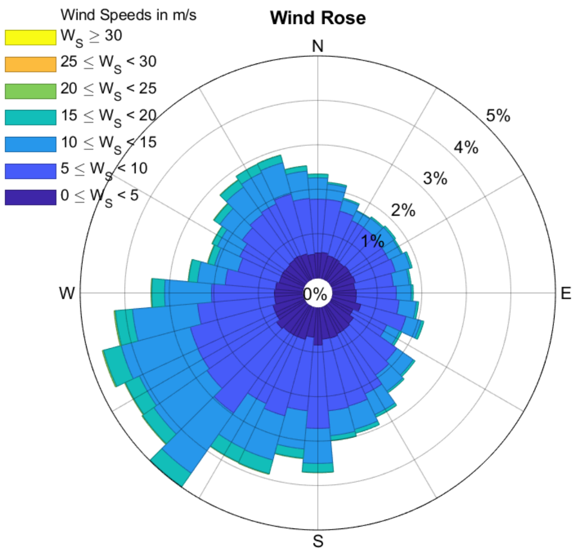


Figure 2-23 - Mean wind direction and speed (coming from) at the Endurance Store area (bp, 2020)

Wave

The Hornsea wave buoy, situated 5 km off Hornsea, is located approximately 10 km from the Humber Pipeline in water of around 12m depth (location shown in Figure 2-2). The average monthly significant wave height between 2008 and 2020 is less than 1 m in all months, with the exception of February and November where the average height is 1.02 m. The longest wave periods (>8.0 s) are associated with the months of December, January, February and March (Channel Coastal Observatory, 2021b). Table 2-6 shows the various average monthly wave properties between 2008 and 2021. Annual maximum significant wave heights reach between 4 and 5 m, with the highest wave in 2021 being 5.52 m in height and occurring on 27th November (Channel Coastal Observatory, 2021b). The storm alert threshold at the Hornsea buoy location is a wave 3.08 m high. This threshold was exceeded four times in 2021 (Channel Coastal Observatory, 2021b).

Table 2-6 - Monthly average wave properties (June 2008-December 2021; Channel Coastal Observatory, 2021b)

Month	Hs (m)	Tp (s)	Direction (°)
January	1.00	8.4	75
February	1.02	7.9	78
March	0.87	8.4	71

Month	Hs (m)	Tp (s)	Direction (°)
April	0.83	7.7	64
May	0.76	6.8	72
June	0.65	6.4	71
July	0.58	5.8	82
August	0.59	5.9	90
September	0.69	6.8	82
October	0.94	7.6	79
November	1.02	7.9	75
December	0.96	8.5	72

The mean wave field from 2008 to 2021 shows the most frequent wave direction to be north-northeast, followed by northeast then east-northeast (Channel Coastal Observatory, 2021b).

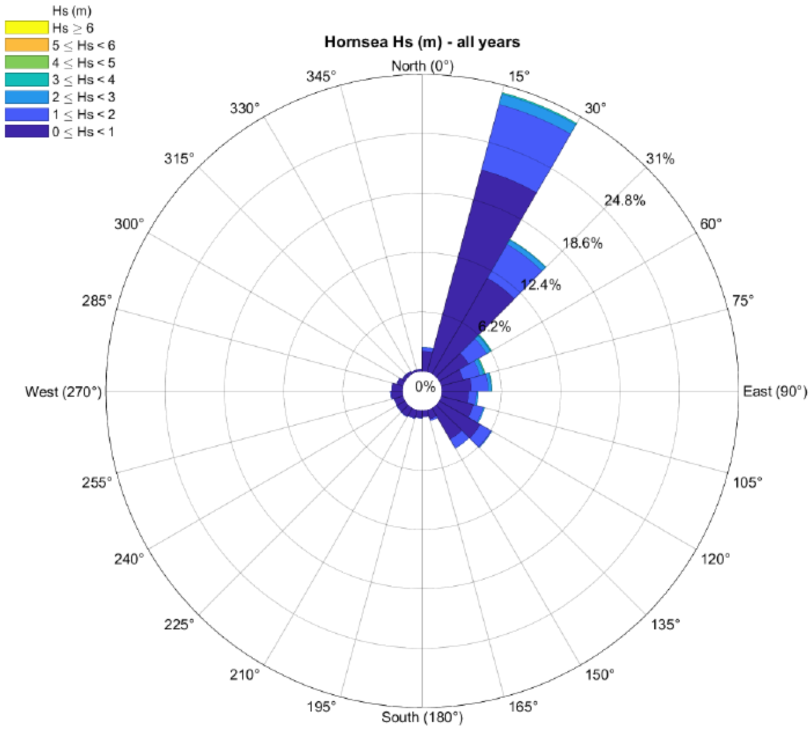


Figure 2-24 - Wave rose for the Hornsea wave buoy (Channel Coastal Observatory, 2021b)

Figure 2-25 shows the mean significant wave height and direction at the Endurance Store. The most frequent waves come from the north, but waves occur from all directions. The predicted maximum significant height is approximately

7 m (bp, 2020). The most frequently occurring waves (based on modelled information), are between 0.5 and 1 m in height, followed by slightly larger waves between 1 and 1.5 m in height (bp, 2020).

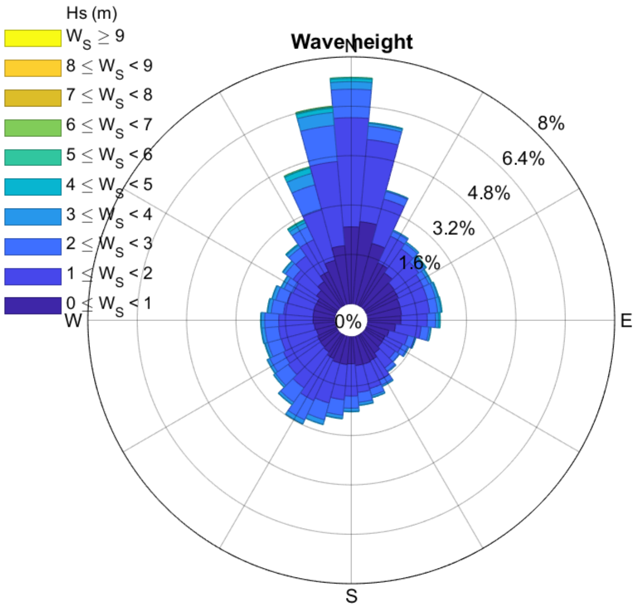


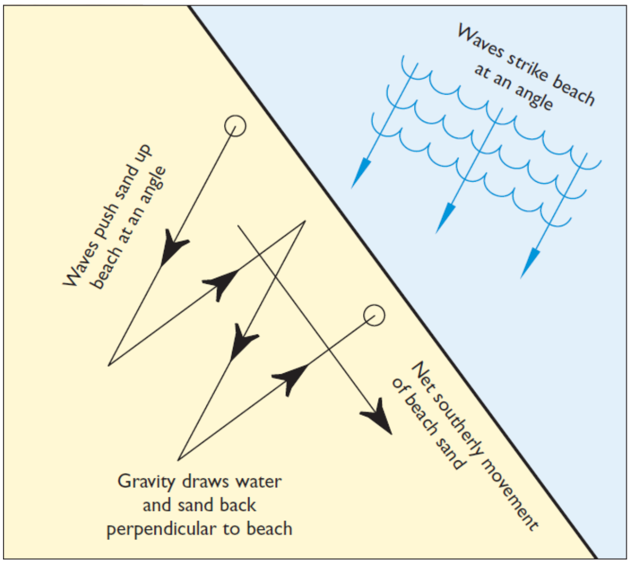
Figure 2-25 - Mean significant wave height and direction (coming from) at the Endurance Store area (bp, 2020)

2.3.6 Sediment Transport Regime

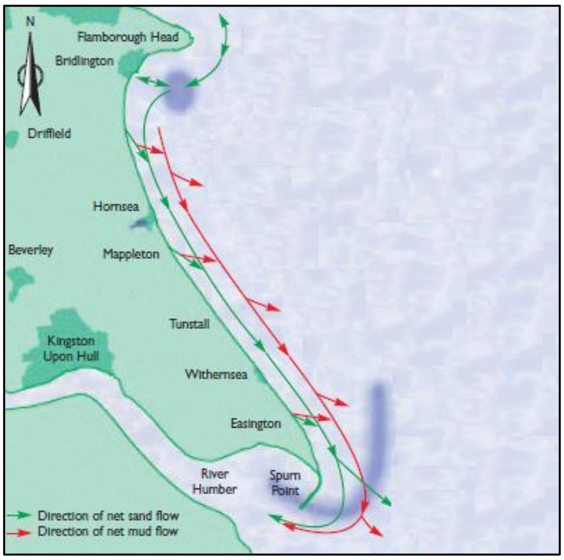
Net sediment transport along the Holderness coast is in a southerly direction, as illustrated in Figure 2-26. In the nearshore, the dominant north-easterly wave propagation direction drives transport, acting to move sediment to the south (Figure 2-26a). Then in deeper water tidal currents take over, with the flood ebb inequality likewise producing a net movement to the south (Figure 2-26b).

The fine clays and the muds eroded from the Holderness coast are put into suspension then rapidly carried south and offshore, most ending up within the Humber Estuary. Sands move more slowly southwards mainly under wave action and remain within the near-shore zone, forming the beaches that can be seen at the base of the cliffs. Larger cobbles and rocks tend to be drawn offshore where they remain and gather, as in deeper water waves are no longer capable of moving them. Over time a blanket of such material develops, helping to protect the underlying clay (ERYC, 2016b).

The offshore seabed sediment composition is shown in Figure 2-19, along with high resolution seabed characterisation informed by a recent survey campaign (Gardline, 2022a). The recent survey data finds clay with localised concentrations of coarse material immediately offshore of the pipeline landfall site, transitioning to fine sand with areas of gravelly sand along the pipeline route heading offshore. This is broadly in agreement with the low resolution BGS data showing sand nearshore and sandy gravel offshore, as the sand layer is known to be highly mobile.



(a)



(b)

Figure 2-26 - Sediment transport figures demonstrating (a) dominant north-easterly wave direction at site leads to net southerly movement of beach sand (ERYC, 2017) and (b) dominant offshore transport of eroded clay cliffs, bed strata and sand in suspension (ERYC, 2017)

The Southern North Sea Sediment Transport Study, Phase 2 (HR Wallingford *et al*., 2002) is a comprehensive study which undertook numerical modelling and field campaigns to better characterise offshore sediment transport of regions such as the Holderness coast. The study culminated in estimates of sediment transport volumes and major transport pathways. Their offshore sediment transport schematic derived through an analysis of seabed features is presented in Figure 2-27.

The potential longshore sediment transport rate for sand has been estimated to be between 200,000 and 350,000 m^3/year (HR Wallingford *et al*., 2002). Transport rates are highest during major storm events, and within about 2 km of the shore (HR Wallingford, 2003).

Cliff erosion rates of up to 1.8 m/yr liberate up to 1,000,000 m^3 of sediment (ERYC, 2017). Erosion of the clay foreshore produces up to a further 2,000,000 m^3 therefore annual sediment production can be up to 3,000,000 m^3 (ERYC, 2017).

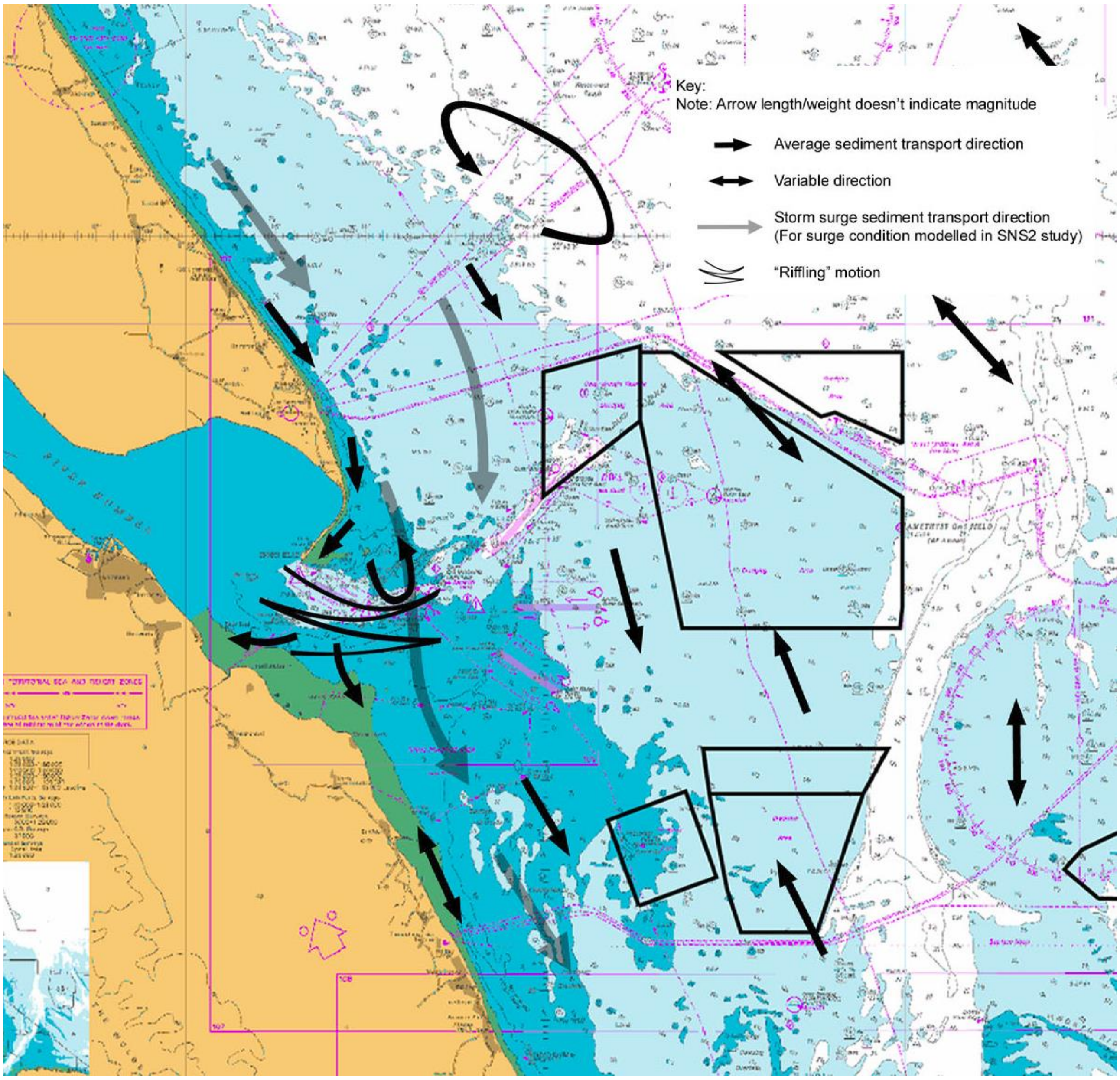


Figure 2-27 - Schematic sediment transport pathways for South Holderness, the entrance to the Humber and North Lincolnshire (the black boxes show licensed aggregate dredging areas) (HR Wallingford et al., 2002).

The bathymetry off Spurn Point is highly variable, indicative of a highly dynamic sediment transport system. Figure 2-28 shows the areas of accretion and erosion along the spit over time (Bateman *et al.*, 2020). Since the 1850s, the Spurn has been partially held in place artificially through hard engineering and management. Recent policy now aims to manage the spit to work with natural processes thereby reverting to a geomorphological system which functions more similarly to that documented before the 1850s (Bateman *et al.*, 2020).

Maintaining sediment supply to the neck and head of the spit, from the anchor and further up the east coast, is key to the long-term resilience of the spit, and will allow for the continuation of dune building. Increased erosion of source material along the East Yorkshire coast and accelerated long-shore transport will aid future spit resilience. However, curtailing the yield of sediment from the East Yorkshire coastline through artificial cliff stabilisation and/or groynes could make the spit less resilient in the future, unless sediment nourishment is adopted (Bateman *et al.*, 2020).

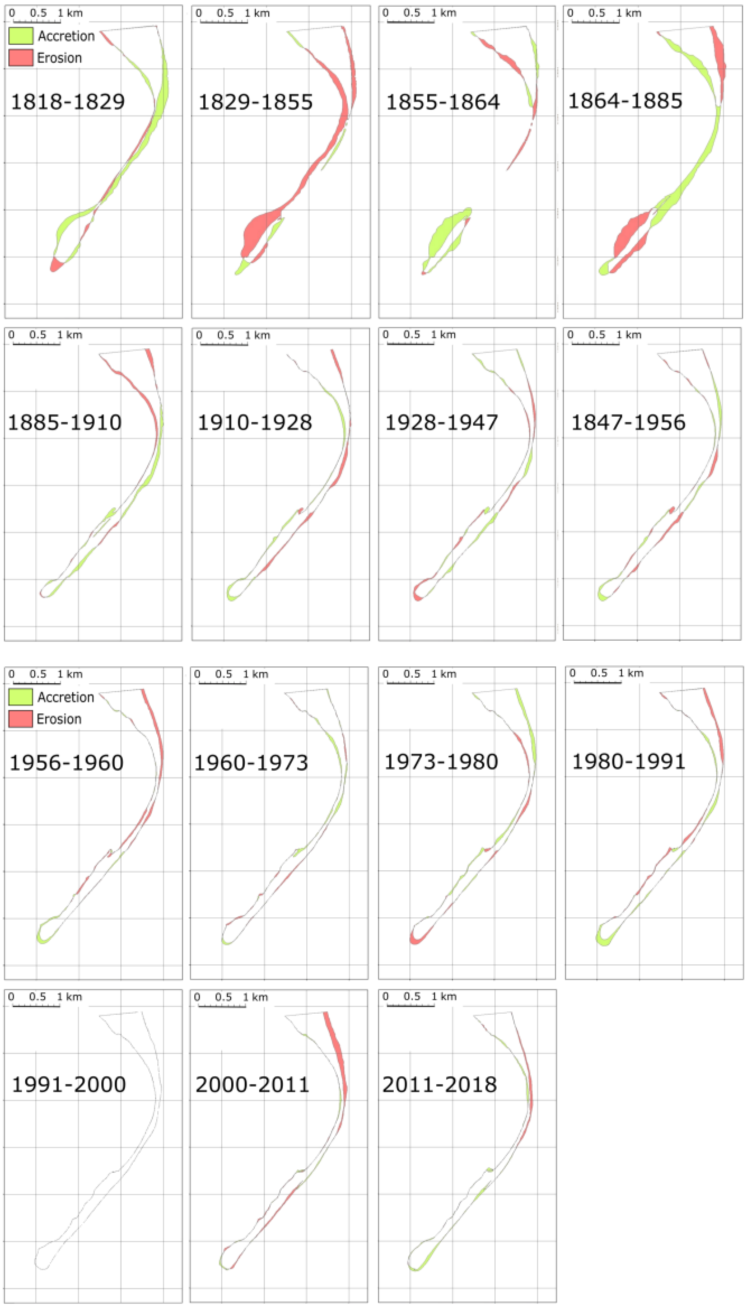


Figure 2-28 - Areas of accretion and erosion on Spurn from 1818 to 2018 (Bateman et al., 2020)

Water within the Humber Estuary contains very high concentrations of fine suspended sediment. On a given tide up to 1.2×10^6 T of sediment may be in the water column. Fluvial input amounts, on average, to 335 T of sediment per tide compared to the average tidal exchange of $1.2x10^5$ T per tide at the mouth. Around 430 T per tide is deposited in the estuary with a net marine import of around 100 T per tide (Able UK Ltd, 2011).

Sedimentation patterns in the estuary are dominated by tidal flow. Much of the sediment entering the estuary from the mouth is returned to the sea on the ebb tide. Some is also deposited across intertidal areas or shifted around sub-tidally. There is a large degree of variability in the suspended sediment concentration (SSC) throughout the estuary, influenced by freshwater and tidal water flows, and the availability of sediment according to local sediment transport processes. British Transport Docks Board measurements report a range of SSC within the middle and outer estuary of between 300 mg/l and 1900 mg/l (BTDB, 1970, cited in Able UK Ltd, 2011).

2.3.7 Coastline

The Holderness coast is one of Europe's fastest eroding coastlines, receding landwards at a rate of up to 1.8 m/year (ERYC, 2017). The lithology of the cliffs along the Holderness coast makes them highly susceptible to erosion; the weakly consolidated boulder clay consists of a clay matrix containing a mixture of coarse sediments and pebbles. Persistent wave and tidal energy from the North Sea drives the erosion of the soft glacially deposited boulder clay cliffs backing the beach, and the cohesive shore platform (clay substrate) and overlying beach sediments on the foreshore. An estimated 1 million m^3 of sediment is released every year due to cliff erosion. The eroded material is carried in a net southerly direction along the coast by longshore drift, towards Easington and Kilnsea where it supplies sediment to the Spurn Head spit and provides the Humber Estuary and the North Lincolnshire coast with valuable sediment (EUCC, 2007).

According to British Geological Survey (BGS) Coastal Vulnerability Data (2021), the cliff face at the Humber Pipeline landfall location has a Class E rating, which indicates a high vulnerability to erosion. The cliff is also described as unlithified which refers to the fact the sediment is unconsolidated and has not turned to solid rock (lithified).

East Riding of Yorkshire Council (ERYC) has been collecting information on cliff erosion at 123 cross-shore profiles (perpendicular to the land) along the Holderness coastline, spaced along the coast approximately every 500 m. The profile closest to the landfall of the Humber Pipeline is profile 109. The profiles are shown in the wider coastal context in Figure 2-29, in addition to the historic and predicted change in coastal profile 109.

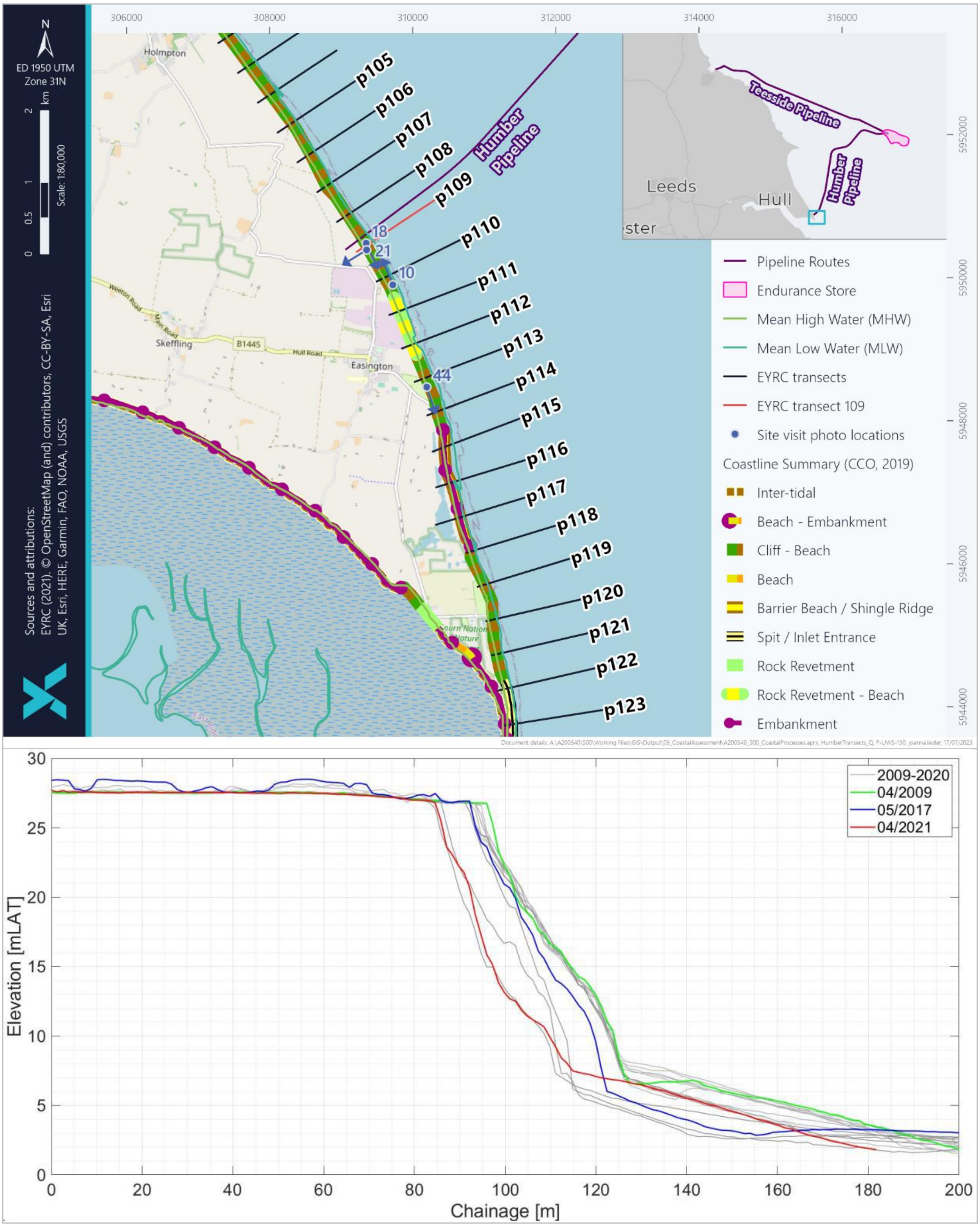


Figure 2-29 - ERYC beach profiles along the Holderness coast to Spurn Point (top) and (bottom) Profile 109 extracted from the LiDAR data sourced from ERYC and CCO (Resilient Coasts, 2022)

The information collected by ERYC consists of measuring cliff positions from Ordnance Survey (OS) maps between 1852 and 1998, collecting GPS profile survey data between 1999 and 2008, and since 2009 data has been extracted from flown airborne LiDAR surveys. These cliff positions have been used to determine an estimate of annual average cliff recession rates at each profile location. The average recession rates from the profiles closest to the Humber Pipeline landfall are presented in Table 2-7.

Table 2-7 - Cliff recession rates in proximity to the Humber Pipeline landfall (ERYC, 2021b)

Profile no.	Location	Cliff top elevation	Average cliff recession rate 1852-1989 (m/yr)	Average cliff recession rate 1989-April 2021 (m/yr)
106	South of Out Newton	23.4	1.62	0.81
107	Dimlington High	35.4	1.69	0.79
108	South of Dimlington High	27.7	1.63	1.41
109	Between Dimlington High and Easington	23.0	1.50	1.52
110	North end of gas terminal site, Easington	18.3	1.67	Defended
111	Centre of gas terminal site, Easington	12.2	1.77	Defended
112	South end of gas terminal site, Easington	12.4	1.75	Defended

The average cliff recession rates between 1852 and 1989 showed a peak of 1.77 m/year at the centre of the Easington gas terminal site, but this section is now fronted by coastal defences so erosion has been halted. The average historical cliff erosion rate at the profile nearest the Humber landfall (109) is 1.50 m/year, while the more recent erosion rate from 1989-2021 is 1.52 m/year (ERYC, 2021b).

The nature of the cliff composition in this region of the coast means that cliff failure is episodic. Alternative wetting and drying of the clay leads to cracking, rotational slips and slides. Any dislodged material is quickly removed from the base of the cliff by wave action, subsequently steepening and destabilising the cliff face; as a result, the cliff recedes intermittently (Sutherland *et al*., 2002). There may be no erosion at a profile for a few years, followed by a cliff failure that can cause retreat of the cliff top by distances of up to, and sometimes more than, 10 m. This is reflected in the differences between the long-term average cliff recession rates (from 1852-1989) and the recent average cliff recession rates (from 1989-2021), the latter being lower for all profiles except 109 (ERYC, 2021a).

South of the Humber Pipeline landfall lies Spurn Head, a coastal spit that extends into the mouth of the Humber estuary (seen in Figure 2-21). This feature provides critical protection to the settlements and industrial developments within the Humber estuary, as well as the Humber Estuary SAC, SPA, Ramsar and SSSI.

Historically, it has been estimated that about 76,450,00 m^3 of material have been lost from the Holderness coast in the last 100 years (Valentin, 1954, cited in EUCC, 2007). However, only 3-6% of this material is deposited at Spurn Head. The remainder of eroded material is deposited in deeper water offshore or is carried across the mouth of the

Humber to be deposited within the estuary itself or on the North Lincolnshire coast (EUCC, 2007; Boyes, Barnard and Elliott, 2016).

2.3.8 Climate Change and Sea Level Rise

Models and observations show an increase in annual and winter mean significant wave heights in the Northeast Atlantic since the 1950s. With regards to the near future, natural variability will continue to dominate. As outlined in Section 2.3.2, extreme water levels can be induced by low-pressure weather systems, and such extreme events may happen more frequently owing to climate change. Furthermore, mean sea level is predicted to rise in the long-term due to the influence of climate change. The findings of IPCC are that at most locations around the world, mean sea-level change is the main factor influencing observed changes to sea-level extremes (Horsburgh, Rennie and Palmer, 2020). Predicting future changes to the strength, frequency and track of storms is difficult, and thus leads to a degree of uncertainty.

Tidal gauge data from 1920 to 2000 reported a recorded historic mean sea level rise of 1.8 mm/year in the Humber Estuary (Townend *et al.*, 2007, in Scarborough Borough Council, 2019). With respect to the Humber Pipeline, the depth of the existing shore platform off the Holderness coast will change in relation rising water levels. Section 2.3.9 describes the findings of the Resilient Coasts (2021) report, which outlined the predicted levels of change the shore platform in relation to predicted sea level rise. A general discussion of sea level rise and projections for the Humber region, based on models that were used to inform the IPCC Fifth Assessment Report (Palmer *et al.*, 2018), is available in ES Chapter 4 Section 4.7.1.

The Environment Agency generates sea level rise allowances for river basin districts across England. These allowances account for glacial isostatic adjustment and provide estimates of sea level rise over defined periods of time, which can be incorporated into a project engineering design basis; thereby ensuring the design has accounted for future change. Within the guidance, the higher central allowance is based on the 70^{th} percentile of sea level rise, and the upper end allowance is based on the 95^{th} percentile of sea level rise. An allowance based on the 70^{th} percentile is exceeded by 30% of the projections in the range. At the 95th percentile it is exceeded by 5% of the projections in the range. The upper end allowance (i.e. worst-case scenario with regards to sea level rise) in the Humber basin for the years 2000-2035 is 6.7 mm per year, and 235 mm over the whole time period. The allowance for 2036-2065 is 11 mm per year and 330 mm overall. The cumulative rise from 2000 to 2125 is 1.55 m (Environment Agency, 2021).

Overall, increases in future extreme sea levels and flooding will be driven by mean sea-level changes, rather than changes in storm surges. As a result of relative sea-level rise, in combination with human activities, the rate and extent of coastal erosion in the UK is expected to increase (Marine Climate Change Impacts Partnership (MCCIP), 2020). Rises in sea level increase the exposure of cliff bases to wave action. In addition, the potential for coastal erosion increases with wave height, as waves reaching the cliff base more frequently. Wave period is also important in driving erosion as steeper, wind-derived waves with short wave periods are more destructive than longer swell-derived waves with long wave periods. The North Sea is typically characterised by high storm surges and short wave periods so erosion along the Holderness coast is likely to be exacerbated by an increase in frequency and severity of storms (Boyes, Barnard and Elliott, 2016).

It has been predicted that the erosion of the Holderness coast will eventually come to a natural halt when the coastline reaches the ancient chalk coastline that currently forms the edge of the Yorkshire Wolds (currently approximately

30 km west of the coast). This is predicted to occur somewhere between 5,000 to 10,000 years from now (Boyes, Barnard and Elliott, 2016).

2.3.9 Coastline Projections

A supporting study has been undertaken to estimate projections of coastal erosion at the Easington landfall (Resilient Coasts, 2022). The study projected how the profile of the cliff and beach would change over time according to predicted rates of recession under present conditions, as well as predicting into the future under climate change sea level rise scenarios. The average erosion rate from 1989 to 2021 at a nearby transect is 1.77 m/year (EYRC, 2021), see Section 2.2.7. However, this study used an increased erosion rate of 3.05 m/year, based on calculating the average just the most recent decade of cliff surveys (2011 to 2021), as there has been an apparent recent acceleration in erosion. The cliff recession and clay bed projected lowering using an erosion rate of 3.05 m/year, but not accounting for climate change, are summarised below in Table 2-8, and the equivalent information is presented in Figure 2-30.

Table 2-8 - Clay bed lowering using cliff and slope erosion rates (Resilient Coasts, 2022)

Feature	Rate (m/year)	Total Recession (m)				Projected Height (mLAT)			
		25 y	30 y	40 y	50 y	25 y	30 y	40 y	50 y
Cliff	3.05	79.4	95	125	156	55.6	40.4	9.8	-20.7
Upper beach toe	0.21	5.6	6.7	8.8	11	-9.2	-10.3	-12.5	-14.6
Lower beach toe	0.13	3.3	4	5.3	6.5	-15.7	-16.4	-17.7	-19
Nearshore	0.04	1.2	1.4	1.8	2.3	-15.3	-15.5	-16	-16.4

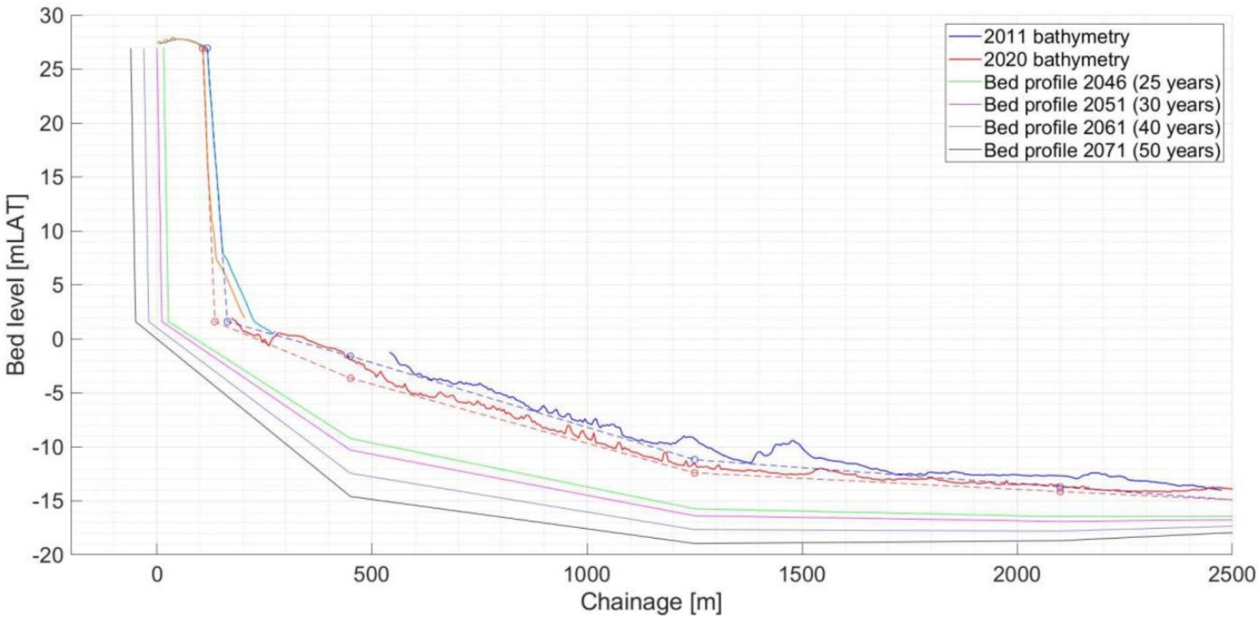


Figure 2-30 – Future projections of the representative clay bed profile lowering (Resilient Coasts, 2022)

The study also investigated the change in the shore platform over time, as the rate of erosion would be expected to increase with an increase in water levels due to climate change. The following future long-term estimates generated by the study are highly simplified and do not consider the role of climate change on the frequency or intensity of extreme events, increased temperatures, and flood or drought cycles, all of which will impact the cliff erosion processes. The estimates were also generated based on construction commencing in 2021.

After 25 years, the shore platform is predicted to lower 0.8 to 1.5 m.
After 30 years, the shore platform is predicted to lower 1.0 to 1.8 m.
After 40 years, the shore platform is predicted to lower 1.3 to 2.4 m.
After 50 years, the shore platform is predicted to lower 1.7 to 3.3 m (Resilient Coasts, 2021).
The impact assessment assumes that the pipeline will be buried to a suitable depth to protect is against any future shore platform lowering.

2.3.10 Humber Site Visit

bp conducted a site visit at the Humber Pipeline landfall location on 7th March 2022. Photographs (Figure 2-31) and notes were taken which are described herein (photo locations shown in Figure 2-29). The site visit was carried out on the days just after the lowest spring tide. The weather was initially overcast but fair and cleared over the course of the visit. The visit was planned to coincide with low tide at 14:25 on the day of the visit.

Sea defences are present along the cliff at the Easington Terminal frontage. To the north of the defences, the beach profile had a notably steeper gradient. To the south of the sea defences, the gradient became less prominent continuing along the coastline. Figure 2-31a was taken in parallel with Easington Beach Caravan Park, located to the south of the Easington Terminal, and approximately 2.2 km south of the Humber Pipeline landfall location. The relatively gentle beach gradient is visible in the photos. Comparatively, Figure 2-31b, shows the beach profile as steeper at the most northerly point reached on the site visit – where the Humber Pipeline landfall is located.

To the north of the sea defences, there was clear exposed bedrock in the intertidal area. Such exposures were not observed in the intertidal area along the front where the sea defences were located or further south. The exposed bedrock is visible in Figure 2-31b. Additionally, sediment composition was noticeably coarser north of the sea defences (e.g. higher gravel content) compared to sediments along the sea defences and further south. To the south, the sand was finer in composition.

With respect to the cliffs along the coast, they were higher in areas surveyed to the north of the sea defences along the Easington Terminal frontage. The difference in cliff height at the north and southern extents of the beach can be seen in Figure 2-31b and Figure 2-31a respectively. The shape of the cliffs also appears to be different between these two areas; to the north (Figure 2-31b) the cliffs are higher but have a more gentles slope gradient. By comparison, the cliffs in the south (Figure 2-31a) are much more severe and almost vertical. This is likely due to the difference in height as the cliffs change along the coast. Along the higher cliffs north of the sea defences no evidence of recent significant cliff erosion was observed (i.e. there was no apparent fresh debris). Instead, the cliffs at the northern end of the beach appear to be vegetated (Figure 2-31b and Figure 2-31c).

Over the course of the site visit, three cofferdams which have been left *in situ* were identified. One of the cofferdams, associated with the PL150 Rough gas export pipeline was particularly exposed (Figure 2-31d).

a) Looking south-southeast down the beach. Cliff to the right with clear definition between overlying sediment and dark clay base (point 44).

b) Looking south-southeast down the beach. Exposed bedrock visible in the intertidal area. Photograph taken at the point of proposed Humber Pipeline landfall (point 18).

c) Looking southwest at the cliffs. Vegetation has grown on old landslip debris (point 21).

d) Looking north-northwest up the beach. Cliff to the left and remnant cofferdam in the foreground (point 10).

Figure 2-31 - Humber site visit photos (point numbers are shown on Figure 2-29)

2.3.11 Sediment Transport Modelling

Sediment modelling was undertaken for the Humber Pipeline, to determine the impact of the cofferdam on sediment transport at downstream protected sites such as Spurn Head SPA/SAC. A six day mean wave and a two day storm wave event were modelled separately, each including and excluding the presence of the cofferdam, to assess its impact (see Appendix 1 for further detail). The mean sediment transport across each modelled simulation is shown in Figure 2-32, which demonstrates that the addition of the cofferdam does not influence sediment transport further south at Spurn Head. Figure 2-33 and Figure 2-34 then show sediment transport time series over the duration of each simulation, extracted at the Bull Sand Fort location. Comparison between the with and without cofferdam simulations shows that no impact is predicted at Spurn Head, under either average or storm wave conditions where sediment transport volumes are greatest.

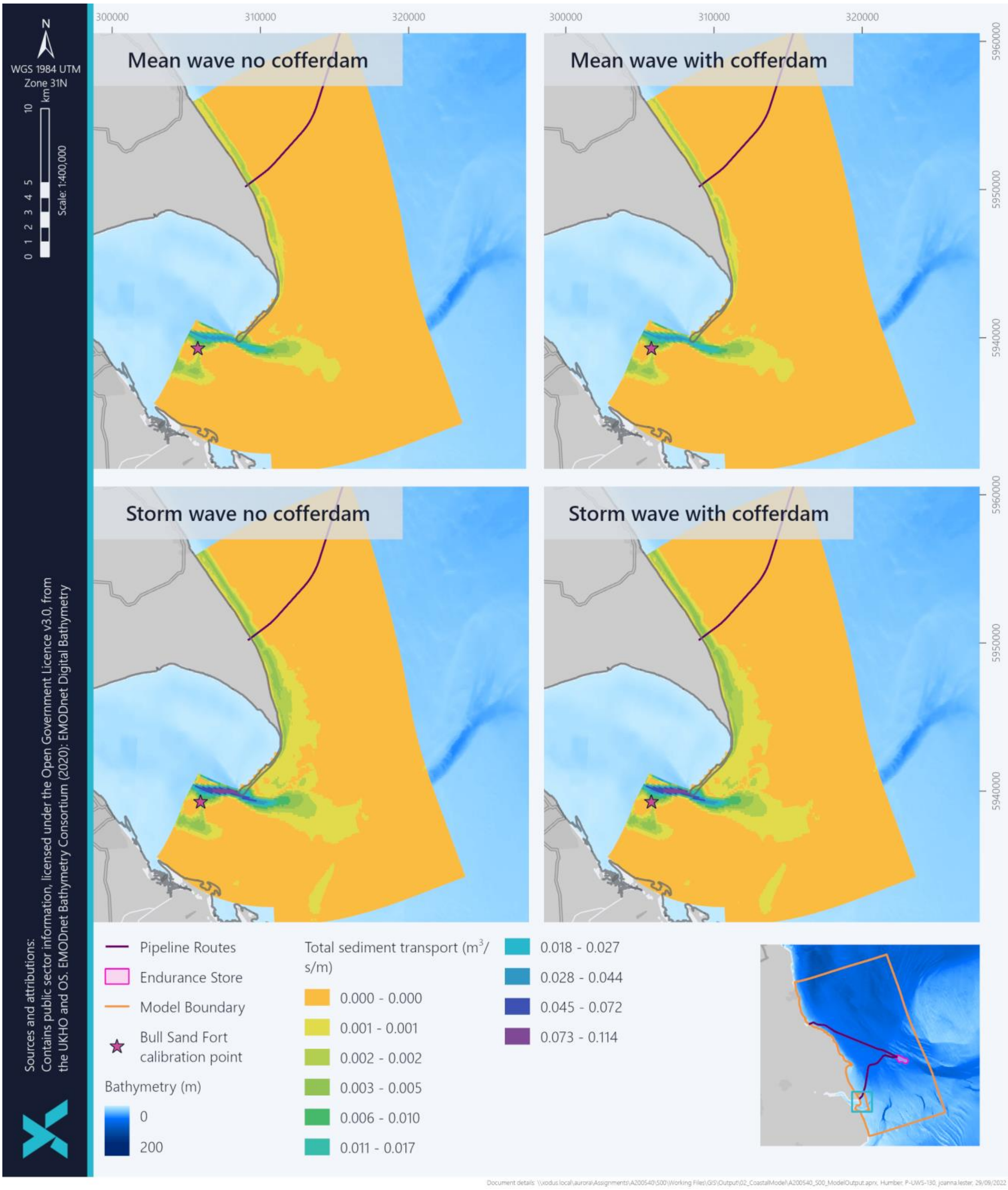


Figure 2-32 – Sediment modelling to understand impact of cofferdam

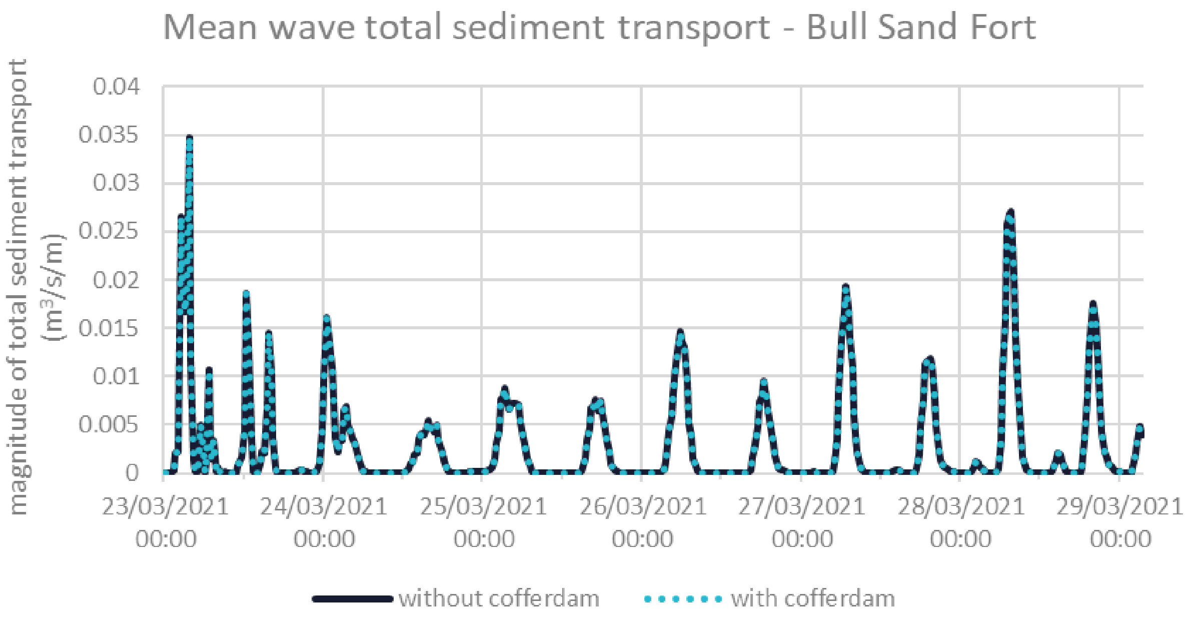


Figure 2-33 – Mean wave total sediment transport at Bull Sand Fort

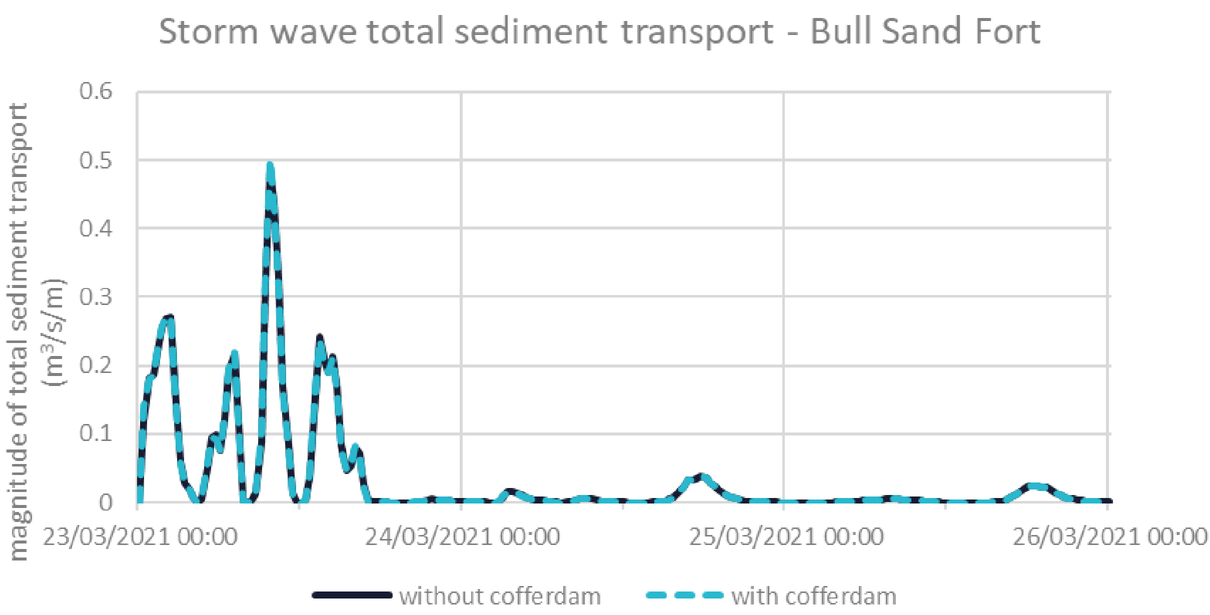


Figure 2-34 – Storm wave total sediment transport at Bull Sand Fort

3 IMPACT ASSESSMENT

The impact assessment is given in Chapter 6, Seabed Disturbance.

REFERENCES

Able UK Ltd (2011). Able Marine Energy Park Environmental Statement Chapter 8: Hydrodynamic and Sedimentary Regime (Doc no: TR030001-000312-08)

ABPmer (2017). Atlas of UK Marine Renewable Energy Resources. Available at: http://www.renewables-atlas.info/

AECOM (2021a). Net Zero Teesside Project Environmental Statement, 6.4 ES Vol III Appendix 14a: Benthic Ecology Survey Report.

AECOM (2021b). Net Zero Teesside Project Environmental Statement, 6.2.14 ES Vol I Chapter 14: Marine Ecology and Nature Conservation.

AECOM (2021c). Net Zero Teesside Project Environmental Statement, Vol III Appendix 9C, Water Framework Directive Assessment. Available online at: https://www.netzeroteesside.co.uk/wp-content/uploads/2021/10/NZT-DCO-6.4.11-ES-Vol-III-Appendix-9C-WFD-Assessment-1.pdf.

Bateman, M., McHale, K., Bayntun, H. and Williams, N. (2020). Understanding historical coastal spit evolution: A case study from Spurn, East Yorkshire, UK. Earth Surface Processes and Landforms, 45(14), pp.3670-3686.

Barne, J. H., C.F. Robson, S.S. Kaznowska, J.P. Doody and N.C. Davidson (1995). Coasts and Seas of the United Kingdom. Region 6 Eastern England: Flamborough Head to Great Yarmouth. Peterborough, Joint Nature Conservation Committee.

BGS (British Geological Survey) (2021). Coastal Vulnerability Data. Available online at: https://www.bgs.ac.uk/datasets/coastal-vulnerability/

Bibby HydroMap (2017). Teesside Windfarm Limited: Operations and Maintenance Geophysical Surveys, Volume 3 - Results Report. Report ref: REP-F-010-1.

Boyes, S.J., Barnard, S. & Elliott, M. (2016). The East Riding Coastline: Past, Present and Future. Prepared for East Riding of Yorkshire Council (ERYC) by the Institute of Estuarine and Coastal Studies (IECS), University of Hull. Funded through the Defra Coastal Change Pathfinder project and the East Riding Coastal Change Pathfinder (ERCCP). Institute of Estuarine and Coastal Studies, University of Hull, Hull, HU6 7RX, UK.

bp (2020). Net Zero Teesside MetOcean Criteria. Document number: UE-2020-0147. July 2020.

bp (2022). Northern Endurance Partnership. Metocean Basis of Design for Sub-Sea. Document number: IE-2022-0076. June 2022.

Channel Coastal Observatory (2021a). Seabed Mapping: HI1543 Sunderland to Redcar. Document ref: TR109.

Channel Coastal Observatory (2021b). Hornsea Directional Waverider Buoy Annual Wave Report. Available from https://www.coastalmonitoring.org/reports/#east_riding.

Department of Trade and Industry (DTI) (2001). Strategic Environmental Assessment of the Mature Areas of the Offshore North Sea. SEA 2 September 2001. Department of Trade and Industry.

Defra (2010). Charting Progress 2, the State of UK Seas. Available online at: http://chartingprogress.defra.gov.uk

Defra (Department for Environment, Food and Rural Affairs) (2016). Holderness Inshore Marine Conservation Zone. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492320/mcz-holderness-factsheet.pdf

EDF Energy (2004). Teesside Offshore Wind Farm Environmental Statement Chapter 12. Coastal Processes.

Environment Agency (2021). Flood risk assessments: climate change allowances. Sea level allowances. Available online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Environment Agency (2022a). Clearing the Waters for All. Available online at: https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters

Environment Agency (2022b). Tees Coastal Water Body, status report 2022. Available online at: https://environment.data.gov.uk/catchment-planning/WaterBody/GB650301500005

Environment Agency (2022c). Yorkshire South Water Body, status report 2022. Available online at: https://environment.data.gov.uk/catchment-planning/WaterBody/GB640402491000

ERYC (East Riding of Yorkshire Council) (2016). Development of the East Riding Coastline. Available from http://www.coastalexplorer.eastriding.gov.uk/pdf/1development.pdf

ERYC (2017). Coastal Processes. Available from: http://www.coastalexplorer.eastriding.gov.uk/pdf/2coastalprocesses.pdf

ERYC (2019). Easington Coastal Defences - Renewal of Existing Planning Permission: Coastal Processes Assessment. Prepared by Royal HaskoningDHV (August 2019).

ERYC (2020). Easington Coastal Defences Beach Management Plan 2020. PB8936-RHD-ZZ-XX-RP-Z-0003

ERYC (2021a). Coastal Explorer: Beach profiles.

ERYC (2021b). Coastal Explorer: Cliff erosion rates.

EUCC (Coastal & Marine Union) (2007). Eurosion Case Study: Holderness Coast (United Kingdom). Available from http://databases.eucc-d.de/plugins/projectsdb/index.php

Eyles, M., A. M. McCabe and D. Q. Bowen (1994). The stratigraphic and sedimentological significance of Late Devensian ice sheet surging in Holderness, Yorkshire. Quaternary Science Reviews 13, 727-759.

Gardline (2022a). NEP Integrated Site Survey – 2021 Environmental Baseline Report.

Gardline (2022b). NEP Integrated Site Survey – 2021 Environmental Survey Habitat Assessment.

Horsburgh, K., Rennie, A. and Palmer, M. (2020). Impacts of climate change on sea-level rise relevant to the coastal and marine environment around the UK. MCCIP Science Review 2020, 116–131. Available online at: https://www.mccip.org.uk/sites/default/files/2021-08/06_sea_level_rise_2020.pdf

HR Wallingford, Cefas/UEA, Posford Haskoning and Dr. Brian D'Olier (2002). Southern North Sea Sediment Transport Study, Phase 2 Sediment Transport Report (Report produced for Great Yarmouth Borough Council).

Humber Estuary Coastal Authorities Group (2010). Flamborough Head to Gibraltar Point Shoreline Management Plan. Appendix C – Assessment of Coastal Behaviour and Baseline Scenarios. Prepared by Scott Wilson, December 2010.

JNCC (2008a). Information Sheet on Ramsar Wetlands. Humber Estuary. Available online at: https://jncc.gov.uk/jncc-assets/RIS/UK11031.pdf [Accessed on 30/08/2021]

JNCC (2008b). Information Sheet on Ramsar Wetlands. Teesmouth and Cleveland Coast. Available online at: https://jncc.gov.uk/jncc-assets/RIS/UK11068.pdf [Accessed on 16/08/2021]

JNCC (2020a). Greater Wash SPA. Available online at: https://jncc.gov.uk/our-work/greater-wash-spa/

JNCC (2020b). Holderness Offshore MPA. Available online at: https://jncc.gov.uk/our-work/holderness-offshore-mpa

JNCC (2022). Humber Estuary SAC. Available online at: https://sac.jncc.gov.uk/site/UK0030170

MCCIP (Marine Climate Change Impacts Partnership) (2020). Marine Climate Change Impacts: Report Card 2020. Available online at: https://www.mccip.org.uk/sites/default/files/2021-08/mccip-report-card-2020_webversion.pdf

Motyka, J. M. and Brampton, A. (1993). Coastal management: Mapping of littoral cells. Technical Report. HR Wallingford.

Natural England (2018). Teesmouth and Cleveland Coast SSSI Citation. Available online at: https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/2000856.pdf [Accessed 09/08/2021]

Natural England (2019). Conservation Advice for Marine Protected Areas: Humber Estuary SPA. Available online at: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9006111&SiteName=humber%20estuary&SiteNameDisplay=Humber%20Estuary%20SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=15&HasCA=1#SiteInfo

Natural England (2020). Natural England Conservation Advice for Marine Protected Areas: Teesmouth and Cleveland Coast SPA. Available online at: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9006061&SiteName=teesmouth&SiteNameDisplay=Teesmouth%20and%20Cleveland%20Coast%20SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=7&HasCA=1

Natural England (2021). Natural England Conservation Advice for Marine Protected Areas: Runswick Bay MCZ. Available online at: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0039&SiteName=runswick&SiteNameDisplay=Runswick%20Bay%20MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=&HasCA=1

Natural England (2022a). Dimlington Cliff SSSI. Available online at: https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S1003488&SiteName=dimlington&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

Natural England (2022b). The Lagoons SSSI. Available online at: https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S1003124&SiteName=lagoons&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

Natural England (2022c). Humber Estuary SSSI. Available online at: https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S2000480&SiteName=humber%20estuary&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

North East Coastal Authorities Group (2007). Shoreline Management Plan 2: River Tyne to Flamborough Head. Produced by Royal Haskoning for North East Coastal Authorities Group (Reference: 9P0184/R/nl/Pbor, February 2007).

PD Teesport (2019). Tees Maintenance Dredging Annual Review 2019. Doc ref: PC1115-RHD-ZZ-XX-RP-Z-001.

Resilient Coasts (2022). Humberside landfall investigation for the Northern Endurance Partnership: Coastal Erosion Study. Document ref: 021_105_STO_NEP.

Scarborough Borough Council (2013). Cell 1 Sediment Transport Study, Phase 1: Scoping Report. Produced by Royal HaskoningDHV for Scarborough Borough Council (Reference: PB1217/R01/303294/Newc, December 2013).

Scarborough Borough Council (2014). Cell 1 Sediment Transport Study, Phase 2: Main Report. Produced by Royal HaskoningDHV for Scarborough Borough Council (Reference: PB1217/R02/303294/Newc, July 2014).

Scarborough Borough Council (2018). Cell 1 Regional Coastal Monitoring Programme Aerial Photography and LiDAR Surveys 2017. Produced by Royal HaskoningDHV for Scarborough Borough Council (February 2018).

Scarborough Borough Council (2020). Cell 1 Regional Coastal Monitoring Programme Walkover Inspection Surveys 2020. Produced by Royal HaskoningDHV for Scarborough Borough Council (October 2020).

Scarborough Borough Council (2021a). Cell 1 Regional Coastal Monitoring Programme Wave & Tide Data Analysis Report 9: 2020-2021. Produced by Royal HaskoningDHV for Scarborough Borough Council (June 2021). Available from:
http://northeastcoastalobservatory.org.uk/data/reports/20_cell_1_monitoring_reports/26_wave_&_tide_reports/

Scarborough Borough Council (2021b). Northeast Coastal Monitoring Programme Seabed Mapping: Sunderland to Redcar (TR109). Produced by Channel Coastal Observatory for Scarborough Borough Council (January 2021).

Scarborough Borough Council (2021c). Cell 1 Regional Coastal Monitoring Programme Analytical Report 13: 'Full Measures' Survey 2020. Produced by Royal HaskoningDHV for Scarborough Borough Council (February 2021).

Sutherland, J., Brew, D.S., Williams, A., HR Wallingford, Posford Haskoning (2002). Southern North Sea Sediment Transport Study, Phase 2 Sediment Transport Report: Appendix 11 - Report on Southern North Sea longshore sediment transport.

Tappin, D R, Pearce, B, Fitch, S, Dove, D, Gearey, B, Hill, J M, Chambers, C, Bates, R, Pinnion, J, Diaz Doce, D, Green, M, Gallyot, J, Georgiou, L, Brutto, D, Marzialetti, S, Hopla, E, Ramsay, E, and Fielding, H. (2011). The Humber Regional Environmental Characterisation. British Geological Survey Open Report OR/10/54. 357pp.

TCE and BMAPA (2015). Aggregate dredging and the Humber coastline. Available online at: http://www.marineaggregates.info/images/publications/BMAPA_Humber_all_low_020715.pdf#:~:text=Off%20the%20coastline%20of%20the%20Humber%20region%20%28Holderness,2.19%20million%20tonnes%20of%20marine%20sand%20and%20gravel.

UKHO (2022). UKHO ADMIRALTY TotalTide.

Waterman Infrastructure & Environment (2021). Humberside Landfall (Easington): Pre-FEED Feasibility Report. March 2022. Document ref: WIE12731-130-R-1-3-3.

APPENDIX 1 COASTAL MODELLING REPORT

BP Exploration Operating Company Ltd

Offshore Environmental Statement for the Northern Endurance Partnership

Coastal Modelling Calibration and Validation Report

ASSIGNMENT A200540-S00
DOCUMENT A-200540-S00-REPT-014

XODUS

Edinburgh

The Auction House
63A George St . Edinburgh
EH2 2JG . UK

T +44 (0)131 510 1010

www.xodusgroup.com

REVISIONS & APPROVALS

This report has been prepared by Xodus Group exclusively for the benefit and use of BP Exploration Operating Company Ltd. Xodus Group expressly disclaims any and all liability to third parties (parties or persons other than BP Exploration Operating Company Ltd) which may be based on this report.

The information contained in this report is strictly confidential and intended only for the use of BP Exploration Operating Company Ltd. This report shall not be reproduced, distributed, quoted or made available – in whole or in part – to any third party other than for the purpose for which it was originally produced without the prior written consent of Xodus Group.

The authenticity, completeness and accuracy of any information provided to Xodus Group in relation to this report has not been independently verified. No representation or warranty express or implied, is or will be made in relation to, and no responsibility or liability will be accepted by Xodus Group as to or in relation to, the accuracy or completeness of this report. Xodus Group expressly disclaims any and all liability which may be based on such information, errors therein or omissions therefrom.

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A01	04/07/2023	Issued for Use	JL	MD	MD	
R01	30/09/2022	Issued for Review	JL	AC	MD	

CONTENTS

EXECUTIVE SUMMARY 82

1 INTRODUCTION 83
1.1 Overview 83
1.2 Objectives 83
1.3 Metocean Context 83

2 MODEL BUILD 85
2.1 Software 85
2.2 Boundaries 85
2.3 Model Gridding 86
2.4 Roughness Map 89
2.5 Datums and Bathymetric Data 90
2.6 Wave Model 90
2.7 Sediment Model 91

3 CALIBRATION / VALIDATION 92
3.1 Overview 92
3.2 Calibration – Water Levels 95
3.2.1 Introduction 95
3.2.2 Bull Sand Fort 95
3.2.3 River Tees 96
3.2.4 Seaham 96
3.2.5 T016A 97
3.2.6 T017C 97
3.2.7 T019D 98
3.2.8 T019E 98
3.2.9 Summary Statistics 99
3.3 Validation - Current Flows 100
3.3.1 Overview 100
3.3.2 SN017AA 100
3.3.3 SN017AB 101
3.3.4 SN017AD 102
3.3.5 SN017P 103
3.3.6 SN017R 104
3.3.7 SN018C 105
3.3.8 SN018D 106
3.3.9 SN019C 107
3.3.10 Summary Statistics 108

4 MODEL OUTPUTS 109

5 CONCLUSIONS 112

REFERENCES 113

PAGE LEFT INTENTIONALLY BLANK

EXECUTIVE SUMMARY

The Northern Endurance Partnership (NEP) Development ('the Development'), is one component of the proposed East Coast Cluster strategic initiative that aims to deliver the UK's first zero carbon industrial cluster. The infrastructure required as part of the Development is entirely subsea in nature and will include two CO_2 pipelines, one each running from Humber and Teesside compression/pumping systems to a common subsea manifold and well injection site at the Endurance Store.

During the construction of the Development there will be a physical disturbance of the seabed associated with installation of the pipelines, in particular activities occurring at the coast in relation to pipeline landfall.

The modelling study's objectives were to:

- Build a calibrated/validated hydrodynamic model for an area covering the Development with particular emphasis on the landfall and nearshore areas at Teesside and Humber. Details of the model development, calibration and validation are presented in this report.
- Use the calibrated/validated model to identify the potential impact on hydrodynamic and sediment process associated with the installation of the Development, in particular activities occurring at the coast in relation to pipeline landfalls.

1 INTRODUCTION

1.1 Overview

The Northern Endurance Partnership (NEP) Development ('the Development'), is one component of the proposed East Coast Cluster strategic initiative that aims to deliver the UK's first zero carbon industrial cluster (for further details see Offshore Environmental Statement for the Northern Endurance Partnership). The infrastructure required as part of the Development is entirely subsea in nature and will include two CO_2 pipelines, one each running from Humber and Teesside compression/pumping systems to a common subsea manifold and well injection site at the Endurance Store (as shown in Figure 0-1). These pipelines are henceforth referred to as the Teesside Pipeline and the Humber Pipeline. CO_2 from both pipelines will be combined and distributed for injection into the Store via well injection facilities on the seabed. The Humber Pipeline landfall is in the Easington area, north of the Perenco Dimlington terminal and the Teesside Pipeline landfall is at Coatham Sands, to the southeast of the mouth of the River Tees.

During the construction of the Development there will be a physical disturbance of the seabed associated with installation of the pipelines, in particular activities occurring at the coast in relation to pipeline landfall.

1.2 Objectives

The modelling study's objectives were to:

- Build a calibrated/validated hydrodynamic model for an area covering the Development landfalls at Teesside and Humber. Details of the model development, calibration and validation are presented in this report.
- Use the calibrated/validated model to identify the potential impact on hydrodynamic and sediment process associated with the installation of the Development, in particular activities occurring at the coast in relation to pipeline landfalls. Outputs from this study will then be included in the Development Environmental Statement.

1.3 Metocean Context

For a full description of the regional metocean context, see Coastal Processes Baseline Study, Section 2. Further details are provided in the Development metocean reports (bp, 2020 and bp, 2022).

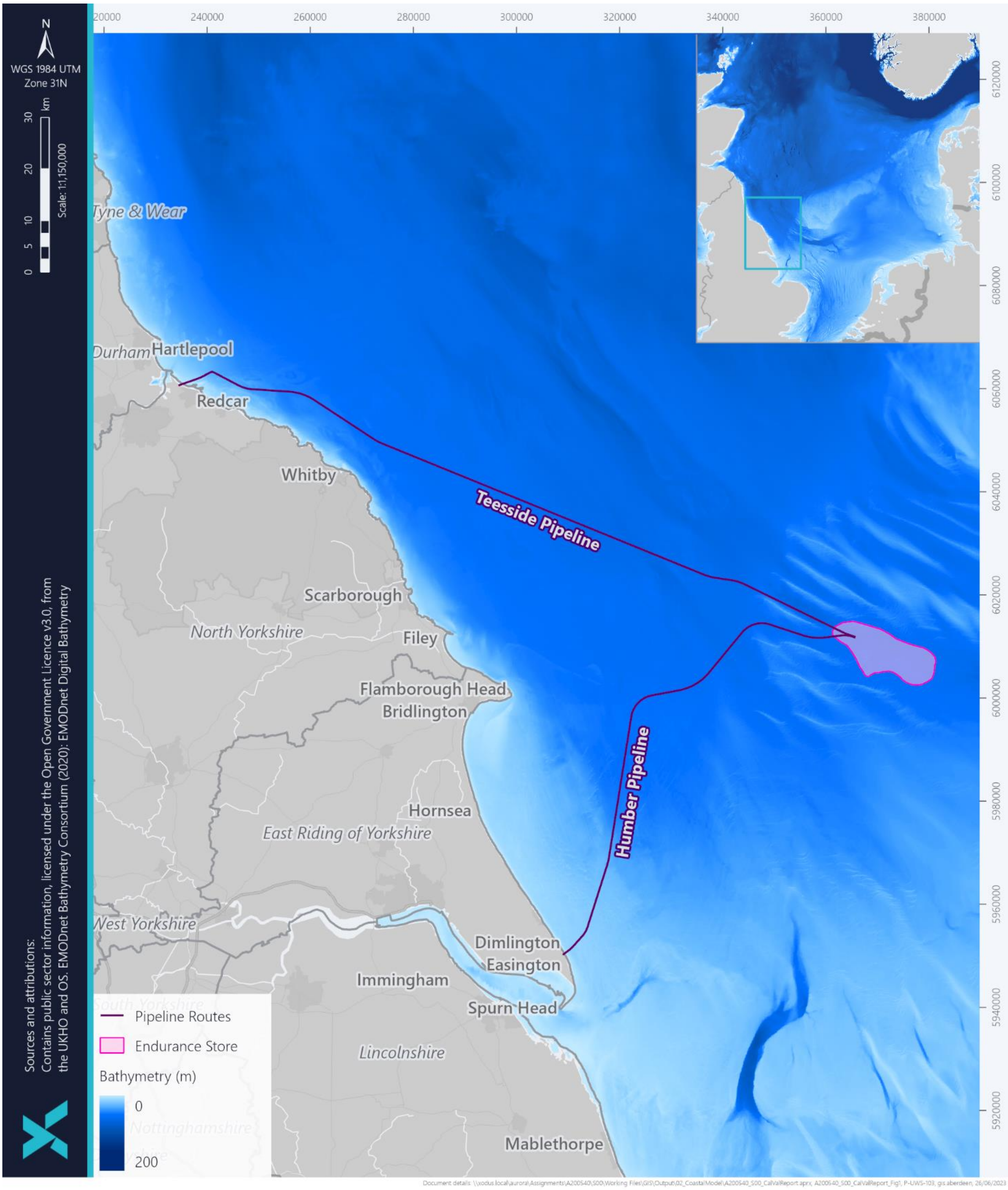


Figure 0-1 – Project overview

2 MODEL BUILD

2.1 Software

The model was developed using Deltares's Delft3D-4 (henceforth referred to as Delft3D) software suite. Delft3D includes a range of hydrodynamic (2D and 3D), wave, sediment transport and water quality modelling tools. For this study the FLOW module was used, along with the wave SWAN model, and the sediment (SED) model. More information can be found at https://www.deltares.nl/en/software/delft3d-4-suite/.

Delf Dashboard was used to create the grid, open boundaries and bathymetry.

2.2 Boundaries

The model boundaries are shown in Figure 0-2. An additional open boundary in the Humber estuary was added to aid the model.

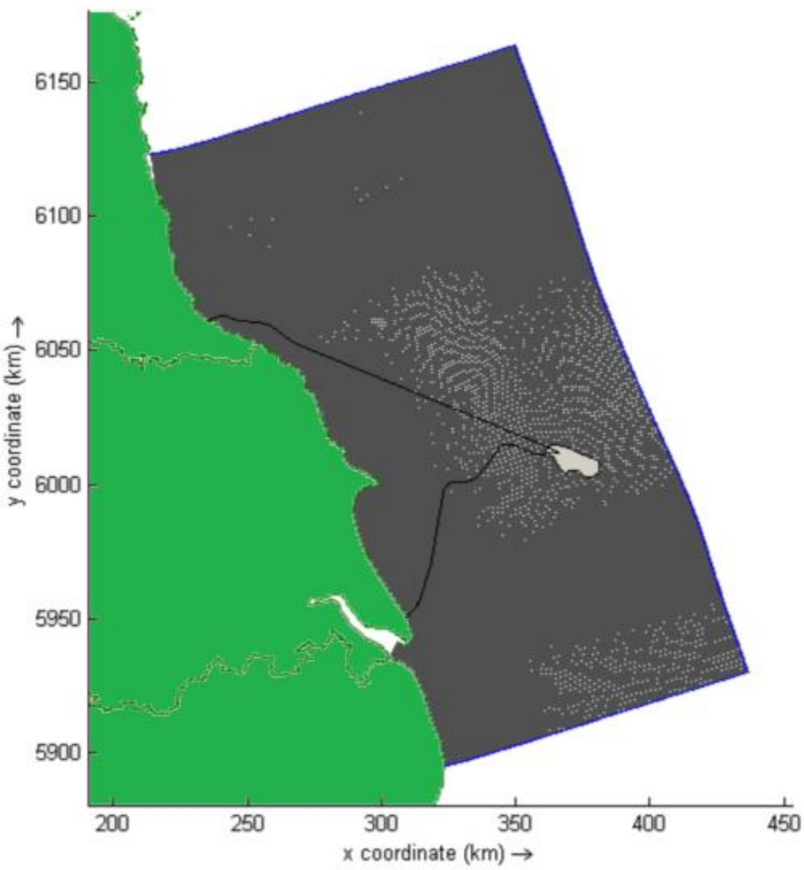


Figure 0-2 - Open sea boundaries in the Humber and Teesside hydrodynamic model

The model is driven by tidal harmonics at the North, South and East offshore boundaries and by a time series of water levels at the inshore Humber boundary. The harmonic constituents for the offshore boundaries were extracted from the TPXO 8.0 Global Inverse Tide Model (Egbert, Bennett and Foreman, 1994 and Egbert and Erofeeva, 2002) using the Delft Dashboard boundary extraction tool. The water levels applied at the inshore boundary were extracted from the Admiralty TotalTide package at Bull Sand Fort.

Test runs using an alternate set of harmonic constituents from the Danish Technical University's Global Ocean Tide Model (DTU10, Cheng and Andersen, 2010), were also undertaken at the same locations but did not provide an improvement in the agreement between modelled flows and flows extracted from the Admiralty's Total Tide package.

2.3 Model Gridding

Gridding is the process of dividing the model area into a large number of computational elements, or "cells". Correct gridding is important, since:

- It determines the resolution of the model, and hence (through controlling the fidelity of the representation of bed topography, and the scale of the hydrodynamic phenomena described by the model) the model accuracy on a local scale.
- It drives the maintenance of computational efficiency.

The grid was constructed using Delf Dashboard with a maximum resolution of approximately 50 m within the areas of interest at the coast and Humber estuary, with a reduction of resolution down to a minimum of approximately 600 m at the open sea boundaries. This was achieved by using a nested grid.

The extent of the adopted model grid is shown in Figure 0-3 with the finer nested grid detail around the sites of interest shown in Figure 0-4. The nested grid increases the cells by three at the boundary.

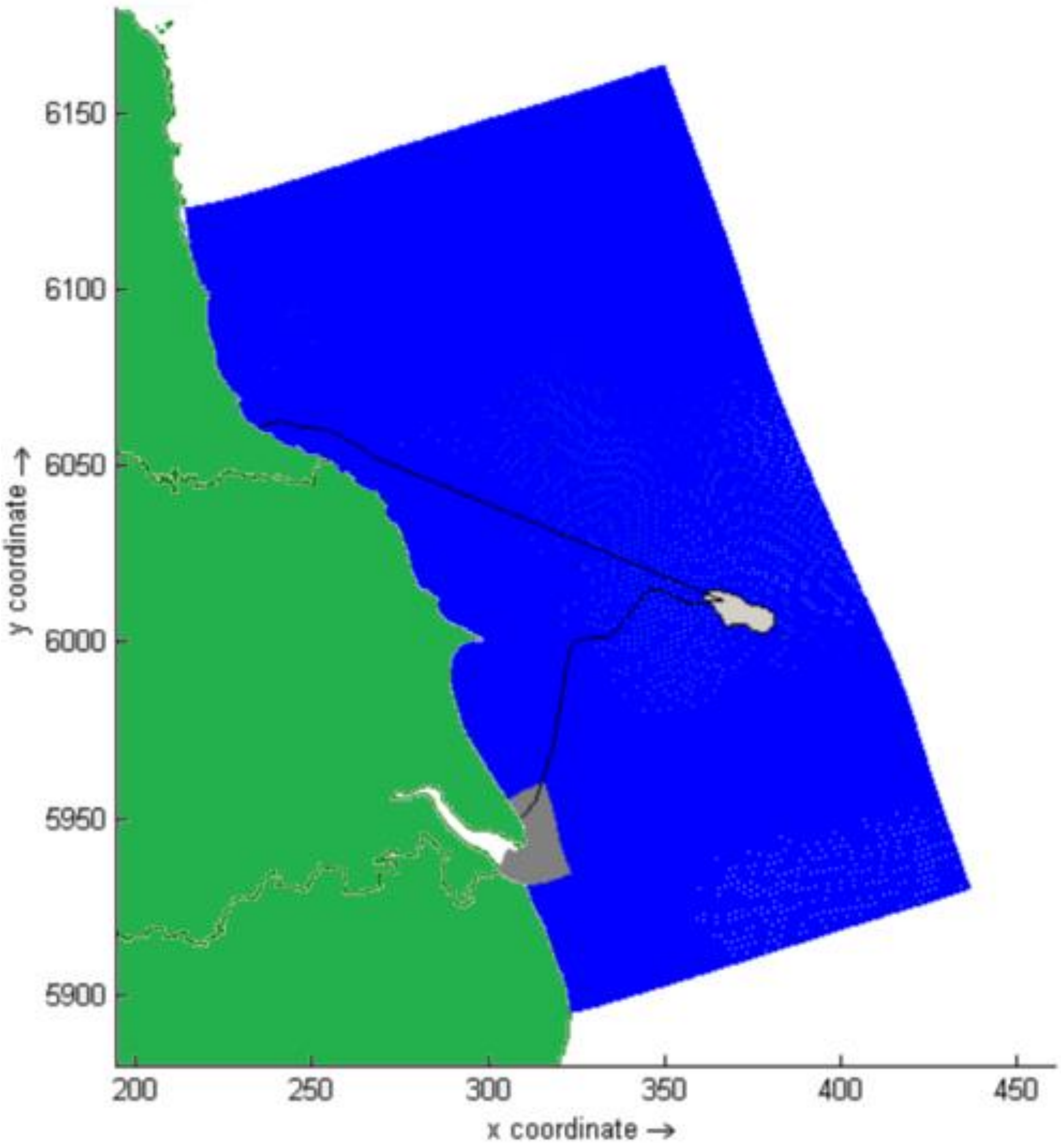


Figure 0-3 – Model grid

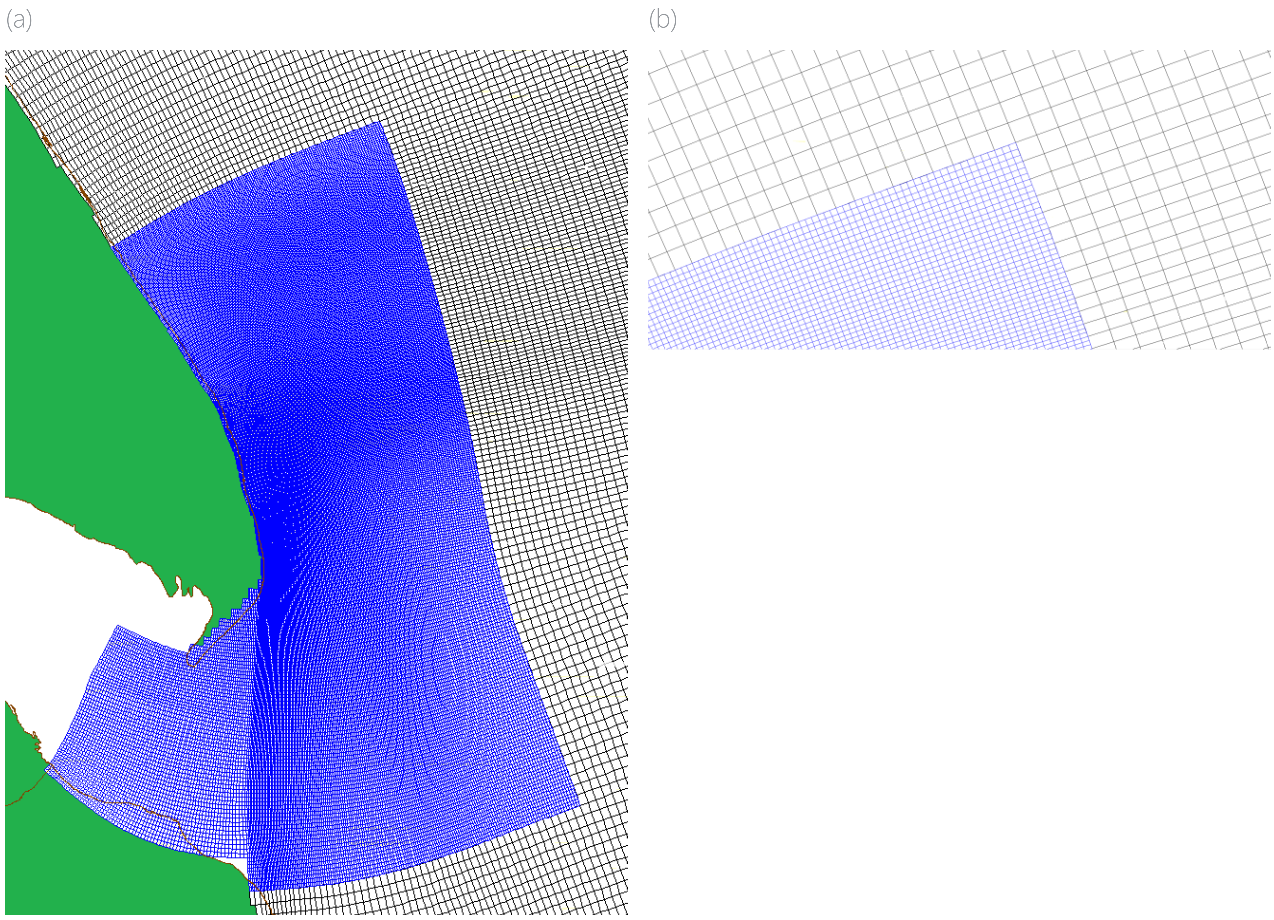


Figure 0-4 – Nested grid (a) detail at Humber, and (b) 1:3 ratio of grid cell size at nested grid boundary

2.4 Roughness Map

A roughness map was chosen which was coarser towards the southern and south eastern boundaries and less coarse to the north, to aid calibration of varying areas of flow, as shown in Figure 0-5. The Manning roughness formula was selected from the model setup options.

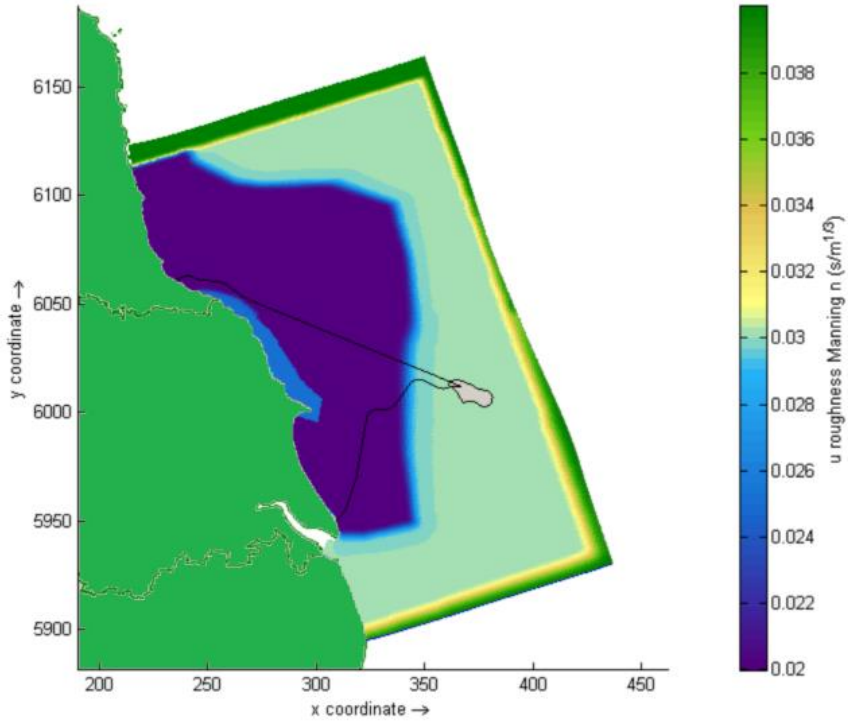


Figure 0-5 – Model roughness grid using the Manning roughness formula

2.5 Datums and Bathymetric Data

The vertical datum in the model is Mean Sea Level and the horizontal datum is the Cartesian UTM 31N grid.

The bathymetric data used within the model was interpolated from the General Bathymetric Chart of the Oceans (GEBCO19). This dataset is a global terrain model for ocean and land, providing elevation data, in meters, on a 15 arc-second interval grid.

The GEBCO bathymetry was interpolated onto the model grid/mesh. This was conducted using a combination of grid-cell averaging and triangular interpolation techniques as appropriate according to data density. The interpolated bathymetry is shown in Figure 0-6.

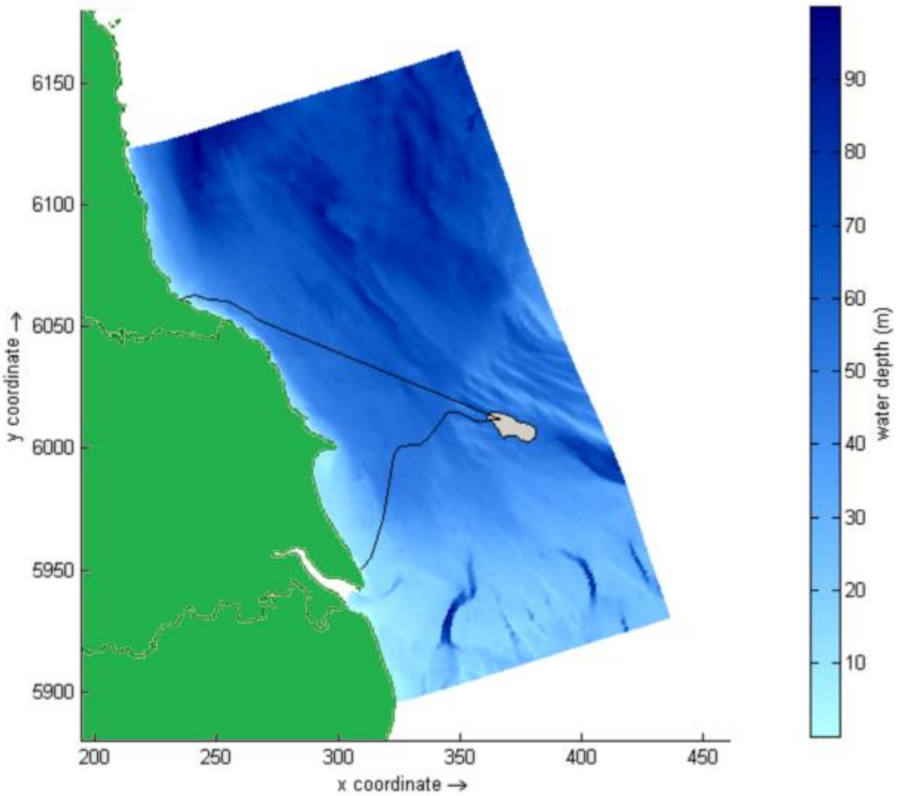


Figure 0-6 – Model bathymetry

2.6 Wave Model

The wave model (SWAN) was based on an extended version of the hydrodynamic model domain. The model was driven by significant wave height, period and directional data applied at all model boundaries (with the exception of the one located at within the Humber), which was derived from data provided from the following sources:

- Hornsea wave buoy (Channel Coastal Observatory, 2021), indicative of normal everyday wave conditions,
- Metocean report which extrapolated extreme waves (bp, 2020), indicative of storm conditions.

The wave conditions were applied uniformly along the boundaries, with a maintenance north-easterly wind of 19 m/s used to propagate waves across the model domain. The wave model was not applied in timeseries mode and instead was propagated from a single condition applied at the wave boundaries. A sense check was undertaken on the wave heights as they propagated through the model domain.

2.7 Sediment Model

The sediment model (SED) used the following parameters: parameters used in the model were D_{50} of 729 µm, specific density of 1,922 kg/m^3 and dry bed density 1,600 kg/m^3.

For the final sediment transport runs, the developed wave model was coupled with the flow model to account for water level variability at the coast, associated with the tidal cycle, and to transport sediments appropriately when in suspension. Modelled wave conditions are outlined in Table 0-1 below. The average wave simulations were conducted for an 8 day period leading up to a mean spring tide. The storm or extreme wave simulations were conducted for a 36 hour time period over the peak Spring tide.

Table 0-1 Modelled wave conditions used to drive sediments

CONDITION	SIGNIFICANT WAVE HEIGHT (M)	PEAK PERIOD (s)	DIRECTION (°)	Data Source
Average	1.5	8	30	Hornsea wave buoy (Channel Coastal Observatory, 2021)
Storm	5.8	11.2	30	Table 4, bp (2020)

3 CALIBRATION / VALIDATION

3.1 Overview

The NEP model has been calibrated and validated against the following datasets taken from ADMIRALTY TotalTide (2022), summarised below in Table 0-2 and shown in Figure 0-7:

- UKHO water level predictions for a selection of standard and secondary ports within the model domain.
- UKHO water level predictions for a selection of offshore water level "T"-sites within the model domain.
- UKHO current velocity predictions from a selection of tidal diamonds within the model domain.

Table 0-2 Summary of calibration validation locations (coordinates given in WGS 84 UTM Zone 31N)

ID	Site	Type	Easting	Northing
1	Bull Sand Fort	Water Levels	305,780	5,939,300
2	River Tees	Water Levels	232,193	6,061,905
3	Seaham	Water Levels	222,814	6,084,788
4	T016A	Water Levels	340,714	5,926,930
5	T017C	Water Levels	375,798	5,953,620
6	T019D	Water Levels	338,773	6,060,570
7	T019E	Water Levels	272,810	6,076,408
8	SN017AA	Current Flow	345,304	5,940,188
9	SN017AB	Current Flow	331,570	5,968,038
10	SN017AD	Current Flow	313,268	5,954,056
11	SN017P	Current Flow	316,235	5,976,054
12	SN017R	Current Flow	355,131	5,967,254
13	SN018C	Current Flow	298,847	6,038,055
14	SN018D	Current Flow	343,426	6,011,237
15	SN019C	Current Flow	337,995	6,042,053

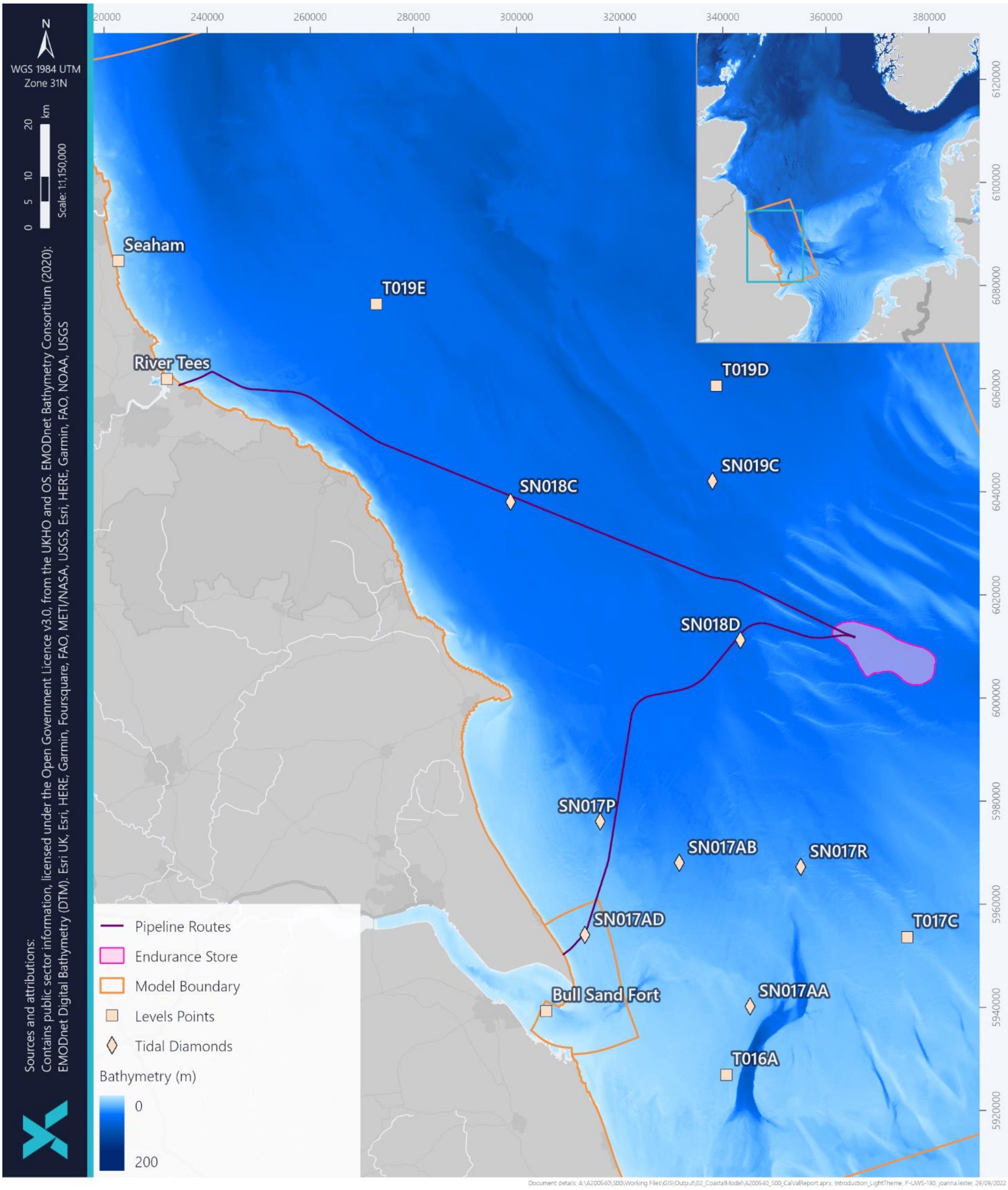


Figure 0-7 – Location of the calibration/validation points across the NEP model domain

For the hydrodynamic calibration process, time series of the model performance was assessed visually against the water level data and tidal diamond velocity data. Once the boundary data conditions had been determined through assessment of water level correlation, changes were made to bed roughness and until the most satisfactory combination of model parameters was arrived at.

On completion of the calibration, model performance statistics were calculated based on the Foundation for Water Research (FWR) guidelines for water levels, current speed and current direction (FRW, 1993). These guidelines are widely used in the water industry to provide an indication of model performance, and for the present site are:

- For water levels, an absolute tolerance of ±0.1 m or a relative tolerance of ±10% of the measured spring tidal ranges or 15% of neap tidal ranges;
- For current speed, an absolute tolerance of ±0.1 m/s or a relative tolerance of ±20% of the peak measured current speed;
- For current direction, a tolerance of ±10°; and
- For phasing, a tolerance of ±15 minutes.

Under certain conditions, models can meet the statistical calibration standards but appear to perform poorly; conversely, seemingly accurate models can fall short of the guidelines. In such cases the guidelines alone cannot be used when assessing the performance of the model, and it is necessary for experienced modellers and oceanographers to offer a critical assessment of model performance, based on the overall weight of evidence and taking all the information into account.

As is typical, the model has been calibrated against water levels, and validated against current flows.

3.2 Calibration – Water Levels

3.2.1 Introduction

Water level calibration plots for the selection of port and levels sites (T-sites) are presented in Figure 0-8 to Figure 0-14 below. These indicate that both overall and for the spring and neap tide in detail, that a very good calibration has been achieved, with the tidal range, phasing and general shape of the curve being correctly reproduced by the model.

3.2.2 Bull Sand Fort

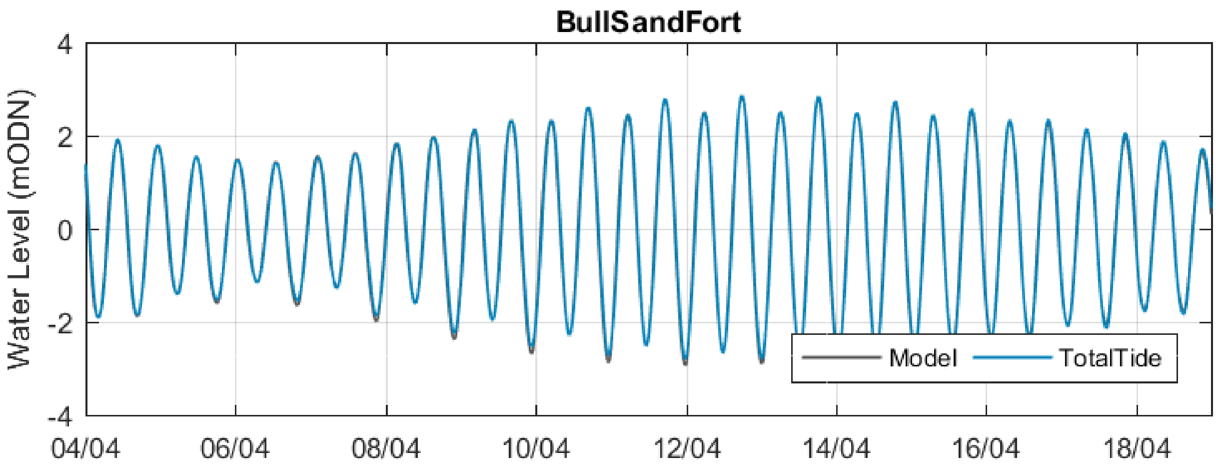


Figure 0-8 Water levels at Bull Sand Fort

3.2.3 River Tees

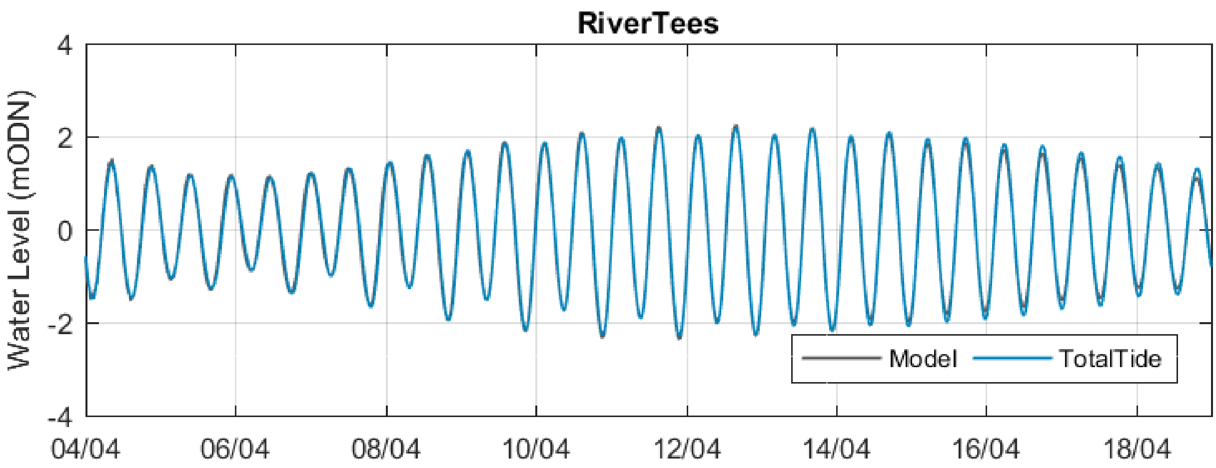


Figure 0-9 Water levels at River Tees

3.2.4 Seaham

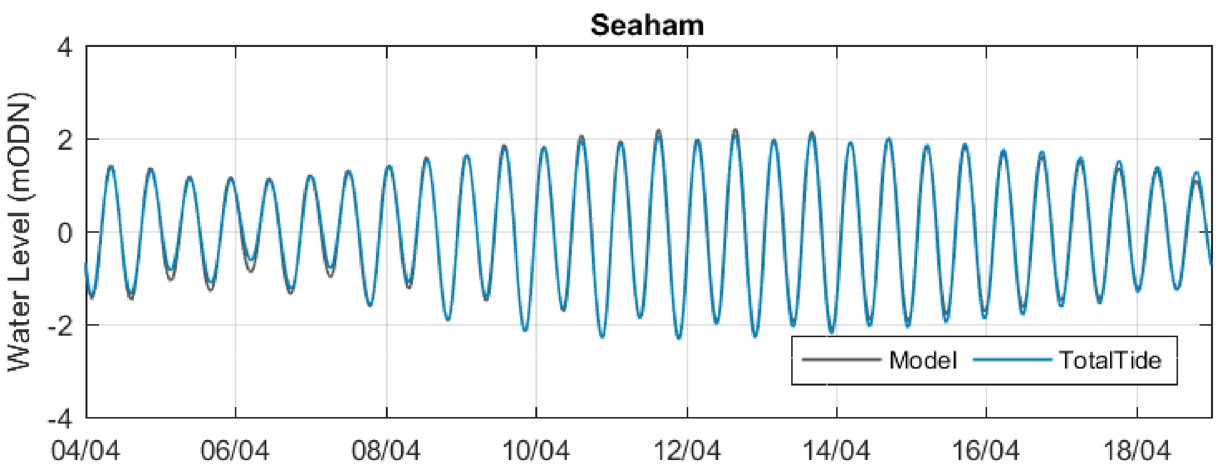


Figure 0-10 Water levels at Seaham

3.2.5 T016A

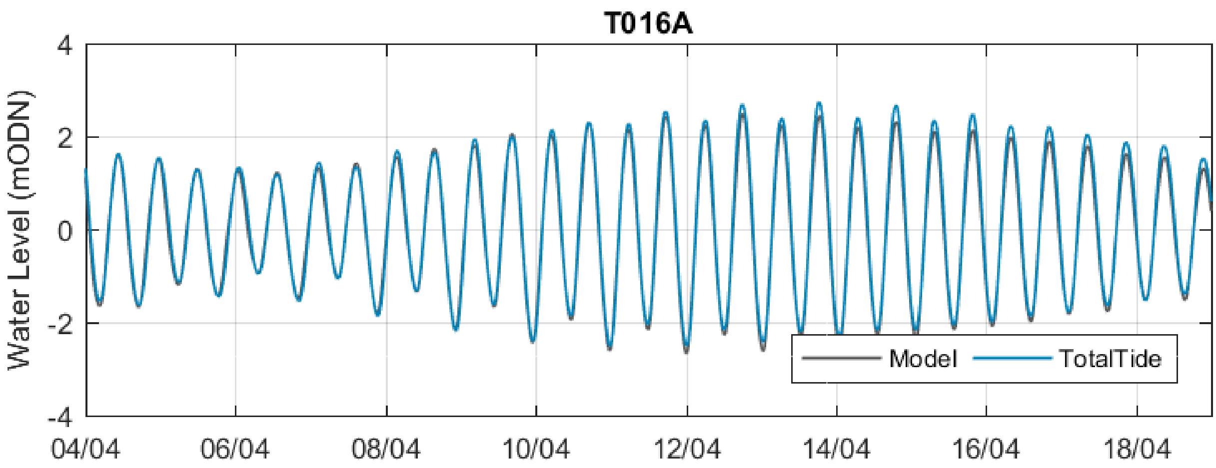


Figure 0-11 Water levels at T016A

3.2.6 T017C

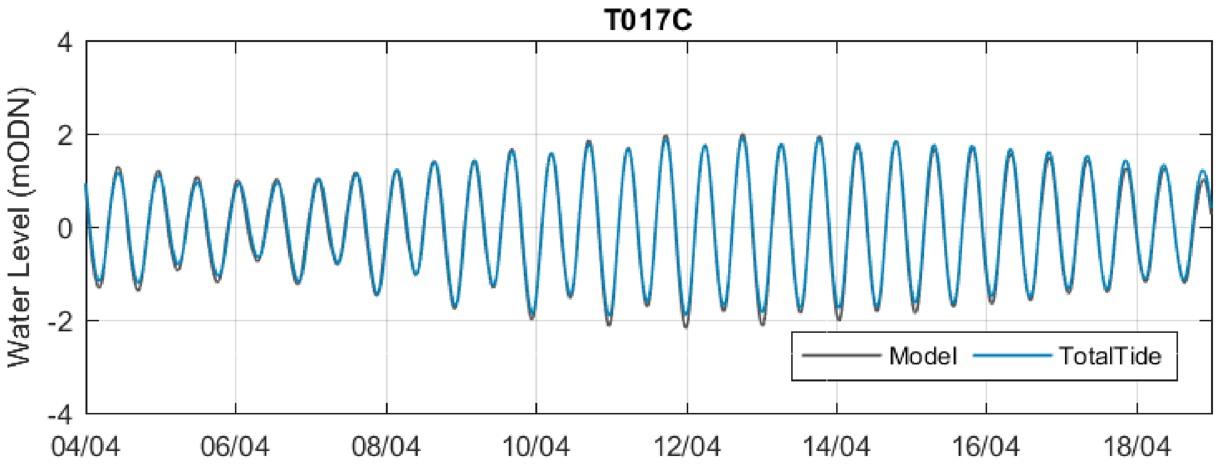


Figure 0-12 Water levels T017A

3.2.7 T019D

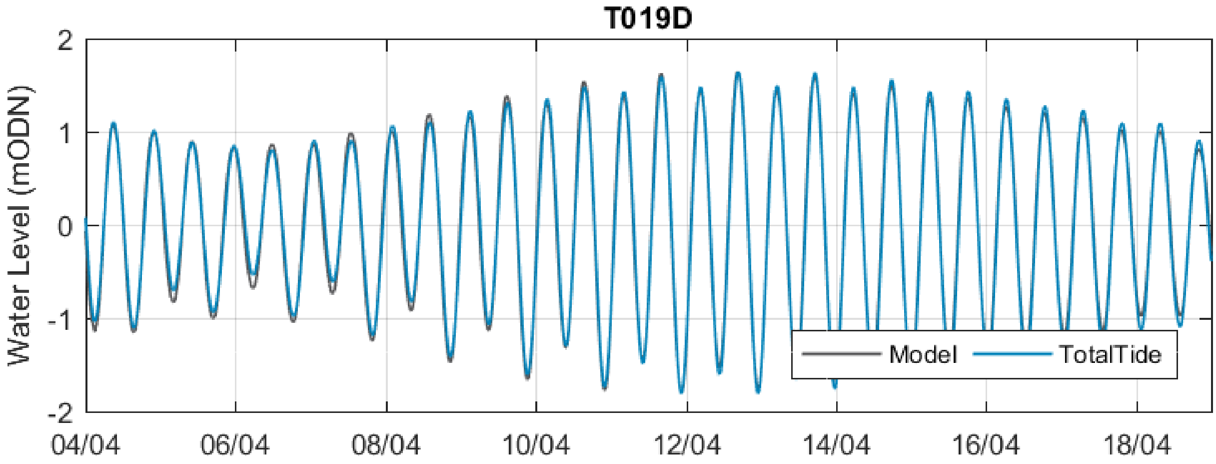


Figure 0-13 Water levels at T019D

3.2.8 T019E

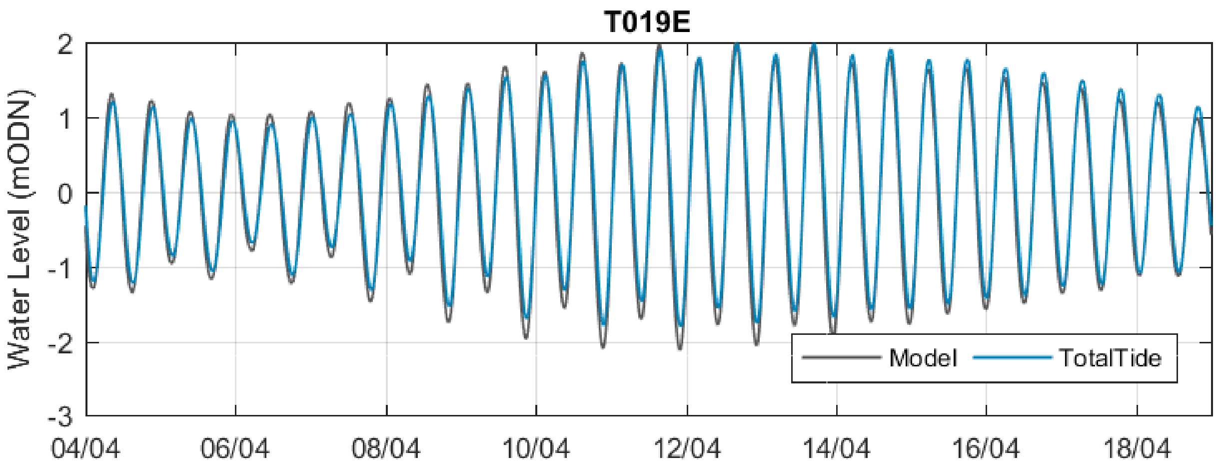


Figure 0-14 Water levels at T019E

3.2.9 Summary Statistics

A selection of summary statistics drawn from the calibration plots is shown below in Table 0-3. The statistical calibration serves to confirm the impression given by the calibration plots, which is that the model generally performs well.

Table 0-3 Water level calibration summary statistics

Site	HW diff (m)	LW diff (m)	RMS diff (m)	HW diff (%)	LW diff (%)	HW time diff (mins)	LW time diff (mins)	Phase diff (mins)
Bull Sand Fort	-0.02	-0.02	0.06	0	0	-3	0	-8
River Tees	-0.03	0.07	0.09	-1	2	-13	0	-3
Seaham	0.02	0	0.1	1	0	-4	5	5
T016A	-0.14	-0.07	0.16	-4	-2	1	0	-4
T017C	0	-0.12	0.11	0	-4	-2	-3	-5
T019D	-0.03	0.02	0.07	-1	1	-10	-2	-5
T019E	0.01	-0.17	0.15	0	-6	-23	-12	-15
Note: HW is high water, LW is low water, RMS is root mean square								

The T-sites are noted in TotalTide to be of secondary quality, as they are inferred from standard ports on the coast and the absolute level and phasing may not be accurate. Therefore the small exceedance of the HW time at T019E of -15 minutes rather than -10 minutes is not considered to be significant.

3.3 Validation - Current Flows

3.3.1 Overview

Current speed and direction calibration plots for the selection of tidal diamond sites are presented in Figure 0-15 to Figure 0-22 below. These indicate that both overall and for the spring and neap tide, that a good calibration has been achieved, with the current speed, direction, phasing and general shape of the curves being well reproduced across the model domain.

3.3.2 SN017AA

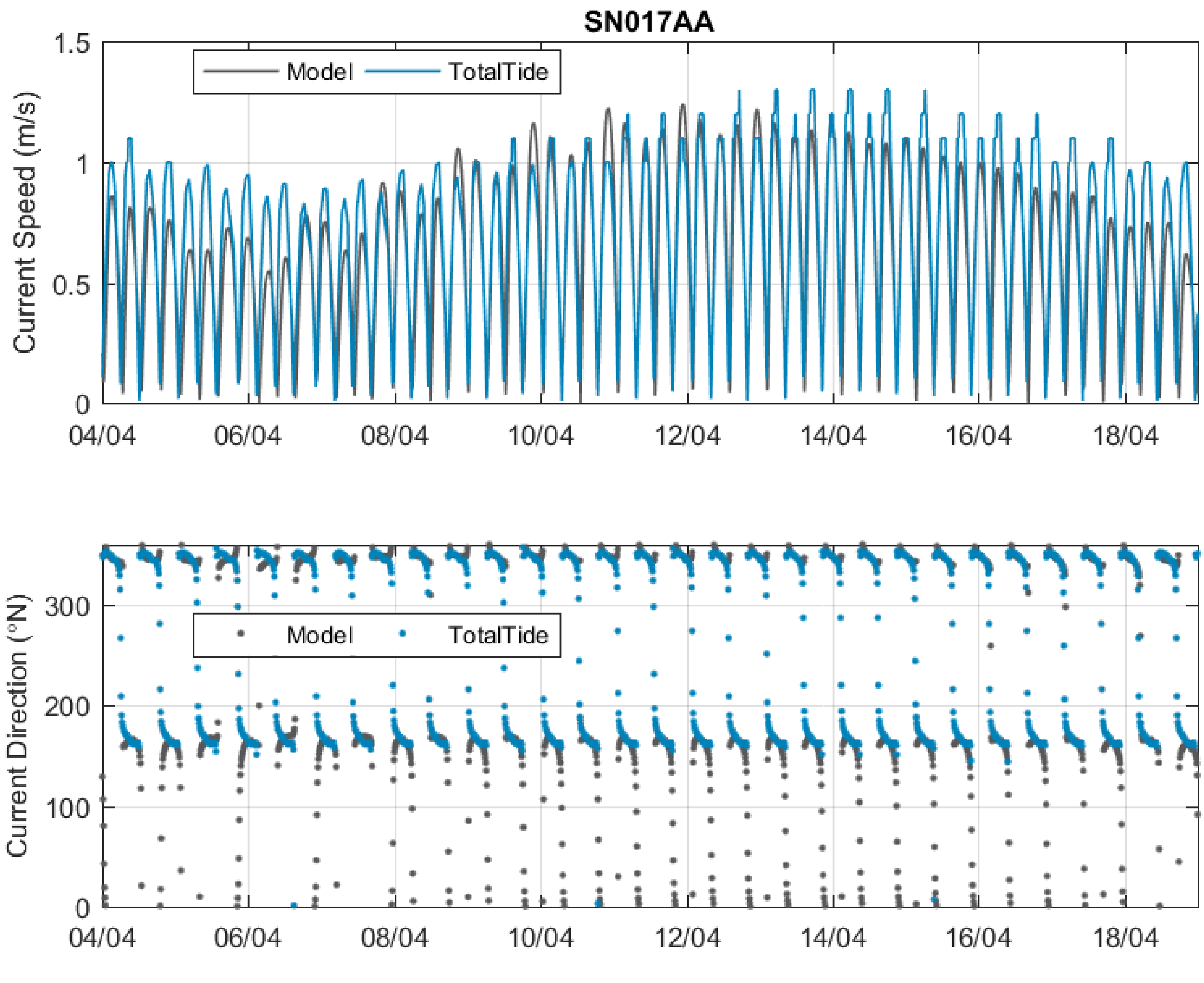


Figure 0-15 Current flow and direction at SN017AA

3.3.3 SN017AB

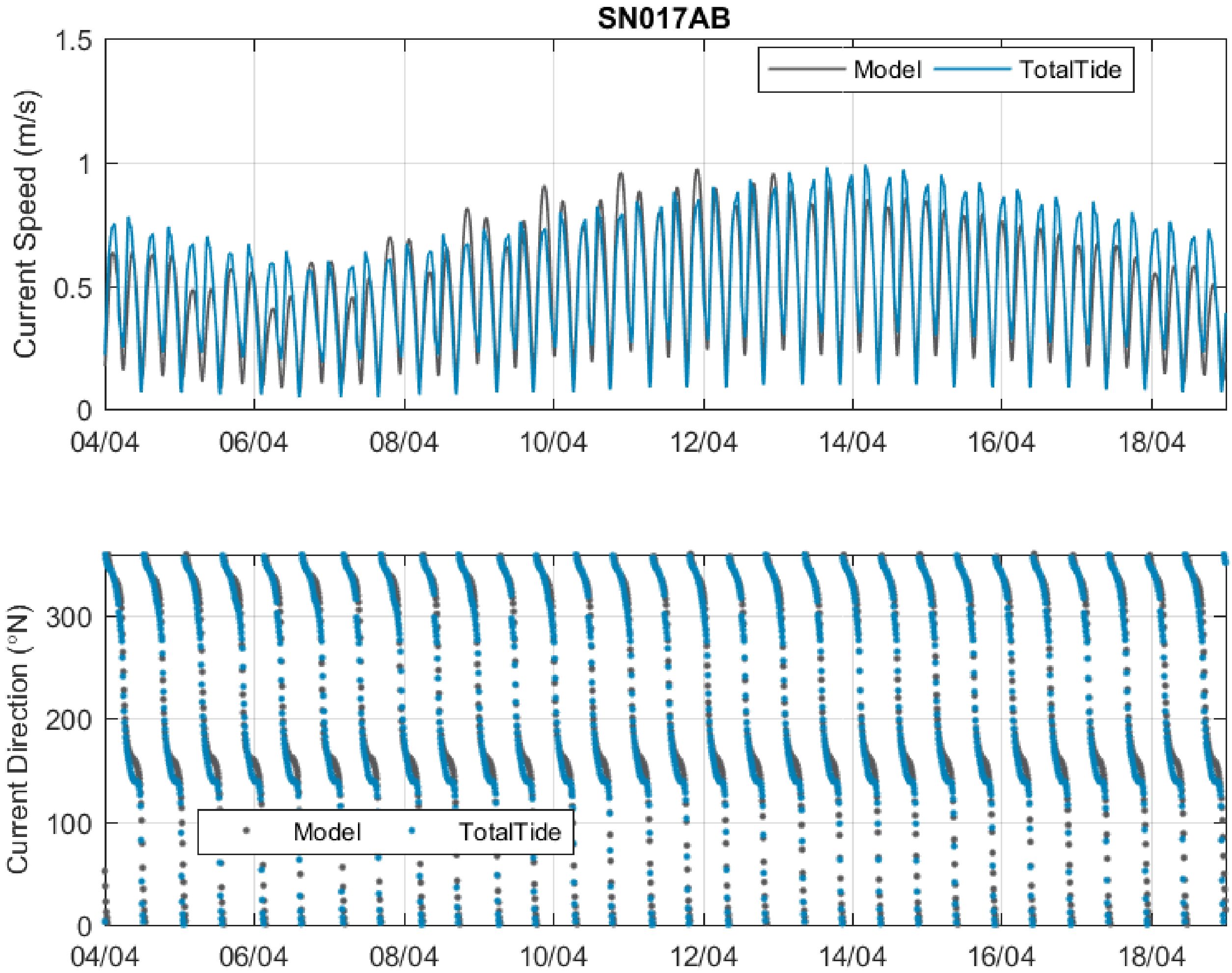


Figure 0-16 Current flow and direction at SN017AB

3.3.4 SN017AD

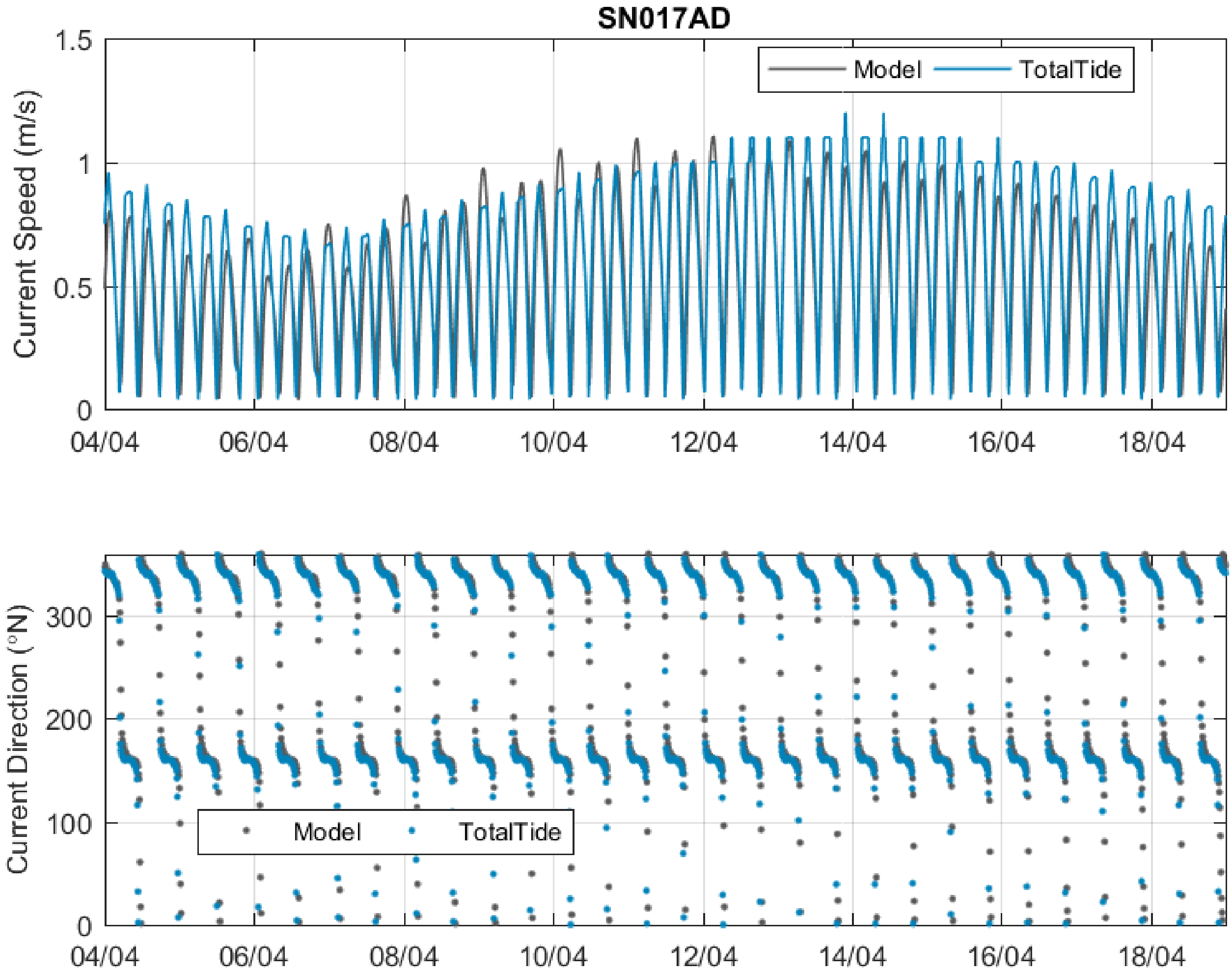


Figure 0-17 Current flow and direction at SN017AD

3.3.5 SN017P

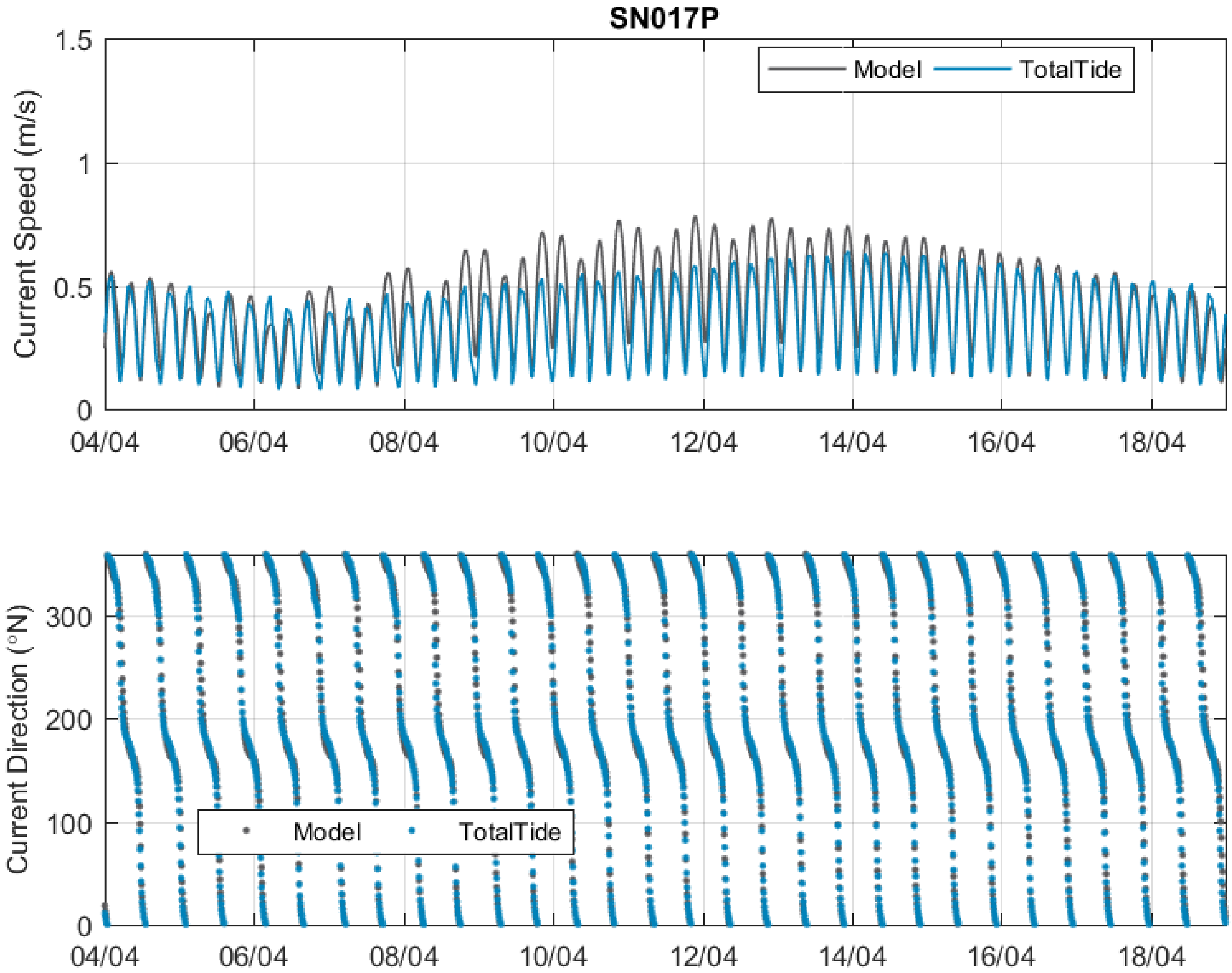


Figure 0-18 Current flow and direction at SN017P

3.3.6 SN017R

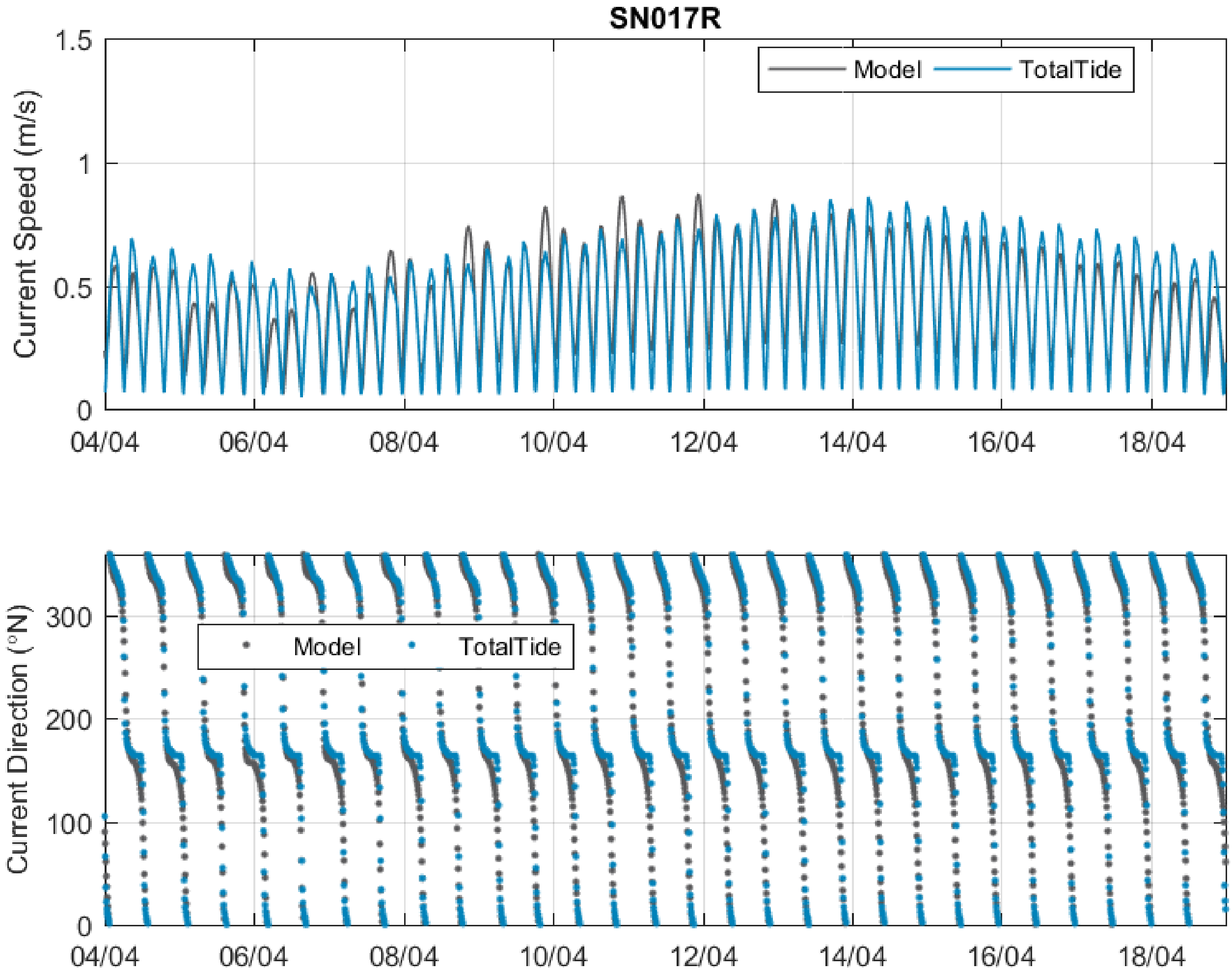


Figure 0-19 Current flow and direction at SN017R

3.3.7 SN018C

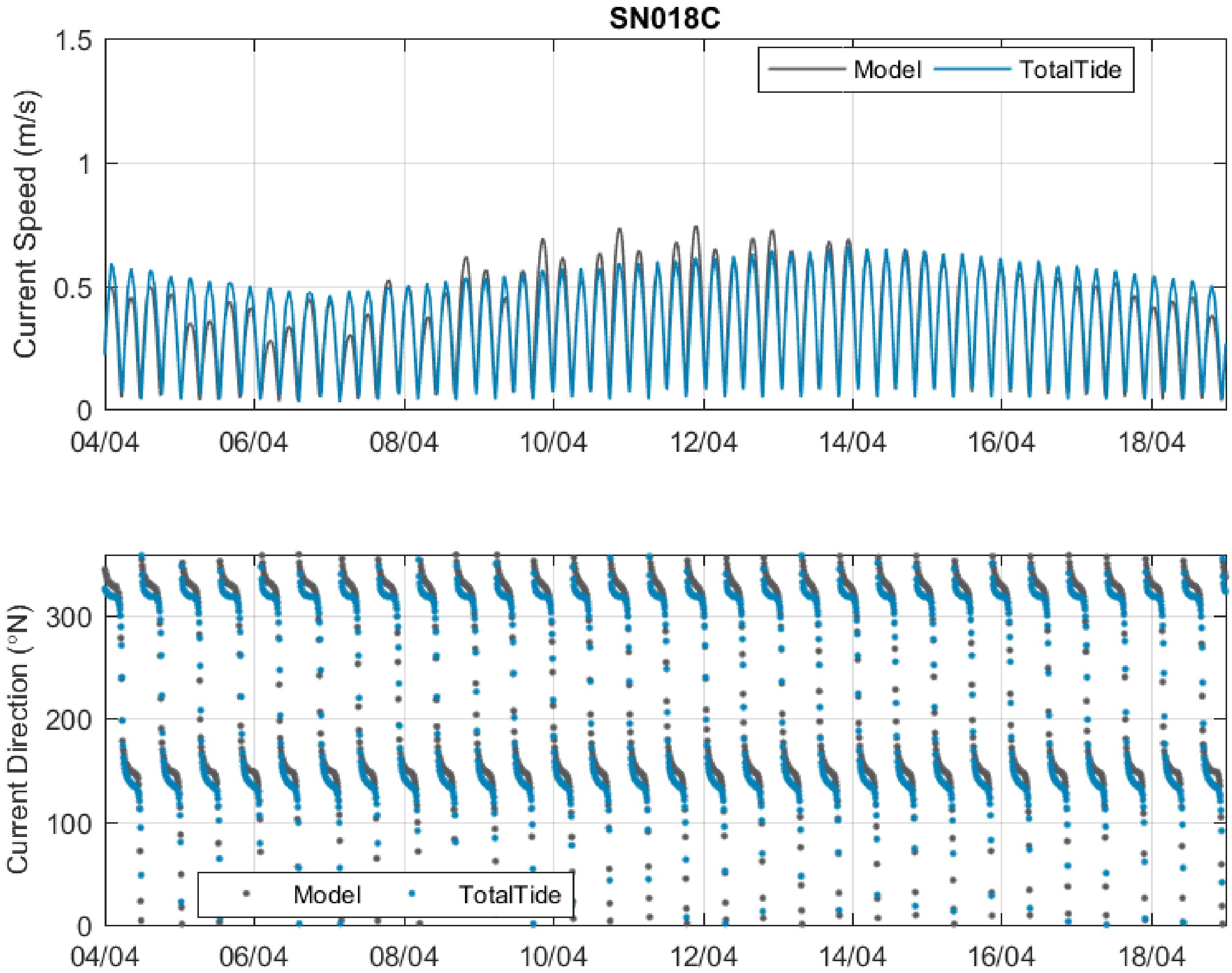


Figure 0-20 Current flow and direction at SN018C

3.3.8 SN018D

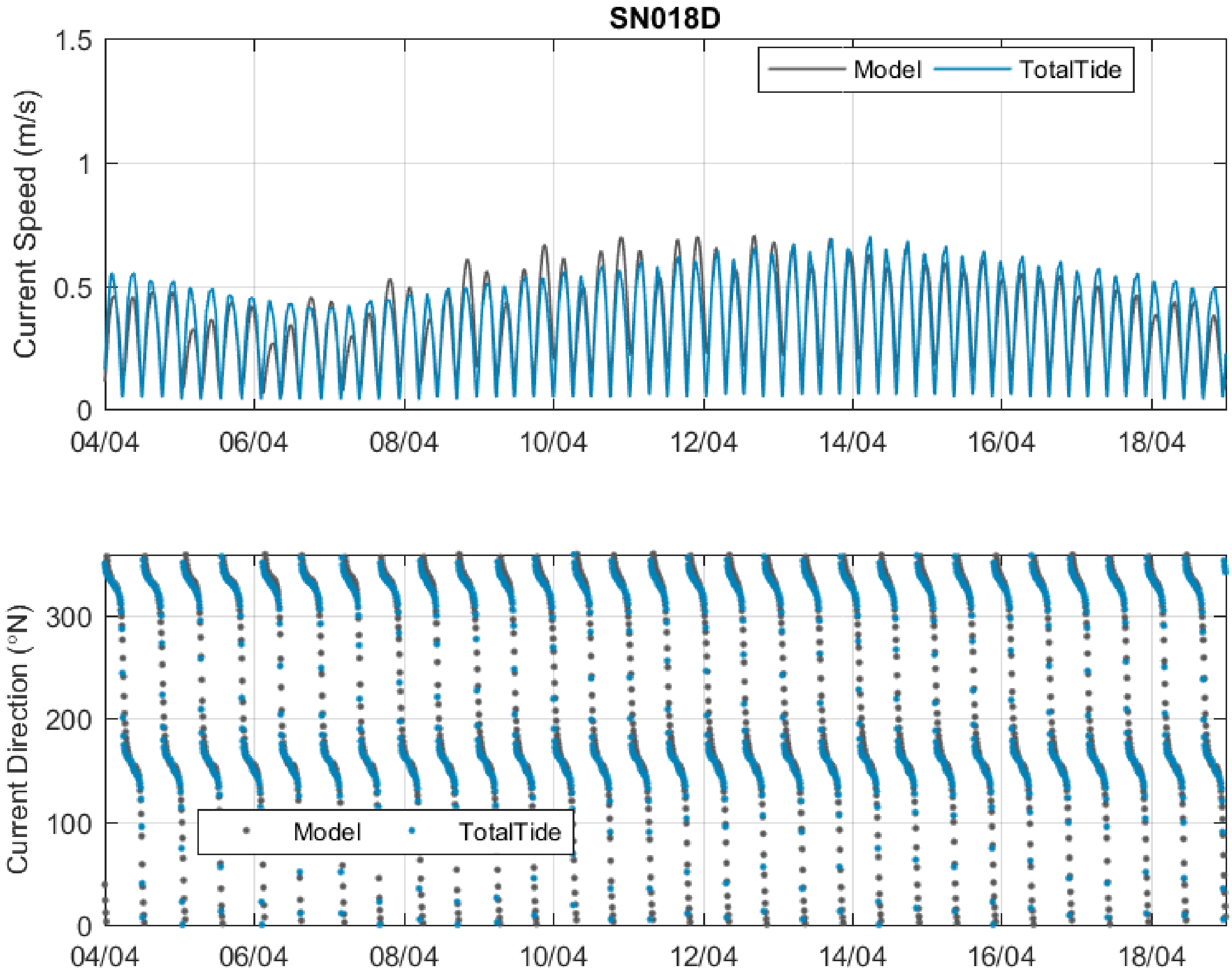


Figure 0-21 Current flow and direction at SN018D

3.3.9 SN019C

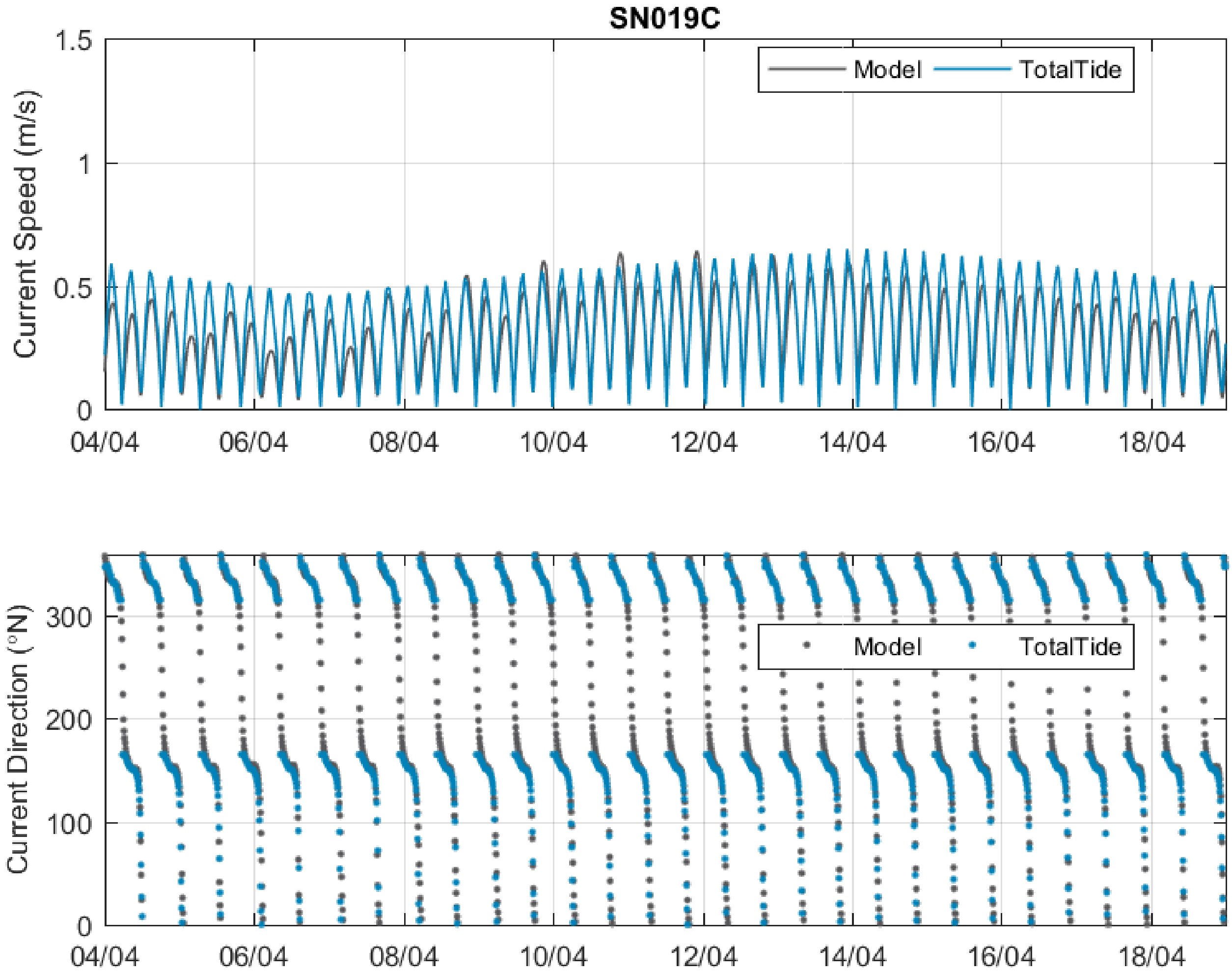


Figure 0-22 Current flow and direction at SN019C

3.3.10 Summary Statistics

A selection of summary statistics drawn from the validation plots is shown below in Table 0-4. The statistical validation serves to confirm the impression given by the validation plots, which is that the model generally performs well.

Table 0-4 Current flow validation summary statistics

Diamond	PF speed diff (m/s)	PE speed diff (m/s)	RMS diff (m/s)	PF speed diff(%)	PE speed diff (%)	PF dir diff (deg)	PE dir diff (deg)	Phasing diff (mins)
SN017AA	-0.17	-0.06	0.16	-13	-5	0	-2	15
SN017AB	-0.07	-0.04	0.1	-7	-4	2	4	12
SN017AD	-0.02	-0.14	0.12	-2	-12	1	2	19
SN017P	0.08	0.05	0.1	13	8	-13	-8	10
SN017R	-0.07	-0.01	0.09	-8	-1	-7	-9	-5
SN018C	-0.03	-0.03	0.06	-5	-5	12	11	-6
SN018D	-0.02	-0.03	0.07	-3	-5	5	1	10
SN019C	-0.11	-0.1	0.08	-17	-15	3	-3	12

Note: PF is peak flood, PE is peak ebb, RMS is root mean square

4 MODEL OUTPUTS

The modelled scenarios consisted of hydrodynamic (FLOW), wave (SWAN) and sediment (SED) models. These were conducted with and without the beach cofferdam at Humber. The cofferdam was represented in the model though the inclusion of thin dams, which creates a full water column blockage to flows into a cell.

At Humber, model simulations for average sediment transport with and without the cofferdam under average and storm wave conditions are shown in Figure 0-23. Time series extractions from each model run are then shown for Bull Sand Fort in the Humber estuary. Collectively, these show that the temporary addition of the cofferdam does not influence sediment transport within the Humber estuary, and any of the protected sites found there.

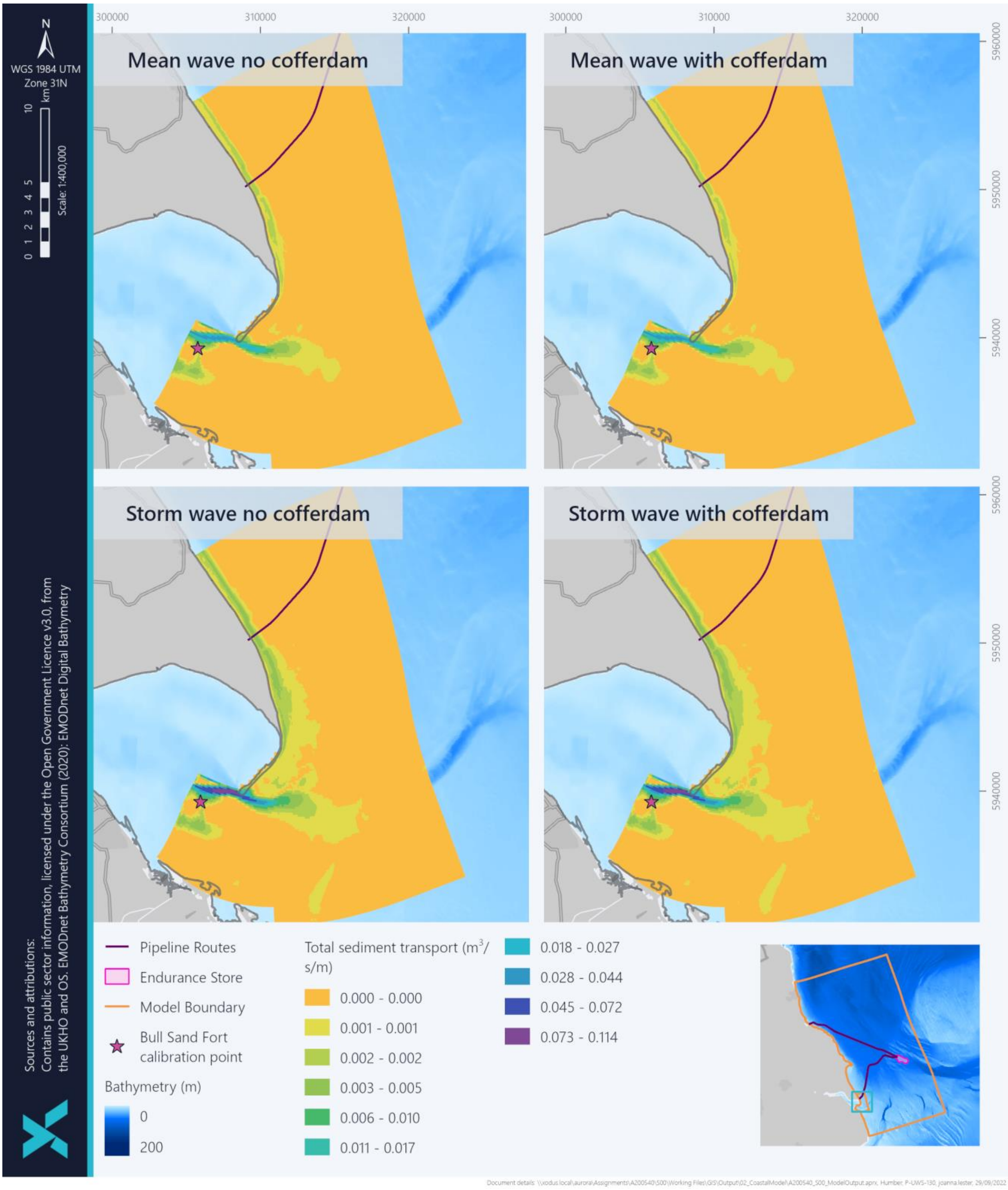


Figure 0-23 Sediment modelling to understand impact of cofferdam at Humber estuary

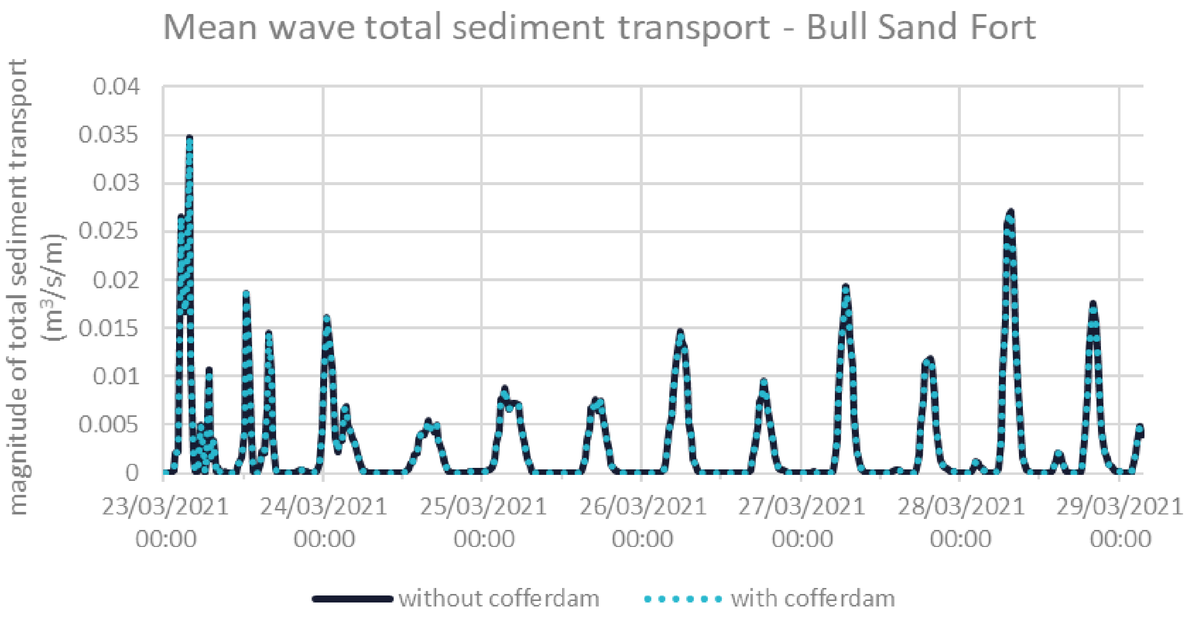


Figure 0-24 Mean wave total sediment transport at Bull Sand Fort

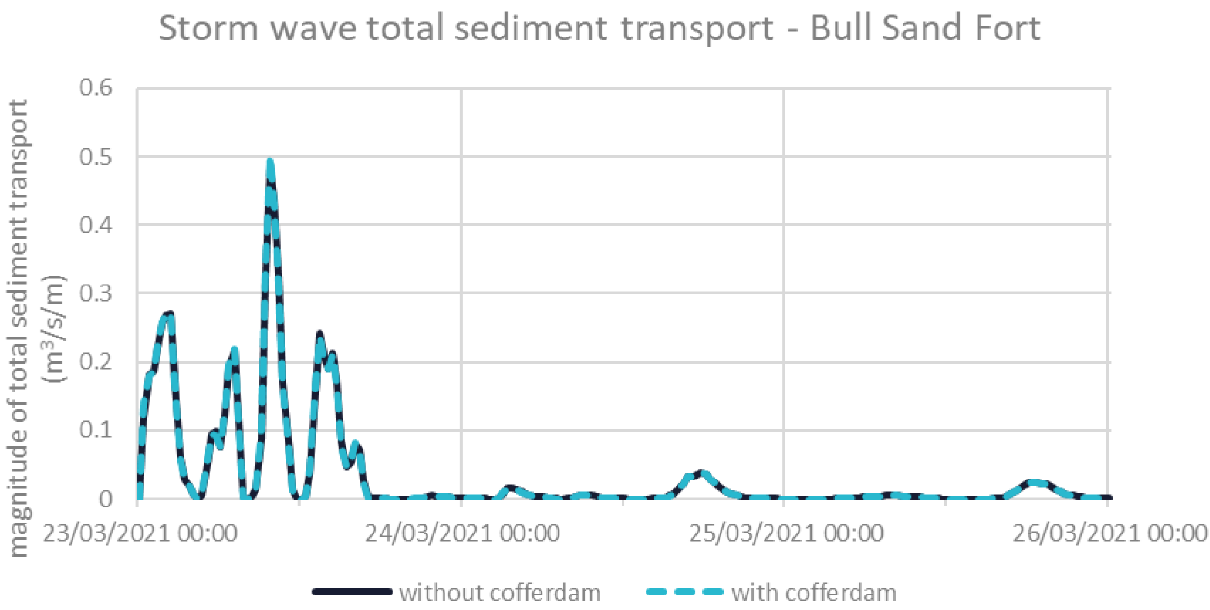


Figure 0-25 Storm wave total sediment transport at Bull Sand Fort

5 CONCLUSIONS

A Deltares Delft3D model of the east coast of the UK has been constructed, running from the Tyne to the Humber Estuary, based around the FLOW hydrodynamic module.

The model has been shown to represent hydrodynamic flows and levels robustly. As a result, it is recommended that the model be accepted as "fit for purpose" for environmental impact assessment of coastal processes.

REFERENCES

ADMIRALTY TotalTide. https://www.admiralty.co.uk/publications/admiralty-digital-publications/admiralty-totaltide

bp (2020). Net Zero Teesside MetOcean Criteria. Document number: UE-2020-0147. July 2020.

bp (2022). Northern Endurance Partnership. Metocean Basis of Design for Sub-Sea. Document number: IE-2022-0076. June 2022.

Channel Coastal Observatory (2020). Hornsea Directional Waverider Buoy Annual Wave Report. Available from https://www.coastalmonitoring.org/reports/#east_riding.

Egbert, G.D., A.F. Bennett and M.G.G. Foreman (1994). TOPEX/POSEIDON tides estimated using a global inverse model. Journal of Geophysical Research, Vol 99, C12, Pages 24,821-24,852.

Egbert and Erofeeva (2002). Efficient Inverse Modeling of Barotropic Ocean Tides. Journal of Atmospheric and Oceanic Technology. DOI: 10.1775/1520-0426.

FWR (Foundation for Water Research) (1993). A Framework for Marine and Estuarine Model Specification in the UK. Foundation for Water research, March 1993.

Yongcun Cheng, Ole Baltazar Andersen (2010). Improvement in global ocean tide model in shallow water regions. Poster, SV.1-68 45, OSTST, Lisbon, Oct.18-22.

Appendix H: Ornithology Technical Report

Northern Endurance Partnership

Ornithological Technical Report

Xodus

Date: 10 July 2023

Rev.no.	Date	Description	Prepared by	Verified by	Approved by
1	29/10/2021	Technical report	HAZ	RWA	RWA
2	23/6/22	Technical report	HAZ	RWA	RWA
3	19/7/22	Technical report	HAZ	RWA	RWA
4	20/7/22	Technical report	HAZ	RWA	RWA
5	10/07/23	Technical report	HAZ	RWA	RWA

Contents

1 Introduction 6
2 Relevant policy and legislation 6
3 Stakeholder consultation 7
4 Project description 8
4.1 Overview 8
4.2 Impacts 8

5 Methodology 10
5.1 Introduction 10
5.2 Abundance and distribution 10
5.3 Conservation importance 11
5.4 Sensitivity 12
5.5 Identification and conservation value of VORs 12

6 Species accounts 13
6.1 Common eider (*Somateria mollissima*) 13
6.2 Velvet scoter (*Melanitta fusca*) 13
6.3 Common scoter (*Melanitta nigra*) 14
6.4 Red-breasted merganser (*Mergus serrator*) 14
6.5 Kittiwake (*Rissa tridactyla*) 15
6.6 Little gull (*Hydrocoloeus minutus*) 16
6.7 Common gull (*Larus canus*) 16
6.8 Great black-backed gull (*Larus marinus*) 17
6.9 Herring gull (*Larus argentatus*) 17
6.10 Lesser black-backed gull (*Larus fuscus*) 18
6.11 Sandwich tern (*Thalasseus sandvicensis*) 18
6.12 Little tern (*Sternula albifrons*) 19
6.13 Roseate tern (*Sterna dougallii*) 20
6.14 Common tern (*Sterna hirundo*) 20
6.15 Arctic tern (*Sterna paradisaea*) 21
6.16 Great skua (*Stercorarius skua*) 22
6.17 Arctic skua (*Stercorarius parasiticus*) 22
6.18 Common guillemot (*Uria aalge*) 23
6.19 Razorbill (*Alca torda*) 23
6.20 Puffin (*Fratercula arctica*) 24
6.21 Red-throated diver (*Gavia stellata*) 24
6.22 Storm petrel (*Hydrobates pelagicus*) 25
6.23 Leach's petrel (*Hydrobates leucorhous*) 25
6.24 Fulmar (*Fulmarus glacialis*) 26

6.25 Manx shearwater (*Puffinus puffinus*) 26
6.26 Gannet (*Morus bassanus*) 27
6.27 Shag (*Phalacrocorax aristotelis*) 27
6.28 Cormorant (*Phalacrocorax carbo*) 28
6.29 Terrestrial and intertidal species 28

7 Identification of Valued Ornithological Receptors 29
8 References 32

Acronyms

Acronym	Description
BAP	Biodiversity Action Plan
DSM	Density Surface Model
EIA	Environmental Impact Assessment
ES	Environmental Statement
GIS	Geographic Information System
HDD	Horizontal Directional Drilling
HRA	Habitat Regulations Assessment
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LBAP	Local Biodiversity Action Plan
NEP	Northern Endurance Partnership
NERC	Natural Environment Research Council
NPPF	National Planning Policy Framework
SAC	Special Area of Conservation
SNS	Southern North Sea
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
VOR	Valued Ornithological Receptor

1 Introduction

The Northern Endurance Partnership (NEP) are currently developing offshore CO_2 transport and storage infrastructure ('the Development') in the UK Southern North Sea (SNS) to serve the proposed Net Zero Teesside and Zero Carbon Humber projects. The Development will transport CO_2 from locations at Teesside and north of the Humber estuary to offshore locations via two pipelines, the Teesside Pipeline, approximately 142 km in length, and the Humber Pipeline, approximately 100 km in length.

This Technical Report is designed to underpin the Environmental Statement (ES) chapters for offshore ornithology in addition to the Habitat Regulations Assessment (HRA) Report. The Technical Report will provide a complete characterisation of baseline ornithological conditions for the Development and will specifically:

- Identify ornithological receptors;
- Evaluate the importance of the receptors; and
- Identify receptors sensitive to the potential impacts that require assessment in the Environmental Impact Assessment (EIA)/HRA.

2 Relevant policy and legislation

The Conservation of Habitats and Species Regulations 2017 (2017 No. 1012) (as amended) and The Conservation of Offshore Marine Habitats and Species Regulations 2017 (2017 No. 1013) (as amended) are the principal pieces of secondary legislation which, prior to the UK's departure from the European Union, transposed the terrestrial and offshore marine aspects of the EU Habitats Directive (Council Directive 92/43/EEC) and certain elements of the EU Wild Birds Directive (Directive 2009/147/EC) into domestic law that applies to the Development. Together, these regulations are collectively known as the "Habitats Regulations".

The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 (2019 No. 579) set out the changes that apply now that the UK has left the European Union. These confirmed that:

- All European protected sites and species retain the same level of protection.
- Among other things, the requirement for HRA to be undertaken continues to apply.

Unless the UK Government implements further legislative changes, the obligations, process and terminology of the Habitats Regulations will, for the purposes of this report, remain as set out in existing legislation and regulations.

The Wildlife and Countryside Act 1981 (as amended) transposes the requirements of the Birds Directive in England and provides protection for wild birds by making it an offence to intentionally kill, injure, or take any wild bird or take, damage or destroy the nest or eggs of a wild bird, as well as intentionally or recklessly disturb breeding birds listed on Schedule 1 of the Act. The Act also provides for the designation of Sites of Special Scientific Interest (SSSI).

The Conservation of Habitats and Species Regulations 2010 (as amended) and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (together the 'Habitats Regulations') allow for the designation of Special Protection Area (SPA)s and Special Area of Conservation (SAC)s (the National Site Network) and set out a mechanism for the protection of those sites in accordance with the Habitats Directive and Birds Directive. In England, Ramsar sites are afforded the same level of protection as SPAs with respect to plans or projects that may affect them[1].

[1] See: https://www.gov.uk/government/publications/changes-to-the-habitats-regulations-2017/changes-to-the-habitats-regulations-2017

Section 40 of the Natural Environment and Rural Communities (NERC) Act 2006 requires all public bodies 'to have regard to the conservation of biodiversity in England' when carrying out their normal functions. The list of habitats and species of 'principal importance for the conservation of biodiversity in England' (Section 41) guides public bodies in implementing their duty. Local planning authorities and other competent authorities therefore must consider the impact on biodiversity from proposed developments.

Section 117 of the National Planning Policy Framework (NPPF) states that planning policies should "promote the recovery of priority species populations, linked to national and local targets" (e.g. Local Biodiversity Action Plan (LBAP) targets) and that the planning system should "contribute to and enhance the natural and local environment by minimising impacts on biodiversity and providing net gains in biodiversity where possible".

3 Stakeholder consultation

This section provides a summary of the consultation responses received in relation to the proposed project and ornithology (Table 3.1).

Table 3.1: Consultation responses

Project stage / Consultee	Response	How this has been addressed?
Scoping report – Joint Nature Conservation Committee (JNCC)	JNCC suggest that the operator use distribution maps from Waggit *et al* (2019) in addition to Kober *et al* (2010) as these include more recent data and use more sophisticated modelling methods.	The density layers associated with both of these sources have been incorporated into this report alongside information from Bradbury *et al.* (2014) and Stone *et al.* (1995). See Section 5.2 for a full description of the usage of these data sources.
Scoping report – JNCC	JNCC also suggest that the operator assess the cumulative impacts of the potential cable routes for The Crown Estate's round 4 preferred offshore wind projects 1, 2 and 3.	If information is available that allows for a full assessment to be undertaken then this will be included in the cumulative assessment
Scoping report – Natural England	The conservation of species protected by law is explained in Part IV and Annex A of Government Circular 06/2005 Biodiversity and Geological Conservation: Statutory Obligations and their Impact within the Planning System. The area likely to be affected by the proposal should be thoroughly surveyed by competent ecologists at appropriate times of year for relevant species and the survey results, impact assessments and appropriate accompanying mitigation strategies included as part of the ES. In order to provide this information there may be a requirement for a survey at a particular time of year. Surveys should always be carried out in optimal survey time periods and to current guidance by suitably qualified and where necessary, licensed, consultants.	The requirement for site-specific survey data has been considered. At this stage, based on the project design and associated impacts, site-specific surveys are not considered necessary as impact assessment can be conducted on a desk-based basis consistent with the approach taken for developments with similar impact characteristics in UK waters.

4 Project description

4.1 Overview

The Development consists of two pipelines which will transfer CO_2 from two locations on the eastern coast of the England to the Endurance Store located approximately 63 km from the nearest coastline (Figure 4.1). The northern pipeline will make landfall on the North Yorkshire coast at Coatham Sands (the Teesside Pipeline) with the southern pipeline making landfall at Easington on the East Riding of Yorkshire coast (the Humber Pipeline). The development includes:

- Installation, connection to subsea infrastructure and commissioning of two CO_2 export pipelines from Teesside and Humber clusters mean low water spring (MLWS) to the Endurance Store, including a Subsea Safety Isolation Valve (SSIV) nearshore Teesside;
- Installation of subsea infrastructure including two manifolds, infield flowlines and an infield pipeline;
- Drilling of five CO_2 injection wells and one Endurance Store observation well and installation of six subsea trees;
- O&M of subsea infrastructure and pipelines;
- Monitoring and management of the storage aquifer during and after CO_2 injection; and
- Installation, commissioning and O&M of cables:
  - One electric power and fibre-optic communications control cable running from Teesside to the subsea infrastructure at the Endurance Store;
  - One electric power and fibre-optic communications control cable between the two manifolds and six cables from the manifolds to each of the wells; and
  - One power, control and hydraulics umbilical running from Teesside to the SSIV.

This technical report only considers the species and impacts associated with the Development that will occur in the offshore environment.

4.2 Impacts

Impacts associated with the Development will primarily be associated with the construction/installation phase of the project. The following potential impact pathways have been identified for ornithological receptors:

- Habitat loss due to the installation of the pipelines and cables;
- Accidental contamination due to the introduction of synthetic compounds or non-synthetic contaminants;
- Disturbance due to noise and physical presence of construction activities leading to temporary exclusion from areas used for foraging, roosting or maintenance behaviours; and
- Indirect effects as a result of displacement of prey species through installation of the pipelines and cables.

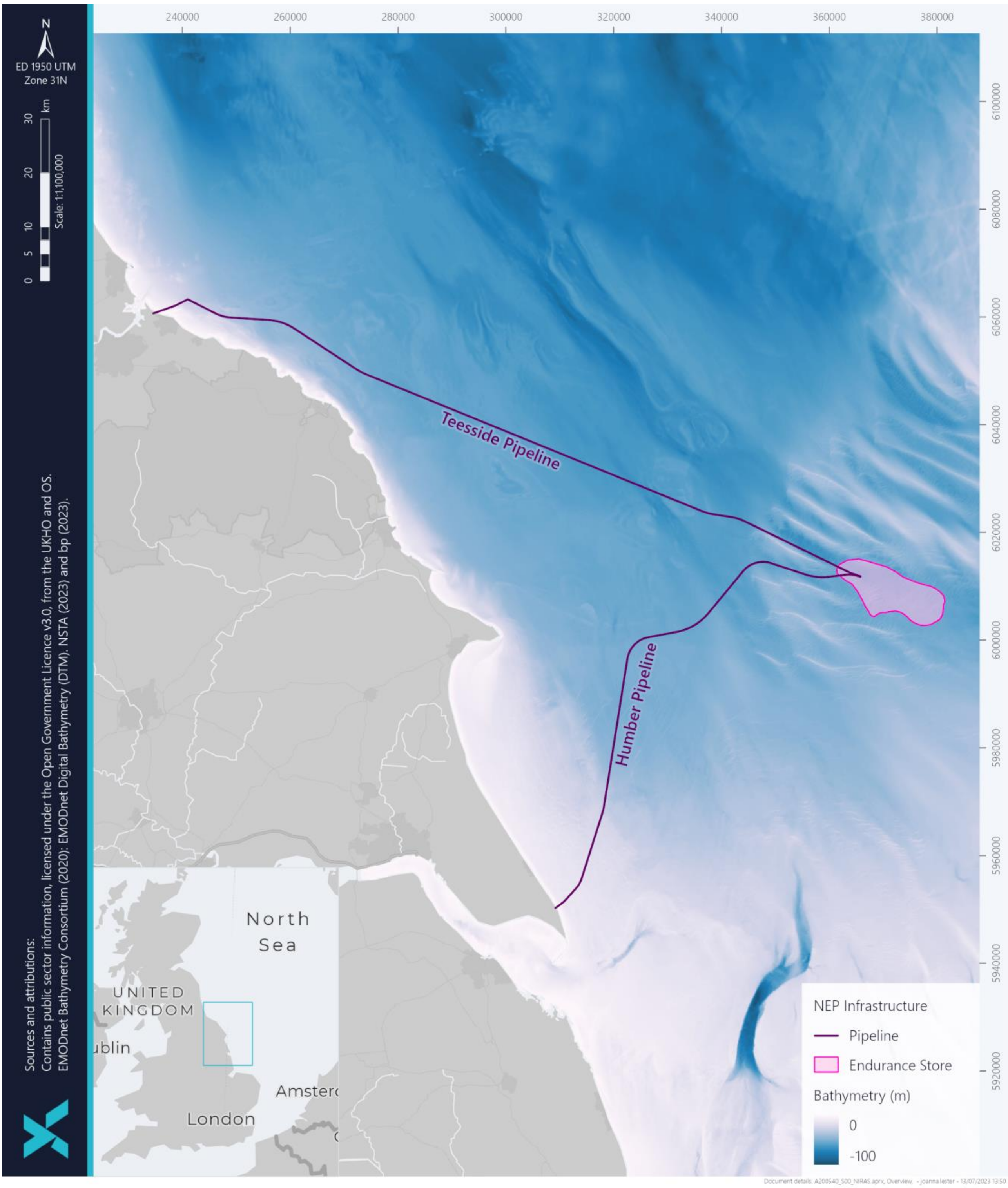


Figure 4.1: Development location

5 Methodology

5.1 Introduction

The Development is located within the marine environment and the scope of the EIA covers impacts occurring from MLWS seaward. The Development may therefore affect a number of seabird species that utilise the area in which the Development is located. In addition, impacts in the marine environment could propagate into the terrestrial and inter-tidal environments and therefore affect species associated with these habitats.

The identification of VORs uses information on the distribution of seabird species in the SNS, the conservation value of each species and the sensitivity of a species to impacts associated with the Development. Where a species is identified as a VOR it will be taken forward for impact assessments within the EIA. The following sections outline the datasets and information sources used to inform the identification of VORs.

A preliminary investigation of potential intertidal and terrestrial VORs is also undertaken in this report based on the location of the landfalls for both pipelines and the likely zone of influence of impacts associated with the Development.

5.2 Abundance and distribution

This section provides an overview of the data used to identify the importance of the Development area for different ornithological receptors. The data used come from publicly available datasets and other information sources.

5.2.1 Southern North Sea

To identify those species which may interact with the Development, a number of sources have been used. For the majority of species the density layers associated with Waggitt *et al.* (2019) have been used. Where a species is not included in this dataset, the density layers associated with Bradbury *et al.* (2014) have been used. If a species is not included in Waggitt *et al.* (2019) or Bradbury *et al.* (2014) then the distribution maps in Kober *et al.* (2010) have been used and if a species is not included in the previous three sources then the information provided in Stone *et al.* (1995) has been used. Where Stone *et al.* (1995) is used, consideration has been given to any changes in the distribution of relevant species that may have occurred since the publication of Stone *et al.* (1995).

Waggitt *et al.* (2019) utilises aerial and vessel survey data collated from the north-east Atlantic between 1980 and 2018. The methods used for standardization and modelling are presented in Waggitt *et al.* (2019). Density layers are presented on a monthly basis and, when abundance is discussed for relevant species on a seasonal basis in Section 6, the seasons presented in Furness (2015) are used. The density layers used to identify the importance of the sea areas associated with the Development show relative importance and do not provide absolute densities. The density layers associated with Waggitt *et al.* (2019) are considered to provide a better representation of the distribution and relative abundance of birds in UK waters due to the modelling methods applied and are therefore used as the primary data source where possible.

Bradbury *et al.* (2014) utilises the European Seabirds At Sea (ESAS) database (1980 to 2011), which includes over 310,000 seabird records which were collected between 1979 and 2011 composed predominantly of boat-based survey data and a Wildfowl & Wetlands Trust Consulting database containing over 400,000 seabird records from visual aerial surveys between 2001 and 2011. Bradbury *et al.* (2014) describes the methods used to provide a number of Density Surface Models (DSMs) showing the abundance and distribution of seabird species in English waters. The DSMs that present densities for each species representing the species-specific breeding and non-breeding seasons for the Biologically Defined Minimum Population Scales (BDMPS) as defined by Furness (2015) incorporating data from both boat and aerial surveys have been used in this report to identify the importance of the sea areas through which the

Development will pass for seabird species. It should be noted that the density layers associated with Bradbury *et al.* (2014) show relative importance and do not provide absolute densities.

Kober *et al.*, (2010) also presents an analysis of the ESAS database albeit using a different modelling approach to that applied by Bradbury *et al.* (2010) with data only up to 2006. It also includes additional species to those for which density layers are presented in Bradbury *et al.* (2014). A full description of the methodology applied is presented in Kober *et al.* (2010).

Stone *et al.* (1995) presents an atlas of seabird distribution in north-west Europe using data from the ESAS database, albeit from data collected up until that point from a variety of different survey programmes. Data were mapped using three methodologies (see Stone *et al.*, 1995 for further information) and presented using seasonal definitions relevant to each species.

5.2.2 Special Protection Areas

In the UK SPAs are designated to protect specific seasonal concentrations of different bird species. If the Development interacts with, is adjacent to or passes through sea areas utilised by birds from SPAs then the relevant species may require consideration as part of assessments. In order to identify SPAs and associated qualifying features that may require consideration in the assessments for the Development, the Geographic Information System (GIS) shapefile of all UK SPAs as provided on the JNCC website has been used. Connectivity between the Development and an SPA may occur in two ways, direct connectivity, where the Development passes through an SPA or indirect connectivity, where the Development passes through areas utilised by a qualifying feature of an SPA (e.g. by a bird foraging in sea areas away from its SPA breeding colony). The SPA shapefile from JNCC has been visualised in a GIS with direct connectivity then identified. For indirect connectivity, consideration has been given to the foraging range of different seabird species from breeding colonies and whether this would overlap with the sea areas through which the Development will pass. Where available site-specific foraging ranges are used but if not available the generic foraging ranges in Woodward *et al.* (2019) have been used. Due to the relatively small spatial and temporal scales of impacts associated with the Development and the limited magnitude of impacts, consideration has only been given to SPAs within 100 km of the Development.

5.2.3 Specific datasets

Where available, datasets for specific sea areas, for example, those associated with the designation of SPAs (see above) have been used. These often use data from more targeted surveys and can provide more suitable and robust data for a smaller suite of species. The datasets used include the following:

- Lawson *et al.* (2015) - An assessment of the numbers and distributions of wintering red-throated diver, little gull and common scoter in the Greater Wash;
- Wilson *et al.* (2014) - Quantifying usage of the marine environment by terns Sterna sp. around their breeding colony SPAs;
- Parsons *et al.* (2015) - Quantifying foraging areas of little tern around its breeding colony SPA during chick-rearing
- Wakefield *et al.* (2013) - Space Partitioning Without Territoriality in Gannets
- Cleasby *et al.* (2020) - Identifying important at-sea areas for seabirds using species distribution models and hotspot mapping
- Departmental briefs for relevant SPAs, where available

5.3 Conservation importance

Conservation importance will be identified based on the inclusion of a species on the following conservation metrics:

- Annex I of the EU Birds Directive (2009/147/EEC) as referred to in the Conservation of Habitats and Species Regulations 2017 (2017 No. 1012) (as amended)

- Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)
- Species listed on the UK Biodiversity Action Plan (UK BAP)
- Species of Principal importance in England (Section 41 of the NERC Act 2006)
- UK Birds of Conservation Concern (Eaton *et al.*, 2015)

In addition, where a bird is a feature of an SPA with which the Development has connectivity this will also be included in this section.

5.4 Sensitivity

In order to identify VORs, the species accounts in Section 6 identifies the sensitivity of each species to the impacts above (see Section 4.2). In relation to disturbance, the sensitivity scores presented in Wade *et al.* (2016) are used and, if not included in Wade *et al.* (2016), the sensitivity scores presented in Bradbury *et al.* (2014), are used. For habitat loss and indirect effects on prey, the habitat flexibility scores provided in Wade *et al.* (2016) are used. For accidental contamination, the scores in Webb *et al.* (2016) are used to identify sensitivity. The sensitivity scores presented in Wade *et al.* (2016) are based upon impacts associated with offshore wind farms and therefore the application of them in this report is considered to be precautionary with any equivalent impacts from the installation and operation of the Development considered to be much lower in magnitude as the equivalent impacts associated with offshore wind farms involve larger spatial and temporal scales.

5.5 Identification and conservation value of VORs

Using the information collected for each species on the abundance, distribution, conservation importance and sensitivity to impacts associated with the Development, VORs are identified. In general a species is considered to be a VOR where it occurs in numbers considered more than negligible, is of conservation importance and/or is sensitive to the impacts associated with the Development.

Following the identification of a species as a VOR, the conservation value of each VOR is then defined. The categories used for conservation value are presented in Table 5.1.

Table 5.1: Definition of terms relating to the conservation value of Valued Ornithological Receptors.

Conservation value	Definition
Negligible	All species of lowest conservation concern (e.g. green listed species on the Birds of Conservation Concern)
Local	Any other species of conservation concern (e.g. Amber-listed species on the Birds of Conservation Concern) not covered in the categories below
Regional	Species listed on the Birds of Conservation Concern Red list And/or Species that are the subject of a specific action plan within the UK or are listed as Species of Principal Importance in England (Section 41 of the NERC Act 2006).
National	Species listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended) not already covered by International criteria; Species listed on Annex 1 of the EU Birds Directive; Bird species that form part of an SSSI that may potentially interact with the Development at some stage of their life cycle;

Conservation value	Definition
	At least 50% of the UK breeding or non-breeding population found in ten or fewer sites (depending on the time of year the Development area is of importance for the species); and/or An impact on an ecologically-sensitive species (<300 breeding pairs or <900 wintering individuals in the UK) (depending on the time of year the Development area is of importance for the species).
International	Bird species that form part of a cited interest of an SPA or Ramsar site that may potentially interact with the Development at some stage of their life cycle including those listed as assemblage features; and/or At least 20% of the European breeding or non-breeding population is found in the UK.

6 Species accounts

6.1 Common eider (*Somateria mollissima*)

6.1.1 Abundance in relation to the Development

The maps presented in Stone *et al.* (1995) do not suggest that the sea areas associated with the Development are of importance for common eider at any point during the year. Since Stone *et al.* (1995), there has been no evidence of substantial changes in the distribution of common eider to suggest that the Development will interact with areas of high density for this species. The closest SPA at which common eider is a designated feature is Lindisfarne SPA where the species is a feature in the non-breeding season. There are no SPAs at which eider is a breeding feature (Stroud *et al.*, 2016)

6.1.2 Conservation status

Common eider is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). There are no SPAs at which common eider is a feature within 100 km of the Development.

6.1.3 Sensitivity

Common eiders are considered moderately sensitive to disturbance and have a low habitat flexibility (Wade *et al.*, 2016). Common eider is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.1.4 Conclusion

There is no evidence to suggest that the sea areas through which the Development will pass are of importance for common eider. As a result common eider is not identified as a VOR.

6.2 Velvet scoter (*Melanitta fusca*)

6.2.1 Abundance in relation to the Development

The maps presented in Stone *et al.* (1995) do not suggest that the sea areas associated with the Development are of importance for velvet scoter at any point during the year. Since Stone *et al.* (1995), there has been no evidence of substantial changes in the distribution of velvet scoter to suggest that the Development will interact with areas of high density for this species. The closest SPA at which velvet scoter is a designated feature is the Firth of Forth SPA where the species is a feature in the non-breeding season. Velvet scoter do not breed in the UK.

6.2.2 Conservation status

Velvet scoter is not listed under Annex I of the EU Birds Directive (2009/147/EEC) but is included on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al*., 2015). There are no SPAs at which velvet scoter is a feature within 100 km of the Development.

6.2.3 Sensitivity

Velvet scoters are considered sensitive to disturbance and have a moderate habitat flexibility (Wade *et al*., 2016). Velvet scoter is considered to have a moderate sensitivity to accidental contamination events (Webb *et al*., 2016).

6.2.4 Conclusion

There is no evidence to suggest that the sea areas through which the Development will pass are of importance for velvet scoter. As a result velvet scoter is not identified as a VOR.

6.3 Common scoter (*Melanitta nigra*)

6.3.1 Abundance in relation to the Development

The maps presented in Stone *et al.* (1995) do not suggest that the sea areas associated with the Development are of importance for common scoter at any point during the year. Since Stone *et al.* (1995), there has been no evidence of substantial changes in the distribution of common scoter in recent years to suggest that the Development will interact with areas of high density for this species. This is supported by the survey data underpinning the designation of the Greater Wash SPA which suggests important areas for common scoter occur in the outer reaches of The Wash (Lawson *et al*., 2015).

The closest SPAs at which common scoter is a designated feature are the Greater Wash SPA and the Lindisfarne SPA at which the species is a feature in the non-breeding season.

6.3.2 Conservation status

Common scoter is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Common scoter is listed as a Species of Principal Importance on the NERC Act 2006 and is therefore included as a Priority Species on the UK BAP. The species is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al*., 2015). The species is a non-breeding feature at the Greater Wash SPA however, there is no connectivity with the species as a feature of the SPA and the Development.

6.3.3 Sensitivity

Common scoters are considered sensitive to disturbance and have a low habitat flexibility (Wade *et al*., 2016). Common scoter is considered to have a moderate sensitivity to accidental contamination events (Webb *et al*., 2016).

6.3.4 Conclusion

There is no evidence to suggest that the sea areas through which the Development will pass are of importance for common scoter. As a result common scoter is not identified as a VOR.

6.4 Red-breasted merganser (*Mergus serrator*)

6.4.1 Abundance in relation to the Development

The maps presented in Stone *et al.* (1995) do not suggest that the sea areas associated with the Development are of importance for red-breasted merganser at any point during the year. Since Stone *et al.* (1995), there has been no evidence of substantial changes in the distribution of red-breasted merganser to suggest the Development will interact with areas of high density for this species. The closest SPA at which red-breasted merganser is a designated feature is the Firth of Forth SPA where the species is a feature in the non-breeding season.

6.4.2 Conservation status

Red-breasted merganser is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently on the UK Birds of Conservation Concern green list (Eaton *et al*., 2015). There are no SPAs at which red-breasted merganser is a feature within 100 km of the Development

6.4.3 Sensitivity

Red-breasted mergansers are considered moderately sensitive to disturbance and have a low habitat flexibility (Bradbury *et al.*, 2014). Red-breasted merganser is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.4.4 Conclusion

There is no evidence to suggest that the sea areas through which the Development will pass are of importance for red-breasted merganser. As a result red-breasted merganser is not identified as a VOR.

6.5 Kittiwake (*Rissa tridactyla*)

6.5.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that offshore sea areas through which both pipelines will pass are of importance for kittiwake throughout the year. In addition, the sea areas through which the Humber Pipeline will pass and the area in which the Endurance Store is located are of importance for kittiwake in the non-breeding season. The generic mean-maximum foraging range[2] of kittiwake is 156.1 km (Woodward *et al.*, 2019) and means that the Development is within the foraging range of breeding kittiwake from the Flamborough and Filey Coast SPA and smaller colonies on the north-east coast of England. Cleasby *et al.* (2020) also suggests that the Development will pass through sea areas within the utilisation distribution of breeding kittiwake from Flamborough and Filey Coast SPA in the breeding season.

6.5.2 Conservation status

Kittiwake is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al*., 2015). The species is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Kittiwake is a breeding feature at the Flamborough and Filey Coast SPA, which is the only SPA at which kittiwake is a designated feature within 100 km of the Development. The Development has connectivity with this SPA.

6.5.3 Sensitivity

Kittiwakes are not considered sensitive to disturbance and have a moderate habitat flexibility (Wade *et al.*, 2016). Kittiwake is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016)..

6.5.4 Conclusion

There is evidence that kittiwake are present in the sea areas through which the Development will pass in the breeding and non-breeding seasons (Waggitt *et al.*, 2019). There is also evidence for connectivity between the Development and birds from the Flamborough and Filey Coast SPA. The species is included on the UK Birds of Conservation Concern red list and is potentially sensitive to impacts associated with the Development. In conclusion, kittiwake is therefore identified as a VOR and of international conservation value due to connectivity between an SPA at which the species is a designated feature and the Development.

[2] A non-site-specific foraging range metric representing the average of the maximum foraging trips recorded from different foraging range studies

6.6 Little gull (*Hydrocoloeus minutus*)

6.6.1 Abundance in relation to the Development

The maps presented in Kober *et al.* (2010) suggest that the inshore areas of the Humber pipeline are of importance for little gull in the breeding season. The closest SPA at which little gull is a designated feature is the Greater Wash SPA where the species is a feature in the non-breeding season with the main concentration of little gull within the SPA in the sea areas adjacent to The Wash (Lawson *et al.*, 2015). Little gull occurs in UK waters during the non-breeding season and it is therefore unclear the distribution maps in Kober *et al.* (2010) suggest there are important areas in UK waters for little gull in the breeding season.

6.6.2 Conservation status

Little gull is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently on the UK Birds of Conservation Concern green list (Eaton *et al.*, 2015).. Little gull is a non-breeding feature at the Greater Wash SPA with this the only SPA at which little gull is a designated feature within 100 km of the Development. There is no connectivity between the Development and little gull from this SPA based on the distribution of birds presented in the information used to support the SPA designation (Lawson *et al.*, 2015).

6.6.3 Sensitivity

Little gulls are not considered sensitive to disturbance and have a moderate habitat flexibility (Bradbury *et al.*, 2014). Little gull is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016)..

6.6.4 Conclusion

Despite Kober *et al.* (2010) suggesting that inshore areas of the Humber pipeline are of importance for the species in the breeding season this is not considered to be correct as very few (if any) birds will actually be present in UK waters in the breeding season. There is no evidence to suggest that the sea areas through which the Development will pass are of importance for little gull during the non-breeding season when bird will be present in UK waters and therefore little gull is not identified as a VOR.

6.7 Common gull (*Larus canus*)

6.7.1 Abundance in relation to the Development

The maps presented in Kober *et al.* (2010) do not suggest that the sea areas in which the Development will be located are of importance for common gull. The Development is not within foraging range of any SPAs at which common gull is a feature in the breeding season (Woodward *et al.*, 2019) and there are no SPAs for the species in the non-breeding season.

6.7.2 Conservation status

Common gull is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). There are no SPAs at which common gull is a feature within 100 km of the Development.

6.7.3 Sensitivity

Common gulls are not considered sensitive to disturbance and have a moderate habitat flexibility (Wade *et al.*, 2016). Common gull is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.7.4 Conclusion

The distribution maps in Kober *et al.* (2010) do not suggest that the sea areas in which the Development will be located are of importance for common gull. The species is included on the UK Birds of Conservation Concern amber list and is considered potentially sensitive to impacts associated with the Development. In conclusion, common gull is therefore not identified as a VOR.

6.8 Great black-backed gull (*Larus marinus*)

6.8.1 Abundance in relation to the Development

The density layers associated with Bradbury *et al*. (2014) suggest that the sea areas through which both Development pipelines will pass and the area in which the Endurance Store is located are of importance for great black-backed gull in the non-breeding season. Furthermore, the areas through which the both pipelines pass are also suggested as important in the breeding season. The nearest breeding colony of great black-backed gull is at Coquet Island with the Development beyond the generic mean-maximum foraging range of the species (73 km) (Woodward *et al*., 2019) from Coquet Island. It is therefore unlikely that breeding birds will be present in the sea areas through which the Development will pass with birds that are present more likely to be non-breeding or immature birds.

6.8.2 Conservation status

Great black-backed gull is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al*., 2015). There are no SPAs at which great black-backed gull is a feature within 100 km of the Development.

6.8.3 Sensitivity

Great black-backed gulls are not considered sensitive to disturbance and have a moderate habitat flexibility (Wade *et al*., 2016). Great black-backed gull is considered to have a moderate sensitivity to accidental contamination events (Webb *et al*., 2016).

6.8.4 Conclusion

There is evidence that great black-backed gull are present in the sea areas through which the Development will pass in the breeding and non-breeding seasons (Bradbury *et al*., 2014). The species is included on the UK Birds of Conservation Concern amber list and is considered potentially sensitive to impacts associated with the Development. Great black-backed gull is therefore identified as a VOR with a local conservation value due to the species inclusion on the UK Birds of Conservation Concern amber list.

6.9 Herring gull (*Larus argentatus*)

6.9.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al*. (2019) suggest that inshore sea areas through which both Development pipelines will pass of importance for herring gull outside of the breeding season. In addition, the offshore areas through which the Teesside Pipeline are also important in the breeding season. The Development is beyond the foraging range of herring gull from those SPAs at which herring gull is a designated breeding feature (Woodward *et al*., 2019).

6.9.2 Conservation status

Herring gull is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Herring gull is listed as a Species of Principal Importance on the NERC Act 2006 and is therefore included as a Priority Species on the UK BAP. The species is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al*., 2015). There are no SPAs at which herring gull is a designated feature within 100 km of the Development.

6.9.3 Sensitivity

Herring gulls are not considered sensitive to disturbance and have a high habitat flexibility (Wade *et al.*, 2016). Herring gull is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.9.4 Conclusion

There is evidence that herring gull are present in the sea areas through which the Development will pass in the breeding and non-breeding seasons (Waggitt *et al.*, 2019). The species is included on the UK Birds of Conservation Concern red list but is not considered sensitive to impacts associated with the Development. Due to the species low sensitivity to impacts associated with the Development, herring gull is not identified as a VOR.

6.10 Lesser black-backed gull (*Larus fuscus*)

6.10.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that the inshore sea areas through which the Humber Pipeline will pass are of importance for lesser black-backed gull towards the end of the breeding season into the non-breeding season of relevance to the species. The Development is beyond the foraging range of lesser black-backed gull from those SPAs at which the species is a designated breeding feature (Woodward *et al.*, 2019).

6.10.2 Conservation status

Lesser black-backed gull is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). There are no SPAs at which lesser black-backed gull is a designated feature within 100 km of the Development.

6.10.3 Sensitivity

Lesser black-backed gulls are not considered sensitive to disturbance and have a high habitat flexibility (Wade *et al.*, 2016). Lesser black-backed gull is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.10.4 Conclusion

There is evidence that lesser black-backed gull are present in the inshore sea areas through which the Humber Pipeline will pass (Waggitt *et al.*, 2019). The species is included on the UK Birds of Conservation Concern amber list but is not considered sensitive to impacts associated with the Development. Due to the species low sensitivity to impacts associated with the Development, lesser black-backed gull is not identified as a VOR.

6.11 Sandwich tern (*Thalasseus sandvicensis*)

6.11.1 Abundance in relation to the Development

The density layers associated with Bradbury *et al.* (2014) suggest that inshore sea areas through which the Teesside Pipeline will pass of importance for Sandwich tern in the breeding season. The closest extant breeding colony is to the north of the Teesside cable at Coquet Island although generic foraging range data (Woodward *et al.*, 2019) suggests no connectivity between this colony and the Teesside Pipeline. It is therefore unlikely that breeding birds will be present in the sea areas through which the Development will pass with birds that are present more likely to be non-breeding or immature birds. The months incorporated into the seasons (from Furness (2015)) used when modelling the density layers associated with Bradbury *et al.* (2014) are also likely to result in an overlap between the presence of breeding birds at colonies and the pre-breeding and post-breeding movements of birds. This can lead to certain sea areas appearing to be of importance in the breeding season with these areas actually representing the pre- and/or post-breeding movements of birds.

6.11.2 Conservation status

Sandwich tern is listed on Annex I of the EU Birds Directive (2009/147/EEC) and the species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al*., 2015). Sandwich tern is a designated breeding feature at the North Norfolk Coast SPA and the Coquet Island SPA. The Development does not have connectivity with Sandwich tern from these sites.

6.11.3 Sensitivity

Sandwich terns are not considered vulnerable to disturbance and have a moderate habitat flexibility (Wade *et al*., 2016). Sandwich tern is considered to have a moderate sensitivity to accidental contamination events (Webb *et al*., 2016).

6.11.4 Conclusion

There is evidence that Sandwich tern are present in the sea areas through which the Development will pass in the breeding season (Bradbury *et al*., 2014). The species is of conservation importance and is potentially vulnerable to the impacts associated with the Development. On the basis of potential impact sensitivity, Sandwich tern is identified as a VOR with a national conservation value due to the species' inclusion on Annex I of the EU Birds Directive.

6.12 Little tern (*Sternula albifrons*)

6.12.1 Abundance in relation to the Development

The density layers associated with Bradbury *et al*. (2014) do not suggest that the sea areas through which both Development pipelines will pass are of importance for little tern in the breeding or non-breeding seasons of relevance to the species.

Both pipelines are located close to little tern breeding colonies which are part of the Teesmouth and Cleveland Coast SPA (Teesside Pipeline) and the Humber Estuary SPA (Humber Pipeline). Site-specific foraging range data presented in Wilson *et al*. (2014) suggests no connectivity between little terns from the Teesmouth and Cleveland Coast SPA and the Teesside Pipeline, based on the usage of a breeding location at Seaton Carew since 2019 (Bell and Leakey, 2019). The months incorporated into the seasons (from Furness (2015)) used when modelling the density layers associated with Bradbury *et al*. (2014) are likely to result in an overlap between the presence of breeding birds at colonies and the pre-breeding and post-breeding movements of birds. This can lead to certain sea areas appearing to be of importance in the breeding season with these areas actually representing the pre- and/or post-breeding movements of birds.

Site-specific foraging data for little tern from the Humber Estuary SPA indicates birds forage up to 6 km along the shore from the SPA (Parsons *et al*., 2015) however, there is no information on the seaward extent of the foraging behaviour of birds from the SPA. Generic foraging range information suggests a mean-maximum foraging range of 5 km with the Humber Pipeline located only 3 km from the breeding colony (Woodward *et al*., 2019).

6.12.2 Conservation status

Little tern is listed on both Annex I of the EU Birds Directive (2009/147/EEC) and Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is also amber-listed on the UK Birds of Conservation Concern (Eaton *et al*. 2015). Little tern is a breeding feature of the Humber Estuary SPA with which the Development has connectivity. Little tern is a designated feature at six SPAs that are within 100 km of the Development (Northumberland Marine SPA, Teesmouth and Cleveland Coast SPA, Humber Estuary SPA, Gibraltar Point SPA, The Wash SPA and North Norfolk Coast SPA). There is connectivity between little tern from the Humber Estuary SPA and the Development.

6.12.3 Sensitivity

Little terns are not considered vulnerable to disturbance but have a low habitat flexibility (Wade *et al.*, 2016). Little tern is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.12.4 Conclusion

There is evidence that little tern are present in the sea areas through which the Development will pass in the breeding season (Bradbury *et al.*, 2014) although the actual abundance of the species in relevant sea areas is low. The project is within the foraging range of little tern from the Humber Estuary SPA. The species is of conservation importance and is also considered vulnerable to the impacts associated with the Development. On the basis of SPA connectivity and potential low impact sensitivity, little tern is identified as a VOR with an international conservation value due to connectivity between an SPA at which the species is a designated feature and the Development.

6.13 Roseate tern (*Sterna dougallii*)

6.13.1 Abundance in relation to the Development

Roseate tern is not included in the analyses presented in Waggitt *et al.* (2019), Bradbury *et al.* (2014), Kober *et al.* (2010) or Stone *et al.* (1995). The closest breeding colony to the Development is located at Coquet Island SPA. The mean-maximum foraging range of roseate tern is 12.6 km Woodward *et al.* (2019) which suggests the Development is beyond the foraging range of the species from Coquet Island SPA.

6.13.2 Conservation status

Roseate tern is listed under Annex I of the EU Birds Directive (2009/147/EEC) and Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Roseate tern is also listed as a Species of Principal Importance on the NERC Act 2006 and is therefore included as a Priority Species on the UK BAP. The species is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). Coquet Island SPA is the only SPA within 100 km of the Development at which Arctic tern is a designated feature. There is no connectivity between Roseate tern from this SPA and the Development.

6.13.3 Sensitivity

Roseate terns are not considered vulnerable to disturbance and have a moderate habitat flexibility (Wade *et al.*, 2016). Roseate tern is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.13.4 Conclusion

There is no evidence to suggest that the sea areas through which the Development will pass are of importance for roseate tern. As a result roseate tern is not identified as a VOR.

6.14 Common tern (*Sterna hirundo*)

6.14.1 Abundance in relation to the Development

The density layers associated with Bradbury *et al.* (2014) suggest that offshore sea areas through which the Humber-pipeline will pass are of importance for common tern in the breeding season. The closest breeding colonies to the two pipelines are at the Teesmouth and Cleveland Coast SPA (Teesside Pipeline) and at the Humber Estuary (Humber Pipeline). The generic mean-maximum foraging range of common tern (Woodward *et al.*, 2019) (18 km) suggests connectivity between the Teesmouth and Cleveland Coast SPA and the Development.

6.14.2 Conservation status

Common tern is listed on Annex I of the EU Birds Directive, and the species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015).

Common tern is a breeding feature at the Teesmouth and Cleveland Coast SPA, The Wash SPA and North Norfolk Coast SPA with these sites the only SPAs within 100 km of the Development at which common tern is a breeding feature. There is connectivity between common tern from the Teesmouth and Cleveland Coast SPA and the Development.

6.14.3 Sensitivity
Common terns are not considered vulnerable to disturbance and have a moderate habitat flexibility (Wade *et al.*, 2016). Common tern is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.14.4 Conclusion
There is evidence that common tern are present in the sea areas through which the Development will pass in the breeding season (Bradbury *et al.*, 2014) and the project is within the foraging range of common tern from two SPA breeding colonies. The species is of conservation importance but is potentially vulnerable to the impacts associated with the Development. On the basis of SPA connectivity and potential impact sensitivity, common tern is identified as a VOR with an international conservation value due to connectivity between an SPA at which the species is a designated feature and the Development.

6.15 Arctic tern (*Sterna paradisaea*)

6.15.1 Abundance in relation to the Development
The density layers associated with Bradbury *et al.* (2014) suggest that offshore sea areas through which the two pipelines will pass are of importance for Arctic tern during the breeding season relevant to the species.

The closest breeding colony of Arctic tern to the Development pipelines are at Coquet Island (Teesside Pipeline) and on the north Norfolk coast (Humber Pipeline). Both of these breeding colonies are beyond the maximum site-specific (data available for Coquet Island only) (Wilson *et al.*, 2014) and generic foraging ranges (Woodward *et al.*, 2019) reported for Arctic tern. It is therefore unlikely that breeding birds will be present in the sea areas through which the Development will pass with birds that are present more likely to be non-breeding or immature birds. The months incorporated into the seasons (from Furness (2015)) used when modelling the density layers associated with Bradbury *et al.* (2014) are also likely to result in an overlap between the presence of breeding birds at colonies and the pre-breeding and post-breeding movements of birds. This can lead to certain sea areas appearing to be of importance in the breeding season with these areas actually representing the pre- and/or post-breeding movements of birds.

6.15.2 Conservation status
Arctic tern is listed on Annex I of the EU Birds Directive, and the species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2015). Coquet Island SPA is the only SPA within 100 km of the Development at which Arctic tern is a designated feature. There is no connectivity between Arctic tern from this SPA and the Development.

6.15.3 Sensitivity
Arctic terns are not considered vulnerable to disturbance and are considered to have a moderate habitat flexibility (Wade *et al.*, 2016). Arctic tern is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.15.4 Conclusion
There is evidence that Arctic tern are present in the sea areas through which the Development will pass in the breeding season (Bradbury *et al.*, 2014). The species is of conservation importance and is potentially vulnerable to the impacts associated with the Development. On the basis of potential impact sensitivity, Arctic tern is identified as a VOR with a national conservation value due to the species' inclusion on Annex I of the EU Birds Directive.

6.16 Great skua (*Stercorarius skua*)

6.16.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that the sea areas through which both Development pipelines will pass and the area in which the Endurance Store is located are not of importance for great skua. The Development is beyond the foraging range of great skua from those SPAs at which great skua is a designated breeding feature (Woodward *et al.*, 2019).

6.16.2 Conservation status

Great skua is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Great skua is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). There are no SPAs at which great skua is a designated feature within 100 km of the Development.

6.16.3 Sensitivity

Great skuas are not considered vulnerable to disturbance and have a moderate habitat flexibility (Wade *et al.*, 2016). Great skua is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.16.4 Conclusion

The density layers from Waggitt *et al.* (2019) suggest that the sea areas in which the Development is located are not important for great skua. The species is included on the UK Birds of Conservation Concern amber list and is considered vulnerable to impacts associated with the Development. Due to the expected low abundance of the species in the sea areas associated with the Development, great skua is not identified as a VOR.

6.17 Arctic skua (*Stercorarius parasiticus*)

6.17.1 Abundance in relation to the Development

The maps presented in Kober *et al.* (2010) suggest that the inshore areas of the Teesside Pipeline are of importance for Arctic skua between May and August and inshore areas of both pipelines between September and November, coinciding with movements of the species from breeding areas to wintering areas. However, the actual densities present in the areas associated with the Development are low with a maximum of approximately 0.2 birds/km^2 indicated by Kober *et al.* (2010). The closest breeding colonies to the Development are in northern Scotland (Orkney and Shetland) and therefore the relative high densities present inshore areas of the Teesside Pipeline inshore between May and August likely represent early post-breeding movements of birds in August.

6.17.2 Conservation status

Arctic skua is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Arctic skua is included as a Priority Species on the UK BAP but is not listed as a species of Principal Importance on the NERC Act (2006). The species is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). There are no SPAs at which Arctic skua is a feature within 100 km of the Development.

6.17.3 Sensitivity

Arctic skuas are not considered vulnerable to disturbance and have a moderate habitat flexibility (Wade *et al.*, 2016). Arctic skua is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.17.4 Conclusion

Although Kober *et al.* (2010) suggests the areas in which the Development will pass are of relative importance for Arctic skua in the post-breeding period, the actual densities present are low. The species is considered potentially vulnerable to loss of habitat however, in the post-breeding period birds will exhibit a higher level of habitat flexibility. Arctic skua is therefore not identified as a VOR due to the limited number of birds that may be exposed to any potential impacts.

6.18 Common guillemot (*Uria aalge*)

6.18.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that the sea areas through which both Development pipelines will pass and the area in which the Endurance Store is located are of importance for common guillemot outside of the breeding season. The generic mean-maximum foraging range of common guillemot is 73.2 km (Woodward *et al.*, 2019) and means that the Development is within the foraging range of common guillemot from the Flamborough and Filey Coast SPA. Cleasby *et al.* (2020) also suggests that the Development will pass through sea areas within the utilisation distribution of common guillemot from Flamborough and Filey Coast SPA in the breeding season.

6.18.2 Conservation status

Common guillemot is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). Common guillemot is a breeding feature at the Flamborough and Filey Coast SPA. The Development has connectivity with common guillemots from this SPA.

6.18.3 Sensitivity

Common guillemots are considered to have a moderate sensitivity to disturbance and have a moderate habitat flexibility (Wade *et al.*, 2016). Common guillemot is considered to have a high sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.18.4 Conclusion

There is evidence that common guillemot are present in the sea areas through which the Development will pass outside of the breeding season (Waggitt *et al.*, 2019) and where connectivity exists with birds from the Flamborough and Filey Coast SPA in the breeding season. The species is included on the UK Birds of Conservation Concern amber list and is considered vulnerable to impacts associated with the Development. Common guillemot is therefore identified as a VOR with an international conservation value due to connectivity between an SPA at which the species is a designated feature and the Development.

6.19 Razorbill (*Alca torda*)

6.19.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that inshore sea areas through which both Development pipelines will pass and the sea area in which the Endurance Store is located are of importance for razorbill outside of the breeding season. The generic mean-maximum foraging range of razorbill is 88.7 km (Woodward *et al.*, 2019) and means that the Development is within the foraging range of razorbill from the Flamborough and Filey Coast SPA. Cleasby *et al.* (2020) also suggests that the Development will pass through sea areas within the utilisation distribution of razorbill from Flamborough and Filey Coast SPA in the breeding season.

6.19.2 Conservation status

Razorbill is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). Razorbill is a breeding feature at the Flamborough and Filey Coast SPA. The Development has connectivity with razorbills from this SPA.

6.19.3 Sensitivity

Razorbills are considered to have a moderate sensitivity to disturbance and have a moderate habitat flexibility (Wade *et al.*, 2016). Razorbill is considered to have a high sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.19.4 Conclusion

There is evidence that razorbill are present in the sea areas in which the Development is located outside of the breeding season (Waggitt *et al.*, 2019) and where connectivity exists with birds from the Flamborough and Filey Coast SPA in the breeding season. The species is included on the UK Birds of Conservation Concern amber list and is considered potentially vulnerable to impacts associated with the Development. Razorbill is therefore identified as a VOR with an international conservation value due to connectivity between an SPA at which the species is a designated feature and the Development.

6.20 Puffin (*Fratercula arctica*)

6.20.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that inshore sea areas through which the Teesside Pipeline will pass are of importance for puffin outside of the breeding season. The generic mean-maximum foraging range of puffin is 137.1 km (Woodward *et al.*, 2019) and means that the Development is within the foraging range of puffin from the Coquet Island SPA and the Farne Islands SPA (Teesside Pipeline) although the density layers associated with Waggitt *et al.* (2019) suggest no connectivity between birds from these SPAs and the sea areas in which the Development will be located.

6.20.2 Conservation status

Puffin is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is however currently red-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). Coquet Island is the only SPA within 100 km of the Development at which puffin is a designated feature. There is connectivity between puffin from this SPA and the Development.

6.20.3 Sensitivity

Puffins are considered to have a moderate sensitivity to disturbance and have a moderate habitat flexibility (Wade *et al.*, 2016). Puffin is considered to have a high sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.20.4 Conclusion

There is evidence that puffin are present in the sea areas in which the Development is located in the non-breeding season (Waggitt *et al.*, 2019). There is also evidence for connectivity between the Development and birds from the Coquet Island SPA and Farne Islands SPA in the breeding season. The species is included on the UK Birds of Conservation Concern red list and is considered potentially vulnerable to impacts associated with the Development. Puffin is therefore identified as a VOR with an International conservation value due to connectivity between an SPA at which the species is a designated feature and the Development.

6.21 Red-throated diver (*Gavia stellata*)

6.21.1 Abundance in relation to the Development

The density layers associated with Bradbury *et al.* (2014) suggest that inshore sea areas through which Humber Pipeline will pass is of importance for red-throated diver in the non-breeding season. These areas correspond with the Greater Wash SPA at which red-throated diver is a qualifying feature. Red-throated diver do not breed in England and the foraging range of the species from breeding locations in Scotland does not interact with the sea areas in which the Development is located (Woodward *et al.*, 2019).

6.21.2 Conservation status

Red-throated diver is listed on Annex I of the EU Birds Directive (2009/147/EEC) and Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently green-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). Red-throated diver is a non-breeding feature at the Greater Wash SPA with this the only SPA at which red-throated diver is a designated feature within 100 km of the Development. The Development has connectivity with red-throated divers from this SPA.

6.21.3 Sensitivity

Red-throated divers are considered to have a high sensitivity to disturbance and have a low habitat flexibility (Wade *et al.*, 2016). Red-throated diver is considered to have a high sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.21.4 Conclusion

There is evidence that red-throated diver are present in the sea areas through which the Development will pass in the non-breeding season (Bradbury *et al.*, 2014) and in which connectivity exists with birds from the Greater Wash SPA in the non-breeding season. The species is of conservation concern and is considered vulnerable to impacts associated with the Development. Red-throated diver is therefore identified as a VOR with an international conservation value due to connectivity between an SPA at which the species is a designated feature and the Development.

6.22 Storm petrel (*Hydrobates pelagicus*)

6.22.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that the sea areas in which the Development is located are not of importance for storm petrel. The Development is not within foraging range of any SPAs at which storm petrel is a breeding feature (Woodward *et al.*, 2019) and there are no SPAs for the species in the non-breeding season.

6.22.2 Conservation status

Storm petrel is listed under Annex I of the EU Birds Directive (2009/147/EEC) but not on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). There are no SPAs at which storm petrel is a feature within 100 km of the Development.

6.22.3 Sensitivity

Storm petrels are not considered vulnerable to disturbance and have a high habitat flexibility (Wade *et al.*, 2016). Storm petrel is considered to have a low sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.22.4 Conclusion

There is no evidence to suggest that the sea areas through which the Development will pass are of importance for storm petrel. As a result storm petrel is not identified as a VOR.

6.23 Leach's petrel (*Hydrobates leucorhous*)

6.23.1 Abundance in relation to the Development

The maps presented in Kober *et al.* (2010) do not suggest that the sea areas associated with the Development are of importance for Leach's petrel at any point during the year. The Development is within the foraging range of Leach's petrel from SPAs at which the species is a breeding feature (Woodward *et al.*, 2019) however, based on the information presented in Kober *et al.* (2010) it is considered highly unlikely that birds utilise the sea areas in which the Development is located.

6.23.2 Conservation status

Leach's petrel is listed under Annex I of the EU Birds Directive (2009/147/EEC) and on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). There are no SPAs at which Leach's petrel is a feature within 100 km of the Development.

6.23.3 Sensitivity

Leach's petrels are not considered vulnerable to disturbance and have a high habitat flexibility (Wade *et al.*, 2016). Leach's petrel is considered to have a low sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.23.4 Conclusion

There is no evidence to suggest that the sea areas through which the Development will pass are of importance for Leach's petrel. As a result Leach's petrel is not identified as a VOR.

6.24 Fulmar (*Fulmarus glacialis*)

6.24.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that offshore sea areas through which both Development pipelines will pass and the sea area in which the Endurance Store is located are not of importance to fulmar in the breeding and non-breeding seasons relevant to the species. Fulmar have a large mean-maximum foraging range (542.3 km; Woodward *et al.*, 2019) meaning there that the Development is within foraging range of fulmar from a number of breeding colonies.

6.24.2 Conservation status

Fulmar is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Fulmar is however currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). Fulmar forms part of the breeding seabird assemblage at the Flamborough and Filey Coast SPA with this the only SPA at which fulmar is a designated feature within 100 km of the Development. The Development has connectivity with fulmars from this SPA.

6.24.3 Sensitivity

Fulmars are not considered vulnerable to disturbance and have a high habitat flexibility (Wade *et al.*, 2016). Fulmar is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.24.4 Conclusion

The density layers from Waggitt *et al.* (2019) suggest that the sea areas in which the Development is located are not important for fulmar. The species is included on the UK Birds of Conservation Concern amber list but is not vulnerable to any of the impacts associated with the Development. Fulmar is therefore not identified as a VOR.

6.25 Manx shearwater (*Puffinus puffinus*)

6.25.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that the sea areas through which both Development pipelines will pass are not of importance for Manx shearwater. Due to the species' large generic foraging range (Woodward *et al.*, 2019), the Development is within the foraging range of Manx shearwater from a number of breeding colonies that are located on the west coast of the UK but significant usage of the SNS by birds from these colonies is considered unlikely.

6.25.2 Conservation status

Manx shearwater is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Manx shearwater is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). There are no SPAs at which Manx shearwater is a designated feature within 100 km of the Development.

6.25.3 Sensitivity

Manx shearwaters are not considered vulnerable to disturbance and have a high habitat flexibility (Wade *et al.*, 2016). Manx shearwater is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.25.4 Conclusion

The density layers from Waggitt *et al.* (2019) suggest that the sea areas in which the Development is located are not important for Manx shearwater. . The species is included on the UK Birds of Conservation Concern amber list and is considered potentially vulnerable to impacts associated with the Development. Manx shearwater is not identified as a VOR as it is not considered that the abundance of birds within the sea areas through which the Development will pass will be more than negligible.

6.26 Gannet (*Morus bassanus*)

6.26.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggest that the sea areas through which both Development pipelines will pass and the area in which the Endurance Store is located are not of importance for gannet throughout the year, despite the presence of breeding birds at the Flamborough and Filey Coast SPA in close proximity to the Development. There are no sea areas of importance in the breeding season that would correspond with birds from the Flamborough and Filey Coast SPA. In contrast the tracking data presented in Wakefield *et al.* (2013) suggest that the sea areas through which both Development pipelines will pass and the area in which the Endurance Store is located are of importance for gannet in the breeding season.

Gannet have a large generic mean-maximum foraging range (315.2 km; Woodward *et al.*, 2019) meaning there that the Development is within foraging range of gannet from a number of breeding colonies.

6.26.2 Conservation status

Gannet is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Gannet is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.*, 2015). Gannet is a breeding feature at the Flamborough and Filey Coast SPA with this the only SPA at which gannet is a designated feature within 100 km of the Development. The Development has connectivity with gannets from this SPA.

6.26.3 Sensitivity

Gannets are not considered vulnerable to disturbance and have a high habitat flexibility (Wade *et al.*, 2016). Gannet is considered to have a moderate sensitivity to accidental contamination events (Webb *et al.*, 2016).

6.26.4 Conclusion

There is evidence that gannet are present in the sea areas through which the Development will pass in the breeding and non-breeding seasons (Bradbury *et al.*, 2014) with connectivity between the Development and birds from the Flamborough and Filey Coast SPA in the breeding season. The species is included on the UK Birds of Conservation Concern amber list and is considered vulnerable to impacts associated with the Development. Gannet is therefore identified as a VOR with an International conservation value due to connectivity between an SPA at which the species is a designated feature and the Development.

6.27 Shag (*Phalacrocorax aristotelis*)

6.27.1 Abundance in relation to the Development

The density layers associated with Waggitt *et al.* (2019) suggests that inshore sea areas through which the Teesside Pipeline will pass are of importance for shag in the non-breeding season. The Development is beyond the foraging range of shag from those SPAs at which shag is a designated breeding feature (Woodward *et al.*, 2019). It is therefore unlikely that breeding birds will be present in the sea areas through which the Development will pass.

6.27.2 Conservation status

Shag is listed on Annex I of the EU Birds Directive (2009/147/EEC) and the species is currently red-listed on the UK Birds of Conservation Concern list (Eaton *et al*., 2015). There are no SPAs at which shag is a designated feature within 100 km of the Development.

6.27.3 Sensitivity

Shags are considered to have a moderate sensitivity to disturbance and have a moderate habitat flexibility (Wade *et al*., 2016). Shag is considered to have a high sensitivity to accidental contamination events (Webb *et al*., 2016).

6.27.4 Conclusion

There is evidence that shag are present in the sea areas through which the Development will pass in the non-breeding season (Waggitt *et al*., 2019). The species is of conservation importance and is potentially vulnerable to the impacts associated with the Development. On the basis of potential impact sensitivity, shag is identified as a VOR with a National conservation value due to the species' inclusion on Annex I of the EU Birds Directive.

6.28 Cormorant (*Phalacrocorax carbo*)

6.28.1 Abundance in relation to the Development

The density layers associated with Bradbury *et al.* (2014) suggest that inshore sea areas through which both Development pipelines will pass are of high importance to cormorant in the breeding season with the inshore areas associated with the Teesside Pipeline of importance in the non-breeding season. The Development is beyond the foraging range of cormorant from those SPAs at which cormorant is a designated breeding feature (Woodward *et al*., 2019).

6.28.2 Conservation status

Cormorant is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently green-listed on the UK Birds of Conservation Concern list (Eaton *et al*., 2015). There are no SPAs at which cormorant is a designated feature within 100 km of the Development.

6.28.3 Sensitivity

Cormorants are not considered vulnerable to disturbance and have a moderate habitat flexibility (Wade *et al*., 2016). Cormorant is considered to have a moderate sensitivity to accidental contamination events (Webb *et al*., 2016).

6.28.4 Conclusion

The sea areas through which the Development will pass are considered to be high importance for cormorant in both the breeding and non-breeding seasons The species is of conservation importance and is vulnerable to impacts associated with the Development, and therefore the species is identified as a VOR with negligible importance due to the species' inclusion on the UK Birds of Conservation Concern green list.

6.29 Terrestrial and intertidal species

The Teesside pipeline makes landfall at Redcar on the North Yorkshire coast. The landfall location is within the Teesmouth and Cleveland Coast SPA which is designated to protect a number of intertidal and terrestrial bird species. These include, in addition to seabird species already discussed above, avocet, knot, redshank, ruff and a non-breeding waterbird assemblage which includes as main components, gadwall, shoveler and sanderling. Of these species, only knot, redshank and sanderling may utilise areas that may be affected by impacts associated with the Development (Ward *et al*., 2003) and are therefore identified as VORs.

The Humber pipeline makes landfall between Easington and Out Newton on the East Riding of Yorkshire coast. The landfall location is within the Humber Estuary SPA. The part of the SPA located at the landfall is also designated as part of The Lagoons SSSI. Of the species included on the SPA and SSSI citations only little tern is included on both.

There are therefore no intertidal or terrestrial species that may be affected by impacts associated with the Humber pipeline.

7 Identification of Valued Ornithological Receptors

The following section summarises the identification of VORs in Section 6. Table 7.1 includes the justification for the inclusion or otherwise of each species included in Section 6. The following species have been identified as VORs:

- Kittiwake
- Great black-backed gull
- Sandwich tern
- Little tern
- Common tern
- Arctic tern
- Common guillemot
- Razorbill
- Puffin
- Red-throated diver
- Gannet
- Shag
- Cormorant

Knot, sanderling and redshank have also been identified as VORs due to their inclusion on the designation of an SPA which is located at the landfall of the Teesside pipeline.

Table 7.1: Identification of VORs for consideration in assessment

Species	Conservation importance					SPA connectivity	Sensitivity				VOR?	Conservation value
	Annex 1	Schedule 1	NERC Act	UK BAP	BoCC		Habitat loss	Accidental contamination	Disturbance	Indirect effects		
Common eider	No	No	No	No	Amber	No	High	Moderate	Moderate	High	No	-
Velvet sco-ter	No	Yes	No	No	Red	No	Moderate	Moderate	Moderate	Moderate	No	-
Common scoter	No	No	Yes	Yes	Red	No	High	Moderate	High	High	No	-
Red-breasted merganser	No	No	No	No	Green	No	High	Moderate	Moderate	High	No	-
Knot	No	No	No	No	Amber	Yes	n/a	n/a	High	n/a	Yes	International
Sanderling	No	No	No	No	Amber	Yes	n/a	n/a	Low	n/a	Yes	International
Redshank	No	No	No	No	Amber	Yes	n/a	n/a	High	n/a	Yes	International
Kittiwake	No	No	No	No	Red	No	Moderate	Moderate	Low	Moderate	Yes	International
Little gull	No	No	No	No	Green	No	Moderate	Moderate	Low	Moderate	No	-
Common gull	No	No	No	No	Amber	No	Moderate	Moderate	Low	Moderate	No	-
Great black-backed gull	No	No	No	No	Amber	No	Moderate	Moderate	Low	Moderate	Yes	Local
Herring gull	No	No	Yes	Yes	Red	No	Low	Moderate	Low	Low	No	-
Lesser black-backed gull	No	No	No	No	Amber	No	Low	Moderate	Low	Low	No	-
Sandwich tern	Yes	No	No	No	Amber	No	Moderate	Moderate	Low	Moderate	Yes	National
Little tern	Yes	Yes	No	No	Amber	Yes	High	Moderate	Low	High	Yes	International

Species	Conservation importance					SPA connectivity	Sensitivity				VOR?	Conservation value
	Annex 1	Schedule 1	NERC Act	UK BAP	BoCC		Habitat loss	Accidental contamination	Disturbance	Indirect effects		
Roseate tern	Yes	Yes	Yes	Yes	Red	No	Moderate	Moderate	Low	Moderate	No	-
Common tern	Yes	No	No	No	Amber	Yes	Moderate	Moderate	Low	Moderate	Yes	International
Arctic tern	Yes	No	No	No	Amber	No	Moderate	Moderate	Low	Moderate	Yes	National
Great skua	No	No	No	No	Amber	No	Moderate	Moderate	Low	Moderate	No	-
Arctic skua	No	No	No	Yes	Red	No	Moderate	Moderate	Low	Moderate	No	-
Common guillemot	No	No	No	No	Amber	Yes	Moderate	High	Moderate	Moderate	Yes	International
Razorbill	No	No	No	No	Amber	Yes	Moderate	High	Moderate	Moderate	Yes	International
Puffin	No	No	No	No	Red	No	Moderate	High	Moderate	Moderate	Yes	International
Red-throated diver	Yes	Yes	No	No	Green	Yes	High	High	High	High	Yes	International
Storm petrel	Yes	No	No	No	Amber	No	Low	Low	Low	Low	No	-
Leach's pet-rel	Yes	Yes	No	No	Amber	No	Low	Low	Low	Low	No	-
Fulmar	No	No	No	No	Amber	Yes	Low	Moderate	Low	Low	No	-
Manx shear-water	No	No	No	No	Amber	No	Low	Moderate	Low	Low	No	-
Gannet	No	No	No	No	Amber	Yes	Low	Moderate	Low	Low	Yes	International
Shag	Yes	No	No	No	Red	No	Moderate	High	Moderate	Moderate	Yes	National
Cormorant	No	No	No	No	Green	No	Moderate	Moderate	Low	Moderate	Yes	Negligible

8 References

Bell, A. and Leakey, M. (2019). Little tern project 2019 report. [Online]. Available at: http://www.inca.uk.com/wp-content/uploads/2019/11/Cleveland-Little-Tern-Report-2019.pdf (Accessed October 2021).

Bradbury, G., Trinder, M., Furness, B., Banks, A.N., Caldow, R.W.G. and Hume, D. (2014). Mapping Seabird Sensitivity to Offshore Wind Farms. PLOS ONE, 12 (1), pp. 1-17.

Cleasby, I.R. Owen, E., Wilson, L.J., Wakefield, E.D., O'Connell, P. and Bolton, M. (2020). Identifying important at-sea areas for seabirds using species distribution models and hotspot mapping. Bioloigcal Conservation, 241, pp. 2-12.

Eaton, M.A., Aebischer, N.J., Brown, A.F., Hearn, R.D., Lock, L., Musgrove, A.J., Noble, D.G., Stroud, D.A. and Gregory, R.D. (2015). Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man. British Birds 108, 708-746.

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters. [Online]. Available at: http://publications.naturalengland.org.uk/publication/6427568802627584 (Accessed May 2015).

Lawson, J., Kober, K., Win, I., Allcock, Z., Black, J., Reid, J.B., Way, L. and O'Brien, S.H., 2015. An assessment of the numbers and distributions of wintering red-throated diver, little gull and common scoter in the Greater Wash. JNCC Report 574. Peterborough: JNCC.MacArthur Green, 2014. Biologically appropriate, species-specific, geographic non-breeding season population estimates for seabirds. [Online]. Available at: https://nepubprod.appspot.com/review/agtzfm5lcH-VicHJvZHIWCxIJTkVQdWJQcm9kGICAgNrvurULDA (Accessed October 2014).

Parsons, M., Lawson, J., Lewis, M., Lawrence, R. and Kuepfer, A., 2015. Quantifying foraging areas of little tern around its breeding colony SPA during chick-rearing. Peterborough: JNCC.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Redd, T.C., Tasker, M.L., Camphuysen, C.J. and Pienkowski, M.W. (1995). An atlas of seabird distribution in north-west European waters. Joint Nature Conservation Committee and Nederlands Institute voor Onderzoek der Zee, Peterborough.

Stroud, D.A., Bainbridge, I.P., Maddock, A., Anthony, S., Baker, H., Buxton, N., Chambers, D., Enlander, I., Hearn, R.D., Jennings, K.R, Mavor, R., Whitehead, S. & Wilson, J.D. (2016). The status of UK SPAs in the 2000s: the Third Network Review. JNCC, Peterborough.

Wade H.M., Masden. E.A., Jackson, A.C. and Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. Marine Policy, 70, pp. 108–113.

Wakefield, E.D., Bodey, T.W., Bearhop, S., Blackburn, J., Colhoun, K., Davies, R., Dwyer, R.G., Green, J.A., Grémillet, D., Jackson, A.L., Jessopp, M.J., Kane, A., Langston, R.H.W., Lescroël, A., Murray, S., Le

Nuz, M., Patrick, S.C., Péron, C., Soanes, L.M., Wanless, S., Votier, S.C. and Hamer, K.C. (2013). Space Partitioning Without Territoriality in Gannets. Science, 341 (6141), 68-70.

Williams, J.M., Tasker, M.L., Carter, I.C. and Webb, A. (1995). A method of assessing seabird vulnerability to surface pollutants. Ibis, 1137, S147-S152.

Wilson, L.J., Black, J., Brewer, M.J., Potts, J.M., Kuepfer, A., Win, I., Kober, K., Bingham, C., Mavor, R. and Webb, A., 2014. Quantifying usage of the marine environment by terns Sterna sp. around their breeding colony SPAs. JNCC Report 500. Peterborough: JNCC.

Woodward, I., Thaxter, C.B., Owen, E. and Cook, A.S.C.P. (2019). Desk-based revision of seabird foraging ranges used for HRA screening. [Online]. Available at: http://www.marinedataexchange.co.uk/ (Accessed July 2020)

Appendix I: Archaeological Assessment

Offshore CCS Infrastructure: Northern Endurance Partnership

Marine Archaeological Technical Report

Ref: 254110.03
July 2023

wessexarchaeology

Portway House
Old Sarum Park
Salisbury
Wiltshire
SP4 6EB

www.wessexarch.co.uk

Report Information

Document title	Northern Endurance Partnership
Document subtitle	Marine archaeological technical report
Document reference	254110.03
Client name	Wessex Archaeology
Address	21-23 Slaters Steps Edinburgh EH8 8PB
On behalf of	Xodus Group Limited
Address	50 Huntly St, Aberdeen AB10 1RS
Site location	Southern North Sea
WA project name	Offshore CCS Infrastructure: Northern Endurance Partnership
WA project code(s)	254110; 254111
Project management by	Dr Andrew Bicket
Document compiled by	Dr Robert MacKintosh
Contributions from	Abby Mynett, David Howell, Stephanie Said
Graphics by	Amy Wright

Quality Assurance

Version & issue date		Status	Author	Approved by
V1	16/09/2022	External Draft	RM/DH	AB
V2	30/09/2022	Updated	RM/DH	AB
V3	05/10/2022	Updated following client comments	BJS	AB
V4	18/07/2023	Updated Project Information	SS	AB

Contents

Summary ... *iii*
Acknowledgements ... *v*

1 INTRODUCTION ... 1
1.1 Project background ... 1
1.2 Development proposal ... 1
1.3 Previous Work ... 2
1.4 Scope of document ... 2
1.5 Aims ... 2
1.6 Copyright ... 3

2 LEGISLATION, GUIDANCE AND POLICY ... 3
2.1 Introduction ... 3
2.2 Marine legislation ... 4
2.3 International conventions ... 4
2.4 National planning policy framework (NPPF) ... 4
2.5 Marine policy ... 4
2.6 Marine guidance ... 5

3 METHODOLOGY ... 6
3.1 Introduction ... 6
3.2 Study Area ... 6
3.3 Coordinate system ... 7
3.4 Archaeological desk-based assessment ... 7
3.5 Geophysical methodology ... 9
3.6 Impact assessment criteria ... 14
3.7 Assumptions and limitations ... 18

4 MARINE ARCHAEOLOGICAL ASSESSMENT: PALAEOGEOGRAPHY ... 18
4.1 Geological baseline ... 18
4.2 Prehistory Baseline ... 19

5 MARINE ARCHAEOLOGICAL ASSESSMENT: MARITIME AND AVIATION SITES ... 24
5.1 Introduction ... 24
5.2 Designated Maritime and Aviation Receptors ... 24
5.3 Geophysical seabed features assessment ... 24
5.4 Maritime archaeological potential ... 41
5.5 Aviation archaeological potential ... 43
5.6 Value ... 44

6 HISTORIC SEASCAPE CHARACTER ... 46

7 CONCLUSIONS AND RECOMMENDATIONS ... 50
7.1 Introduction ... 50
7.3 Seabed features ... 51
7.4 Recommendations ... 51

REFERENCES ... 54

APPENDICES ... 58
Appendix 1: Terminology ... 58
Appendix 2: Legislation, policy and guidance ... 60
Appendix 3: Palaeogeographic features of archaeological potential ... 65
Appendix 4: Seabed anomalies of archaeological potential: Humber Pipeline GSA ... 66
Appendix 5: Seabed anomalies of archaeological potential: Teesside Pipeline GSA ... 127
Appendix 6: Seabed anomalies of archaeological potential: Endurance Store GSA ... 211

Appendix 7: Maritime recorded losses 220
Appendix 8: Aviation recorded losses 225

List of Figures

Figure 1 Project Development Area Location
Figure 2 Sea level curve and chronology of the southern North Sea
Figure 3 A to **C** Palaeolandscape features of archaeological potential
Figure 4 A to **R** Seabed features of archaeological potential
Figure 5 Seabed features of archaeological potential data examples

Wreck Sheets

Sheet 1 ID 7007 – UKHO 8870/8869 – *Francis*
Sheet 2 ID 7040 – UKHO 8911 – *Paraciers*
Sheet 3 ID 7063 – UKHO 8945 – *John Rettig* (Probably)
Sheet 4 ID 7066 – UKHO 8951 – *Horsted*
Sheet 5 ID 7072 – UKHO 8958 – *Helmsman* (Probably)
Sheet 6 ID 7078 – UKHO 8967 – *Onward* (Possibly)
Sheet 7 ID 7188 – UKHO 6605 – Unknown
Sheet 8 ID 7210 – UKHO 6389 – *Teesdale* (Possibly)
Sheet 9 ID 7217 – UKHO 6063 – *John Miles*
Sheet 10 ID 7253 – UKHO 6018 – *Earl Percy*
Sheet 11 ID 7260 – UKHO 6353 – Unknown
Sheet 12 ID 7262 – UKHO 6057 – *Afrique*
Sheet 13 ID 7263 – UKHO 6351 – *Audax*
Sheet 14 ID 7264 – UKHO 6355 – *Rutil*
Sheet 15 ID 7270 – UKHO 6362 – Unknown
Sheet 16 ID 7308 – UKHO 6039 – *Gwalia* (Possibly)
Sheet 17 ID 7319 – UKHO 87230 – Unknown
Sheet 18 ID 7339 – UKHO 6226 and 66452 – *Black Prince* (Possibly)
Sheet 19 ID 7536 – UKHO 6832 – Unknown
Sheet 20 ID 7541 – UKHO 6830 – Unknown

List of Tables

Table 1 Software used for geophysical assessment
Table 2 Criteria for assigning data quality rating
Table 3 Criteria discriminating relevance of identified features to proposed scheme
Table 4 Criteria to assess the archaeological value of marine assets
Table 5 Value of seabed prehistory heritage assets.
Table 6 Shallow stratigraphy of the ASA
Table 7 Anomalies of archaeological potential within the Teesside Pipeline GSA
Table 8 Types of anomaly identified
Table 9 Anomalies of archaeological potential within the Humber Pipeline GSA
Table 10 Types of anomaly identified
Table 11 Anomalies of archaeological potential within the Endurance Store GSA
Table 12 Types of anomaly identified
Table 13 Recorded Losses – summary by date
Table 14 Summary of key periods of maritime potential
Table 15 Summary of key periods of aviation potential
Table 16 Identified archaeological receptor value
Table 17 Primary Cultural Processes in Teesside Pipeline and Humber Pipeline ASA
Table 18 Primary Cultural Processes in the Endurance Store ASA.
Table 19 Recommended AEZs within the Development Area

Summary

Wessex Archaeology was commissioned by Xodus Group Limited on behalf of BP Exploration Operating Company Ltd. to provide consultancy services in relation to the marine archaeological environment for the Northern Endurance Partnership (NEP) carbon capture and storage (CCS) development. The proposed development area (hereafter 'the Development Area') comprises an offshore geological storage site, the Endurance Store, approximately 63 km from the nearest coastline, and two 28", concrete coated, CO_2 export pipelines running from Humber ('the Humber Pipeline') and Teesside ('the Teesside Pipeline') to a subsea manifold and well injection site at the Endurance Store.

This document comprises a desk-based assessment and an assessment of geophysical data (obtained from three Geophysical Study Areas and comprising sub-bottom profiler, sidescan sonar and magnetometer data sets acquired by Gardline Geosurvey Ltd and multibeam echosounder, Pseudo SSS mosaic and Backscatter mosaic data acquired by XOCEAN Ltd) to describe the marine archaeological baseline in the Development Area. The aims of the document were to assess the known and potential marine archaeological resource within the Archaeological Study Area, comprising a 250 m buffer around the Development Area, up to the Mean Low-Water Spring (MLWS). This will inform the environmental impact assessment within the NEP Environmental Statement.

A total of five palaeogeographic features of archaeological potential were identified, all within the Humber Pipeline Geophysical Study Area. These are summarised as follows:

- a total of 2 channels were assigned a P1 archaeological rating;
- a total of 3 cut and fills assigned a P2 archaeological rating;

Additionally, one palaeochannel feature was previously identified within the local Historic Environment Record but was not identified within sub-bottom profiler data. This has been retained within the gazetteer as a precaution.

Further work would be needed to ground truth and confirm (or otherwise) the assessment of these features. As such it is recommended that, should any future ground investigation (e.g. coring) work be carried out within any of these areas, a suitably qualified archaeological contractor be consulted during the geotechnical site selection process, and that any resulting logs (or samples, for any cores taken for archaeological purposes) be made available for geoarchaeological assessment.

Additionally, it is recommended that if any objects of possible archaeological interest are recovered during any groundwork operations, that they should be reported using a pre-agreed reporting protocol. This will establish whether the recovered objects are of archaeological interest and recommend appropriate mitigation measures.

The assessment of the geophysical data and secondary sources within the Geophysical Study Areas resulted in a total of 542 anomalies identified as being of possible archaeological interest. These are summarised as follows:

- a total of 25 were assigned an A1 archaeological discrimination (Anthropogenic origin of archaeological interest);
- a total of 95 were assigned an A2_h archaeological discrimination (Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature);

- a total of 415 were assigned an A2_l archaeological discrimination (Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature); and

- a total of seven items, four recorded wrecks and three recorded obstructions, were assigned an A3 archaeological discrimination (Historic record of possible archaeological interest with no corresponding geophysical anomaly).

There is the potential for further unknown maritime, aircraft and seabed prehistory sites and artefacts to be located within the Development Area.

Archaeological Exclusion Zones of 100 m are recommended for the 20 wrecks identified within the Archaeological Study Area, for the four items of debris and debris fields associated with wrecks, for a very large magnetic anomaly that may represent ferrous debris, for four recorded wrecks and for three recorded obstructions.

Acknowledgements

This project was commissioned by Xodus Group Limited on behalf of BP Exploration Operating Company Ltd. Wessex Archaeology is grateful to Mairi Dorward in this regard.

Data was provided by the United Kingdom Hydrographic Office (UKHO), the National Record of the Historic Environment (NRHE), the Redcar and Cleveland, North Yorkshire and Humber Historic Environment Records (HERs). Wessex Archaeology is grateful to the staff of all the above organisations for their assistance during the project. Geophysical data was acquired by XOCEAN and Gardline on behalf of BP Exploration Operating Company Ltd.

The report was researched and compiled by Dr Robert MacKintosh, with illustrations prepared by Amy Wright. The geophysical assessment was undertaken by Abby Mynett, with contributions from David Howell. Tim Marples and Dr Andrew Bicket managed the project on behalf of Wessex Archaeology.

Offshore CCS Infrastructure: Northern Endurance Partnership

Marine archaeological technical report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by Xodus Group to prepare a marine archaeological technical report for the offshore routes and offshore geological storage site of a Carbon Capture and Storage (CCS) infrastructure project (hereafter 'the Development', **Figure 1**). The technical report will inform an Environmental Impact Assessment (EIA) submitted through the Environmental Statement (ES).

1.1.2 The technical report will assess the baseline marine historic environment of the Development Area and consider potential impacts associated with activity to the seaward side of the Mean Low Water Springs (MLWS). The development falls within English territorial waters and the UK Exclusive Economic Zone (EEZ).

1.2 Development proposal

1.2.1 Northern Endurance Partnership (NEP) will route CO_2 from industrial clusters in the Teesside and Humber regions to the offshore geological storage site, the Endurance Store which is located approximately 63 km from the nearest coastline. The Teesside Pipeline runs for approximately 142 km between Teesside and the Endurance Store. The Humber Pipeline runs for approximately 100 km between Easington on the East Yorkshire coast and the Endurance Store.

1.2.2 At the Endurance Store, two manifolds will combine and distribute the CO_2 through infield flowlines to five injection wells.

1.2.3 Aspects of the development within the scope of this ES which may impact the historic marine environment include:

- Installation, connection to subsea infrastructure and commissioning of two CO_2 export pipelines from Teesside and Humber clusters MLWS to the Endurance Store, including a Subsea Safety Isolation Valve (SSIV) nearshore Teesside;
- Installation of subsea infrastructure including two manifolds, infield flowlines and an infield pipeline;
- Drilling of five CO_2 injection wells and one Endurance Store observation well and installation of six subsea trees;
- Operation and maintenance of subsea infrastructure and pipelines;
- Monitoring and management of the storage aquifer during and after CO_2 injection; and
- Installation, commissioning and operation and maintenance of cables:

- One electric power and fibre-optic communications control cable running from Teesside to the subsea infrastructure at the Endurance Store;
- One electric power and fibre-optic communications control cable between the two manifolds and six cables from the manifolds to each of the wells; and
- One power, control and hydraulics umbilical running from Teesside to the SSIV.

1.2.4 The Endurance Store, the Teesside Pipeline and the Humber Pipeline are within a Development Area. To provide baseline context for the desk-based assessment an Archaeological Study Area (ASA) comprising a further 250 m buffer around the Development Area was created. An area that did not have the same boundaries as the Development Area was subject to geophysical survey, and forms three Geophysics Study Areas (GSAs), each relating to an area around the three offshore components of the Development: the Humber Pipeline, the Teesside Pipeline and the Endurance Store (**Figure 1**; **Section 3.2**).

1.3 Previous Work

1.3.1 Wessex Archaeology has previously produced archaeological assessments for other aspects of the Development. This includes an assessment of geophysical data and secondary sources to support a marine licence application for a Ground Investigation works package at three landfall sites (Wessex Archaeology 2022).

1.3.2 Parts of the Development Area have previously been assessed by Wessex Archaeology for the Tolmount pipeline and Tolmount Area Development (Wessex Archaeology 2017) and Humber Gateway Offshore Wind Farm (Wessex Archaeology 2014).

1.4 Scope of document

1.4.1 This report comprises the desk-based assessment, as far as is possible from available information, looking at the nature, extent, and significance of the known and potential marine archaeological resource between MLWS at the Teesside Pipeline and Humber Pipeline landfalls and the Endurance Store Area. An additional 250 m buffer has been added to the Development Area to form the ASA in order to capture nearby archaeological receptors that may be relevant to the archaeological baseline.

1.4.2 The report also consists of an assessment of geophysical survey data from the three GSAs, comprising sub-bottom profiler (SBP), sidescan sonar (SSS) and magnetometer (Mag.) data sets acquired by Gardline Geosurvey Ltd. (Gardline), and multibeam echosounder (MBES), Pseudo SSS mosaic and Backscatter mosaic data acquired by XOCEAN Ltd. (XOCEAN). The data was acquired through multiple surveys during 2020 and 2021.

1.5 Aims

1.5.1 The aim of the marine archaeological desk-based assessment is to summarise the known and potential archaeological baseline within the ASA to subsequently inform the Written Scheme of Investigation (WSI) and the mitigation strategy therein.

1.5.2 The specific objectives of this assessment are to:

- Provide details of relevant legislation, national and local planning policy, and best practice guidance;

- outline the known and potential marine heritage assets within the ASA based on a review of existing information; and

- assess the significance of known and potential heritage assets through weighted consideration of their valued components.

1.5.3 The aim of the geophysical assessment is to identify any anomalies of archaeological and palaeoenvironmental potential within the GSAs, in order to further inform the planning process ahead of the Development. This is to be undertaken through the following objectives:

- identify any buried palaeolandscape features of possible archaeological potential;

- confirm the presence of known or previously located marine sites of archaeological potential and to comment on their apparent character;

- identify, locate and characterise hitherto unrecorded marine sites of archaeological potential;

- compare the results with known records (e.g. from the United Kingdom Hydrographic Office (UKHO) and the NRHE); and

- provide recommendations for archaeological mitigation.

1.6 Copyright

2 LEGISLATION, GUIDANCE AND POLICY

2.1 Introduction

2.1.1 The assets of the planned development are partly located within English Territorial Waters (up to 12 nautical miles (NM) from the coast), and partly beyond territorial waters, but within the UK marine area.

2.1.2 Historic England (HE) is responsible for the archaeological resource within England's Territorial Waters (to the 12 nautical miles (NM) limit) and is consultee for the resource in the UK Exclusive Economic Zone (EEZ). The Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) is responsible for regulating environmental and decommissioning activity for offshore oil and gas operations, including carbon capture and storage operations, on the UK continental shelf. The regulations covering environmental impact assessment for OPRED regulated works are set out in The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020.

2.1.3 The following section provides a summary of the national, regional and local planning and legislative framework that governs the treatment of the marine historic environment in the planning process.

2.2 Marine legislation

2.2.1 Within English Territorial Waters the following legislation applies:

- *Marine and Coastal Access Act* 2009 (MCAA)
- *Protection of Wrecks Act* 1973*:* Section One and Two;
- *Ancient Monuments and Archaeological Areas Act* 1979 (AMAA);
- *Protection of Military Remains Act* 1989 (PMRA); and
- *Merchant Shipping Act* 1995.

2.2.2 The *Marine and Coastal Access Act* 2009 (MCAA) is the primary legislation relevant to marine development within English Territorial Waters.

2.2.3 Marine historic assets may also be designated under the *Protection of Wrecks Act* 1973 and the AMAA 1979. Military wrecks and aircraft remain may be protected under the PMRA 1986. Ownership of any wreck remains is determined in accordance with the *Merchant Shipping Act* 1995*.*

2.2.4 Within the EEZ the following legislation applies:

- *Marine and Coastal Access Act* 2009;
- *Protection of Military Remains Act* 1989; and
- *Merchant Shipping Act* 1995*.*

2.3 International conventions

2.3.1 The United Nations Educational, Scientific and Cultural Organisation (UNESCO) Convention was concluded in 2001 and is a comprehensive attempt to codify the law internationally with regards to underwater cultural heritage. The UK has not ratified the Convention, but has stated that it has adopted the Annex of the Convention, which governs the conduct of archaeological investigations, as best practice for archaeology.

2.4 National planning policy framework (NPPF)

2.4.1 The primary planning framework relevant in England is the National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, 2021). A core planning principle is to conserve heritage assets in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life of this and future generations.

2.5 Marine policy

2.5.1 UK Marine Policy Statement (MPS) was adopted in 2011 by all UK Administrations in March 2011 as part of a new system of marine planning being introduced across UK seas (DEFRA 2011). The statement was intended to facilitate and support the formulation of Marine Plans, ensuring that marine resources are used in a sustainable way in line with high level marine objectives.

2.5.2 Under the MCAA, England was divided into marine planning regions, with an associated authority responsible for preparing a Marine Plan for that area. The MPS sets out the framework for preparing Marine Plans and making decisions affecting the marine environment. The MPS also states that Marine Plans must ensure a sustainable marine environment that will protect heritage assets.

2.5.3 The MMO have divided the inshore and offshore waters around England into 11 plan areas for which marine plans are to be produced. The Teesside Pipeline's landfall is within the North East Inshore marine plan area and the Humber Pipeline's landfall is within the East Inshore marine plan area. Both pipelines travel through both the North East Offshore area and East Offshore area. The Endurance Store Area is within the East Offshore area.

2.5.4 The East Inshore and East Offshore Marine Plan Policy SOC2 states that proposals that may affect heritage assets should demonstrate, in order of preference:

(a) that they will not compromise or harm elements which contribute to the significance of the heritage asset;

(b) how, if there is compromise or harm to a heritage asset, this will be minimised;

(c) how, where compromise or harm to a heritage asset cannot be minimised, it will be mitigated against; or

(d) the public benefits for proceeding with the proposal if it is not possible to minimise or mitigate compromise or harm to the heritage asset (DEFRA 2014).

2.5.5 The North East Inshore and North East Offshore Marine Plan (DEFRA 2021) states that proposals unable to conserve and enhance elements contributing to the significance of heritage assets will only be supported if they demonstrate that they will, in order of preference:

(a) avoid;

(b) minimise;

(c) mitigate harm to those elements contributing to the significance of heritage assets;

(d) if it is not possible to mitigate, then public benefits for proceeding with the proposal must outweigh the harm to the significance of heritage assets.

2.6 Marine guidance

2.6.1 There is no specific heritage guidance for offshore CCS developments, therefore the guidance below is taken from current best practice in related industries. The assessment has therefore been completed in line with the following national, regional and industry specific standards and guidance:

- Code of Conduct (CIfA 2014a);

- Standard and Guidance for Archaeological Advice by Historic Environment Services (CIfA 2014b);

- Standard and Guidance for Historic Environment Desk-based Assessment (CIfA 2014c);
- Regulations for Professional Conduct (CIfA 2019);
- Overarching National Policy Statement for Energy (EN-1), London, TSO (Department of Energy & Climate Change 2011);
- Military Aircraft Crash Sites – Archaeological Guidance on their Significance and Future Management (English Heritage (now Historic England) 2002);
- Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record (Historic England 2015a);
- Managing Significance in Decision-Taking in the Historic Environment (Historic England 2015b);
- Preserving Archaeological Remains: Decision-Taking for Sites under Development (Historic England 2016);
- Deposit Modelling and Archaeology. Guidance for Mapping Buried Deposits, Historic England, Swindon ((English Heritage (now Historic England) 2020);
- Code of Practice for Seabed Development (Joint Nautical Archaeology Policy Committee (JNAPC) 2006);
- Our Seas - A shared resource: High level marine objectives (DEFRA 2009);
- Ships and Boats: Prehistory to Present - Designation Selection Guide (English Heritage (now Historic England) 2012);
- Marine Geophysics Data Acquisition, Processing and Interpretation Guidance Notes (English Heritage (now Historic England) 2013);

3 METHODOLOGY

3.1 Introduction

3.1.1 The methodology employed during this assessment follows best practice professional guidance outlined by the Chartered Institute for Archaeologists' Standard and guidance for historic environment desk-based assessment (CIfA 2014c).

3.2 Study Area

3.2.1 The Development Area comprises two pipeline corridors approximately 142 km and 100 km in length from MLWS at Teesside and Humber to the Endurance Store. The Development Area around the Humber Pipeline and the Teesside Pipeline is defined by a 2.0 km corridor centred on the two pipeline routes. The Endurance Store itself is an area approximately 21 km long by 9 km wide (**Figure 1**).

3.2.2 An additional 250 m buffer was added around the pipeline corridors and the Endurance Site, extending above MLWS at the two landfalls. which comprises the ASA, used to conduct the desk based assessment.

3.2.3 Three separate GSAs covers the area subject to geophysical survey. The GSAs around the Humber Pipeline and the Teesside Pipeline is defined by a 2.0 km corridor centred on the two pipeline routes, and the GSA around the Endurance Store is defined by the SBP data extents (**Figure 1**). The assessment of geophysical data in these GSAs incorporates and supersedes the desk-based assessment, so unless otherwise stated, the assessment and mitigation are all contained within the GSAs.

3.3 Coordinate system

3.3.1 The survey data was acquired in ED50 UTM31N and the results are presented in the same coordinate system.

3.3.2 Information relating to the archaeological and cultural heritage that did not include location or positional information were used to inform the marine archaeological baseline assessment where relevant.

3.4 Archaeological desk-based assessment

Key themes

3.4.1 The marine themes relevant to marine archaeological baseline as assessed in this report are:

- Seabed prehistory (for example, palaeochannels and other features that contain prehistoric sediment, and derived Palaeolithic artefacts e.g. handaxes); and
- Seabed features, including maritime sites (such as shipwrecks and associated material including cargo, obstructions and fishermen's fasteners) and aviation sites (aircraft crash sites and associated debris); and
- Historic seascape character.

Data sources

3.4.2 Database searches of the following sources were completed to establish a baseline to MLWS at both landfalls and across the entire marine element of the Development covered by the ASA.

3.4.3 The sources consulted were:

- The Wrecks and Obstructions database held by the UKHO;
- Historic England's NRHE;
- Databases of designated assets held by Historic England;
- North Yorkshire HER;
- Humber HER;
- Redcar and Cleveland HER;
- Historical maps and Ordnance Survey maps;
- Admiralty Charts; and,

- Relevant primary and secondary sources in Wessex Archaeology's own library and those available through the Archaeology Data Service and other websites. Both published and unpublished archaeological reports relating to excavations and observations in the area around the ASA were reviewed.

Data structure

3.4.4 In order to compile the marine archaeological baseline as presented in this report, where possible, the data were incorporated into a project Geographic Information System (GIS) using ArcGIS 10.8.1, enabling the data to be spatially analysed. The data were subsequently compiled into gazetteers of maritime and aviation resources within the ASA; these were used to inform the archaeological assessment of geophysical data that are presented in **Section 5**.

3.4.5 The UKHO, NRHE and HER records have been discriminated between records for which there is known material on the seabed and 'recorded losses' (vessels that are known to have been lost, but do not, except by chance, have material on the seabed at their recorded loss location). A list of recorded losses within the ASA is provided in **Appendices 7** and **8.**

3.4.6 Information relating to the archaeological and cultural heritage that did not include location or positional information were also used to inform the marine archaeological baseline assessment where relevant.

3.4.7 For archaeological sites that were recorded in a national or local HER as well as the UKHO database, the co-ordinates from the UKHO are the ones used. As these relate to surveyed co-ordinates and supporting survey metadata, they are judged likely to be more accurate (unless other verifiable spatial data is available).

3.4.8 Some NRHE and HER heritage assets were provided as polygons. These may overlap the ASA while their centroid point may lie outside the ASA.

Chronology

3.4.9 Archaeological material is generally studied within a framework of 'periods' or 'ages' that reflect the activities and cultural changes taking place over time. All dates are referred to as BCE (Before Common Era), BP (Before Present) or AD (Anno Domini) within the text. BCE refers to calibrated radiocarbon chronology that can be considered equivalent to calendar years. BP dates are used for periods of time older than circa 5,000 years ago.

3.4.10 A list of the main archaeological periods of the British Isles is referred to in the text, along with their broadly defined dates, are presented in **Appendix 1** which reflects the archaeological record recorded from coastal and marine contexts.

Seabed prehistory

3.4.11 The baseline summary for seabed prehistory was based on a review of geological mapping of seabed sediments, solid geology and bathymetry from published BGS sources. This assessment was further supported by reference to grey literature (Wessex Archaeology 2017).

Seabed features: maritime and aviation sites

3.4.12 The baseline summary for maritime and aviation archaeology was assessed by means of accessing any records of sites, find spots, wrecks, casualties, and seabed features obtained from the UKHO, NRHE, and separate HER's within the ASA. The baseline assessment of maritime and aviation archaeology was further supplemented by a review of relevant primary and secondary source material to provide an indication on the nature of maritime and aviation activity across the region. As well as summarising the known archaeological resource, the baseline assessment underlines the potential for encountering unknown shipwreck and aircraft crash sites within the ASA.

3.4.13 The data obtained were reviewed and those located within the ASA were extracted and compiled to form a gazetteer as part of the known maritime and aviation baseline. were added to the project GIS and used to inform the geophysical assessment.

Assessment of Historic Seascape Character (HSC)

3.4.14 In accordance with the European Landscape Convention, 'landscape' can be defined as 'an area, as perceived by people, whose character is the result of the action and interaction of natural and /or human factors' (Council of Europe, 2000). The term 'seascape' can be defined as a subset of 'landscape', and has 'an area of sea, coastline and land, as perceived by people, whose character results from the actions and interactions of land and sea, by natural and / or human factors' (ibid.).

3.4.15 Seascape assessment reflects the holistic approach to landscape assessment as defined in the European Landscape Convention, extending it to the sea. Seascape Character Areas include coastal land, intertidal and marine environments up to the territorial limit (12 NM). Historic Seascape Characterisation is the identification and interpretation of the historic dimension of the present day coastal and marine environment (Natural England 2012, 33). This is done by mapping and describing the historic cultural influences which define present seascape perceptions across all of England's marine areas and costal land.

3.4.16 The baseline summary for character of the historic seascape within the ASA was assessed using the results of the HSC undertaken by the SeaZone and Maritime Archaeology Ltd with a methodology developed through the England's Historic Seascapes Programme (Merritt & Dellino-Musgrave, 2009), covering most of the ASA, and the East Yorkshire to Norfolk HSC carried out by Newcastle University, covering the southern end of the Humber Pipeline (Aldred 2014). Further consolidation work to bring together the local assessments into a national dataset was completed in 2018 (LUC 2018). The HSC include ArcGIS shapefiles of the character areas and reports including a regional and national assessment of the historic seascape character types.

3.4.17 The Yorkshire and Lincolnshire Rapid Coastal Zone Assessment carried out by Humber Field Archaeology in 2008 was also consulted (Brigham, Buglass, & George, 2008; Buglass & Brigham, 2008) for contextual information.

3.5 Geophysical methodology

Data sources

3.5.1 A number of data sources were consulted during this assessment, including:

- Geophysical survey datasets acquired by XOCEAN comprising MBES, Pseudo SSS mosaic and Backscatter mosaic data;
- Geophysical datasets acquired by Gardline comprising SBP, SSS and Mag;
- Recorded wreck and obstruction data acquired via the UKHO and NRHE; and
- Relevant background mapping from the area (British Geological Survey (BGS) 1989, admiralty charts received from UKHO).

Technical specifications

3.5.2 The MBES, Backscatter and Pseudo SSS backscatter geophysical datasets were acquired by XOCEAN in 2021, the SBP, SSS and Mag. data were acquired by Gardline in 2021, and the SBP data over the Endurance Store GSA was acquired by Gardline in 2020.

3.5.3 The XOCEAN 2021 data were acquired by Autonomous Survey Vehicle (ASV) over the 2.0 km wide Humber Pipeline and Teesside Pipeline corridor GSAs, and the Endurance Store GSA. The Pseudo SSS data were acquired in approximately the nearshore 32.0 km of the Humber Pipeline GSA and approximately the nearshore 16.0 km of the Teesside Pipeline GSA. The data were acquired by ASV with main lines run across the width of the corridor (i.e. at 90 degrees to the proposed route). The MBES and Backscatter data were acquired over all the GSAs.

3.5.4 The Gardline 2021 SBP, SSS and Mag. data were acquired along the central three lines of the Humber Pipeline and Teesside Pipeline GSAs with 50.0 m line spacing. The data coverage stops approximately 18.0 km from both landfalls and does not cover the Endurance Store GSA.

3.5.5 The Gardline 2020 SBP data was acquired in a 2 x 2 km spaced grid over approximately 100 km^2 of the Endurance Store GSA. Some additional SSS and Mag. data were also acquired within the Endurance Store GSA, but these were not interpreted as part of this assessment due to their sparse coverage.

3.5.6 No survey reports or technical specifications of the equipment used during data acquisition were provided with the data.

Processing

3.5.7 A number of datasets were assessed over the GSAs, each dataset was processed separately using the following software (**Table 1**).

Table 1 Software used for geophysical assessment

Dataset	Processing Software	Interpretation and rationalisation
SBP	CodaOctopus Survey Engine v5.5	ArcMap v10.8.1
MBES	QPS Fledermaus v7.7.5	
SSS	CodaOctopus Survey Engine v5.5	
Mag.	Proprietary software	
Pseudo SSS mosaic	NA	
Backscatter mosaic	NA	

3.5.8 The SBP and MBES data were used as the primary datasets for the palaeographic assessment and SSS, MBES and Mag. datasets were used for the seabed features assessment.

3.5.9 The SBP data were processed using CodaOctopus Survey Engine Seismic+ software. This software allows the data to be visualised with user selected filters and gain settings in order to optimise the appearance of the data for interpretation. The software then allows an interpretation to be applied to the data by identifying and selecting sedimentary boundaries and shallow geological features that might be of archaeological interest.

3.5.10 The SBP data were interpreted with a two-way travel time (TWTT) along the z-axis. In order to convert from TWTT to depth, the velocity of the seismic waves was estimated to be 1,600 ms^{-1}. This is a standard estimate for shallow, unconsolidated sediments.

3.5.11 The SBP data can also be used to identify small reflectors, which may indicate buried material such as a wreck site covered by sediment. The position and dimensions of any such objects are noted in a gazetteer, and an image acquired of each anomaly for future reference. It should be noted that anomalies of this type are rare, as the sensors must pass directly over such an object in order to detect an anomaly.

3.5.12 For the SBP assessment, only the centre line of each pipeline corridor was initially assessed. Where features of interest were identified, additional lines were then interpreted in order to more accurately map the extents of these features. All lines were assessed from the Endurance Store GSA. The SBP assessment was primarily undertaken using the Gardline 2020 and 2021 data sets, with the nearshore gap filled using XOCEAN data.

3.5.13 The MBES data were analysed to identify any unusual seabed structures that could be shipwrecks or other anthropogenic debris. The data were gridded at 1.0 m and analysed using QPS Fledermaus software, which enables a 3-D visualisation of the acquired data and geo-picking of seabed anomalies. The MBES data were also used in the palaeogeographic assessment.

3.5.14 The high frequency *.xtf* SSS data files were processed using CodaOctopus Survey Engine Sidescan+ software. This allowed the data to be replayed with various gain settings in order to optimise the quality of the images. The data were interpreted for any objects of possible anthropogenic origin. This involves creating a database of anomalies within Coda by tagging individual features of possible archaeological potential, recording their positions and dimensions, and acquiring an image of each anomaly for future reference.

3.5.15 A mosaic of the SSS is produced during this process to assess the quality of the sonar towfish positioning. This process allows the position of anomalies to be checked between different survey lines and for the positioning to be further refined if necessary.

3.5.16 The form, size and/or extent of an anomaly is a guide to its potential to be an anthropogenic feature and therefore of archaeological interest. A single small but prominent anomaly may be part of a much more extensive feature that is largely buried. Similarly, a scatter of minor anomalies may be unrelated individual features, define the edges of a buried but intact feature, or may be all that remains as a result of past impacts from, for example, dredging or fishing. Assessment is made of such groups of anomalies during data interpretation to determine which of these alternatives is the most likely.

3.5.17 The Mag. data were processed using proprietary software in order to identify any discrete magnetic contacts which could represent buried metallic debris or structures such as wrecks.

3.5.18 The software enables both the visualisation of individual lines of data and gridding of data to produce a magnetic anomaly map. The data were first smoothed to try and eliminate any spiking. A trend was then fitted to the resulting data, and the trend values subtracted from the smoothed values. This was carried out to remove natural variations in the data (such as diurnal variation in magnetic field strength and changes in geology). The processed data were then gridded to produce a map of magnetic anomalies, and individual anomalies tagged based on the grid and individual profile lines. Images are taken in a similar process to that of the SSS data.

3.5.19 For the purposes of this assessment, any identified magnetic anomalies have been classified depending on their amplitude as small (5 nanoTesla (nT) to 49 nT), medium (50 nT to 99 nT), large (>100 nT) and very large (>500 nT).

3.5.20 The Pseudo SSS and Backscatter mosaic images were viewed in ArcMap and the data were interpreted for any objects of possible anthropogenic origin. This involves creating a database of anomalies by identifying individual features of possible archaeological potential, recording their positions and dimensions, and acquiring an image of each anomaly for future reference.

Data quality

3.5.1 Once processed, the geophysical data sets were individually assessed for quality and their suitability for archaeological purposes, and rated using the following criteria (**Table 2**).

Table 2 Criteria for assigning data quality rating

Data quality	Description
Good	Data which are clear and unaffected or only slightly affected by weather conditions, sea state, background noise or data artefacts. Seabed datasets are suitable for the interpretation of upstanding and partially buried wrecks, debris fields, and small individual anomalies. The structure of wrecks is clear, allowing assessments on wreck condition to be made. Subtle reflectors are clear within SBP data. These data provide the highest probability that anomalies of archaeological potential will be identified.
Average	Data which are moderately affected by weather conditions, sea state and noise. Seabed datasets are suitable for the identification of upstanding and partially buried wrecks, the larger elements of debris fields and dispersed sites, and larger individual anomalies. Dispersed and/or partially buried wrecks may be difficult to identify. Interpretation of continuous reflectors in SBP data is problematic. These data are not considered to be detrimentally affected to a significant degree.
Below Average	Data which are affected by weather conditions, sea state and noise to a significant degree. Seabed datasets are suitable for the identification of relatively intact, upstanding wrecks and large individual anomalies. Dispersed and/or partially buried wrecks, or small isolated anomalies may not be clearly resolved. Small palaeogeographic features, or internal structure may not be resolved in SBP data.
Variable	This category contains datasets where the individual lines range in quality. Confidence of interpretation is subsequently likely to vary within the GSAs.

3.5.2 The MBES data were rated as ‘Variable’ using the above criteria table. The data quality varied throughout the dataset, with some areas heavily affected by weather, with probable vessel crabbing, roll noise and differences in depths between lines visible (up to 0.2 m), which has impacted the ability to identify smaller features in those areas. The data quality and resolution of 1.0 m was found to be of a fair standard and suitable for archaeological assessment of objects and debris over 1.0 m in size.

3.5.3 The SSS data have been rated as ‘Average’ using the above criteria table. Some data files displayed weather noise and cable snatching due to sea state and/or weather conditions, particularly in the nearshore areas, but overall, the data were not affected to a significant degree and are therefore considered suitable for archaeological interpretation

3.5.4 The Mag. data have been rated as ‘Average’ using the above criterial table. The line spacing of 50 m in the offshore survey area means that smaller ferrous features which aren’t directly covered by a line of Mag. data may not have been picked up in the data. However larger features such as wrecks and substantial ferrous debris were largely still identifiable in the data and, as such, the dataset was considered suitable for archaeological interpretation.

3.5.5 The Pseudo SSS mosaic dataset has been rated as 'Below Average' using the above criteria table. The Pseudo SSS mosaic images were used for the nearshore data assessment of both the Humber Pipeline and the Teesside Pipeline. The data were heavily affected by weather and probable vessel crabbing, as such large individual anomalies such as wrecks were identifiable but smaller anomalies more difficult to identify.

3.5.6 The Backscatter mosaic data were rated as 'Variable', displaying the same data issues as the MBES data highlighted above.

3.5.7 The SBP data were generally rated as 'Good' using the above criteria table. Relatively limited penetration was achieved due to the equipment used, but the shallow geology was generally imaged down to bedrock, particularly along the pipeline routes. Some of the data from the nearshore areas exhibited significant weather noise, but the data were considered suitable for archaeological assessment.

Data limitations

3.5.8 There are two areas in the Humber Pipeline GSA where there is no data coverage; these have been illustrated in Figures 4B – 4E.

3.5.9 The SSS and Mag. data were only acquired along the central three lines of the pipeline corridors with 50.0 m line spacing, and this data coverage stops approximately 18.0 km from both landfall locations. Where there is no SSS coverage, the Backscatter and Pseudo SSS mosaic data have been used to infill the 2.0 km corridors. There is no SSS or Mag. coverage in the Endurance Store GSA.

3.5.10 In general, SSS data is considered the highest resolution data type and the most suitable for archaeological assessment. As such, it cannot be guaranteed that all anomalies of archaeological potential have been identified in the areas outside the extents of the SSS data coverage. Additionally, the potential remains for ferrous debris, either buried or without surface expression, to be present in the areas outside the extents of the Mag. data coverage.

Anomaly grouping and discrimination

3.5.11 The previous section describes the initial interpretation of all available geophysical datasets which were conducted independently of one another. This inevitably leads to the possibility of any one object being the cause of numerous anomalies in different datasets and apparently overstating the number of archaeological features in the GSAs.

3.5.12 To address this fact the anomalies were grouped together; allowing one ID number to be assigned to a single object for which there may be, for example, a UKHO record, a MBES anomaly, and multiple SSS anomalies.

3.5.13 Once all the geophysical anomalies and desk-based information have been grouped, a discrimination flag is added to the record in order to discriminate against those which are not thought to be of an archaeological concern. For anomalies located on the seabed, these flags are ascribed as follows (**Table 3**).

Table 3 Criteria discriminating relevance of identified features to proposed scheme

Overview classification	Discrimination	Criteria	Data type
Archaeological	P1	Feature of probable archaeological interest, either because of its palaeogeography or	SBP, MBES

		likelihood for producing palaeoenvironmental material	
Archaeological	P2	Feature of possible archaeological interest	SBP, MBES
Archaeological	A1	Anthropogenic origin of archaeological interest	MBES, SSS, Mag, Backscatter mosaic, Pseudo SSS mosaic
Archaeological	A2_h	Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature	MBES, SSS, Mag, Backscatter mosaic, Pseudo SSS mosaic
Archaeological	A2_l	Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature	MBES, SSS, Mag, Backscatter mosaic, Pseudo SSS mosaic
Archaeological	A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly	MBES, SSS, Mag, Backscatter mosaic, Pseudo SSS mosaic

3.5.14 The grouping and discrimination of information at this stage is based on all available information and is not definitive. It allows for all features of potential archaeological interest to be highlighted, while retaining all the information produced during the course of the geophysical interpretation and desk-based assessment for further evaluation should more information become available.

3.5.15 Any anomalies located outside of the defined GSAs, either previously recorded in known databases (e.g. UKHO) or identified during this geophysical assessment, are deemed beyond the scope of the current assessment and are subsequently not included in this report.

3.6 Impact assessment criteria

Asset sensitivity

3.6.1 In order to assess the potential impacts of a development upon marine cultural heritage, the conceptual approach known as the 'source-pathway-receptor' model is adopted. This approach is based on the identification of the source (i.e. the origin of a potential impact), the pathway (i.e. the means by which the effect of the activity could impact a receptor) and the receptor that may be impacted (e.g. known/potential heritage assets). For the significance of any given impact to be fully understood and for appropriate mitigation to be proposed, the sensitivity of any marine cultural heritage assets that may be impacted need to be considered. This section outlines how the sensitivity of marine heritage assets is ascertained.

3.6.2 The capability of an asset to accommodate change and its ability to recover if affected is a function of its sensitivity. Asset sensitivity is typically assessed via the following factors:

- Adaptability - the degree to which an asset can avoid or adapt to an effect;

- Tolerance - the ability of an asset to accommodate temporary or permanent change without significant adverse impact;
- Recoverability - the temporal scale over and extent to which an asset will recover following an effect; and
- Value - a measure of the asset's importance, rarity and worth.

3.6.3 Archaeological and cultural heritage assets cannot typically adapt, tolerate or recover from physical impacts resulting in material damage or loss caused by development. Consequently, the sensitivity of each asset is predominantly quantified only by its value.

Value of an asset

3.6.4 Based on Historic England's *Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment* (English Heritage 2008, 21), the significance of a historic asset 'embraces all the diverse cultural and natural heritage values that people associate with it, or which prompt them to respond to it'.

3.6.5 Within this document, significance is weighed by consideration of the potential for the asset to demonstrate the following value criteria:

- Evidential value – deriving from the potential of a place to yield evidence about past human activity;
- Historical value – deriving from the ways in which past people, events and aspects of life can be connected through a place to the present. It tends to be illustrative or associative;
- Aesthetic value – deriving from the ways in which people draw sensory and intellectual stimulation from a place; and
- Communal value – deriving from the meanings of a place for the people who relate to it, or for whom it figures in their collective experience or memory. Communal values are closely bound up with historical (particularly associative) and aesthetic values but tend to have additional and specific aspects.

3.6.6 With regards to assessing the value of shipwrecks, the following criteria listed in English Heritage's *Ships and Boats: Prehistory to Present – Designation Selection Guide* (English Heritage 2012) can be used to assess an asset in terms of its value:

- Period;
- Rarity;
- Documentation;
- Group value;
- Survival/condition; and
- Potential.

3.6.7 These aspects help to characterise each asset whilst also comparing them to other similar assets. The criteria also enable the potential to contribute to knowledge, understanding and outreach to be assessed.

3.6.8 The value of known archaeological and cultural heritage assets were assessed on a five-point scale using professional judgement informed by criteria provided in **Table 4** below.

Table 4 Criteria to assess the archaeological value of marine assets

Value	Definition
High	• Best known, only example or above average example and / or significant or high potential to contribute to knowledge and understanding and / or outreach. Assets with a demonstrable international or national dimension to their importance are likely to fall within this category; • wrecked ships and aircraft that are protected under the Marine Scotland Act 2010, Protection of Wrecks Act 1973, Ancient Monuments and Archaeological Areas Act 1979 or Protection of Military Remains Act 1986 with an international dimension to their importance, plus as-yet undesignated sites that are demonstrably of equivalent archaeological value; and • known submerged prehistoric sites and landscapes with the confirmed presence of largely in situ artefactual material or palaeogeographic features with demonstrable potential to include artefactual and/or palaeoenvironmental material, possibly as part of a prehistoric site or landscape.
Medium	• Average example and / or moderate potential to contribute to knowledge and understanding and / or outreach; • includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have moderate potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation; and • prehistoric deposits with moderate potential to contribute to an understanding of the palaeoenvironment.
Low	• Below average example and / or low potential to contribute to knowledge and understanding and / or outreach; • includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have low potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation; and • prehistoric deposits with low potential to contribute to an understanding of the palaeoenvironment.
Negligible	• Poor example and / or little or no potential to contribute to knowledge and understanding and / or outreach. Assets with little or no surviving archaeological interest.
Unknown	• There is not presently enough information available about the site to assess its value.

3.6.9 Furthermore, *On the Importance of Shipwrecks* (Wessex Archaeology 2006) suggests importance can be assessed through the following criteria: build, use, loss, survival and investigation.

3.6.10 To further supplement this approach, the ALSF-funded Marine Class Description and principles of selection for aggregate producing areas project (ALSF 5383), undertaken by Wessex Archaeology (2008b), proposed a composite timeline that considers wrecks in five distinct date ranges. The timeline considers the broad chronology of shipbuilding, thus drawing out generalisations regarding the age and special value of sites. The timeline is summarised as follows:

- **Pre- 1500 AD:** this covers the period from the earliest Prehistoric evidence for human maritime activity to the end of the medieval period, c. 1508. Little is known of watercraft or vessels from this period and archaeological evidence of them is so rare that all examples of craft are likely to be of special value;

- **1500 to 1815:** this encompasses the Tudor period in England and the Stuart periods in Scotland and Britain, the Wars of the Three Kingdoms, the Anglo-Dutch Wars and later the American Independence and French Revolutionary Wars. Wreck and vessel remains from this date are also quite rare, and can be expected to be of special value;

- **1816 to 1913:** this period witnessed great changes in the way in which vessels were built and used, corresponding with the introduction of metal to shipbuilding, and steam to propulsion technology. Examples of watercraft from this period are more numerous and as such, it is those that specifically contribute to an understanding of these changes that should be regarded as having special value;

- **1914 to 1945:** this period encompasses the First World War (WWI), the Interwar years and the Second World War (WWII). This date range contains Britain's highest volume of recorded boat and ships losses. Those which might be regarded as having special interest are likely to relate to technological changes and to local and global activities during this period; and

- **Post 1945:** the final period extends from 1946 through the post-war years to the present day. Vessels from this date range would have to present a strong case if they are to be considered of special interest.

3.6.11 According to this composite timeline, vessels that pre-date 1816 are likely to be considered of special value on the basis of their rarity and subsequent national and international value in our understanding of maritime activity and shipping movements during these periods.

3.6.12 Wrecks dating from 1816 to the present day are more plentiful amongst known wrecks. The Marine Class Description and Principles of Selection project (Wessex Archaeology, 2008b) further revealed that a total of 96% of known and dated wrecks were lost in the period between 1860 and 1950. Due to their predominance in the known marine archaeological record, the special value of wrecks of this period thus depends upon their ability to exhibit both integral and relative factors based on attributes relating to the Wessex Archaeology 'BULSI' system of wreck assessment. The ALSF-funded project *Assessing Boats and Ships 1860-1950* (Wessex Archaeology 2011) explored this further by providing a national stock-take of known wrecks in territorial waters off England and review it in the light of the framework for assessing special interest prepared in the Marine Class Description and Principles of Selection project (Wessex Archaeology, 2008b) and historical thematic studies.

3.6.13 The Early Ships and Boats Prehistory to 1840 provided further information about earlier vessels (Wessex Archaeology 2013). Through undertaking a national stock-take of wrecks dating to this period within English territorial waters, this project provides supplementary guidance on the key themes and interests represented by such wrecks, in order to inform decisions regarding importance and mitigation. These are summarised thus:

- Does it illustrate a key narrative of the period;
- Does it represent a distinct and tangible link to significant persons or events;
- Is it representative of significant loss of life or related responses in seafaring safety;
- Does it make a distinct cultural contribution; and
- Does it have current relevance or parallels.

3.6.14 The perceived value of each marine archaeological asset is generally assessed and assigned on a site-by-site basis, depending on the criteria listed in **Table 4**. The UK Marine Policy Statement (DEFRA 2011, p.90) describes a heritage asset as holding a degree of significance. Significance relates to the heritage interest of an asset that may be archaeological, architectural, artistic or historic.

3.6.15 Furthermore, the nature of the archaeological resource is such that there is a high level of uncertainty concerning the distribution of potential, unknown archaeological remains on the seabed. It is often the case that data concerning the nature and extent of sites is out of date, extremely limited or entirely lacking. As a precautionary measure, unknown potential cultural heritage receptors are therefore considered to be of high sensitivity and high value.

3.7 Assumptions and limitations

Archaeological data

3.7.1 Data used to compile this report consists of primary geophysical survey data and secondary information derived from a variety of sources, only some of which have been directly examined for the purposes of this assessment. The assumption is made that the secondary data, as well as that derived from other secondary sources, are reasonably accurate for their use as contextual information for the primary datasets, unless otherwise stated in the text.

3.7.2 The records held by the UKHO, NRHE, local HERs and the other sources used in this assessment are not a record of all surviving cultural heritage assets, rather a record of the discovery of a wide range of archaeological and historical components of the marine historic environment. The information held within these is not complete and does not preclude the subsequent discovery of further elements of the historic environment that are, at present, unknown. In particular, this relates to buried archaeological features.

4 MARINE ARCHAEOLOGICAL ASSESSMENT: PALAEOGEOGRAPHY

4.1 Geological baseline

4.1.1 The basement geology generally comprises the Chalk Group to the south, along most of the proposed route of the Humber Pipeline, and the Lias group to the north, along most of the proposed route of the Teesside Pipeline. The Chalk Group is an extensive deposit of chalk present throughout much of the North Sea and southern England, which was laid down in shallow marine conditions during the Upper Cretaceous period (Cameron *et al.* 1992). The Lias Group is a deposit of mudstone and limestone, of Late Triassic and Early Jurassic age. Both proposed routes also cross the Jurassic mudstone of the Kimmeridge

Clay Formation. The Endurance Store is located within the Lias Group and the West Sole Group sandstone and mudstone which is also Jurassic in origin.

4.1.2 The boundary between this basement geology and the overlying sediments represents a significant hiatus and regional unconformity. No sediments of Tertiary age are recorded as being present in the ASA and the basement geology is directly overlain by a sequence of Pleistocene and later deposits (Cameron *et al.* 1992).

4.1.3 The Quaternary history of the North Sea is dominated by repeated glacial / interglacial cycles which are reflected in the shallow geology of the region. Episodes of lodgement and ablation till deposition are punctuated by episodes of erosion by glacial outwash and deposition of shallow marine sediments (Cameron *et al.* 1992; Tappin *et al.* 2011). These sequences are generally separated by marked erosion surfaces created by repeated ice sheet advance, including deep, infilled glacial channels and valleys.

4.1.4 Gradual continued sea level rise since the Last Glacial Maximum (LGM) during the Devensian eventually inundated the Development Area. Reconstructed sea level curves indicate that most of the proposed route will have been inundated by 7,000 BP, and the current approximate coastline will have been achieved by 5,000 BP (Shennan & Horton 2002; Tappin *et al.* 2011; Sturt *et al.* 2013).

4.1.5 The erosive power of this most recent marine transgression will have been much less than during the previous glacial advances, so the potential remains for the preservation of relict post-LGM land surfaces within the ASA. However, previously assessed data sources from the vicinity of the ASA suggest these surviving terrestrial features are likely to be restricted to incised features such as palaeochannels (Tappin *et al.* 2011).

4.1.6 Features such as these have been previously identified within the vicinity of the ASA, and a number of studies have been undertaken surrounding the proposed route that have provided an insight into the palaeogeography of the region, specifically relating to the terrestrial landscape that would have existed between the LGM and the Holocene transgression (Bicket and Tizzard 2015).

4.1.7 Evidence from previous investigations suggests potential for the presence of a preserved, post-LGM palaeolandscape along the proposed routes of the Humber Pipeline and the Teesside Pipeline (Wessex Archaeology 2017). The HER data records one such feature, a palaeochannel located close to the landfall of the Teesside Pipeline (2001, **Appendix 3**).

4.1.8 At present, the proposed routes are located within a fully marine environment. The modern sediment input is likely to be variable, with the nearshore section of the proposed routes receiving more sediment input (e.g. from erosion of the Yorkshire Coast) than the more offshore section, and the seabed is likely to exhibit areas of both active and relict bedforms.

4.2 Prehistory Baseline

4.2.1 The archaeological history of the southern North Sea is directly linked to the previously described glacial / interglacial cycles and the associated changes of environment across the region. During periods of relatively low sea level, the exposed terrestrial landscape would have been an attractive environment for different Hominin species, (including potentially *Homo antecessor*,) *H. heidelbergensis*, *H. neanderthalensis*, and, eventually, modern humans (*H. sapiens*) (**Figure 2**).

4.2.2 The earliest direct evidence for Hominin activity in the UK was identified at the Lower Palaeolithic sites of Happisburgh, on the Norfolk coast, and Pakefield, on the Suffolk coast, dating from c. 900,000 and 700,000 BP, respectively (Parfitt *et al.* 2005; 2010). These sites are both located within sediments of Cromerian age, and pre-date the earliest known glaciation of the UK. The northernmost onshore find of Neanderthal levallois-technique stone artefact is Holderness (Bicket and Tizzard 2015), suggesting their range from after 300 000 BP extended as far north as the ASA.

4.2.3 The southern North Sea off the east coast of East Anglia is known to contain relatively well preserved palaeolandscape features such as fluvial channels, created during periods of sea level lowstand but while the landscape was still free of ice (Bicket and Tizzard 2015). The remains of this terrestrial landscape are frequently recovered by dredging and fishing in numerous areas around the southern North Sea, generally in the form of the remains of extinct megafauna (e.g. mammoths, bison etc.).

4.2.4 The discovery of actual human artefacts, such as hand axes and worked bone, is a rarer occurrence, but artefacts have been recovered in significant numbers and in very good condition. The earliest direct offshore evidence of human occupation of this landscape has been identified in the form of Palaeolithic artefacts dating to the Saalian period (c. 380,000 - 130,000 BP) associated with the Palaeo-Yare river within Area 240, offshore Great Yarmouth (Tizzard *et al*. 2014; 2015). Further isolated archaeological artefacts such as the Mesolithic Maglemosian bone harpoon from Leman and Owers Bank (Godwin and Godwin 1933), as well as worked flints and faunal remains reported through the marine aggregate industry Protocol for Reporting Finds of Archaeological Interest, all indicate the potential for the presence of archaeological material.

4.2.5 The region surrounding the ASA has experienced several major glacial events, and, as such, much of the evidence for past landscapes is likely to have been adversely affected by the associated glacial erosion and extensive deposition of glacial till (Tappin *et al*. 2011).

4.2.6 However the potential remains for a preserved palaeolandscape to be present within the ASA. The ASA would have been an attractive terrestrial landscape suitable for human habitation, i.e. the northern coast of Doggerland until around 7,000 BP (Sturt *et al*. 2013; Bicket and Tizzard 2015).

4.2.7 Relict fluvial (palaeochannels) and other submerged terrestrial geomorphological systems such as these are considered to be of high archaeological potential, as many known prehistoric sites, such as Star Carr in North Yorkshire (Tappin *et a*l. 2011), are associated with lakes, waterways and rivers. Buried palaeochannels and their associated deposits, both on land and offshore, therefore have the potential to contain both in situ and derived archaeological artefacts (such as lithic objects) (Bicket and Tizzard 2015).

4.2.8 Additionally, soft sediment infills associated with many buried palaeochannel features and overbank deposits can contain preserved organic material. This material, such as pollen, is also of potential importance to palaeoenvironmental studies and can aid in reconstructing and dating the identified buried landscape (Gribble and Leather 2011; Bicket and Tizzard 2015).

Value

4.2.9 There is the potential for the presence of as yet undiscovered in situ prehistoric sites and finds. The values assigned to any potential heritage assets are outlined in **Table 5**.

Table 5 Value of seabed prehistory heritage assets.

Asset Type	Definition	Value

Potential *in situ* prehistoric sites	Primary context features and associated artefacts and their physical setting (if found).	High
	Known submerged prehistoric sites and landscape features with the demonstrable potential to include artefactual material.	High
Potential submerged landscape features	Other known submerged palaeolandscape features and deposits likely to date to periods of prehistoric archaeological interest with the potential to contain *in situ* material.	High
Potential derived prehistoric finds	Isolated discoveries of prehistoric archaeological material discovered within secondary contexts.	Medium
Potential palaeoenvironmental evidence	Isolated examples of palaeoenvironmental material	Low
	Palaeoenvironmental material associated with specific palaeolandscape features or archaeological material	High

4.2.10 On the basis of age and the rarity of Palaeolithic and Mesolithic finds underwater, if any sites or material was discovered, it would likely be of high, probably national archaeological importance. A guidance note published by English Heritage *Identifying and Protecting Palaeolithic Remains: archaeological guidance for planning authorities and developers* (1998) indicated that sites containing Palaeolithic features are so rare in Britain that they should be regarded as of **national importance** and wherever possible should remain undisturbed.

4.2.11 In the event that prehistoric archaeological material discovered offshore is found in situ it should be considered of particularly high archaeological importance. As such, the features and deposits that have the potential to contain within them in situ material should be considered as **high value** assets.

4.2.12 Prehistoric archaeological material discovered within secondary contexts also has the potential to provide valuable information on patterns of human land use and demography in a field of study that is still little understood and rapidly evolving. They are, however, by their very nature derived and, as such, isolated prehistoric finds should be regarded as **medium value** assets.

4.2.13 Palaeoenvironmental evidence in the context of an in situ prehistoric site (if found) will be of high value. More widely, palaeolandsurfaces and palaeolandscape features will be considered of high value for the purpose of this assessment owing to the Quaternary scientific potential of such sedimentary sequences, to contextualise the wider early prehistoric palaeogeography and the potential of palaeolandscape features to preserve in situ artefacts and sites (Bicket and Tizzard 2015). Palaeoenvironmental evidence from isolated contexts will be regarded as **low value**.

4.3 Geophysical palaeolandscapes assessment

4.3.1 The SBP data were assessed to identify any surviving possible palaeolandscape features that may be of archaeological or palaeoenvironmental potential. As the GSAs contain two linear schemes (i.e. the Humber Pipeline GSA and the Teesside Pipeline GSA), the background geology contains a number of pre-quaternary formations. However, the identified stratigraphy can be summarised as follows (**Table 6**):

Table 6 Shallow stratigraphy of the ASA

Unit	Unit Name	Geophysical Characteristics [1]	Sediment Type [2]	Archaeological Potential
4	Holocene Seabed Sediments (post-transgression) (Marine Isotope Stage (MIS) 1)	Generally observed as a veneer along the pipeline corridors or thickening into large mobile sand deposits further offshore. Boundary between surficial sediments and underlying units not always discernible.	Gravelly sand/sandy gravel with shell fragments. Sand waves and ripples indicate sediment is mobile in places.	Considered of low potential in itself, but possibly contains re-worked artefacts and can cover wreck sites and other cultural heritage.
3	Channel Deposits (Late Devensian – Early Holocene) (MIS 2 to 1)	Sporadic possible channel or cut and fill features of varying acoustic character.	Potentially relict fluvial and associated deposits, potentially including organic deposits.	Potential to contain *in situ* and derived archaeological material, and palaeoenvironmental material.
2	Bolders Bank Formation (Late Devensian) (MIS 3 to 2)	Erosive basal reflector above Pre-Quaternary bedrock. Acoustically unstructured/chaotic; an occasionally consistent internal reflector suggests possibly two sub-units.	Expected to be stiff sandy, gravelly, clay – glacial till	Sub-glacial deposit; low archaeological potential.
1	Pre-Quaternary Bedrock (Upper Triassic to Upper Cretaceous)	Variable, but generally distinct erosive upper reflector, often with dipping internal reflectors	Various depending on exact formation, but mainly mudstone, chalk, and limestone	Pre-Earliest occupation of the UK

(1) Based on geophysical data

(2) Based on historic borehole data (where available) and Cameron *et al.* (1992)

4.3.2 Unit 1 was identified within all three of the GSAs, and is characterised by a distinct, erosive upper reflector and often dipping internal reflectors. The unit often outcrops at seabed, particularly towards the nearshore, and is elsewhere directly covered by a regional deposit of Unit 2.

4.3.3 This is interpreted as the Pre-Quaternary basement geology, generally dating from Upper Triassic to Upper Cretaceous periods. As such, it is deemed too old to be of archaeological potential, although its upper layers could have formed a land surface upon which archaeological material may have been deposited.

4.3.4 Unit 2 has also been identified within all three GSAs, and where present is identified as a relatively thin unit directly overlying Unit 1. The unit is acoustically unstructured, but often contains a relatively consistent internal reflector suggesting two sub-units.

4.3.5 This is interpreted as the Bolders bank Formation, a regional deposit of glacial till dating from the late Devensian. The two potential sub-units may represent both a lodgement and ablation till (Cameron *et al.* 1992). As a unit deposited either directly beneath or immediately proximal to an ice sheet, Unit 2 is not considered to be of archaeological potential.

4.3.6 Unit 3 comprises a number of possible remnant terrestrial features interpreted to date from the late Devensian to Early Holocene; as such, these are considered to be of possible archaeological potential. The distribution of these Unit 3 features is illustrated in **Figures 3A – 3C**, and the individual features are described in **Appendix 3** and discussed below.

4.3.7 A total of five palaeogeographic features of archaeological potential were identified within the geophysical data, all of which are within the Humber Pipeline GSA. Feature **7601** was primarily identified in the MBES data as a long, shallow, curvilinear depression oriented along the pipeline corridor. The depression shallows and eventually tapers off to the south, and is buried by an area of mobile seabed sediment to the north. It was only partially identified in the SBP data, where it is visible as a very shallow possible cut and fill feature cut into the underlying till, with relatively poorly defined basal and internal reflectors. This is interpreted as a possible preserved, underfilled palaeochannel, but it may be a seabed feature produced by local currents.

4.3.8 Feature **7600** is a narrow but distinct cut and fill feature cutting into the underlying Unit 2. It is characterised by a relatively poorly defined basal reflector and is mainly distinguished by a change in fill from the surrounding till. The fill comprises parallel internal reflectors, and there may be multiple phases of cut and fill although this is unclear. This is also interpreted as a possible buried palaeochannel.

4.3.9 The remaining three features (**7602**, **7603**, and **7604**), are very shallow, poorly defined, possible cut and fill features characterised by poorly defined basal reflectors and unstructured fill. These are tentative features and could either be the remnants of eroded fluvial features or be internal features within Unit 2.

4.3.10 No palaeogeographic features of archaeological potential were identified along the Teesside Pipeline GSA. However, a palaeochannel has previously been identified close to the Teesside Pipeline landfall and recorded within the local HER (SMR 6396) (**Figure 3C**). This was identified during geophysical assessments in advance of the Teesside Offshore Wind Farm development and was reported to be approximately 300 m wide and 4 km long. The assessed SBP data passed directly over the southern extent of this feature, but no evidence for it was definitively identified within the data. However, as it is recorded in the HER, this palaeochannel is retained within the gazetteer in Appendix 3 as feature **2001**.

4.3.11 No palaeogeographic features of archaeological potential were identified within the Endurance Store GSA.

4.3.12 Overlying all of the above units, where present, is Unit 4; interpreted to be modern marine sand. This is generally observed as a veneer along the Humber Pipeline and Teesside Pipeline GSAs, which thickens into large mobile sand deposits further offshore, particularly in the Endurance Store GSA. The boundary between Unit 4 and the underlying units not always discernible.

4.3.13 As modern marine sediment, Unit 4 is not considered of archaeological potential in itself. However, it does have the potential to contain isolated reworked artefacts, and can potentially cover archaeological sites (e.g. shipwrecks) where it attains sufficient thickness.

5 MARINE ARCHAEOLOGICAL ASSESSMENT: MARITIME AND AVIATION SITES

5.1 Introduction

5.1.1 The following assessment of the maritime resource is based on records of known shipwrecks, aircraft crash sites and obstructions.

5.2 Designated Maritime and Aviation Receptors

5.2.1 There are no designated maritime or aviation sites that have been identified from the desk-based assessment within the ASA.

5.3 Geophysical seabed features assessment

Introduction

5.3.1 The geophysical data were assessed to identify features of archaeological potential relating to maritime and aviation activity.

5.3.2 Any sites located outside of the defined GSAs, either previously recorded in known databases (e.g. UKHO) or identified during this geophysical assessment, are deemed beyond the scope of the current project and are subsequently not included in this report.

5.3.3 A number of features overlap the GSAs at the eastern end of the Humber Pipeline and Teesside Pipeline GSAs and the western extent of the Endurance Store GSA, these have only been reported on once in this report based on their respective dataset, but are highlighted in the gazetteer.

5.3.4 It should be noted that one recorded wreck within the Teesside Pipeline GSA has been interpreted to be modern based on UKHO data, and therefore not of archaeological potential. This wreck and interpreted associated debris have not been included in the seabed features assessment results, however its position is recorded here for reference (249093 E, 6060462 N).

Seabed features assessment results

Teesside Pipeline GSA

5.3.5 The results of this assessment are collated in gazetteer format detailed in Appendix III and illustrated in **Figures 4A – 4H**.

5.3.6 A total of 324 features have been identified as being of possible archaeological potential within the Teesside Pipeline GSA and are discriminated as shown in **Table 7**.

Table 7 Anomalies of archaeological potential within the Teesside Pipeline GSA

Archaeological discrimination	Quantity	Interpretation
A1	16	Anthropogenic origin of archaeological interest
A2_h	54	Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
A2_l	249	Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
A3	5	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total	**324**	

5.3.7 Furthermore, these anomalies can be classified by probable type, which can further aid in assigning archaeological potential and importance (**Table 8**).

Table 8 Types of anomaly identified

Anomaly classification	Definition	Number of anomalies
Wreck	Areas of coherent structure including wrecks of ships, submarines and some aircraft (where coherent structure survives)	11
Debris field	A discrete area containing numerous individual debris items that are potentially anthropogenic, and can include dispersed wreck sites for which no coherent structure remains	11
Debris	Distinct objects on the seabed, generally exhibiting height or with evidence of structure, that are potentially anthropogenic in origin	13
Seabed disturbance	An area of disturbance without individual, distinct objects. Potentially indicates wreck debris or other anthropogenic features buried just below the seabed.	8
Rope/chain	Curvilinear dark reflectors, often with a small amount of height, indicating rope or chain (if ferrous)	12
Bright reflector	Individual objects or areas of low reflectivity, characteristic of materials that absorb acoustic energy, such as waterlogged wood or synthetic materials. Precise nature is uncertain.	4
Dark reflector	Individual objects or areas of high reflectivity, displaying some anthropogenic characteristics. Precise nature is uncertain	48
Mound	A mounded feature with height not considered to be natural. Mounds may form over wreck sites or other debris.	61
Magnetic	No associated seabed surface expression, and have the potential to represent possible buried ferrous debris or buried wreck sites	151
Recorded wreck	Position of a recorded wreck at which previous surveys have identified definite seabed anomalies, but for which no associated feature has been identified within the current data set.	3
Recorded obstruction	Position of a recorded obstruction (e.g. foul ground, fisherman's fastener recorded by the UKHO), but for which no associated feature has been identified within the current data set	2
Total		**324**

5.3.8 A total of 16 anomalies have been discriminated as A1 within the Teesside Pipeline GSA.

5.3.9 Wreck **7210** is a charted and recorded wreck in the UKHO records (6389) recorded as the steam ship *Teesdale* (Possibly) (**Sheet 8**). The vessel was torpedoed by a submarine in June 1917 and survived the attack, having been beached to prevent sinking and undergone temporary repairs; however, it foundered while on passage to the Tees for docking and repair, and sank on 2 August 1917. The wreck is visible in the Pseudo SSS mosaic as a large, irregular area of seabed disturbance comprising irregular bright reflectors, distinct to the surrounding seabed. The wreck was also visible in the Backscatter mosaic data as an indistinct and intermittent spread of dark reflectors measuring 80.4 x 29.3 x 3.0 m. In the MBES dataset the wreck appears to be upright and is visible as a spread of distinct and indistinct mounds orientated north-west to south-east on the seabed. The south-east end of the wreck comprises two tall mounds measuring approximately 6.2 x 6.1 x 2.5 m individually. At the north-western end of the wreck a group of multiple angular low-lying mounds with pointed peaks is visible. The hull of the wreck is not discernible, and internally very indistinct, low-lying mounds are visible between the interpreted bow and stern, suggesting it is highly degraded and may be partially buried. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.10 In the UKHO record the wreck was last surveyed in 2017 and described as being upright and intact but mostly flattened with geophysical dimensions of 70.0 x 15.1 x 4.9 m. In the 2021 geophysical data the wreck appears highly degraded and may be buried. The wreck is situated at the edge of the MBES data extents and so the dimensions should be considered a minimum.

5.3.11 Wreck **7217** is a recorded wreck in the UKHO (6063) and NRHE (908830) records, recorded as the steam ship *John Miles*, which struck a mine in 1917 (**Sheet 9**). In the Backscatter mosaic data the wreck is visible as an area of seabed disturbance comprising two small elongate dark reflectors with a bright reflector between the two. The wreck is orientated NNE to SSW and measures 46.4 x 10.7 x 3.3 m. In the MBES data the wreck appears mostly intact and upright. Internally multiple irregular low-lying mounds are visible within the interpreted hull. The bow appears to be to the NNE and a large and prominent mound is visible at the SSW end of the wreck, and may be a boiler. The majority of the wreck does not stand proud of the seabed, and it is situated within an area of outcropping geology. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.12 In the UKHO record the wreck was last surveyed in 2017 with geophysical dimensions of 45.9 x 9.2 x 4.3 m and described as being upright and intact, but severely disintegrated. In the 2021 geophysical data the wreck appears mostly intact and upright with some possible surviving superstructure visible at the SSW end.

5.3.13 Wreck **7253** is a recorded wreck in the UKHO (6018) and NRHE (908827) records as the steam ship *Earl Percy*, which collided with the SS *Gainsborough* and sank in 1888 (**Sheet 10**). In the Backscatter mosaic data, the wreck is visible as an elongate area of seabed disturbance comprising an indistinct group of dark and bright reflectors orientated approximately north-west to south-east, measuring 75.3 x 21.9 x 4.3 m. In the MBES data the wreck appears upright and is visible as a compact, elongate area of mounds. The north-west end of the wreck is characterised by a depression surrounded by a slight perimeter representing interpreted hull, with some angular mounds at the extreme north-west end. Three tall mounds (up to 4.3 m) are visible in the south-east section of the wreck, which may represent surviving superstructure. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.14 In the UKHO record the wreck was last surveyed in 2016 with geophysical dimensions of 74.0 x 8.2 x 5.0 m, and described as being upright and intact, but severely disintegrated. In the 2021 geophysical data the wreck appears to be upright and mostly intact but highly degraded.

5.3.15 Wreck **7260** is a recorded wreck that corresponds with a UKHO (6353) and NRHE (908606) record for an unknown wreck (**Sheet 11**). In the Backscatter mosaic data, the wreck is visible as an area of seabed disturbance comprising an indistinct area of very high reflectivity, with a distinct, roughly square shaped dark reflector visible in the centre. The wreck measures 61.6 x 23.1 x 1.1 m and is orientated approximately east to west. In the MBES data the wreck is visible as a large spread of uneven seabed comprising a number of highly angular mounds. The largest mound measure 8.2 x 5.0 m and is situated in the centre of the wreck. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.16 In the UKHO record the wreck was last surveyed in 2016 with geophysical dimensions of 53.1 x 6.8 x 4.0 m and described as being as well broken up. In the 2021 geophysical data the wreck appears to be upright, although the hull is not defined or prominent above the seabed, suggesting it may be buried or highly degraded.

5.3.17 Wreck **7262** is a recorded wreck that corresponds with a UKHO (6057) and NRHE (909237) record for the steam ship *Afrique*, which sank in 1918 after being torpedoed by *UC-40* (**Sheet 12**). In the Backscatter mosaic data, the wreck is visible as a large, elongate area of seabed disturbance measuring 102.6 x 30.2 x 4.6 m and comprises dark and bright reflectors in an approximate oval shape. The wreck is orientated north-west to south-east on the seabed. In the MBES data the wreck is visible as a very large, upright wreck located on a relatively featureless area of seabed. The wreck appears mostly intact, although there is evidence of collapse around the interpreted hull. Internally, multiple angular mounds are visible and likely represent broken up deck and debris features. Three very prominent mounds are located at the centre of the wreck which may represent engine or boiler remains. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.18 In the UKHO record wreck was last surveyed in 2016, with geophysical dimensions of 95.7 x 19.8 x 4.7 m and described as being upright and intact, but severely disintegrated. In the 2021 geophysical data the wreck appears mostly intact and upright, but highly degraded with evidence of collapse around the interpreted hull.

5.3.19 Wreck **7263** is a recorded wreck that corresponds with a UKHO (6351) and NRHE (936953) record for the steam ship *Audax*, which sank in 1918 after being torpedoed by *UB-80* (**Sheet 13**). The wreck is visible in the Backscatter mosaic data as a distinct, slightly elongate and irregular area of disturbed seabed measuring 72.2 x 19.9 x 3.3 m. The wreck comprises indistinct dark reflectors with some bright reflectors visible, suggesting multiple objects. In the MBES dataset the wreck is visible as a distinct, likely upright wreck orientated approximately east to west and lying on a relatively featureless area of seabed. Internally, slightly irregular linear mounds are visible, with two large mounds visible at either end of the wreck likely to represent remnant boilers or other parts of the superstructure. Some minor disturbed seabed and scour is present surrounding the interpreted hull. The majority of the wreck is only 0.1 – 0.5 m above the surrounding seabed level, suggesting it is heavily degraded or partially buried. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.20 In the UKHO record the wreck was last surveyed in 2016 with geophysical dimensions of 70.0 x 11.5 x 5.6 m and described as being severely disintegrated. In the 2021 data the wreck appears mostly intact but highly degraded.

5.3.21 Wreck **7264** is a recorded wreck that corresponds with a UKHO (6355) and NRHE (908603) record for the steam ship *Rutil*, which disappeared in September 1916 and was presumed to have struck a mine and sunk (**Sheet 14**). The wreck is visible in the SSS data as a large, mostly intact wreck, measuring 51.5 x 15.7 x 3.1 m. A thick curvilinear dark reflector is visible, interpreted to be the hull, although the south-western edge of the hull is not coherent and may have collapsed or degraded. Internally, linear and small angular dark reflectors are visible, some with significant height. In the MBES data the wreck is visible as a very large, distinct, and upright wreck orientated approximately north-west to south-east on the seabed. The wreck has tall mounds at the north-west and south-east ends, possibly indicating surviving superstructure. The wreck has multiple associated items of debris identified in the vicinity (**7265**, **7266** and **7268**) and sediment build-up is visible surrounding all sides of the wreck, up to a distance of 10.0 m and a height of 0.5 m. The wreck has a very large magnetic anomaly associated with it, measuring 874 nT, indicating ferrous material is present.

5.3.22 In the UKHO record the wreck was last surveyed in 2016 with geophysical dimensions of 63.9 x 12.0 x 2.9 m and was described as being upright and intact but well disintegrated. In the 2021 data the wreck appears upright and mostly intact, the wreck is situated within an area of mobile sediments, which may periodically bury the wreck and any associated debris.

5.3.23 Debris field **7265** is situated at the south-east end of wreck **7264** and has been discriminated as A1. The feature is visible in the SSS data as three sub-angular dark reflectors with shadows measuring 7.9 x 7.3 x 1.4 m; the largest object measures 2.2 x 1.4 m, and there are smaller, indistinct dark reflectors surrounding the three larger objects. The feature is visible in the MBES dataset as a distinct sub-angular mound. The debris field has no corresponding Mag. Anomaly; however the large Mag. Anomaly associated with wreck **7264** may be masking smaller anomalies in this area. It has been interpreted as a possible debris field associated with wreck **7264**.

5.3.24 Wreck **7270** is a recorded wreck that corresponds with a UKHO (6362) and NRHE (908602) record for an unknown steam ship, first identified in 1987 (**Sheet 15**). In the Backscatter mosaic data, the wreck is visible as a large and indistinct area of high reflectivity, orientated north-west to south-east on the seabed, measuring 57.5 x 17.7 x 3.6 m. In the MBES dataset the wreck is visible as a large, upright and mostly intact wreck. The interpreted hull of the wreck is distinct, and internally linear mounds are visible interpreted to be surviving deck structure. At the north-west end of the wreck (likely the bow) a large mound is visible measuring 9.8 x 6.7 x 3.6 m. Indistinct mounds are visible directly on either side of the hull, that may be collapsed structure, and the wreck has significant scour at both ends. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.25 In the UKHO record the wreck was last surveyed in 2016 with geophysical dimensions of 55.5 x 9.3 x 4.6 m and described as being upright and intact, but severely disintegrated. In the 2021 data the wreck appears upright and mostly intact, with some surviving superstructure. The wreck is situated within an area of mobile sediment, which may periodically bury the wreck and any associated debris.

5.3.26 Wreck **7308** is a recorded wreck that corresponds with a UKHO (6039) and NRHE record for a steam ship, *Gwalia* (Possibly), which was built in 1881 and sank after a collision in 1907 (**Sheet 16**). In the SSS data the wreck is visible as a large, upright wreck comprising a thick curvilinear dark reflector interpreted to be the hull, measuring 88.2 x 25.3 x 4.8 m. The dark reflector appears disjointed in places, suggesting it is broken up or degraded. Internally multiple linear, angular and rounded dark reflectors with shadows are visible, interpreted as surviving deck structure. The wreck is orientated approximately north to south; the northern-most end of the wreck has come away from the main structure with a 4.0 m gap between, and this section of the vessel measures 15.9 x 15.0 x 4.8 m. In the MBES dataset the wreck has multiple distinct mounded features within the interpreted hull, some linear features are visible. In the centre of the wreck a large mound measuring 11.3

x 10.1 x 2.8 m is visible indicating surviving superstructure. The southern end of the wreck is highly degraded and there are multiple items of associated debris identified in the vicinity (**7304**, **7305**, **7306**, **7307** and **7309**). The wreck has a very large Mag. Anomaly associated with it, measuring 8,847 nT, indicating substantial ferrous material is present.

5.3.27 In the UKHO record the wreck was last surveyed in 2016, with geophysical dimensions of 85.3 x 15.2 x 4.9 m and was described as being severely disintegrated and broken up into three pieces, with the bow and the stern having fallen onto the seabed, but the midship section still upright. In the 2021 geophysical data the larger width measurement suggests the wreck has degraded further. The wreck is surrounded by sediment accumulation that may periodically bury the wreck and associated debris.

5.3.28 One debris field (**7306**) and two items of debris (**7305** and **7307**) associated with wreck **7308** have been discriminated as A1 due to their anthropogenic characteristics. Debris field **7306** is situated on the north-western edge of wreck **7308** and is visible in the SSS data as three straight dark reflectors with bright shadows parallel to one another, measuring 5.3 x 3.0 x 0.6 m. Individually these features measure a maximum of 2.2 x 0.5 m. Debris **7305** and **7307** were identified in the SSS data and are situated at the south-western edge of wreck **7308**, measuring 1.3 x 0.2 x 0.3 m and 5.1 x 0.3 x 0.3 m respectively.

5.3.29 Wreck **7319** is a recorded wreck that corresponds with a UKHO (87230) and NRHE (909229) record for an unknown wreck, first identified in 2016 (**Sheet 17**). In the Backscatter mosaic data, the wreck is visible as a large but indistinct area of seabed disturbance measuring 42.3 x 16.7 x 3.0 m, comprising an area of high reflectivity with no defined edge. In the MBES data the wreck is visible as a large irregular oval-shaped mound, orientated north-west to south-east. The north-western section of the wreck is more prominent and distinct than the southern end, which has little height off the surrounding seabed, suggesting it is highly degraded or partially buried. The south-east edge of the wreck is situated within an area of scour up to 0.4 m deep. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.30 In the UKHO record the wreck is described as being upright but severely degraded with geophysical dimensions of 38.4 x 12.2 x 4.5 m. In the 2021 geophysical data the wreck appears upright and mostly intact but highly degraded. The wreck is situated within an area of mobile sediment that may periodically conceal the wreck and any associated debris.

5.3.31 Wreck **7339** is a recorded wreck that corresponds with two UKHO records (6226 and 66452) and a NRHE (909221) record for *Black Prince* (Possibly), a wooden sailing vessel built in 1838 which collided with SS *Larch* and sank in 1890 (**Sheet 18**). In the Backscatter mosaic data, the wreck is visible as an indistinct area of seabed disturbance measuring 65.4 x 20.2 x 4.1 m, comprising an elongate dark reflector, with some possible more distinct features within. A distinct bright reflector is visible on the west edge of the wreck measuring 4.8 x 2.6 m. In the MBES data the wreck is visible as a large, upright, and mostly intact wreck orientated north to south. Internally the wreck has an uneven surface, with two distinct mounds visible in the centre, measuring approximately 4.0 x 3.5 x 2.5 m, indicating surviving superstructure. There is no apparent scouring or sediment build up surrounding the wreck, although the southern end of the wreck does not stand proud of the seabed and may be buried or highly degraded. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.32 In the UKHO record the wreck was first identified in 1986 and last surveyed in 2016 with geophysical dimensions of 63.4 x 10.6 x 5.0 m, and was described as being upright and intact, but severely disintegrated. In the 2021 geophysical data the wreck is upright and mostly intact. Surviving superstructure is visible in the centre of the wreck and the southern end may be buried or highly degraded.

5.3.33 One magnetic anomaly has been classified as A1: anomaly **7503** has a very large amplitude of 1,460 nT. There is nothing anomalous visible in the SSS or MBES data at this position and it has been interpreted as substantial ferrous debris which is either buried or has no surface expression. Amplitudes over 1,000 nT are considered of higher archaeological potential as they suggest the presence of a more significant amount of ferrous material.

5.3.34 Three recorded wrecks have been identified within the Teesside Pipeline GSA and discriminated as A3 (**7197**, **7208** and **7323**). Recorded wreck **7197** is recorded by the UKHO (66499) as the Spanish steam ship *Santiago*, built in 1888 with a triple expansion engine and two boilers. It sank after a collision whilst travelling between Newcastle and Pauillac with a cargo of coal. The wreck was dispersed in the 1920s and was not identified in a MBES survey in 2018. No anomalous features were identified in the Pseudo SSS mosaic or MBES data at this location, and this location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. As remains have been found at this location previously it has been retained as a precaution in this report, but it may be that the wreck is erroneously positioned and is actually located elsewhere or is currently completely buried.

5.3.35 Recorded wreck **7208** is an unknown wreck in the UKHO records (87228), first identified in 2017 with geophysical dimensions of 10.8 x 5.6 x 1.0 m. No anomalous features were identified in the Pseudo SSS mosaic or MBES data at this location and this location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. As remains have been identified at this position previously, it has been retained as a precaution in this report. It is possible that the wreck is currently completely buried or that the position has been recorded incorrectly.

5.3.36 Recorded wreck **7323** (UKHO 73382, NRHE 1603291) is possibly the *Hetty*, a steam ship built in 1875 which sank following a collision in 1894. Divers in 1996 reported an iron-hulled vessel with three anchors at the bow and a boiler visible on the seabed. Previous geophysical dimensions from 1989 are recorded as 50.0 m length. No anomalous features were identified in the Pseudo SSS mosaic or MBES data at this location and this location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. As remains have been found at this location previously it has been retained as a precaution in this report. It is possible that the wreck is currently completely buried, or it may be that the position of the wreck has been recorded incorrectly.

5.3.37 Two recorded obstructions have been identified within the Teesside Pipeline GSA and discriminated as A3 (**7205** and **7209**). Anomaly **7205** is described in the UKHO records (60766) as a piece of debris measuring 15.3 x 1.9 x 0.5 m, which was first identified in 2000. A remotely operated vehicle (ROV) survey in 2001 identified a large engine block and the possible remains of a small vessel in a large section of fishing net with buoys attached. In 2015 a stand-alone small bus engine was found by divers and the feature was not located by MBES survey in 2016. No anomalous features were identified in the Pseudo SSS mosaic or MBES data at this location, which was not directly covered by the SSS or Mag. Datasets so it is not possible to ascertain whether ferrous material is present here. This record has been interpreted as the position of a possible item of debris not visible in the 2021 data and which may be modern. However, this can't be confirmed without visual inspection. It is also possible that the debris has been moved, recovered, or is currently buried.

5.3.38 Anomaly **7209** is recorded by the UKHO (63999) as an anchor first identified in 2004. The feature was not located during a MBES survey in 2016 and the record was amended to dead. No anomalous features were identified in the Pseudo SSS mosaic or MBES data at this location and this location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. It has been interpreted as the position of a possible item of debris not visible in the 2021 data and may be modern however, this can't be confirmed without visual inspection. It is also possible that the debris is currently buried or that it has been moved or recovered.

5.3.39 The remaining 303 anomalies within the Teesside Pipeline GSA have all been discriminated as A2_h or A2_l during this assessment.

5.3.40 A total of nine debris fields have been identified within the Teesside Pipeline GSA and discriminated as A2_h (for the full list see Appendix III). Debris field **7388** was identified in the SSS data as a distinct and compact group of very small dark reflectors, some of which have slight shadows. The feature as a whole has a very large, tapered shadow, significant height and measures 13.9 x 8.1 x 1.6 m (**Figure 5**). The feature was visible in the MBES dataset as a distinct and isolated sub-angular mound, with steep sides and a rounded peak. The debris field has a large Mag. anomaly associated, measuring 166 nT, indicating ferrous material is present, and it has been interpreted as a possible ferrous debris field.

5.3.41 Nine anomalies have been classified as items of debris and discriminated as A2_h (for the full list see Appendix III). The largest of these was **7352**, identified in the SSS data as a distinct straight linear dark reflector with a bright short shadow measuring 13.4 x 0.6 x 0.3 m. The feature has a large Mag. Anomaly associated with it, measuring 163 nT, indicating ferrous material is present and has been interpreted to be a possible ferrous item of debris. The smallest item of debris identified was **7304**, measuring 1.6 x 0.2 x 0.1 m, this was identified in the SSS as a distinct thin dark reflector with a short bright shadow. The feature is situated 5.0 m west of wreck **7308** and may be associated debris.

5.3.42 A total of eight anomalies have been classified as seabed disturbances (for the full list, please see Appendix III). Seabed disturbance **7267** is situated within an area of mobile sediments 13.0 m south-east of wreck **7264**. It was identified in the SSS data as an area of disturbed seabed measuring 9.6 x 7.8 x 0.5 m and containing depressions and indistinct dark reflectors with slight shadows (**Figure 5**). No anomalous features were identified in the MBES or Mag. Data at this location and it has been interpreted to be a possible natural feature or may contain possible debris associated with wreck **7264**.

5.3.43 A total of 12 anomalies have been classified as lengths of rope or chain and discriminated as A2_h (for the full list, please see Appendix III). The longest of these was **7360**, which was identified in the SSS data as a long and thin, curvilinear dark reflector with a slight shadow, measuring approximately 79.7 x 0.4 x 0.1 m (**Figure 5**). The feature is orientated approximately north-west to south-east on the seabed and is possibly associated with debris field **7359** situated 20.0 m to the north-west. It may also be an extension of rope or chain **7361** situated 31.0 m to the south-east. No anomalous features were identified in the MBES data at this location. The feature is associated with a medium Mag. Anomaly, measuring 97 nT, indicating some ferrous material is present and the feature has been interpreted as a possible long length of partially ferrous rope or chain. Lengths of rope and chain may not be of archaeological potential in themselves, but they may be attached to archaeological features (e.g. anchors) or be snagged on mostly buried debris not visible in the SSS or MBES data.

5.3.44 Four anomalies have been classified as bright reflectors and discriminated as A2_l (**7373**, **7453**, **7454** and **7494**). Bright reflectors **7453** and **7454** are situated within 11.0 m of one another and may be associated (**Figure 5**). Anomaly **7453** is visible in the SSS data as an elongate bright reflector that is right-angled at its west end, measuring 6.4 x 3.3 m and anomaly **7454** is visible in the SSS data as a distinct irregularly shaped bright reflector measuring 5.6 x 3.1 m. No anomalous features were identified in the MBES data at these locations and their positions were not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at their locations. They have been interpreted to be possible natural features or may be possible items of debris.

5.3.45 A total of 48 anomalies have been classified as dark reflectors and discriminated as A2_l (for the full list see Appendix III). The largest of these is **7242**, which was identified in the Backscatter mosaic data as a slightly curvilinear dark reflector measuring 22.5 x 1.3 m. It is situated within an area of scour. No anomalous features were identified in the MBES data at this location and this position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present. It has been interpreted as a possible natural feature or may be possible debris.

5.3.46 A total of 61 anomalies have been classified as mounds and discriminated as A2_l (for the full list see appendix III). Mounds **7235**, **7236** and **7237** were all identified in the MBES data and are in a row, aligned east to west on the seabed, spaced approximately 45.0 m apart. They have similar characteristics and dimensions, with the largest mound measuring 2.7 x 2.6 x 0.5 m (**7237**). No anomalous features were identified in the Backscatter mosaic data at their positions, and they were not directly covered by the SSS or Mag. Datasets so it is not possible to ascertain whether ferrous material is present at their locations. They have been interpreted as possible natural features or may be possible debris that may be modern, such as fishing gear. However, this can’t be confirmed without visual inspection.

5.3.47 The remaining 150 anomalies have been classified as magnetic anomalies (for full list, please see Appendix III). These are anomalies that have been identified in the Mag. Data but have no anomalous corresponding features identified in the SSS or MBES data. These range in size from 5 nT (**7282**, **7416**, **7468**, **7491** and **7501**) to 195 nT (**7455**), and are considered to be possible ferrous items of debris which are either buried or have no surface expression

<u>Humber Pipeline GSA</u>

5.3.48 The results of this assessment are collated in gazetteer format detailed in **Appendix 4** and illustrated in **Figures 4I – 4Q**.

5.3.49 A total of 197 features have been identified as being of possible archaeological potential within the Humber Pipeline GSA and are discriminated as shown in **Table 9**.

Table 9 Anomalies of archaeological potential within the Humber Pipeline GSA

Archaeological discrimination	Quantity	Interpretation
A1	7	Anthropogenic origin of archaeological interest
A2_h	40	Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature

A2_I	148	Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
A3	2	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total	**197**	

5.3.50 Furthermore, these anomalies can be classified by probable type, which can further aid in assigning archaeological potential and importance (**Table 10**).

Table 10 Types of anomaly identified

Anomaly classification	Definition	Number of anomalies
Wreck	Areas of coherent structure including wrecks of ships, submarines and some aircraft (where coherent structure survives)	7
Debris field	A discrete area containing numerous individual debris items that are potentially anthropogenic, and can include dispersed wreck sites for which no coherent structure remains	11
Debris	Distinct objects on the seabed, generally exhibiting height or with evidence of structure, that are potentially anthropogenic in origin	12
Seabed disturbance	An area of disturbance without individual, distinct objects. Potentially indicates wreck debris or other anthropogenic features buried just below the seabed.	20
Rope/chain	Curvilinear dark reflectors, often with a small amount of height, indicating rope or chain (if ferrous)	7
Bright reflector	Individual objects or areas of low reflectivity, characteristic of materials that absorb acoustic energy, such as waterlogged wood or synthetic materials. Precise nature is uncertain	5
Dark reflector	Individual objects or areas of high reflectivity, displaying some anthropogenic characteristics. Precise nature is uncertain	66
Mound	A mounded feature with height not considered to be natural. Mounds may form over wreck sites or other debris.	19
Magnetic	No associated seabed surface expression, and have the potential to represent possible buried ferrous debris or buried wreck sites	48
Recorded wreck	Position of a recorded wreck at which previous surveys have identified definite seabed anomalies, but for which no associated feature has been identified within the current data set.	1
Recorded obstruction	Position of a recorded obstruction (e.g. foul ground, fisherman's fastener recorded by the UKHO), but for which no associated feature has been identified within the current data set	1
Total		**197**

5.3.51 A total of seven anomalies have been discriminated as A1 within the Humber Pipeline GSA.

5.3.52 Wreck **7007** corresponds with two charted UKHO records (8870 and 8869), recorded as the steam ship *Francis*, which was driven ashore and wrecked in heavy seas in 1872 (**Sheet 1**). In the 2021 Pseudo SSS mosaic data the wreck is visible as a large spread of angular and elongate dark reflectors with bright shadows, orientated approximately NNE to SSW and measuring 62.7 x 27.0 x 2.0 m. In the MBES data the wreck is visible as a compact sub-elliptical group of angular mounds. The SSW end is pointed and distinct and the NNE end becomes indistinguishable from the outcropping geology, meaning the full extent of the wreck is unclear and the dimensions may be inaccurate. The mounds are generally low-lying, however some objects up to 2.0 m tall have been identified at the centre of the wreck. The wreck is possibly upright, although no identifiable internal superstructure is visible. This location was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location, however the UKHO record suggests that it would have a large associated Mag. anomaly. In the UKHO record the wreck was last surveyed in 2020 and described as being broken down with an associated debris field included in the measurements of 60.3 x 21.6 x 3.5 m.

5.3.53 Wreck **7040** is a charted wreck that corresponds with a UKHO record (8911) and NRHE record (907898) for the steam ship *Paraciers*, which was torpedoed in 1917 by *UC-46* (**Sheet 2**). In the Pseudo SSS mosaic the wreck is visible as a large spread of dark reflectors with shadows measuring 74.3 x 27.8 x 1.6 m. A number of straight linear dark reflectors are visible, the longest measures 8.7 x 0.9 m. The wreck is orientated north-west to south-east and is situated on a relatively featureless area of seabed. In the MBES data the wreck is visible as a large spread of uneven seabed, comprising mainly angular mounds and smaller sub-angular mounds. The largest mound is situated in the centre of the wreck, measuring 6.8 x 3.7 m, and may be a boiler.

5.3.54 In the UKHO record the wreck was last surveyed in 2020 and was described as being very broken up with two boilers visible with geophysical dimensions of 74.5 x 21.7 x 1.6 m. In the 2021 geophysical data the wreck appears broken up and degraded with some associated debris identified in the vicinity (**7041**).

5.3.55 Wreck **7063** is a charted wreck that corresponds with a UKHO record (8945) and NRHE record (907912) for the steam ship *John Rettig* (Probably), which was torpedoed in 1918 by *UB-107* (**Sheet 3**). In the Pseudo SSS mosaic data the wreck is visible as a group of bright reflectors and very small, indistinct dark reflectors with shadows. The wreck is orientated north-east to south-west and measures 93.2 x 22.3 x 6.5 m. At the south-west end of the wreck a large dark reflector with a bright shadow is visible, measuring 11.9 x 4.8 m and the NNE end of the wreck has a rectangular dark reflector measuring 5.4 x 3.0 m. In the MBES dataset the wreck appears generally intact and upright on the seabed, but slightly tilted on its eastern edge. Internally, rounded and angular mounds are visible, indicating some possible surviving superstructure, and a tall mound visible in the centre measuring 11.5 x 5.3 x 3.5 m may be a boiler. The interpreted hull looks slightly disjointed and may be partially buried or broken up. There is scouring around the south-east end of the wreck up to 9.0 m in length and 1.5 m deep and slight scouring and sediment accumulation at the NNE end of the wreck. This location was not directly covered by the Mag. Dataset, however there is a small, very broad, Mag. Anomaly on the closest Mag. Line (**7062**) 100 m to the south-west; this may be a halo response of nearby ferrous material, which would correspond with the UKHO record that states such material is present.

5.3.56 In the UKHO record the wreck was last surveyed in 2016 with geophysical dimensions of 93.7 x 23.7 x 9.5 m and a strong associated magnetic anomaly. It was described as being broken up, with the centre sections disintegrated. In the 2021 geophysical data the wreck appears mostly intact with some surviving superstructure visible. The lower height measurement since 2016 suggests the wreck may have collapsed or degraded. The wreck has surrounding sediment accumulation which may periodically bury and uncover it, and any associated debris.

5.3.57 Wreck **7066** is a charted wreck that corresponds with a UKHO record (8951) and a NRHE record (908372) for the steam ship *Horsted*, which was sunk by a mine or torpedo in 1939 (**Sheet 4**). In the Pseudo SSS mosaic data the wreck is orientated north to south and visible as an ovoid area of mainly bright reflectors, with dark reflectors visible at the northern and southern ends, and measuring 87.9 x 19.2 x 4.5 m. In the southern part of the wreck, curvilinear and rounded dark reflectors with shadows are visible and at the northern end, a thick curvilinear dark reflector is visible which is interpreted to be surviving hull. Significant scouring is present to the north and south of the wreck. In the MBES data the wreck appears upright and mostly intact; internally, multiple rounded and angular mounds are visible, with larger angular mounds located at its northern end, which may be boilers. The interpreted hull does not protrude high above the seabed and there is evidence of sediment accumulation around the wreck, possibly indicating it may be collapsed or buried. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location, however the UKHO record suggests it is ferrous.

5.3.58 In the UKHO record the wreck was last surveyed in 2016 with geophysical dimensions of 88.1 x 21.1 x 6.7 m, and was described as being upright but broken up with two boilers visible near the stern and a strong associated Mag. Anomaly. In the 2021 geophysical data the wreck appears mostly intact but may be partially buried; the lower recorded height measurement suggests it has collapsed or degraded since the 2016 survey.

5.3.59 Wreck **7072** is a charted wreck that corresponds with a UKHO record (8958) and NRHE record (908376) for a tanker ship, *Helmsman* (Probably), which foundered in severe gales in 1927 (**Sheet 5**). In the Pseudo SSS mosaic data the wreck is visible as a distinct ovoid bright reflector orientated north-west to south-east on the seabed. Some indistinct, dark reflectors are visible at the north-west and south-east ends of the wreck and a small number of internal, indistinct linear dark reflectors are visible. The wreck measures 38.4 x 9.3 x 3.6 m and has scouring to the north and south, with some sediment accumulation at the south-east end which may periodically bury the wreck. In the MBES data the wreck appears intact and upright, with multiple internal low-lying mounds visible. The tallest mound is situated in the centre of the wreck and measures 8.3 x 5.2 x 1.0 m. The wreck is situated within an area of scour up to 0.2 m deep and is isolated on the seabed. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location, however the UKHO record suggests it is ferrous. In the UKHO record the wreck was last surveyed in 2016 and described as being upright and intact with geophysical dimensions of 40.9 x 9.2 x 4.7 m and a strong associated Mag. Anomaly.

5.3.60 Wreck **7078** is a charted wreck that corresponds with a UKHO record (8967) and NRHE record (907923) for the steam ship *Onward* (Possibly), which sank in heavy seas in 1862 (**Sheet 6**). In the Backscatter mosaic data the wreck is visible as a large oval dark reflector orientated north to south, interpreted to represent the hull, measuring 73.8 x 29.2 x 2.9 m. Internally some indistinct, linear dark reflectors are visible, with a square shaped dark reflector measuring 10.4 x 7.8 m visible at the northern end of the wreck and some scour to the NNW. In the MBES data the interpreted hull of the wreck appears to be disjointed with little height off the seabed, indicating possible collapse. Numerous, internal small angular and linear mounds are visible. At the southern end of the wreck a large mound measuring 13.9 x 7.2 x 1.0 m is visible, and may be a boiler. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location, however the UKHO record suggests it is ferrous.

5.3.61 In the UKHO record the wreck was last surveyed in 2016 and described as being disintegrated with just the aft section intact and the boilers still visible, with geophysical dimensions of 75.5 x 25.3 x 7.5 m and a strong associated Mag. Anomaly. In the 2021 geophysical data the wreck is relatively compact but appears degraded and possibly broken; the increase in width and decrease in height may be evidence of collapse since 2016.

5.3.62 Wreck **7188** is a charted wreck associated with a UKHO record (6605) for an unknown wreck (**Sheet 7**). In the Backscatter mosaic data the wreck is visible as an irregular area of seabed disturbance comprising indistinct dark and bright reflectors measuring 35.6 x 13.2 x 3.0 m. One very distinct dark reflector is visible at the western extent of the wreck, and the wreck is situated within an area of large mobile sand waves. In the MBES data the wreck is visible as an ovoid group of angular mounds. Internally multiple, straight-edged, rectangular and angular mounds are visible, with the tallest mounds in the centre and east end of the wreck. The wreck is orientated east to west and appears to be upright on the seabed, and mostly intact. The wreck has some surrounding scour, with the largest area of scour measuring 20.0 m in length and -1.0 m deep at the south-west side of the wreck. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.63 In the UKHO record the wreck was last surveyed in 1987 and described as being partially buried in the flank of a sand wave with geophysical dimensions of 52.0 x 10.0 x 3.6 m. The smaller dimensions in the 2021 data suggest the wreck may have degraded further or become further buried by mobile sediments since 1987. A piece of associated debris (**7189**) has been identified 35.0 m south of the wreck and there is potential for further debris to be buried in the vicinity.

5.3.64 Two anomalies have been discriminated as A3. Anomaly **7036** is a recorded wreck (UKHO 9047, NRHE 907893), possibly the steam ship *Georgios Antippa*, built in 1894 and sunk by submarine in 1917 whilst carrying a cargo of coal. The forward part of the wreck was located at this position in 1984, but it has not been located in MBES survey since then and the record has been amended to dead. No anomalous features were identified in the Pseudo SSS mosaic or MBES data at this location and this position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. As remains have been found at this location previously it has been retained as a precaution in this report, but it may be that the wreck is erroneously positioned and is actually located elsewhere or is currently completely buried.

5.3.65 Anomaly **7059** is a recorded obstruction (NRHE 1593305) described as two pieces of metal framework discovered during a survey in advance of construction work on the Humber Gateway offshore wind farm (Wessex Archaeology 2014). The objects were investigated by a remotely operated underwater vehicle (ROV) as part of an unexploded ordnance (UXO) ground-truthing assessment. A small piece of metal framework, measuring 0.2 x 0.1 m, was exposed on the seabed. It appears to be attached to another piece of metal, measuring 0.6 x 0.3 m, located approximately 0.6 m away. The rest of the structure remains buried on the seabed. No anomalous features were identified in 2021 Pseudo SSS or MBES data at this location and this position was not directly covered by the SSS or Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. As remains have been found at this location previously it has been retained as a precaution in this report

5.3.66 The remaining 188 features within the Humber Pipeline GSA have all been discriminated as A2_h or A2_l during this assessment.

5.3.67 Eleven debris fields have been discriminated as A2_h (for the full list see Appendix II). Debris field **7041** is situated 15.0 m north of wreck **7040** and is possibly associated (**Figure 5**). In the Pseudo SSS mosaic data the feature is visible as a rounded area of seabed disturbance measuring 14.5 x 10.4 m. The feature comprises indistinct dark reflectors and linear scour marks, with a rounded bright reflector measuring 2.7 x 1.9 m visible at the western extent. In the MBES data the anomaly is visible as an uneven area of seabed. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.68 The largest debris field identified is **7191**, which was visible in the SSS data as a long, thin and slightly curvilinear dark reflector with a slight shadow in places, measuring approximately 109.9 x 0.7 x 0.3 m. The feature is orientated north-west to south-east on the seabed and has dark reflectors attached across its extent, measuring approximately 2.0 x 1.2 m individually. No anomalous features were identified in the MBES data at this location. The feature was not fully covered by the Mag. Data, but has a small Mag. Anomaly associated with it at its north-west end, measuring 14 nT, indicating some ferrous material is present. This has been interpreted to be a possible partially ferrous debris field, and may be modern such as fishing gear; however, this can't be confirmed without visual inspection.

5.3.69 Twelve items of debris have been identified within the Humber Pipeline GSA and discriminated as A2_h (for the full list see Appendix II). The largest of these is debris **7006** (**Figure 5**), measuring 18.8 x 7.4 x 0.3 m. In the Pseudo SSS mosaic data the feature is visible as an elongate dark reflector with a large, bright shadow. In the MBES data the feature is visible as a linear mound orientated NNW to SSE, which is wider at the NNW end and has gently sloping sides and an uneven peak. The eastern edge of the mound is more defined and is situated in an area of outcropping bedrock. This feature is situated 5.0 m south of wreck **7007** and may be associated debris. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.70 One item of ferrous debris has been identified within the Humber Pipeline GSA (**7128**). The feature measures 5.5 x 1.2 x 0.4 m and was visible in the SSS data as a distinct angular dark reflector with an indistinct linear dark reflector attached and an uneven shadow, possibly suggesting uneven height. No anomalous features were identified in the MBES data at this location. The feature has a medium Mag. Anomaly associated with it, measuring 62 nT, indicating some ferrous material is present and has been interpreted to be possible ferrous debris.

5.3.71 Twenty seabed disturbances have been identified within the Humber Pipeline GSA and discriminated as A2_l (for the full list see Appendix II). The largest seabed disturbance identified is **7035**, measuring 46.4 x 17.6 x 0.4 m. This was identified in the MBES dataset as a large area of seabed disturbance comprising low-lying mounds and depressions, orientated east to west on the seabed. This feature is situated 25.0 m south-west of recorded wreck position (**7036**). The smallest seabed disturbance identified is **7002**, measuring 6.2.x 5.0 m. This was visible in the Pseudo SSS mosaic data as an area of seabed disturbance comprising an indistinct group of dark reflectors with scouring extending 19.0 m to the south-east. In the MBES data the feature was visible as an uneven area of seabed. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. It has been interpreted as a possible natural feature or may be possible debris.

5.3.72 A total of seven anomalies have been classified as lengths of rope or chain and discriminated as A2_h (**7097**, **7099**, **7156**, **7157**, **7158**, **7159** and **7169**). The longest rope or chain identified is **7158**, measuring 74.5 x 1.0 m. The feature was visible in the Backscatter mosaic data as a long thin and relatively straight dark reflector with a shadow, orientated north-east to south-west on the seabed, and situated within an area of mobile sand waves. A similar rope or chain (**7159**) is situated 10.0 m to the south and may be associated. No anomalous features were identified in the MBES data at this location and this position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present. Lengths of rope or chain may not be of archaeological potential in themselves, but they may be attached to archaeological features (e.g. anchors) or be snagged on mostly buried debris not visible in the geophysical data.

5.3.73 A total of five bright reflectors have been identified within the Humber Pipeline GSA and discriminated as A2_I (**7052**, **7143**, **7145**, **7147** and **7153**). The largest bright reflector identified is **7143**, measuring 11.6 x 1.1 m. The feature was visible in the Backscatter mosaic data as a straight and elongate bright reflector, orientated north-east to south-west on the seabed. No anomalous features were identified in the MBES data at this location and this position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. It has been interpreted as a possible natural feature or may be possible debris.

5.3.74 A total of 66 anomalies have been classified as dark reflectors and discriminated as A2_I (for the full list see Appendix II). The largest of these is **7165**, measuring 19.6 x 3.0 m. The feature was visible in the Backscatter mosaic data as an indistinct linear dark reflector or possibly multiple small, rounded objects close together on the seabed. The feature is situated within an area of large mobile sand waves and was not visible in the MBES data. This position was not directly covered by the SSS or Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. It has been interpreted as a possible natural feature or may be possible debris.

5.3.75 A total of 19 mounds have been identified within the Humber Pipeline GSA and discriminated as A2_I (for the full list see Appendix II). Mounds **7032** and **7033** are situated within 15.0 m of one another, have similar characteristics and are possibly associated, measuring 23.4 x 7.2 x 0.7 m and 24.0 x 7.6 x 0.6 m respectively. Mound **7032** was visible in the MBES data as an elongate mound with steeply sloping sides and a slightly uneven peak, orientated north to SSE on the seabed and tallest at its northern end. Mound **7033** was visible in the MBES data as a distinct, elongate mound with steeply sloping sides and a slightly pointed peak in its centre. Neither of these features were visible in the Pseudo SSS mosaic and the positions were not directly covered by the SSS or Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at these locations. They have been interpreted as possible natural features or may be possible debris.

5.3.76 The remaining 48 anomalies have been classified as magnetic anomalies (for full list see Appendix II). These are anomalies that have been identified in the Mag. Data but have no anomalous corresponding features identified in the SSS or MBES data. These range in size from 8 nT (**7083** and **7174**) to 298 nT (**7057**) and are considered to be ferrous items of debris which are either buried or have no surface expression.

Endurance Store GSA

5.3.77 The results of this assessment are collated into gazetteer format detailed in Appendix IV and illustrated in **Figures 4Q – 4R**.

5.3.78 A total of 21 features have been identified as being of possible archaeological potential within the Endurance Store GSA and are discriminated as shown in **Table 11**.

Table 11 Anomalies of archaeological potential within the Endurance Store GSA

Archaeological discrimination	Quantity	Interpretation
A1	2	Anthropogenic origin of archaeological interest

A2_h	1	Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
A2_l	18	Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
A3	0	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total	**21**	

5.3.79 Furthermore, these anomalies can be classified by probable type, which can further aid in assigning archaeological potential and importance (**Table 12**).

Table 12 Types of anomaly identified

Anomaly classification	Definition	Number of anomalies
Wreck	Areas of coherent structure including wrecks of ships, submarines and some aircraft (where coherent structure survives)	2
Debris field	A discrete area containing numerous individual debris items that are potentially anthropogenic, and can include dispersed wreck sites for which no coherent structure remains	1
Seabed disturbance	An area of disturbance without individual, distinct objects. Potentially indicates wreck debris or other anthropogenic features buried just below the seabed.	3
Bright reflector	Individual objects or areas of low reflectivity, characteristic of materials that absorb acoustic energy, such as waterlogged wood or synthetic materials. Precise nature is uncertain.	5
Dark reflector	Individual objects or areas of high reflectivity, displaying some anthropogenic characteristics. Precise nature is uncertain	10
Total		**21**

5.3.80 A total of two anomalies have been discriminated as A1 within the Endurance Store GSA (**7536** and **7541**).

5.3.81 Wreck **7536** is a charted and recorded wreck that corresponds with a UKHO record (6832) for an unknown wreck, first identified in 1981 (**Sheet 19**). In the Backscatter mosaic data the wreck is visible as an area of seabed disturbance measuring 31.4 x 7.3 m and comprising dark and bright reflectors. In the MBES data the wreck appears upright and is visible as a distinct, elongate mound up to 1.3 m tall with an uneven peak, orientated north-east to south-west. The tallest point of the wreck is situated at the south-west end, with uneven mounds visible in the centre of the wreck, that may be surviving superstructure. The wreck position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.82 In the UKHO record the wreck was last surveyed in 1985 with geophysical dimensions of 40.0 x 12.0 x 2.6 m and was described as lying in two parts, with the smaller part approximately 7.0 m to the south-east of the main section. In the 2021 geophysical the wreck appears upright, with some surviving superstructure visible. The wreck is situated within large mobile sand waves, which may periodically cover the wreck and any associated debris. The smaller dimensions recorded in the 2021 survey suggests it has degraded or become buried and as such the dimensions should be considered a minimum.

5.3.83 Wreck **7541** is a charted and recorded wreck that corresponds with a UKHO record (6830) for an unknown wreck, first identified in 1981 (**Sheet 20**). In the Backscatter mosaic data, the wreck is visible as a large area of seabed disturbance, measuring 28.5 x 8.1 m comprising areas of low and high reflectivity. The wreck is distinct to the surrounding seabed and situated within large mobile sand waves. A possible dark reflector is visible in the southern end of the wreck measuring 5.3 x 2.9 m. In the MBES data the wreck is visible as a large, elongate mound up to 1.8 m tall, with a slightly uneven peak, and with the tallest point at the southwestern end. The wreck appears intact and is orientated approximately north-east to south-west, with some minor scour surrounding it. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location.

5.3.84 In the UKHO record the wreck was last surveyed in 1985 with geophysical dimensions of 36.0 x 16.0 x 2.6 m and was noted to be intact, with a sand wave located to the north-west. In the 2021 geophysical data the wreck appears intact and may be upright, though this is unclear. The smaller dimensions recorded suggests the wreck has degraded since the 1985 survey and may be partially buried, so the dimensions should be considered a minimum.

5.3.85 The remaining 19 features within the Endurance Store GSA have all been discriminated as A2_h and A2_l during this assessment.

5.3.86 One anomaly has been classified as a debris field and discriminated as A2_h (**7533**). This was identified in the Backscatter mosaic data as an elongate, slightly angular dark reflector measuring 32.4 x 11.0 m. The feature is indistinct in places, possibly suggesting it comprises multiple objects, and is orientated north-west to south-east. In the MBES data the feature is visible as a distinct elongate mound with gently sloping sides and an uneven peak, the feature is 0.6 m tall. The mound becomes narrower to the north-west end and appears more irregular in the south-east.

5.3.87 A total of three anomalies have been classified as seabed disturbances and discriminated as A2_l (**7525**, **7537** and **7539**). Anomaly **7537** was identified in the Backscatter mosaic data as an area of seabed disturbance measuring 35.5 x 6.2 m, comprising a distinct linear dark reflector situated within large mobile sand waves. In the MBES data the feature is visible as a large mound situated on a sand wave crest. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. The feature is situated 23.0 m west of wreck **7536** and may be a possible natural feature, such as sediment build-up, or further buried structure associated with the wreck.

5.3.88 Five anomalies have been classified as bright reflectors and discriminated as A2_l (**7521**, **7522**, **7528**, **7534** and **7535**). The largest of these was **7521**, which measures 14.4 x 1.4 m. This was visible in the Backscatter mosaic data as a distinct, long and straight bright reflector lying perpendicular to the sand waves. No anomalous features were identified in the MBES data at this location and it has been interpreted as a possible natural feature or may be a possible item of debris.

5.3.89 A total of ten anomalies have been classified as dark reflectors and discriminated as A2_l (for the full list see Appendix IV). The smallest of these was **7532**, which measures 4.0 x 1.3 x 0.2 m. This was visible in the Backscatter mosaic data as distinct sub-rounded dark reflector and was situated 13.0 m east of similar dark reflector **7531** and may be associated.

Both of these features were visible as a low-lying mounds in the MBES dataset and are interpreted to be possible natural features or may be a possible items of debris.

5.4 Maritime archaeological potential

Introduction and general background

5.4.1 The assessment of potential for the discovery of shipwreck and shipwreck-derived material within the ASA draws on the results of the geophysical survey and desk-based research combined with further research of the wider area.

5.4.2 There is potential for discoveries of maritime craft from the Mesolithic to the modern period. Post-medieval and modern wrecks, as they were generally made of more substantial material, are more likely to have been discovered through surveys undertaken by UKHO and others, and thus recorded in the archaeological record. However, there is still potential for discovery of previously unrecorded wreck sites, particularly of wooden wrecks, broken up wrecks or partially buried wrecks that are more difficult to detect through geophysical survey.

5.4.3 Many vessels were lost without a record being made, and sometimes even the records that were created have since been lost. Examining the recorded losses discussed above provides an indication to the potential for further discoveries, as do the factors discussed below.

Recorded losses

5.4.4 As discussed in **Section 3.4**, Recorded Losses are records for ships or aircraft that are known to have wrecked or crashed offshore, but for which the exact locations are not known. Recorded Losses are often grouped together by their general area of loss into Maritime Named Locations (displayed spatially as polygons or centre points of polygons, often associated with NRHE data), however many records (particularly from the HER dataset) are given co-ordinates (displayed spatially as points), although these are similarly unsubstantiated.

5.4.5 Recorded Losses can be considered as an indication of the potential for archaeological maritime remains to exist within the ASA and the type and number of wrecks that could be present. These records relate to vessels reportedly lost or for which no physical wreck remains have ever been identified. There will be a bias in these records towards vessels dating to the post-medieval period and later, and also towards vessels that sank in inshore waters.

5.4.6 The UKHO, NRHE and HER datasets have 93 records of recorded losses. These are records for which although a vessel (or vessels) is known to have been lost in the general area, no material has been encountered on the seabed at the recorded location. A full gazetteer of these has been included in **Appendix 7**. The Gazetteer does not include positional data due to the inherent inaccuracy of the data.

5.4.7 Most losses are recorded from the post-medieval period, and while this to some extent could represent a significant increase in shipping during the post medieval period, it also reflects the fact that record keeping, and the maintaining of those records, had improved significantly. The recorded losses can be considered as an indication of the potential for archaeological maritime remains to exist within the ASA and the type and number of wrecks that could be present, although the records are by no means conclusive and are heavily biased to the post medieval period, particularly the 19th century.

5.4.8 **Table 13** shows the distribution of these documented losses according to the date of loss for those records whose positions fall within the ASA. Details regarding these losses are presented in **Appendix 7**.

Table 13 Recorded Losses – summary by date

Date	Number of records of ships	Number of records of aircraft	Number of records of cargo from wrecks
Pre 1508 AD	5	-	-
1509 to 1815	10	-	-
1816 to 1913	74	0	2
1914 to 1945	2	0	-
Post – 1946	1	0	-
Unknown	1	0	-
Total	**93**	**0**	**2**

5.4.9 In general, Recorded Losses paint a vibrant picture of the types of voyages being undertaken around the east coast of England. The losses across generally represent 19th and early 20th century vessels, including those involved in national and international trade and the fishing industry.

5.4.10 There are also two records of items of cargo found on Coatham Sands in 1841 that presumably came from a wreck or wrecks.

5.4.11 Of the 93 records of vessels that were lost, 89 have a recorded vessel type. These include: a range of sailing vessels including schooners, brigs, brigantines, sloops, barques, barquentines, snows and more general sailing cargo vessels and colliers. Fishing vessels include ketch, luggers, cobles as well as steam and motor fishing vessels. Steam cargo ships and colliers are also present, as are tugs and barges. Finally, one whaler is amongst the records, that was lost in 1826 returning from Greenland. The types of vessels highlight the wide range of maritime activities in the ASA over time.

Overview of Potential

5.4.12 There is potential for the presence of archaeological material of maritime nature spanning from the Mesolithic period to the present day within the ASA. The key periods of potential are summarised in **Table 14** below.

Table 14 Summary of key periods of maritime potential

Period	Summary
Pre-1508 AD	Low potential for material associated with prehistoric maritime activities. Prehistoric maritime activities include coastal travel, fishing and the exploitation of other marine and coastal resources. Vessels of this period include rafts, hide covered watercraft and log boats
	Low potential for material associated with later prehistoric maritime activities, including seaworthy watercraft suitable for overseas voyages to facilitate trade and the exploitation of deep water resources. Such remains are likely to comprise larger boat types, including those representing new technologies such as the Bronze Age sewn plank boats which are associated with a growing scale of seafaring activities.
	Low potential for material of Romano-British date, associated with the expansion and diversification of trade with the Continent. Watercraft of this period, where present, may be representative of a distinct shipbuilding tradition known as 'Romano-Celtic' shipbuilding, often considered to represent a fusion of Roman and northern European methods.
	Low potential for material associated with coastal and seafaring activity in the 'Dark Ages', associated with the renewed expansion of trade routes and Germanic and Norse invasion

	and migration. Vessels of this period may be representative of new shipbuilding traditions such as the technique.
	Low potential for material associated with medieval maritime activity, including that associated with increasing trade between the UK and Europe, the development of established ports around the southern North Sea and the expansion of fishing fleets and the herring industry. Vessels of this period are representative of a shipbuilding industry which encompassed a wide range of vessel types (comprising both larger ships and vernacular boats). Such wrecks may also be representative of new technologies (e.g. the use of flush-laid strakes in construction), developments in propulsion, the development of reliable navigation techniques and the use of ordnance.
1509 to 1815	Medium potential for post-medieval shipwrecks representative of continuing technological advances in the construction, fitting and arming of ships, and in navigation, sailing and steering techniques. Vessels of this period continued to variously represent both the clinker techniques and construction utilising the flush-laid strakes technique.
	Medium potential for post-medieval shipwrecks associated with the expansion of transoceanic communications and the opening up of the New World.
	Medium potential for post-medieval shipwrecks associated with the establishment of the Royal Navy during the Tudor period and the increasing scale of battles at sea.
	Medium potential for post-medieval shipwrecks associated with continuing local trade and marine exploitation including the transport of goods associated with the agricultural revolution.
1816 to 1913	Higher potential for the discovery of shipwrecks associated with the introduction of iron and later steel in shipbuilding techniques. Such vessels may also be representative of other fundamental changes associated with the industrial revolution, particularly with regards to propulsion and the emergence of steam propulsion and the increasing use of paddle and screw propelled vessels.
	Higher potential for the discovery of shipwrecks demonstrating a diverse array of vernacular boat types evolved for use in specific environments.
	Higher potential for wrecks associated with large scale worldwide trade, the fishing industry or coastal maritime activity including marine exploitation.
1914 to 1945	Higher potential for the discovery of shipwrecks associated with the two world wars including both naval vessels and merchant ships. Wrecks of this period may also be associated with the increased shipping responding to the demand to fulfil military requirements. A large number of vessels dating to this period were lost as a result of enemy action
Post- 1946	Potential for wrecks associated with a wide range of maritime activities, including military, commerce, fishing and leisure. Although ships and boats of this period are more numerous, loses decline due to increased safety coupled with the absence of any major hostilities. Vessels dating to this period are predominantly lost as a result of any number of isolated or interrelated factors including human error, adverse weather conditions, collision with other vessels or navigational hazards or mechanical faults.

5.5 Aviation archaeological potential

5.5.1 Marine aviation archaeology receptors comprise the remains or associated remains of military and civilian aircraft that have been lost at sea. Evidence is divided into three primary time periods based on major technological advances in aircraft design: Pre-1939; 1939-1945; and post-1945.

5.5.2 There are three aircraft recorded losses within the ASA, two Heinkel He 111 bombers shot down in 1940, and a British Hudson MK I reconnaissance aircraft that ditched off Redcar in 1941.

5.5.3 As these are recorded losses the positional data is unreliable and serve only to provide an indication of the types of aircraft that flew over this coastline. In many cases the location is only a set of general coordinates, a general distance and bearing from a landmark, or the location of the crew's dinghy, or recovered remains.

Overview of Potential

5.5.4 There is potential for the presence of aviation material dating from the early 20th century until more recent times, with a concentration dating to the World Wars and in particular to the Second World War (Wessex Archaeology 2008a). Discoveries may occur anywhere within the Development Area. Aircraft crash sites are also difficult to identify through archaeological assessments of geophysical survey, although past experience indicates material from the site, such as engines or other material may be recorded as small obstructions or anomalies.

5.5.5 The key periods of aviation potential that may be uncovered within the ASA are summarised in **Table 15**.

Table 15 Summary of key periods of aviation potential

Period	Summary
Pre- 1939	Minimum potential for material associated with the early development of aircraft. Aircraft of this period may represent early construction techniques (e.g. those constructed of canvas covered wooden frames) or may be associated with the mass-production of fixed wing aircraft in large numbers during WWI.
	Minimum potential for material associated with the development of civil aviation during the 1920s and 1930s, associated with the expansion of civilian flight from the UK to a number of European and worldwide destinations.
1939 to 1945	Very high potential for WWII aviation remains, particularly as the east coast acted as a hub for hostile activity. Aircraft of this period are likely to be representative of technological innovations propelled by the necessities of war which extended the reliability and range of aircraft.
Post- 1945	Potential for aviation remains associated with military activities dominated by the Cold War, the evolution of commercial travel and recreational flying and the intensification of offshore industry (including helicopter remains). Aircraft of this period may be representative of advances in aerospace engineering and the development of the jet engine

5.6 Value

5.6.1 This section will apply the assessment of value criteria set out in **Section 3.6** to the known and potential maritime and aviation archaeological receptors.

5.6.2 The present assessment of value relies on descriptions of the sites from the UKHO, NRHE, Canmore, and the HER's, and therefore the results of the assessment could be amended based on archaeological assessment of further data. This assessment is based on the criteria for assessing archaeological value, as set out in **Table 4**, and on available guidance (English Heritage 2012; Wessex Archaeology 2011).

5.6.3 Each of the 20 identified wrecks (the A1 receptors outlined above) have been assessed according to the full range of criteria for assessing value (section 3.6). They have been judged as being either of medium or high value (See **Table 16** and accompanying Wreck Sheets).

Table 16 Identified archaeological receptor value

ID Number	Wreck name	Classification	Value	Position (ED50 UTM31N)	
				Easting	Northing
7007	*Francis*	Wreck	Medium	309166	5951536
7036	*Georgios Antippa*	Recorded wreck	Medium	315924	5959415

ID Number	Wreck name	Classification	Value	Position (ED50 UTM31N)	
				Easting	Northing
7040	*Paraciers*	Wreck	Medium	316112	5960258
7059	Unknown Obstruction	Recorded Obstruction	High	318987	5974322
7063	*John Rettig*	Wreck	Medium	319425	5974528
7066	*Horsted*	Wreck	Medium	320229	5975612
7072	*Helmsman*	Wreck	Medium	319021	5977560
7078	*Onward*	Wreck	Medium	319348	5980106
7188	Unknown Wreck	Wreck	High	358336	6012230
7197	*Santiago*	Recorded Wreck	Medium	236310	6060858
7205	Unknown Obstruction	Recorded Obstruction	High	239580	6062526
7208	Unknown Wreck	Recorded Wreck	High	240669	6063095
7209	Probable Anchor	Recorded Obstruction	High	240706	6062879
7210	*Teesdale*	Wreck	Medium	243520	6063523
7217	*John Miles*	Wreck	Medium	249133	6061305
7253	*Earl Percy*	Wreck	Medium	258712	6059647
7260	Unknown Wreck	Wreck	High	259927	6056931
7262	*Afrique*	Wreck	Medium	260730	6058476
7263	*Audax*	Wreck	Medium	261810	6057750
7264	*Rutil*	Wreck	Medium	261883	6056726
7265	Debris potentially associated with 7264	Debris field	Medium	261892	6056699
7270	Unknown Wreck	Wreck	High	262099	6055310
7305	Debris potentially associated with 7308	Debris	Medium	267609	6052543
7306	Debris potentially associated with 7308	Debris field	Medium	267608	6052609
7307	Debris potentially associated with 7308	Debris	Medium	267614	6052537
7308	*Gwalia*	Wreck	Medium	267616	6052571
7319	Unknown Wreck	Wreck	High	270387	6050868
7323	*Hetty*	Recorded Wreck	Medium	271454	6050820
7339	*Black Prince*	Wreck	Medium	278244	6048535
7503	Unknown Magnetic Receptor	Magnetic	High	352788	6017861
7536	Unknown Wreck	Wreck	High	376037	6011477

ID Number	Wreck name	Classification	Value	Position (ED50 UTM31N)	
				Easting	Northing
7541	Unknown Wreck	Wreck	High	377671	6005054

5.6.4 Named wrecks which are undesignated are judged as **medium** value and are judged to reflect the criteria of average examples of their types.

5.6.5 Wrecks, recorded wrecks or recorded obstructions that have not been positively identified as a named vessel are judged as of **high** value due to their unknown potential. Similarly, as the value of potential wrecks cannot be evaluated until they are discovered, potential wrecks of all periods should be expected to be of **high** value.

5.6.6 As it is currently unknown whether the remains of any aircraft are in the ASA, it is not known whether there are any aircraft which crashed while in military service, and therefore automatically protected under the *Protection of Military Remains Act* 1986.

5.6.7 Any further aircraft material discovered would have to be assessed on a case-by-case basis, but it should be treated as of **high** value until proven otherwise.

6 HISTORIC SEASCAPE CHARACTER

6.1.1 In 2009 a project was initiated to demonstrate the implementation of the HSC methodology in an area of sea stretching from Northumberland to Yorkshire (Merritt & Dellino-Musgrave, 2009). It therefore covers part of the ASA. The southern extent of the Humber pipeline is covered by East Yorkshire to Norfolk HSC (Aldred 2014). These local studies were superseded by the National Historic Seascape Characterisation Consolidation Project completed in 2018 (LUC 2018).

6.1.2 The updated method assesses and defines areas with HSC types that promote an understanding of historic trends and processes in order to inform the sustainable management of change over time. This is achieved by addressing the multi-level character of the sea by splitting the marine zone into four tiered levels; the sea surface, the water column, the sea floor and the sub-sea floor. The characterisation is GIS-based, enabling key characteristics within the ASA to be identified, and are summarised below (**Tables 17** and **18**).

6.1.3 The known and potential prehistoric, maritime and aviation heritage assets that form part of the HSC have been discussed in the relevant baseline characterisations above. The character descriptions below refer only to the cultural processes which have shaped the historic seascape of the ASA.

Table 17 Primary Cultural Processes in Teesside Pipeline and Humber Pipeline ASA

Zone	Broad Character Types	Character Sub-Types
Coastal and Conflated	Energy industry	Hydrocarbon installation
		Hydrocarbon pipeline
		Renewable energy installation
	Fishery	Demersal trawling

Zone	Broad Character Types	Character Sub-Types
		Fishing ground
		Fixed netting
		Longlining
		Potting
	Military facility	Military practice area
	Mixed maritime activity	Mixed maritime activity
	Navigation activity	Harbour
		Navigation route/area
	Navigation hazard	Dangerous wreck
		Obstruction
		Rocky outcrop
		Wreck cluster
	Palaeolandscape	Palaeochannel
	Recreation	Leisure fishing
		Leisure sailing
	Telecommunications	Submarine cable
Sea-surface	Energy Industry	Hydrocarbon installation
		Renewable energy installation
	Fishery	Fishing ground
		Fixed netting
		Longlining
		Potting
		Seine netting
	Mixed maritime activity	Mixed maritime activity
	Navigation activity	Harbour
		Navigation route/area
	Navigation hazard	Dangerous wreck

Zone	Broad Character Types	Character Sub-Types
	Recreation	Leisure fishing
		Leisure sailing
Water Column	Energy Industry	Hydrocarbon installation
		Renewable energy installation
	Fishery	Demersal trawling
		Fishing ground
		Fixed netting
		Longlining
		Low level fishing
		Potting
		Shellfishing
	Military Facility	Military practice area
	Navigation activity	Harbour
	Navigation hazard	Dangerous wreck
		Obstruction
Sea-floor	Energy Industry	Hydrocarbon field (gas)
		Hydrocarbon installation
		Hydrocarbon pipeline
		Renewable energy installation
	Fishery	Demersal trawling
		Fishing ground
		Potting
		Shellfishing
	Marine features	Coarse sediment plains
		Fine sediment plains
		Mixed sediment plains
	Navigation hazard	Dangerous wreck

Zone	Broad Character Types	Character Sub-Types
		Obstruction
		Shoals and flats
		Wreck cluster
	Telecommunications	Submarine cable
Sub sea-floor	Energy Industry	Hydrocarbon field (gas)
		Hydrocarbon installation
		Hydrocarbon pipeline
		Renewable energy installation
	Fishery	Demersal trawling
		Shellfishing
	Marine features	Coarse sediment plains
		Fine sediment plains
		Mixed sediment plains
	Palaeolandscape	Palaeochannel

Table 18 Primary Cultural Processes in the Endurance Store ASA.

Zone	Broad Character Types	Character Sub-Types
Coastal and Conflated	Energy industry	Hydrocarbon installation
	Fishery	Fishing ground
	Military facility	Military practice area
	Navigation activity	Navigation route/area
	Palaeolandscape	Palaeochannel
Sea-surface	Energy Industry	Hydrocarbon installation
	Fishery	Demersal trawling
		Fishing ground
	Navigation activity	Navigation route/area
Water Column	Energy Industry	Hydrocarbon installation

Zone	Broad Character Types	Character Sub-Types
	Fishery	Demersal trawling
		Fishing ground
		Seine netting
	Military Facility	Military practice area
Sea-floor	Energy Industry	Hydrocarbon field (gas)
		Hydrocarbon installation
	Fishery	Demersal trawling
		Fishing ground
	Marine features	Fine sediment plains
Sub sea-floor	Energy Industry	Hydrocarbon field (gas)
		Hydrocarbon installation
	Fishery	Demersal trawling
	Marine features	Fine sediment plains
	Palaeolandscape	Palaeochannel

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

7.1.1 Archaeological receptors relating to seabed prehistory, maritime and aviation archaeology have been identified within the Development Area or have the potential to be discovered. The Development has the potential to physically and adversely impact known and potential archaeological receptors within the construction footprint and area of effect of indirect physical effects such as changes in seabed sediment regimes, scour etc.

7.1.2 Typically, adequate and appropriate mitigation is required to ensure that the archaeological value of the baseline within this report is maintained. Recommendations for appropriate mitigation are set out below.

7.2 Palaeogeographic features

7.2.1 A total of five palaeogeographic features of archaeological potential were identified within the ASA, all within the Humber Pipeline corridor. These are summarised as follows:

- a total of 2 channels were assigned a P1 archaeological rating;
- a total of 3 cut and fills assigned a P2 archaeological rating;

7.2.2 Additionally, one palaeochannel feature (**2001**) was previously identified within the local HER but was not identified within the SBP data. This has been retained within the gazetteer as a precaution.

7.2.3 Further work would be needed to ground truth and confirm (or otherwise) the assessment of these features. As such it is recommended that, should any future ground investigation (e.g. coring) work be carried out within any of these areas, a suitably qualified archaeological contractor be consulted during the geotechnical site selection process, and that any resulting logs (or samples, for any cores taken for archaeological purposes) be made available for geoarchaeological assessment.

7.2.4 Additionally, it is recommended that if any objects of possible archaeological interest are recovered during any groundwork operations, that they should be reported using a pre-agreed reporting protocol. This will establish whether the recovered objects are of archaeological interest and recommend appropriate mitigation measures.

7.3 Seabed features

7.3.1 The assessment of the geophysical data within the GSA resulted in a total of 542 anomalies identified as being of possible archaeological interest. These are summarised as follows:

- a total of 25 were assigned an A1 archaeological discrimination;
- a total of 95 were assigned an A2_h archaeological discrimination;
- a total of 415 were assigned an A2_l archaeological discrimination; and
- a total of seven items; four recorded wrecks and three recorded obstructions, were assigned an A3 archaeological discrimination.

7.4 Recommendations

Avoidance

7.4.1 The primary mitigation for the protection of known archaeological receptors is avoidance. This is achieved through the implementation and monitoring of Archaeological Exclusion Zones (AEZs), which are proposed for identified high value seabed features of anthropogenic origin (i.e. A1 classified geophysical anomalies).

7.4.2 For the 20 wrecks identified within the ASA, AEZs of 100 m around the wreck extents are recommended (**Table 19**). For the four items of debris and debris fields associated with wrecks, AEZs of 100 m around their recorded positions or feature extents are recommended. For the very large magnetic anomaly that may represent ferrous debris, either buried or with no seabed surface expression, a 100 m AEZ around its recorded position is recommended.

7.4.3 For the four recorded wrecks, precautionary AEZs of 100 m are recommended and for the three recorded obstructions precautionary AEZs of 100 m are recommended. Although no features of interest were identified in the geophysical data at those locations, the UKHO records state that remains have previously been found at these positions, and so there is potential for wrecks and associated debris to be present on the seabed and may be buried within the vicinity.

Table 19 Recommended AEZs within the Development Area

ID Number	Classification	Position (ED50 UTM31N)		Exclusion Zone
		Easting	Northing	
7007	Wreck	309166	5951536	100 m buffer around current feature extent
7036	Recorded wreck	315924	5959415	100 m around recorded position
7040	Wreck	316112	5960258	100 m buffer around current feature extent
7059	Recorded Obstruction	318987	5974322	100 m around recorded position
7063	Wreck	319425	5974528	100 m buffer around current feature extent
7066	Wreck	320229	5975612	100 m buffer around current feature extent
7072	Wreck	319021	5977560	100 m buffer around current feature extent
7078	Wreck	319348	5980106	100 m buffer around current feature extent
7188	Wreck	358336	6012230	100 m buffer around current feature extent
7197	Recorded Wreck	236310	6060858	100 m around recorded position
7205	Recorded Obstruction	239580	6062526	100 m around recorded position
7208	Recorded Wreck	240669	6063095	100 m around recorded position
7209	Recorded Obstruction	240706	6062879	100 m around recorded position
7210	Wreck	243520	6063523	100 m buffer around current feature extent
7217	Wreck	249133	6061305	100 m buffer around current feature extent
7253	Wreck	258712	6059647	100 m buffer around current feature extent
7260	Wreck	259927	6056931	100 m buffer around current feature extent
7262	Wreck	260730	6058476	100 m buffer around current feature extent
7263	Wreck	261810	6057750	100 m buffer around current feature extent
7264	Wreck	261883	6056726	100 m buffer around current feature extent
7265	Debris field	261892	6056699	100 m buffer around current feature extent
7270	Wreck	262099	6055310	100 m buffer around current feature extent
7305	Debris	267609	6052543	100 m buffer around feature position
7306	Debris field	267608	6052609	100 m buffer around current feature extent
7307	Debris	267614	6052537	100 m buffer around feature position
7308	Wreck	267616	6052571	100 m buffer around current feature extent
7319	Wreck	270387	6050868	100 m buffer around current feature extent
7323	Recorded Wreck	271454	6050820	100 m around recorded position
7339	Wreck	278244	6048535	100 m buffer around current feature extent
7503	Magnetic	352788	6017861	100 m around recorded position
7536	Wreck	376037	6011477	100 m buffer around current feature extent
7541	Wreck	377671	6005054	100 m buffer around current feature extent

7.4.4 For features assigned A2h and A2_l archaeological discrimination ratings, no AEZs are recommended at this time. However, avoidance of these features by micro-siting is recommended if they are proposed to be directly impacted by development in the future. If micro-siting is not possible, then further assessment (for instance during pre-construction UXO clearance works) to ascertain the nature of the features may be required.

Reduction

7.4.5 Reduction of impact can be achieved by means of appropriate mitigation identified through potential opportunities for further investigation of receptors (e.g. during pre-installation surveys which may include visual survey methods and UXO assessment).

7.4.6 Further investigations mean that anomalies can either have their archaeological value removed, if they prove to be of non-anthropogenic nature or modern, or their value as archaeological receptors confirmed. If their value is confirmed, mitigation in the form of either avoidance (which may be enacted by the implementation of an AEZ) or through remedying or offsetting measures as identified through a WSI which includes a Protocol for Archaeological Discoveries (PAD).

7.4.7 It is recommended that if any objects of possible archaeological interest are recovered during any groundwork operations, that they should be reported using an established PAD. This will establish whether the recovered objects are of archaeological interest and recommend appropriate mitigation measures.

Remedying and offsetting

7.4.8 In cases where avoidance is either inappropriate or impossible, the damage to archaeological receptors should be offset. In the case of seabed prehistoric receptors, this can be achieved by undertaking a palaeoenvironmental assessment of deposits with High geoarchaeological potential, principally peat deposits.

7.4.9 Recovery of artefacts and/or other archaeological receptors should be a final resort, when all other mitigation has failed. Any recovery should be completed under the supervision of an appropriately qualified and experienced marine archaeologist. If required, recovery methods will be identified through the WSI. Due to the vast differences in practice and implementation within recovery requirements and methodologies, each recovery will additionally be covered by a specific Method Statement agreed in consultation with the Archaeological Curator, should be implemented.

REFERENCES

ADS 2013. *Caring for Digital Data in Archaeology: a guide to good practice*. Archaeology Data Service & Digital Antiquity Guides to Good Practice

Aldred O 2014. *Historic Seascape Characterisation (HSC) East Yorkshire to Norfolk Section One: Background, Methodology and Results.* Newcastle University.

Chartered Institute for Archaeologists 2014a. *Code of Conduct: professional ethics in archaeology.* Updated 2021

Chartered Institute for Archaeologists 2014b. *Standard and Guidance for Archaeological Advice by Historic Environment Services.* Updated 2020

Chartered Institute for Archaeologists 2014c. *Standard and guidance for historic environment desk-based assessment*. Updated 2020

Chartered Institute for Archaeologists 2019. *Regulations for Professional Conduct.* Updated 2021

Department for Environment, Food and Rural Affairs 2014. *East Inshore and East Offshore Marine Plans.* London

Department of Energy & Climate Change 2011. *Overarching National Policy Statement for Energy (EN-1)*. London: TSO

Bicket, A. and Tizzard, L. 2015. A Review of the Submerged Prehistory and Palaeolandscapes of the British Isles. *Proceedings of the Geologists' Association*, 126(6), pp. 643-663.

Brigham, T., Buglass, J., & George, R. 2008. *Rapid Coastal Zone Assessment Survey. North Yorkshire. Bempton to Donna Nook.*

Buglass, J., & Brigham, T. 2008. *Rapid Coastal Sone Assessment Survey. North Yorkshire. Whitby to Reighton.* English Heritage (now Historic England).

Cameron, T.D.J., Crosby, A., Balson, P.S., Jeffery, D.H., Lott, G.K., Bulat, J. and Harrison, D.J., 1992. *The Geology of the Southern North Sea*. London HMSO, British Geological Survey United Kingdom Offshore Report.

Council of Europe 2000. *European Landscape Convention,.* Florence: Council of Europe.

Department for Environment, Food and Rural Affairs, 2009. *Our Seas- a shared resource.* Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/182486/oursea s-2009update.pdf

Department for Environment, Food and Rural Affairs, 2011. *Marine Policy Statement.* Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69322/pb3654 -marine-policy-statement-110316.pdf

English Heritage, 1998. *Identifying and Protecting Palaeolithic Remains: Archaeological Guidance for Planning Authorities and Developers.* London, English Heritage. Available at https://content.historicengland.org.uk/images-books/publications/identifying-protecting-palaeolithic-remains-archaeological-guidance-planning-authorities-developers/IdentifyingAndProtectingPalaeolithicRemains.pdf/

English Heritage 2002. *Military Aircraft Crash Sites: archaeological guidance on their significance and future management.* London, English Heritage. Available at: https://content.historicengland.org.uk/images-books/publications/military-aircraft-crash-sites/milaircsites.pdf/

English Heritage (now Historic England) 2008. Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment. Available at: https://historicengland.org.uk/images-books/publications/conservation-principles-sustainable-management-historic-environment/ (accessed January 2022)

English Heritage 2012. Ships and Boats: Prehistory to Present: Designation Selection Guide. London, English Heritage. Available at: https://content.historicengland.org.uk/images-books/publications/dsg-ships-boats/ships-boats-sg.pdf/

English Heritage 2013. *Marine Geophysics Data Acquisition, Processing and Interpretation Guidance Notes.* Available at: https://content.historicengland.org.uk/images-books/publications/dsg-ships-boats/ships-boats-sg.pdf/

Gaffney, V., Thomson, K. and Fitch, S. (eds.), 2007. *Mapping Doggerland, The Mesolithic Landscapes of the Southern North Sea*. Oxford Archaeopress.

Godwin H and Godwin ME 1933. British Maglemose Harpoon Sites. *Antiquity* 25

Gribble, J. and Leather, S., for EMU Ltd 2011. *Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance of the Renewable Energy Sector*. COWRIE Ltd. 2011.

Historic England 2015a. *Geoarchaeology – Using earth sciences to understand the archaeological record.* Available at: https://historicengland.org.uk/images-books/publications/geoarchaeology-earth-sciences-to-understand-archaeological-record/heag067-geoarchaeology/ (accessed January 2022)

Historic England 2015b. *Managing Significance in Decision-Taking in the Historic Environment: Good Practice Advice in Planning Note 2*. Available at: https://historicengland.org.uk/images-books/publications/gpa2-managing-significance-in-decision-taking/ (accessed 12 April 2022)

Historic England 2016. *Preserving Archaeological Remains: Decision-taking for Sites under Development.* Available at: https://historicengland.org.uk/images-books/publications/preserving-archaeological-remains/ (accessed 12 April 2022)

Historic England 2020. *Deposit Modelling and Archaeology. Guidance for Mapping Buried Deposits* Available at: https://historicengland.org.uk/images-books/publications/deposit-modelling-and-archaeology/ (accessed 12 April 2022)

JNAPC 2006. *JNAPC Code of Practice for Seabed Development*. York, Joint Nautical Archaeology Policy Committee. Available at: http://www.jnapc.org.uk/jnapc_brochure_may_2006.pdf

LUC (Land Use Consultants) 2018. *National Historic Seascape Characterisation Consolidation [data-set].* York: Archaeology Data Service [distributor] https://doi.org/10.5284/1046273

Merritt, O., & Dellino-Musgrave, V. 2009. *Historic Seascape Characterisation (HSC): Deconstrating the Method. Section 1: Implementing the Method.* Bentley: SeaZone Solutions Ltd.

Ministry of Housing, Communities and Local Government 2021. *National Planning Policy Framework.* London: Ministry of Housing, Communities and Local Government

Natural England 2012. *An Approach to Seascape Character Assessment.* Natural England.

Parfitt, S.A, Barendregt, R.W., Breda, M., Candy, I., Collins, M.J., Coope, G.R., Durbidge, P., Field, M.H., Lee, J.R., Lister, A.M., Mutch, R., Penkman, K.E.H., Preece, R.C., Rose, J., Stringer, C.B., Symmons, R., Whittaker, J.E., Wymer, J.J., and Stuart, A.J. 2005. The Earliest Record of Human Activity in Northern Europe. *Nature*, 438, pp. 1008–1012.

Parfitt, S.A, Ashton, N.M., Lewis, S.G., Abel, R.L., Coope, G.R., Field, M.H., Gale, R., Hoare, P.G., Larkin, N.R., Lewis, M.D., Karloukovski, V., Maher, B.A, Peglar, S.M., Preece, R.C., Whittaker, J.E., and Stringer, C.B., 2010. Early Pleistocene Human Occupation at the Edge of the Boreal Zone in Northwest Europe. *Nature*, 466, pp. 229–233.

Shennan, I. and Horton, B. 2002. Holocene Land- and Sea-Level Changes in Great Britain. *Journal of Quaternary Science*, 17, pp. 511-526.

Sturt, F., Garrow, D. and Bradley, S. 2013. New Models of North West European Holocene Palaeogeography and Inundation. *Journal of Archaeological Science*, 40, pp. 3963-3976.

Tappin, D.R., Pearce, B., Fitch, S., Dove, D., Gearey, B., Hill, J.M., Chanbers, C., Bates, R., Pinnion, J., Diaz Doce, D., Green, M., Gallyot, J., Georgiou, L., Brutto, D., Marzialetti, S., Hopla, E., Ramsay, E., and Fielding, H. 2011. *The Humber Regional Environmental Characterisation*. British Geological Survey Open Report, Marine Aggregate Levy Sustainability Fund, OR/10/54.

Tizzard, L., Bicket, A.R., Benjamin, J., and De Loecker, D. 2014. A Middle Palaeolithic Site in the Southern North Sea: Investigating the Archaeology and Palaeogeography of Area 240. *Journal of Quaternary Science*, 29(7), pp. 698-710.

Tizzard, L., Bicket, A.R., Benjamin, B. De Loecker, D., 2015. *A Middle Palaeolithic Site in the southern North Sea: Investigating the Archaeology and Palaeogeography of Area 240*. Salisbury, Wessex Archaeology Monograph no 35.

Wessex Archaeology 2006. *On the Importance of Shipwrecks.* Salisbury. Wessex Archaeology. Available at http://archaeologydataservice.ac.uk/archiveDS/archiveDownload?t=arch-684-1/dissemination/pdf/58591_02_Vol1_Final.pdf

Wessex Archaeology 2008a. Aircraft Crash Sites at Sea: A Scoping Study. London. English Heritage. Available at: http://blogs.wessexarch.co.uk/aircraftcrashsitesatsea/files/2008/03/aircraft_crash-sites_at_sea_report.pdf (accessed 26 November 2021)

Wessex Archaeology 2008b. Marine Class Description and principles of selection for aggregate producing areas project (ALSF 5383). Available at: https://archaeologydataservice.ac.uk/archives/view/marinemcd_eh_2008/downloads.cfm (accessed 12 April 2022)

Wessex Archaeology 2011. *Assessing Boats and Ships 1860-1950.* Available at http://archaeologydataservice.ac.uk/archives/view/boatsandships_eh_2011/downloads.cfm (accessed 12 April 2022)

Wessex Archaeology 2013. Early Ships and Boats Prehistory to 1840. Available at: https://www.wessexarch.co.uk/our-work/early-ships-and-boats

Wessex Archaeology 2014. *Humber Gateway Offshore Wind Farm: Ground Truthing Surveys (2011 and 2013) Archaeological Assessment*. Unpublished report ref. 85771.02

Wessex Archaeology 2017. *Tolmount Area Development Easington, East Riding of Yorkshire: Marine Archaeological Desk-Based Assessment*. Unpublished report ref. 111460.01

Wessex Archaeology 2022. *Offshore CCS Infrastructure: Northern Endurance Partnership, Marine licence baseline content.* Unpublished report ref. 254110.01

APPENDICES

Appendix 1: Terminology

The terminology used in this assessment follows definitions contained within Annex 2 of NPPF:

Archaeological interest	There will be archaeological interest in a heritage asset if it holds, or potentially may hold, evidence of past human activity worthy of expert investigation at some point. Heritage assets with archaeological interest are the primary source of evidence about the substance and evolution of places, and of the people and cultures that made them.
Conservation (for heritage policy)	The process of maintaining and managing change to a heritage asset in a way that sustains and, where appropriate, enhances its significance.
Designated heritage assets	World Heritage Sites, Scheduled Monuments, Listed Buildings, Protected Wreck Sites, Registered Park and Gardens, Registered Battlefields and Conservation Areas designated under the relevant legislation.
Heritage asset	A building monument, site, place, area or landscape identified as having a degree of significance meriting consideration in planning decisions, because of its heritage interest. Heritage assets include designated heritage assets and assets identified by the local planning authority (including local listing).
Historic environment	All aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora.
Historic environment record	Information services that seek to provide access to comprehensive and dynamic resources relating to the historic environment of a defined geographic area for public benefit and use.
Setting of a heritage asset	The surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance or may be neutral.
Significance (for heritage policy)	The value of a heritage asset to this and future generations because of its heritage interest. That interest may be archaeological, architectural, artistic or historic. Significance derives not only from a heritage asset's physical presence, but also from its setting.
Value	An aspect of worth or importance.

Chronology

Where referred to in the text, the main archaeological periods are broadly defined by the following date ranges:

Prehistoric		**Historic**	
Palaeolithic	970,000 – 9500 BCE	**Romano-British**	AD 43 – 410
Lower Palaeolithic	970,000 – 300,000 BCE	**Saxon**	AD 410 – 1066
Middle Palaeolithic	300,000 – 40,000 BCE	**Medieval**	AD 1066 – 1500
Upper Palaeolithic	40,000 – 10,000 BCE	**Post-medieval**	AD 1500 – 1800
Late Upper Palaeolithic	12,000 – 9500 BCE	**19th Century**	AD 1800 – 1899
Early Post-glacial	9500 – 8500 BCE	**Modern**	1900 – present day
Mesolithic	8500 – 4000 BCE		
Neolithic	4000 – 2400 BCE		
Bronze Age	2400 – 700 BCE		
Iron Age	700 BCE – AD 43		

Appendix 2: Legislation, policy and guidance

Designated Heritage Assets

Designation	Associated Legislation	Overview
World Heritage Sites	-	The UNESCO World Heritage Committee inscribes World Heritage Sites for their Outstanding Universal Value (OUV) – *cultural and/ or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity.* England protects its World Heritage Sites and their settings, including any buffer zones or equivalent, through the statutory designation process and through the planning system. The National Planning Policy Framework sets out detailed policies for the conservation and enhancement of the historic environment, including World Heritage Sites, through both plan-making and decision-taking.
Scheduled Monuments and Areas of Archaeological Importance	*Ancient Monuments and Archaeological Areas Act* 1979	Under the *Ancient Monuments and Archaeological Areas Act* 1979, the Secretary of State (DCMS) can schedule any site which appears to be of national importance because of its historic, architectural, traditional, artistic or archaeological interest. The historic town centres of Canterbury, Chester, Exeter, Hereford and York have been designated as Archaeological Areas of Importance under Part II of the *Ancient Monuments and Archaeological Areas Act* 1979. Additional controls are placed upon works affecting Scheduled Monuments and Areas of Archaeological Importance under the Act. The consent of the Secretary of State (DCMS), as advised by Historic England, is required for certain works affecting Scheduled Monuments.
Listed Buildings	*Planning (Listed Buildings and Conservation Areas) Act* 1990	In England, under Section 1 of the *Planning (Listed Buildings and Conservation Areas) Act* 1990, the Secretary of State is required to compile lists of buildings of special architectural or historic interest, on advice from English Heritage/ Historic England. Works affecting Listed Buildings are subject to additional planning controls administered by Local Planning Authorities. Historic England is a statutory consultee in certain works affecting Listed Buildings. Under certain circumstances, Listed Building Consent is required for works affecting Listed Buildings.
Conservation Areas	*Planning (Listed Buildings and Conservation Areas) Act* 1990	A Conservation Area is an area which has been designated because of its special architectural or historic interest, the character or appearance of which it is desirable to preserve or enhance. In most cases, Conservation Areas are designated by Local Planning Authorities. Section 72 (1) of the *Planning (Listed Buildings and Conservation Areas) Act* 1990 requires authorities to have regard to the fact that there is a Conservation Area when exercising any of their functions under the Planning Acts and to pay special attention to the desirability of preserving or enhancing the character or appearance of Conservation Areas. Although a locally administered designation, Conservation Areas may nevertheless be of national importance and significant developments within a Conservation Area are referred to Historic England.

Designation	Associated Legislation	Overview
Registered Parks and Gardens and Registered Battlefields	*National Heritage Act* 1983	The Register of Parks and Gardens was established under the *National Heritage Act* 1983. The Battlefields Register was established in 1995. Both Registers are administered by Historic England. These designations are non-statutory but are, nevertheless, material considerations in the planning process. Historic England and The Garden's Trust (formerly known as The Garden History Society) are statutory consultees in works affecting Registered Parks and Gardens
Protected Wreck Sites	*Protection of Wrecks Act* 1973	The *Protection of Wrecks Act* 1973 allows the Secretary of State to designate a restricted area around a wreck to prevent uncontrolled interference. These statutorily protected areas are likely to contain the remains of a vessel, or its contents, which are of historical, artistic or archaeological importance.
Protected Places and Controlled Sites	*Protection of Military Remains Act 1986*	The *Protection of Military Remains Act* 1986 provides protection for designated military vessels and for all aircraft that crashed while in military service. The Act provides two types of protection: Protected Places (wrecks designated by name and can be designated even if the location of the site is not known) and Controlled Sites (sites designated by location – covers wrecks within the last 200 years). It is illegal to disturb sites or remove anything from sites. Protected Places can be visited by divers, but the rule is look but don't touch. For Controlled Sites it is illegal to conduct any operations (including diving or excavation) within the Controlled Site unless licensed to do so by the Ministry of Defence.

Other relevant legislation

Legislation	Overview
Merchant Shipping Act 1995	This Act sets out the procedures for determining the ownership of underwater finds that turn out to be 'wreck', defined as any flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes ship, aircraft, hovercraft, parts of these, their cargo or equipment. If any such finds are brought ashore, the salvor is required to give notice to the Receiver of Wreck. This Act is administered by the Maritime and Coastguard Agency.
Marine and Coastal Areas Act 2009 (Marine Policy Statement 2011)	Marine licensing and marine planning made the responsibility of the Marine Management Organisation (MMO). England's inshore and offshore waters have been divided into 11 plan areas, for which marine plans are being produced by the MMO.

Legislation	Overview
Revised Draft National Policy Statement for Energy (EN-1) DECC 2010)	This National Policy Statement (NPS) sets out the national policy for energy infrastructure, and the importance of archaeological assessment in the development process.
Revised Draft National Policy Statement for Renewable Energy (EN-3) DECC 2010)	This NPS, taken together with EN-1, provides the primary basis for the decisions by the Planning Inspectorate on renewable energy infrastructure development applications. It sets out the importance of the historic environment and the ways it can be impacted by development, outlines guidance for application assessments, Planning Inspectorate decision making, and mitigation measures.
UNESCO Convention on the Protection of the Underwater Cultural Heritage	The UNESCO Convention was concluded in 2001, and is a comprehensive attempt to codify the law internationally, with regards to underwater cultural heritage. The UK abstained in the vote on the final draft of the Convention, however it has stated that it has adopted the Annex of the Convention, which governs the conduct of archaeological investigations, as best practice for archaeology. Although the UK is not a signatory, the Convention entered into force on 2nd January 2009, having been signed or ratified by 20 member states.

Relevant Policy

Policy	Overview
Marine Policy Statement 2011	The Marine Policy Statement was jointly published by all UK Administrations in March 2011 as part of a new system of marine planning being introduced across UK seas.

NPPF Section 12 Para. 128	In determining applications, local planning authorities should require an applicant to describe the significance of any heritage assets affected, including any contribution made by their setting. The level of detail should be proportionate to the assets' importance and no more than is sufficient to understand the potential impact of the proposal on their significance. As a minimum the relevant historic environment record should have been consulted and the heritage assets assessed using appropriate expertise where necessary. Where a site on which development is proposed includes or has the potential to include heritage assets with archaeological interest, local planning authorities should require developers to submit an appropriate desk-based assessment and, where necessary, a field evaluation.
NPPF Section 12 Para.129	Local planning authorities should identify and assess the particular significance of any heritage asset that may be affected by a proposal (including by development affecting the setting of a heritage asset) taking account of the available evidence and any necessary expertise. They should take this assessment into account when considering the impact of a proposal on a heritage asset, to avoid or minimise conflict between the heritage asset's conservation and any aspect of the proposal.
NPPF Section 12 Para. 132	When considering the impact of a proposed development on the significance of a designated heritage asset, great weight should be given to the asset's conservation. The more important the asset, the greater the weight should be. Significance can be harmed or lost through alteration or destruction of the heritage asset or development within its setting. As heritage assets are irreplaceable, any harm or loss should require clear and convincing justification. Substantial harm to or loss of a grade II listed building, park or garden should be exceptional. Substantial harm to or loss of designated heritage assets of the highest significance, notably scheduled monuments, protected wreck sites, battlefields, grade I and II* listed buildings, grade I and II* registered parks and gardens, and World Heritage Sites, should be wholly exceptional.
NPPF Section 12 Para. 135	The effect of an application on the significance of a non-designated heritage asset should be taken into account in determining the application. In weighing applications that affect directly or indirectly non designated heritage assets, a balanced judgement will be required having regard to the scale of any harm or loss and the significance of the heritage asset.
NPPF Section 12 Para. 137	Local planning authorities should look for opportunities for new development within Conservation Areas and World Heritage Sites and within the setting of heritage assets to enhance or better reveal their significance. Proposals that preserve those elements of the setting that make a positive contribution to or better reveal the significance of the asset should be treated favourably
NPPF Section 12 Para. 139	Non-designated heritage assets of archaeological interest that are demonstrably of equivalent significance to scheduled monuments, should be considered subject to the policies for designated heritage assets.

NPPF Section 12 Para. 141	Local planning authorities should make information about the significance of the historic environment gathered as part of plan-making or development management publicly accessible. They should also require developers to record and advance understanding of the significance of any heritage assets to be lost (wholly or in part) in a manner proportionate to their importance and the impact, and to make this evidence (and any archive generated) publicly accessible. However, the ability to record evidence of our past should not be a factor in deciding whether such loss should be permitted.
North East Inshore and North East Offshore Marine Plan DEFRA 2021) Policy E-HER-1	Policy NE-HER-1 Proposals that demonstrate they will conserve and enhance the significance of heritage assets will be supported. Where proposals may cause harm to the significance of heritage assets, proponents must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - any harm to the significance of heritage assets. If it is not possible to mitigate, then public benefits for proceeding with the proposal must outweigh the harm to the significance of heritage assets. This policy aims to conserve and enhance marine and coastal heritage assets by considering the potential for harm to their significance. This consideration will not be limited to designated assets and extends to those non-designated assets that are, or have the potential to become, significant. The policy will ensure that assets are considered in the decision-making process and will make provisions for those assets that are discovered during developments.
East Inshore and East Offshore Marine Plan DEFRA 2014) Policy SOC2	The Inshore and Offshore plans provide a clear approach to managing the East Inshore and East Offshore areas, their resources, and the activities and interactions that take place within them. They will help ensure the sustainable development of the marine area. Policy SOC2 Proposals that may affect heritage assets should demonstrate, in order of preference: d) that they will not compromise or harm elements which contribute to the significance of the heritage asset e) how, if there is compromise or harm to a heritage asset, this will be minimised f) how, where compromise or harm to a heritage asset cannot be minimised it will be mitigated against or g) the public benefits for proceeding with the proposal if it is not possible to minimise or mitigate compromise or harm to the heritage asset

Appendix 3: Palaeogeographic features of archaeological potential

ID	Classification	Archaeological Discrimination	Depth Range (mBSB)		Description	Section	External References
			From	To			
7600	Channel	P1	0.6	6.3	Narrow but distinct cut and fill feature cut into the underlying till and identified on multiple survey lines. Characterised by a relatively poorly defined basal reflector and is mainly distinguished by a change in fill from the surrounding till. The fill comprises parallel internal reflectors, and there may be multiple phases although this is unclear. Possible buried palaeochannel.	Humber Pipeline	-
7601	Channel	P1	0.1	2.0	Possible underfilled channel feature identified running along the same orientation as the pipeline corridor. Primarily identified in the MBES data as a long, shallow, curvilinear depression that shallows and eventually tapers off to the south and is buried by an area of mobile seabed sediment to the north. Partially identified in the SBP data, where it is visible as a very shallow possible cut and fill feature cut into the underlying till, with relatively poorly defined basal and internal reflectors. Potentially a preserved, underfilled palaeochannel, but may be a seabed feature produced by local currents.	Humber Pipeline	-
7602	Cut and fill	P2	0.5	2.3	Possible cut and fill feature cut into underlying till, characterised by a poorly defined basal reflector and single phase of unstructured fill. May be the remnants of an eroded palaeochannel but could be an internal till feature.	Humber Pipeline	-
7603	Cut and fill	P2	0.4	2.1	Possible cut and fill feature cut into underlying till, characterised by a poorly defined basal reflector and single phase of unstructured fill. May be the remnants of an eroded palaeochannel but could be an internal till feature.	Humber Pipeline	-
7604	Cut and fill	P2	0.6	4.0	Possible cut and fill feature cut into underlying till, characterised by a poorly defined basal reflector and single phase of unstructured fill. May be the remnants of an eroded palaeochannel but could be an internal till feature.	Humber Pipeline	-
2001	Palaeochannel	A3	-	-	A palaeochannel was identified during an offshore geophysical survey carried out as part of an Environmental Statement for Teesside Offshore Wind Farm. The channel is approximately 300 m wide and roughly 4 km long. Not identified within the current geophysical data but retained as a precaution.	Teesside Pipeline	6396 (SMR)

Appendix 4: Seabed anomalies of archaeological potential: Humber Pipeline GSA

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7000	Mound	309061	5951160	A2_I	9.0	2.8	0.2	-	Identified as a low-lying linear mound with gently sloping sides and a pointed peak, orientated north-east to south-west. The feature is indistinct and situated within a wider boulder field. No anomalous features were identified in the Pseudo SSS data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7001	Seabed disturbance	309375	5951098	A2_I	36.5	26.0	-	-	Identified as a seabed disturbance comprising a large spread of angular and rounded dark reflectors, some features have shadows. The feature is situated within an area of scour and depressions. Visible as a spread of angular mounds in the MBES dataset, within a wider boulder field. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7002	Seabed disturbance	309952	5950150	A2_I	6.2	5.0	-	-	Identified as a seabed disturbance comprising an indistinct group of dark reflectors with scouring to the south-east for 19.0 m. Visible in the MBES dataset as an uneven area of seabed. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7003	Dark reflector	309961	5950185	A2_I	6.6	3.3	0.3	-	Identified as a distinct irregularly shaped dark reflector with a shadow. Also identified in the MBES dataset as a slightly angular mound in a depression, situated 20.0 m east of a large boulder field but appears anomalous. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7004	Dark reflector	309982	5950310	A2_I	8.2	6.4	0.3	-	Identified as a large oval shaped dark reflector with a slight shadow or scour. Also identified in the MBES dataset as an uneven sub-angular mound. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7005	Mound	310154	5951028	A2_I	15.5	7.2	1.2	-	Identified as a distinct, large mound with steeply sloping sides and a rounded peak, situated within an area of outcropping geology, but tall and distinct for this area of seabed. Also visible in the Pseudo SSS mosaic as an oval area of disturbed seabed, however it is distorted in the data. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7006	Debris	309159	5951495	A2_h	18.8	7.4	0.3	-	Identified as an elongate dark reflector with a large bright shadow. Also identified in the MBES dataset as a linear mound orientated NNW – SSE, the mound is wider at the NNW end with gently sloping sides and an uneven peak. The north-eastern edge of the mound is more defined and it is situated in an area of outcropping bedrock. Situated 5.0 m SSW of wreck **7007** and may be associated. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a large item of debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7007	Wreck	309166	5951536	A1	62.7	27.0	2.0	-	A wreck identified as a large spread of angular and elongate dark reflectors with bright shadows, orientated approximately NNE to SSW. Also identified in the MBES dataset as a compact sub-elliptical group of angular mounds, the SSW end of the69feature is pointed and the NNE end merges into the outcropping geology and so the extent of the wreck is unclear and the dimensions may be exaggerated or a minimum. The mounds are angular and generally low-lying; however some objects have been measured up to 2.0 m at the centre of the wreck. The wreck appears to be highly degraded, and it is not possible to tell which end is the bow or stern. The wreck is possibly upright, though no identifiable internal superstructure is visible. Associated with a UKHO record for the steam ship *Francis*, (ex-Paris), built of iron in 1856 and sank in 1872 after being driven ashore on passage from London to Gothenburg. The wreck was last surveyed in 2021 and described as being broken down with a debris field and geophysical dimensions of 60.3 x 21.6 x 3.5 m. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location, however the UKHO record suggests that it would have a large Mag. Anomaly associated. Interpreted as a highly degraded wreck.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	UKHO 8869, UKHO 8870

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7008	Debris	309460	5951699	A2_h	4.6	0.5	-	-	Identified as a distinct, elongate dark reflector with a bright, uneven shadow, possibly suggesting uneven height. No anomalous features were identified in the MBES data at this location, it is situated in an area of outcropping geology. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7009	Debris	311156	5952364	A2_h	3.1	0.5	-	-	Identified as a distinct elongate dark reflector with a short but bright shadow. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7010	Dark reflector	311876	5952567	A2_l	2.6	0.5	0.5	-	Identified as a thin and distinct, elongate dark reflector with a large bright shadow. Visible in the MBES dataset as a slightly elongate mound with an uneven peak, or two mounds close together. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7011	Dark reflector	311335	5952708	A2_l	1.9	0.5	1.2	-	Identified as an indistinct, elongate dark reflector with a bright flared shadow, slightly distinct to the surrounding seabed. Also identified in the MBES dataset as an isolated and distinct angular mound with steeply sloping sides and a rounded peak. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7012	Seabed disturbance	310816	5953261	A2_I	27.5	19.2	1.3	-	Identified as an area of seabed disturbance comprising indistinct dark reflectors, some with slight shadows situated within depressions or scour. The largest dark reflector measures 5.8 x 0.8 m. Also identified in the MBES data as a compact group of mounds, or one very irregular mound with an uneven peak, the feature is distinct to the surrounding uneven seabed and slightly anomalous. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7013	Dark reflector	310835	5953246	A2_I	3.1	0.6	-	-	Identified as an elongate dark reflector with a short bright shadow, situated 15.0 m south-east of seabed disturbance **7012** and may be related. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7014	Mound	310845	5953257	A2_I	7.0	4.1	1.1	-	Identified as a distinct oval mound with a rounded peak, the feature is lower at its southern edge and may be two objects close together. Situated 20.0 m east of seabed disturbance **7012** and may be related. Visible as an indistinct, irregularly shaped dark reflector with a slight shadow in the Pseudo SSS Mosaic. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7015	Mound	311648	5953336	A2_I	4.1	3.0	1.2	-	Identified as a distinct angular mound with steep sides and slightly uneven peak, quite tall and slightly more anomalous than the surrounding natural features on this area of seabed. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7016	Dark reflector	312746	5952903	A2_I	3.7	1.4	-	-	Identified as a distinct rectangular dark reflector with a large bright shadow, situated on an uneven area of seabed. Visible as an area of uneven seabed in the MBES dataset. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7017	Dark reflector	312649	5953057	A2_I	2.5	0.7	0.5	-	Identified as an elongate dark reflector with a large bright shadow. Also visible in the MBES dataset as an angular mound with a pointed peak. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7018	Dark reflector	312073	5953587	A2_I	4.0	0.7	-	-	Identified as an elongate and thin dark reflector with a bright uneven shadow, possibly suggesting uneven height. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7019	Dark reflector	311736	5953888	A2_I	2.9	0.7	-	-	Identified as an elongate dark reflector with a large bright shadow. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7020	Dark reflector	311599	5954016	A2_I	3.4	0.5	-	-	Identified as an elongate and thin dark reflector with a bright uneven shadow, possibly suggesting uneven height. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7021	Dark reflector	312006	5953863	A2_I	5.8	2.6	1.1	-	Identified as an elongate slightly irregularly shaped dark reflector with a bright uneven shadow, possibly suggesting uneven height. Also identified in the MBES data as a large angular mound with steep sides and a pointed slightly dipped peak. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7022	Seabed disturbance	312039	5954559	A2_l	7.2	3.8	-	-	Identified as a seabed disturbance comprising a group of small, angular dark reflectors in a curvilinear alignment with bright shadows. The largest object measures 1.2 x 0.9 m and looks anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7023	Debris field	312128	5954568	A2_h	5.4	4.1	1.4	-	Identified as a compact group of dark reflectors with bright rounded shadows, three rounded objects are visible, the largest measures 3.3 x 1.6 m. The features are distinct and anomalous to the surrounding seabed with scouring to the north-east and south-west. Also identified in the MBES dataset as a distinct angular mound with steep sides and an uneven peak, possibly two mounds close together. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible small debris field.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7024	Dark reflector	312787	5955948	A2_l	2.0	0.6	0.2	-	Identified as an elongate dark reflector with a large, bright shadow, distinct to the surrounding seabed. Visible in the MBES dataset as a small slightly elongate mound in a slight depression. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7025	Dark reflector	313130	5956550	A2_I	4.3	0.6	-	-	Identified as an elongate dark reflector with a bright uneven shadow, possibly suggesting uneven height. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7026	Dark reflector	314796	5956002	A2_I	2.2	0.9	0.2	-	Identified as an elongate dark reflector with a large, bright and straight-edged shadow. The feature is distinct to the surrounding seabed. Visible in the MBES data as an oval mound. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7027	Dark reflector	314615	5956413	A2_I	3.0	1.6	1.2	-	Identified as a distinct dark reflector with a very bright, bulbous shadow. Also identified in the MBES data as a distinct rounded mound with steep sides and a pointed peak. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7028	Seabed disturbance	313315	5957703	A2_I	6.4	5.8	-	-	Identified as a round area of seabed disturbance comprising slightly angular dark reflectors with slight shadows and depressions or areas of bright reflector. The feature appears slightly anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7029	Dark reflector	313680	5957685	A2_I	3.5	0.9	-	-	Identified as an elongate dark reflector with a large, bright and straight edged shadow, the feature appears distinct to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7030	Mound	313491	5957899	A2_I	3.4	3.0	0.4	-	Identified as a distinct rounded mound with a double peak. The feature is situated in a slight depression and anomalous to the surrounding seabed. No anomalous features were identified in the Pseudo SSS Mosaic data at this location; however it is situated close to the nadir. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7031	Dark reflector	314655	5958003	A2_I	1.5	0.6	1.0	-	Identified as a slightly elongate dark reflector with a bright uneven shadow, possibly suggesting uneven height. The feature has scouring to the north-east and south-west for a maximum of 10.0 m. Also identified in the MBES dataset as distinct slightly angular mound with steep sides and a pointed double peak. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7032	Mound	315029	5957892	A2_I	23.4	7.2	0.7	-	Identified as an elongate mound with steeply sloping sides and a slightly uneven peak, orientated north to SSE and is tallest at its northern end. The feature is anomalous to the surrounded seabed and situated 15 m south-west of a similar anomalous feature (**7033**). No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7033	Mound	315054	5957916	A2_I	24.0	7.6	0.6	-	A distinct, elongate mound with steeply sloping sides and a slightly pointed peak in its centre. The feature is slightly anomalous to the surrounding seabed, but situated 15 m north-east of a similar feature (**7032**) and may be related anomalous and similar object to the south-west. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7034	Seabed disturbance	314765	5958856	A2_I	9.1	7.1	-	-	Identified as an area of seabed disturbance comprising slightly angular dark reflectors and depressions or shadows, the feature appears slightly anomalous to the surrounding seabed. Visible as a depression in the MBES data. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7035	Seabed disturbance	315885	5959389	A2_l	46.4	17.6	0.4	-	Identified as a large area of seabed disturbance comprising low-lying mounds and depressions, orientated east to west on the seabed. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Situated 25 m south-west of a recorded wreck (**7036**) position. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7036	Recorded wreck	315924	5959415	A3	-	-	-	-	The recorded position of a wreck that was possibly the steam ship *Georgios Antippa*, built in 1894 and sunk by submarine in 1917 whilst carrying a cargo of coal. The forward part of the wreck was located at this position in 1984, but it has not been located on multibeam since then and has been amended to dead. No anomalous features were identified in the Pseudo SSS Mosaic or MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. As remains have been found at this location previously it has been retained as a precaution in this gazetteer and will be given a recommended precautionary AEZ.	-	-	Humber Pipeline	UKHO 9047; HOB UID 907893; HER MHU22786
7037	Debris	315567	5959627	A2_h	16.1	6.0	0.5	-	Identified as a long, elongate mound with steeply sloping sides and a slightly uneven peak. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris.	MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7038	Dark reflector	314586	5960007	A2_I	3.9	0.8	0.2	-	Identified as a thin, curvilinear dark reflector with a slight shadow. Visible as a thin elongate mound in the MBES data. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7039	Seabed disturbance	315753	5960342	A2_I	19.5	12.2	0.2	-	Identified as an area of seabed disturbance comprising a spread of indistinct, angular and elongate dark reflectors with shadows, the dark reflectors are quite indistinct. The largest object measures 4.8 x 0.5 m and the feature appears slightly anomalous to the surrounding seabed. Visible in the MBES data as a group of angular mounds, though there are a number of features interpreted to be natural on this area of seabed. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7040	Wreck	316112	5960258	A1	74.3	27.8	1.6	-	Identified as a large spread of dark reflectors interpreted as a wreck. Some features have shadows and a number of straight linear dark reflectors are visible, with the longest measuring 8.7 x 0.9 m. The wreck is orientated north-west to south-east and is situated on a relatively featureless seabed. The wreck has little/no discernible structure, though this may be due to data distortion, some possible slatted features are visible. Also identified in the MBES data as a large spread of uneven seabed comprising mainly angular mounds, some smaller rounded objects are visible and the largest mound in the centre of the wreck measures 6.8 x 3.7 m, this may be a boiler. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for *Paraciers*, a steam ship sunk in 1917, with build dimensions of 97.8 x 12.2 x 7.3 m. The wreck was last surveyed in 2020 and described as being very broken up with two boilers visible and geophysical dimensions of 74.5 x 21.7 x 3.2 m. In the 2021 data this wreck appears to be very broken up and degraded.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	UKHO 8911; HOB UID 907898
7041	Debris field	316083	5960306	A2_h	14.5	10.4	-	-	Identified as a rounded area of disturbed seabed comprising indistinct dark reflectors and linear scour marks, with a rounded bright reflector measuring 2.7 x 1.9 is visible to the west of the feature. Visible as an uneven area of seabed in the MBES data. Situated 15.0 m north of wreck 7040 and likely associated. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field associated with wreck 7040.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7042	Dark reflector	314495	5960806	A2_I	2.5	0.6	0.2	-	Identified as a slightly elongate, thin dark reflector with a short dull shadow, the feature has some slight scour to the south. Visible as a thin oval mound in the MBES dataset. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7043	Dark reflector	314649	5961610	A2_I	4.1	2.4	0.3	-	Identified as an angular dark reflector that may be broken up or multiple objects, the feature has a bright irregular shadow suggesting uneven height. Visible as an angular mound in the MBES data. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7044	Dark reflector	315586	5962218	A2_I	4.8	2.6	0.2	-	Identified as an angular dark reflector with a very bright uneven shadow, possibly suggesting uneven height. Also identified in the MBES data as a small angular mound that has a double peak. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7045	Seabed disturbance	315643	5962667	A2_I	8.2	8.0	0.2	-	Identified as an area of seabed disturbance with some indistinct small, angular dark reflectors within, the feature has some slight scour to the north-east. Visible in the MBES data as a mound in a slight depression. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7046	Debris	315746	5963029	A2_h	12.6	4.0	0.6	-	Identified as an indistinct, elongate dark reflector with a bright variable shadow, possibly suggesting uneven height. Also identified in the MBES dataset as an elongate, slightly angular mound with steep sides and uneven peak orientated east to west on the seabed. The mound height decreases at its western extent and it has a small object at this end, it is situated in a slight depression. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7047	Dark reflector	315693	5963286	A2_l	3.6	0.9	0.1	-	Identified as a distinct elongate dark reflector with a bright, uneven shadow, possibly indicating uneven height. Visible as a small double peaked mound in the MBES dataset. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7048	Dark reflector	316404	5963114	A2_l	5.0	0.5	0.5	-	Identified as a thin and distinct, elongate dark reflector with a bright, uneven shadow, possibly indicating uneven height. Visible as a small uneven mound in the MBES data. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7049	Seabed disturbance	315386	5963554	A2_I	12.8	0.8	0.3	-	Identified as a seabed disturbance comprising an almost linear alignment of five dark reflectors with bright shadows, the largest object measures 0.9 x 0.8 m, orientated NNE to SSW on the seabed. In the MBES data three small oval mounds are visible. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7050	Seabed disturbance	317685	5964941	A2_I	12.7	9.0	-	-	Identified as an area of seabed disturbance comprising small angular dark reflectors, within areas of bright reflector that may be scour or depressions. The feature is anomalous to the surrounding seabed. Visible in the MBES data as an uneven depression. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7051	Seabed disturbance	316227	5965901	A2_I	30.1	18.5	0.3	-	Identified as an area of seabed disturbance comprising large oval spread of low-lying mounds and depressions, the feature is orientated north-west to south-east and situated on a rough and uneven seabed. No anomalous features were identified in the Pseudo SSS mosaic. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7052	Bright reflector	316696	5968112	A2_I	4.7	1.3	-	-	Identified as an elongate, slightly irregularly shaped bright reflector, with no clear dark reflector associated. The feature is distinct and slightly anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7053	Dark reflector	317104	5968346	A2_I	6.2	0.7	-	-	Identified as a slightly curvilinear dark reflector with a slight shadow across its length. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7054	Seabed disturbance	316931	5968487	A2_I	6.3	2.6	0.9	-	Identified as an area of seabed disturbance comprising three small dark reflectors with bright shadows that appear to be aligned, the largest object measures 1.1 x 1.1 m. Also identified in the MBES dataset as distinct mound with a pointed peak, relatively tall and angular object with some slight seabed disturbance surrounding it. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7055	Dark reflector	318029	5969478	A2_l	3.3	0.6	0.1	-	Identified as a distinct straight dark reflector with a very bright shadow. Visible in the MBES data as a low-lying oval mound. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Humber Pipeline	-
7056	Mound	318110	5970902	A2_l	3.8	3.7	0.8	-	Identified as a distinct angular mound with steep sides and a pointed peak, the feature is relatively tall and isolated. No anomalous features were identified in the Pseudo SSS data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7057	Magnetic	318765	5971904	A2_h	-	-	-	298	Identified as a large dipole with peak and trough on one profile line. The anomaly is at the end of the line and may not be fully sampled but appears to be a ‘real’ anomaly and so has been retained as a higher priority due to its size. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7058	Dark reflector	318968	5973550	A2_l	2.7	0.7	0.8	-	Identified as a distinct sub-angular dark reflector with a very large bright shadow and significant height. The feature is situated within slight seabed disturbance or scour. Visible as a thin mound in the MBES data. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7059	Recorded Obstruction	318987	5974322	A3	-	-	-	-	Two pieces of metal framework discovered during a survey by E.ON, in advance of construction work on the Humber Gateway offshore wind farm. The objects were investigated by a remotely operated underwater vehicle (ROV) as part of an UXO ground-truthing anomaly assessment. A small piece of metal framework, measuring 0.1 x 0.2 m, was exposed on the seabed. It appears to be attached to another piece of metal, measuring 0.6 x 0.3 m, located approximately 0.6 m away. The rest of the structure remains buried on the seabed. No anomalous features were identified in 2021 Pseudo SSS or MBES data at this location. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as possible debris and may be modern however, this can't be confirmed without visual inspection.	-	-	Humber Pipeline	HOB UID 1593305
7060	Dark reflector	319140	5974142	A2_I	3.6	1.2	0.5	-	Identified as a distinct, slightly elongate dark reflector that is bulbous in its centre with a long, bright and uneven shadow suggesting uneven height. The feature is isolated on the seabed. Visible as a slight depression in the MBES data. No anomalous 86 features were identified the Mag. dataset at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7061	Magnetic	319257	5974259	A2_I	-	-	-	19	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7062	Magnetic	319293	5974481	A2_I	-	-	-	22	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location, however this is the closest Mag. Line to wreck **7063** situated 100 m north-east and may be a halo of a larger anomaly. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7063	Wreck	319425	5974528	A1	93.2	22.3	6.5	-	A large wreck orientated north-east to south-west visible as a group of bright reflectors and very small indistinct dark reflectors with shadows. At the south-west end of the feature a large dark reflector with a bright shadow is visible, measuring 11.9 x 4.8 m. The NNE end of the wreck has a rectangular dark reflector measuring 5.4 x 3.0 m. Also identified in the MBES data as generally intact and upright with surviving superstructure, including a tall mound visible in the centre that may be a boiler, measuring 11.5 x 5.3 x 3.5 m. The highest point of the wreck is at the north-east end. The wreck appears less defined along the eastern edge, possibly tilted and the hull looks slightly disjointed and may be partially buried or broken up. There is scouring around the south-east end of the wreck up to 1.5 m deep and 9.0 m long and slight scouring and sediment accumulation to the north of the wreck. This position was not directly covered by the SSS or Mag. Datasets, however there is a small, very broad, Mag. Anomaly (**7062**) on the closest Mag. Line, 100 m south-west, that may be a halo response of nearby ferrous material and the UKHO record suggests it is ferrous. Associated with a UKHO record for *John Rettig* (Probably), a steam ship built in 1915 with built dimensions of 80.8 x 12.8 x 6.1 m. The vessel was sunk in 1918 by UB-107 and is described as being broken up with the centre sections disintegrated and a strong magnetic anomaly associated. Interpreted as a large, mostly intact wreck.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	UKHO 8945; HOB UID 907912; HER MHU22794

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7064	Debris	319357	5974567	A2_h	3.9	0.6	0.5	-	Identified as an elongate slightly curvilinear dark reflector with a large bright slightly tapered shadow, isolated and distinct anomaly. Also identified in the MBES dataset as a low-lying mound with a slightly uneven peak, situated on a featureless seabed, situated 66.0 m north-west of wreck **7063** and may be associated debris. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as possible debris.	SSS, MBES	Gardline 2021, Xocean 2021	Humber Pipeline	-
7065	Debris field	319478	5975261	A2_h	18.9	0.5	0.4	-	Identified as a long and thin, slightly curvilinear dark reflector with a short, bright shadows across its length. The possible length of rope or chain has two dark reflectors attached at either end, the largest measures 1.9 x 1.5 m. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it Is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field, and may be modern such as fishing gear however, this can't be confirmed without visual inspection.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7066	Wreck	320229	5975612	A1	87.9	19.2	4.5	-	A large wreck orientated north to south and situated on an uneven area of seabed, identified as an ovoid area of mainly bright reflector, with dark reflectors visible at the northern and southern ends. In the southern part of the wreck, curvilinear and rounded dark reflectors with shadows are visible. At the northern end, a thick curvilinear dark reflector is visible which is interpreted to be surviving hull. Significant scouring is present to the north and south of the wreck. Also identified in the MBES data as an upright, possibly tilted and mostly intact wreck. There are multiple internal rounded and angular mounds visible and there are some larger angular mounds visible on its north end, which may be boilers. The majority of the interpreted hull does not protrude high above the seabed, generally 0.5 m maximum, and there is evidence of sediment accumulation around the wreck possibly indicating it may be collapsed or buried. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location, however the UKHO record suggests it is ferrous. Associated with a UKHO record for *Horsted*, a steam ship built in 1936 with build dimensions of 78.0 x 11.3 x 4.9 m. The vessel was sunk in 1939 by a large explosion either from a mine or torpedo. The wreck was last surveyed in 2016 and was described as being upright but broken up with two boilers visible near the stern and a strong Mag. anomaly associated, with geophysical dimensions of 88.1 x 21.1 x 6.7 m. Interpreted as a large wreck that is possibly partially buried.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	UKHO 8951; HOB UID 908372; HER MHU23434

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7067	Debris	320265	5975560	A2_h	6.1	3.3	0.1	-	Identified as a rectangular shaped, dull bright reflector. Also identified in the MBES data as a low-lying angular mound with a slight double peak, situated 34.0 m ESE of wreck **7066** and may be associated debris. This position was not directly covered by the SSS and Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7068	Dark reflector	318596	5976095	A2_l	4.3	4.0	0.2	-	Identified as an indistinct, slightly elongate dark reflector with a very bright shadow. Also identified in the MBES data as a distinct mound with steeply sloping sides and a double pointed peak, isolated on a relatively featureless seabed. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7069	Magnetic	319583	5976245	A2_l	-	-	-	27	Identified as a small, sharp symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7070	Magnetic	319599	5976338	A2_l	-	-	-	28	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7071	Dark reflector	319532	5976440	A2_l	3.2	0.6	0.2	-	Identified as a distinct elongate dark reflector with a bright pointed shadow, isolated on a relatively featureless seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7072	Wreck	319021	5977560	A1	38.4	9.3	3.6	-	A large wreck orientated north-west to south-east, the wreck appears as a distinct ovoid bright reflector and fairly intact. Internally some indistinct dark reflectors are visible at either ends of the wreck and some possible linear dark reflectors are also visible internally and there is scour to the north and south. Also identified in the MBES data as an intact and upright wreck. Internal multiple low-lying mounds are visible, with the tallest mound situated in the centre of the wreck measuring 8.3 x 5.2 m. The wreck is situated within an area of scour up to 0.2 m deep and is isolated on the seabed. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location, although the UKHO record suggests it is ferrous. Associated with a UKHO record for *Helmsman* (Probably), a tanker built in 1905 and sunk in 1927. It was last surveyed in 2016 and described as being upright and intact with a strong Mag. anomaly associated. Interpreted as an intact wreck.	Pseudo SSS Mosaic, MBES	Xocean 2021	Humber Pipeline	UKHO 8958; HOB UID 908376; HER MHU23892
7073	Magnetic	319821	5977976	A2_l	-	-	-	9	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7074	Debris field	319830	5978038	A2_h	17.1	1.3	0.7	45	Identified as a distinct curvilinear dark reflector with a very bright, irregular shadow along its length, possibly suggesting uneven height. There may be multiple objects close together, with a distinct dark reflector at the north-eastern extent of the feature measuring 2.4 x 1.9 m. No anomalous features were identified in the MBES data at this location. Associated with a small, sharp asymmetric dipole with peak and trough on one profile line in the Mag. data, indicating ferrous material is present. Interpreted as a ferrous debris field.	SSS, Mag.	Gardline 2021	Humber Pipeline	-
7075	Magnetic	319882	5978047	A2_l	-	-	-	9	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7076	Dark reflector	319961	5978248	A2_l	2.0	0.5	1.1	-	Identified as a distinct, slightly curvilinear dark reflector with a very long, bright and tapered shadow, the feature has scour to the north and south of around 15.0 m. Visible as a depression in the MBES data. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7077	Mound	320616	5979376	A2_l	10.3	9.2	0.6	-	Identified as a distinct slightly angular mound with one steeply sloping edge and the others gently sloping the peak is slightly angular. The feature is relatively isolated on the seabed. No anomalous features were identified in the SSS data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7078	Wreck	319348	5980106	A1	73.8	29.2	2.9	-	A large wreck orientated approximately north to south on the seabed, visible as a large oval dark reflector interpreted to represent the hull. At the northern end of the wreck a square shaped dark reflector is visible, measuring 10.4 x 7.8 m. There is some possible slight scour to the NNW of the wreck. Internally some indistinct linear dark reflectors are visible. In the MBES data the interpreted hull of the wreck appears to be disjointed and collapsed with little height off the seabed, with numerous small angular and linear mounds area visible, interpreted as possible internal structure. At the southern end of the wreck a large mound measuring 13.9 x 7.2 x 1.0 m is visible, which may be a boiler. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location, although the UKHO record suggests it is ferrous. Associated with a UKHO record for *Onward* (Possibly), a steam ship built in 1861 with build dimensions of 61.7 x 8.0 x 5.3 m, and which sank in heavy seas in 1862. It was last surveyed in 2016 and described as being disintegrated with just the aft section intact, boilers still visible and a strong Mag. anomaly associated, with geophysical dimensions of 75.5 x 25.3 x 7.5 m. The height difference between the 2016 and 2021 survey suggests the wreck has collapsed and degraded further. Interpreted as a possibly collapsed or degraded, though relatively compact, wreck.	Backscatter Mosaic, MBES	Xocean 2021	Humber Pipeline	UKHO 8967; HOB UID 907923; HER MHU22774

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7079	Magnetic	320155	5980277	A2_h	-	-	-	60	Identified as a medium, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7080	Magnetic	320332	5981020	A2_l	-	-	-	47	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7081	Magnetic	320410	5981207	A2_l	-	-	-	12	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7082	Debris field	320264	5981345	A2_h	38.9	3.6	0.4	-	Identified as an indistinct group of linear and rounded dark reflectors with shadows, two angular objects (maximum 2.2 x 1.5 m) are connected by thin linear dark reflectors that may be lengths of ropes or chains. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field, and may be modern such as fishing gear however, this can't be confirmed without visual inspection.	SSS	Gardline 2021	Humber Pipeline	-
7083	Magnetic	320511	5981802	A2_l	-	-	-	8	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7084	Magnetic	320483	5981836	A2_l	-	-	-	11	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7085	Magnetic	320431	5981936	A2_l	-	-	-	16	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7086	Dark reflector	320578	5981936	A2_l	2.4	0.2	0.1		Identified as a slightly elongate and straight dark reflector with a bright uneven short shadow, possibly suggesting uneven height. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7087	Magnetic	320470	5982169	A2_l	-	-	-	11	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7088	Magnetic	320528	5982520	A2_h	-	-	-	240	Identified as a large, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7089	Mound	320985	5982537	A2_I	6.0	2.0	0.1	-	Identified as a low-lying, elongate mound with steep sides and an uneven peak. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. datasets so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7090	Magnetic	320557	5982688	A2_I	-	-	-	11	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7091	Magnetic	320567	5982746	A2_I	-	-	-	25	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7092	Magnetic	320686	5982874	A2_I	-	-	-	9	Identified as a small asymmetric dipole with peak and trough on one profile line. Also visible on other profile lines. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7093	Dark reflector	320755	5982936	A2_I	7.3	6.7	0.5	-	Identified as an indistinct, thin linear dark reflector that is slightly bulbous or has an object at its centre measuring 2.1 x 1.0 m. The feature has a bright uneven shadow suggesting uneven height, may be multiple objects. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7094	Magnetic	320639	5983183	A2_l	-	-	-	26	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7095	Magnetic	320766	5983360	A2_l	-	-	-	10	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7096	Debris	320767	5983614	A2_h	11.8	0.4	0.1	-	Identified as a distinct slightly curvilinear dark reflector with a bright shadow, situated in sand waves. One of a number of anomalies on this area of seabed that may be related (**7097**–- **7099**). No anomalous features were identified in the MBES or Mag. data at this location. Interpreted as possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7097	Rope/chain	320783	5983637	A2_h	15.5	0.5	0.1	-	Identified as a short, thin and slightly curvilinear dark reflector with a short bright shadow. The feature is intermittent in places. One of a number of anomalies on this area of seabed that may be related (**7096**, **7098**, **7099**). No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible short length of rope or chain.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7098	Dark reflector	320797	5983680	A2_l	7.1	0.4	0.1	-	Identified as a thin and intermittent dark reflector with a short bright shadow. One of a number of anomalies on this area of seabed that may be related (**7096**, **7097**, **7099**). No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7099	Rope/chain	320810	5983758	A2_h	52.3	0.4	0.1	-	Identified as a long, thin and indistinct dark reflector with a bright short shadow. The feature is orientated north to south on the seabed. One of a number of anomalies on this area of seabed that may be related (**7096**–- **7098**). No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible length of rope or chain.	SSS	Gardline 2021	Humber Pipeline	-
7100	Magnetic	320785	5984026	A2_l	-	-	-	29	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7101	Dark reflector	321336	5984710	A2_l	2.2	0.6	-	-	Identified as a distinct right-angled dark reflector with a possible short shadow, situated within sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7102	Magnetic	321061	5985637	A2_h	-	-	-	266	Identified as a large, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7103	Mound	321583	5985944	A2_l	12.2	3.7	0.2	-	Identified as a low-lying, elongate mound that is irregular in plan. The top of the mound is uneven and it appears distinct to the surrounding seabed. The feature is orientated north-east to south-west. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7104	Mound	320938	5986694	A2_l	7.0	4.3	0.2	-	Identified as a slightly curvilinear, elongate mound with steep sides and a pointed peak, situated on an uneven area of seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7105	Magnetic	321403	5987086	A2_l	-	-	-	19	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7106	Magnetic	321609	5988646	A2_h	-	-	-	86	Identified as a medium, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7107	Magnetic	321726	5989033	A2_l	-	-	-	13	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7108	Magnetic	321628	5989110	A2_l	-	-	-	15	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7109	Magnetic	321787	5989718	A2_h	-	-	-	73	Identified as a medium negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7110	Seabed disturbance	322563	5992828	A2_l	23.9	18.6	-	-	Identified as an irregular area of seabed disturbance comprising some indistinct dark and bright reflectors, possibly two curvilinear objects visible. The feature is anomalous to the surrounding seabed. This location is covered by the MBES data but it is unclear on the overlapping lines. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7111	Magnetic	322409	5993434	A2_l	-	-	-	42	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7112	Mound	323391	5996193	A2_I	16.3	11.9	0.2	-	Identified as a large oval mound with gently sloping sides and a slightly pointed peak. The feature appears slightly anomalous to the surrounding seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7113	Magnetic	323331	5997888	A2_I	-	-	-	22	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7114	Mound	323889	5998038	A2_I	3.7	3.4	0.5	-	Identified as an indistinct mound with steep sides and a pointed peak, the feature is anomalous to the surrounding seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7115	Seabed disturbance	322841	5998280	A2_I	23.0	9.5	-	-	Identified as an area of seabed disturbance comprising multiple indistinct small dark reflectors and small bright reflectors, which looks anomalous and relatively distinct to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7116	Magnetic	323585	5998538	A2_I	-	-	-	12	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7117	Magnetic	323608	5998693	A2_I	-	-	-	9	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7118	Dark reflector	322665	5998660	A2_I	4.1	2.2	-	-	Identified as a distinct and angular dark reflector. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7119	Dark reflector	322861	5999106	A2_I	5.2	0.9	-	-	Identified as a thin curved dark reflector, the feature has a slight scour or shadow. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7120	Dark reflector	324235	6000080	A2_I	6.1	4.1	0.2	-	Identified as a distinct slightly curvilinear dark reflector. Also identified in the MBES data as a slightly elongate mound with steep sides and a pointed peak, anomalous to the surrounding uneven area of seabed. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic, MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7121	Dark reflector	324661	5999973	A2_I	3.2	1.0	0.3	-	Identified as a distinct elongate dark reflector with a bright bulbous shadow, slightly anomalous to the surrounding seabed. No anomalous features were identified in the MBES or Mag. data at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.	SSS	Gardline 2021	Humber Pipeline	-
7122	Seabed disturbance	325432	5999947	A2_I	29.1	7.6	-	-	Identified as a seabed disturbance comprising an irregularly shaped group of dark reflectors, orientated approximately north to south and anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7123	Dark reflector	324282	6000360	A2_I	13.6	12.5	-	-	Identified as an irregularly shaped large dark reflector, the feature is anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7124	Dark reflector	325335	6000565	A2_I	5.4	0.3	0.1	-	Identified as an indistinct elongate dark reflector with a bright, uneven shadow. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7125	Dark reflector	325860	6000731	A2_l	1.5	0.9	0.8	-	Identified as a distinct angular dark reflector with a large bright and uneven shadow, possibly suggesting uneven height. The feature is situated within scour and isolated. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7126	Debris	326648	6000831	A2_h	10.7	8.5	6.2	-	Identified as a very distinct sub-angular dark reflector that appears to be most distinct on the south-western edge. Also identified in the MBES data as a very tall mound with steep, almost vertical sides and an angular stepped peak. The feature is isolated and very anomalous to the relatively featureless seabed. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as an item of debris.	Backscatter Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7127	Magnetic	327619	6001260	A2_l	-	-	-	27	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7128	Debris	327852	6001337	A2_h	5.5	1.2	0.4	62	Identified as a distinct angular dark reflector with an indistinct linear piece coming off it, the shadow is uneven suggesting uneven height. No anomalous features were identified in the MBES data at this location. Associated with a medium, sharp asymmetric dipole with peak and trough on one profile line in the Mag data, indicating ferrous material is present. Interpreted as ferrous debris.	SSS, Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7129	Magnetic	328279	6001419	A2_l	-	-	-	28	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7130	Debris field	329157	6001431	A2_h	40.2	7.6	0.5	30	Identified as a group of small, angular and elongate dark reflectors with shadows situated within an area of mobile sediments, the largest object measures 1.8 x 0.5 x 0.4 m. There is an indistinct curvilinear rope or chain also visible connecting some of the objects. Faintly visible as an uneven area of seabed in the MBES data. Associated with a small negative monopole with peak and trough on one profile line at I"s north-east end in the Mag. data, indicating some ferrous material is present. Interpreted as a possible debris field, and may be fishing gear however, this can't be confirmed without visual inspection.	SSS, Mag.	Gardline 2021	Humber Pipeline	-
7131	Magnetic	329222	6001336	A2_l	-	-	-	14	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7132	Dark reflector	330127	6001502	A2_l	2.1	0.5	0.3	-	Identified as an indistinct straight dark reflector with a bright shadow, the feature looks anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7133	Magnetic	330951	6001488	A2_I	-	-	-	22	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7134	Magnetic	332418	6001523	A2_I	-	-	-	32	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7135	Dark reflector	332907	6001589	A2_I	8.9	3.0	-	-	Identified as a distinct elongate, dark reflector orientated north-east to south-west, the feature is more distinct at the south-west end. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7136	Dark reflector	333271	6001716	A2_I	1.8	0.7	0.8	-	Identified as a dark reflector that appear to be two or three very thin linear dark reflectors in a parallel alignment with a large shadow that extends beyond the range. One of two (**7137**) identical anomalies next to one another. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7137	Dark reflector	333268	6001716	A2_I	2.2	0.8	0.7	-	Identified as a dark reflector that appear to be 2 or 3 very thin linear dark reflectors in a parallel alignment with a large shadow that extends beyond the range. One of two (**7136**) identical anomalies next to one another. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7138	Dark reflector	333028	6002286	A2_I	3.1	2.1	0.3	-	Identified as an indistinct slightly elongate dark reflector with a slight scour or shadow. Also identified in the MBES data as a small slightly angular mound with steep sides and a pointed peak. The feature is situated within a depression measuring 19.1 x 13.6 m and within large sand waves, it is anomalous and isolated. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7139	Dark reflector	334993	6002120	A2_I	10.6	4.0	-	-	Identified as a tapered dark reflector with one pointed end, the feature is possibly in a slight depression or scour. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7140	Seabed disturbance	336486	6002403	A2_I	24.3	10.6	-	-	Identified as an oval area of seabed disturbance comprising small, indistinct angular dark reflectors with some areas of indistinct bright reflector. Visible as a textured area of seabed in the MBES data. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7141	Dark reflector	336124	6002867	A2_I	3.0	1.8	-	-	Identified as an oval dark reflector that appears quite distinct to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7142	Dark reflector	335656	6003491	A2_I	9.0	2.0	-	-	Identified as a distinct rectangular dark reflector within large sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7143	Bright reflector	337073	6003452	A2_I	11.6	1.1	-	-	Identified as a straight and elongate bright reflector, orientated north-east to south-west. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7144	Debris field	336849	6004225	A2_h	88.1	0.4	0.1	-	Identified as three long, thin, and slightly curvilinear dark reflectors that become one feature at either end, possibly multiple lengths of ropes or chains. The feature has at least five small sub-angular dark reflectors attached along its length, the largest measures 1.0 x 0.7 x 0.6 m. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field, and may be modern such as fishing gear however, this can't be confirmed without visual inspection.	SSS	Gardline 2021	Humber Pipeline	-
7145	Bright reflector	336724	6004443	A2_l	5.3	2.1	-	-	Identified as a rectangular bright reflector, possibly with some scour to the south-west. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7146	Seabed disturbance	336498	6005001	A2_l	10.5	7.4	-	-	Identified as a rounded area of seabed disturbance comprising small, indistinct dark reflectors with some areas of indistinct bright reflector around the edges. Visible as a slightly textured area of seabed in the MBES data. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7147	Bright reflector	337544	6006906	A2_I	3.8	2.8	-	-	Identified as a square shaped bright reflector with some possible associated scour to the NNE for up to 90.0 m. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7148	Seabed disturbance	338209	6006381	A2_I	19.1	5.2	0.5	-	Identified as an area of seabed disturbance comprising a spread of small angular and curvilinear dark reflectors with shadows situated within sand waves, the largest object measures 2.2 x 1.2 m. Visible in the MBES data as a number of low-lying elongate mounds within sand waves. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7149	Dark reflector	339369	6006312	A2_I	3.1	2.2	0.2	-	Identified as a small angular dark reflector in possible scour or area of seabed disturbance. Visible in the MBES data as an angular mound with steeply sloping sides and a pointed peak within large sand waves. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7150	Dark reflector	338659	6006718	A2_I	3.3	1.1	0.1	-	Identified as a slightly irregular, elongate dark reflector with a bright shadow. The feature is isolated and anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7151	Mound	338716	6006546	A2_I	10.5	4.3	0.3	-	Identified as an indistinct, elongate low-lying mound with gently sloping sides and an uneven peak, situated within sand waves and appears slightly anomalous. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7152	Mound	338461	6006986	A2_I	11.9	7.7	1.0	-	Identified as a distinct, slightly angular mound situated between large sand waves, the feature has a rounded peak and some scour on its southern edge. Visible as an elongate slightly curved dark reflector in the backscatter data. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7153	Bright reflector	339955	6007017	A2_l	4.3	2.1	-	-	Identified as an oval shaped bright reflector within sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7154	Magnetic	340150	6008906	A2_l	-	-	-	20	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7155	Dark reflector	340949	6009857	A2_l	3.8	1.5	0.2	-	Identified as a distinct angular dark reflector with a bright shadow, and may be related or attached to, nearby rope/chain **7156** and is situated within an area of mobile sediments. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7156	Rope/chain	340955	6009866	A2_h	60.6	0.4	0.2	-	Identified as a long, thin and curvilinear slightly intermittent dark reflector with a short bright shadow in places. The feature possibly has an object attached (**7155**) and is situated within an area of mobile sediments. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location Interpreted as a possible length of rope or chain.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7157	Rope/chain	341155	6010116	A2_h	22.0	0.3	0.2	-	Identified as a long, thin and curvilinear spread of intermittent dark reflectors with slight shadows. The feature is indistinct and situated within an area of mobile sediments. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location Interpreted as a possible length of rope or chain.	SSS	Gardline 2021	Humber Pipeline	-
7158	Rope/chain	341673	6010832	A2_h	74.5	1.0	-	-	Identified as a long thin and relatively straight dark reflector with a shadow, orientated north-east to south-west on the seabed, and situated within an area of mobile sediments. Similar feature (**7159**) is situated 10.0 m south. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location Interpreted as a possible length of rope or chain.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7159	Rope/chain	341664	6010797	A2_h	44.4	1.0	-	-	Identified as a long thin and mainly straight dark reflector with a shadow, orientated north-east to south-west on the seabed, and situated within an area of mobile sediments. Similar feature (**7158**) is situated 10.0 m north. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location Interpreted as a possible length of rope or chain.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7160	Dark reflector	342445	6011721	A2_l	3.0	0.8	0.2	-	Identified as an elongate dark reflector with a bright, uneven shadow, and may be two objects close to one another but this is unclear. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7161	Magnetic	342499	6011863	A2_l	-	-	-	20	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7162	Magnetic	344038	6013844	A2_h	-	-	-	51	Identified as a medium asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7163	Magnetic	344706	6014427	A2_l	-	-	-	47	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7164	Magnetic	345154	6014569	A2_l	-	-	-	13	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7165	Dark reflector	345354	6014610	A2_I	19.6	3.0	-	-	Identified as an indistinct linear dark reflector or multiple small, rounded objects close together situated within an area of mobile sediments. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7166	Mound	345384	6014846	A2_I	4.8	4.3	0.5	-	Identified as a small but very distinct angular mound with steep sides and a flat peak, situated within large sand waves. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7167	Dark reflector	347084	6015201	A2_I	1.7	1.1	0.7	-	Identified as a distinct angular dark reflector with a bright tapered shadow situated within an area of mobile sediments. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7168	Magnetic	347565	6015275	A2_I	-	-	-	25	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7169	Rope/chain	348050	6016192	A2_h	17.4	1.7	-	-	Identified as a long thin and slightly curvilinear bright reflector with a slight scour or shadow, orientated NNE to SSW on the seabed and within an area of mobile sediments. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible short length of rope or chain.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7170	Dark reflector	348514	6015973	A2_l	9.7	0.5	-	-	Identified as a long and thin dark reflector with a bright scour or shadow. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7171	Dark reflector	350927	6014983	A2_l	6.0	1.5	-	-	Identified as an elongate dark reflector with a bright scour or shadow associated, possibly two objects close together. The feature is situated within an area of large sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7172	Magnetic	350865	6014345	A2_h	-	-	-	73	Identified as a medium, sharp symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7173	Magnetic	351077	6014302	A2_h	-	-	-	115	Identified as a large negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7174	Magnetic	352218	6013774	A2_l	-	-	-	8	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7175	Dark reflector	352223	6013073	A2_l	2.9	2.0	-	-	Identified as a small dark reflector with a bright, flared area of scour or shadow. The feature is distinct to the surrounding large mobile sand waves and has some indistinct scour to the north-west. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7176	Dark reflector	353220	6013304	A2_l	1.2	0.9	0.6	-	Identified as a slightly angular dark reflector with a bright shadow, one of four (**7177**, **7178** and **7179**) similar features that appear to be in a north-east to south-west alignment. No anomalous features were identified in the MBES or Mag. data at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7177	Dark reflector	353245	6013325	A2_I	1.3	1.1	0.6	-	Identified as a slightly angular dark reflector with a bright shadow, one of four (**7176**, **7178** and **7179**) similar features that appear to be in a north-east to south-west alignment. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7178	Dark reflector	353291	6013363	A2_I	1.0	0.8	0.4	-	Identified as a slightly angular dark reflector with a bright shadow, one of four (**7176**, **7177** and **7179**) similar features that appear to be in a north-east to south-west alignment. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7179	Dark reflector	353318	6013384	A2_I	1.5	1.3	0.6	-	Identified as a slightly angular dark reflector with a bright shadow, one of four (**7176**, **7177** and **7178**) similar features that appear to be in a north-east to south-west alignment. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7180	Debris field	353909	6012906	A2_h	48.0	0.8	0.2	-	Identified as a debris field comprising a long, intermittent curvilinear dark reflector with a short bright shadow, a distinct, a slightly curvilinear dark reflector with a bright shadow is also visible, measuring 8.1 x 0.4 x 0.1 m situated within large mobile sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field.	SSS	Gardline 2021	Humber Pipeline	-
7181	Dark reflector	353875	6012893	A2_l	3.4	0.4	0.1	-	Identified as an indistinct curvilinear dark reflector with a short shadow situated within large mobile sand waves. Possibly related to debris field **7180** situated 8.0 m north-east . No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7182	Seabed disturbance	355726	6012999	A2_l	15.2	12.1	0.5	-	Identified as an area of seabed disturbance containing indistinct elongate and angular mounds, situated within large sand waves. The feature is anomalous to the surrounding seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7183	Mound	356232	6012287	A2_l	15.4	6.1	0.7	-	Identified as an elongate, slightly angular mound that is taller at its west end, orientated east to west on the seabed and lying perpendicular to the sand waves. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-
7184	Debris field	356620	6011741	A2_h	50.1	0.5	0.6	-	Identified as a long, thin, and slightly curvilinear dark reflector with a short shadow in places. The feature is orientated approximately WNW to ESE and has two dark reflectors attached across its length, the largest measures 1.6 x 1.6 x 0.4 m. Situated 15.0 m north-west of debris field (**7185**) and may be related. No anomalous features were identified in the MBES data at this location. This position was only covered by the Mag. dataset at its western end, so it is not possible to ascertain whether ferrous material is present along the entire length. Interpreted as a possible debris field, and may be modern such as fishing gear however, this can’t be confirmed without visual inspection.	SSS	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7185	Debris field	356665	6011728	A2_h	13.7	0.4	0.1	-	Identified as a thin and straight linear dark reflector with a bright shadow. The feature is orientated approximately north-west to south-east with a dark reflector attached at its north-west end measuring 2.1 x 1.2 x 0.5 m. Situated 15.0 m south-east of debris field (**7184**) and may be related. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field, and may be modern such as fishing gear however, this can't be confirmed without visual inspection.	SSS	Gardline 2021	Humber Pipeline	-
7186	Dark reflector	356681	6011719	A2_l	7.9	0.4	0.1	-	Identified as an indistinct, straight dark reflector with a slight shadow in its centre. The feature is situated 14.0 m south-east of debris field **7185** and may be related. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7187	Mound	357420	6012298	A2_l	125.0	2.0	0.2	-	Identified as a straight linear mound with gently sloping sides and a pointed peak, the feature is orientated approximately east to west and is intermittent in places, situated within large mobile sand waves. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7188	Wreck	358336	6012230	A1	35.6	13.2	3.0	-	Identified as an irregular area of seabed disturbance comprising indistinct dark and bright reflectors, situated within a large mobile sand waves. One very distinct dark reflector is visible at the western extent of the feature. Also identified in the MBES dataset as large wreck visible as an ovoid group of angular mounds situated within large mobile sand waves. The wreck is orientated east to west and appears to be upright on the seabed, however the hull is not discernible. Multiple internal, straight-edged, rectangular, and angular mounds are visible, with the tallest mounds in the centre and east end of the wreck. The wreck appears mostly intact and has surrounding scour, the largest area of scour measures 20.0 m in length and -1.0 m deep at the south-west side. This position was not directly covered by the SSS or Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for an unknown wreck last surveyed in 1987, described as being partially buried in the flank of a sand wave, with geophysical dimensions of 52.0 x 10.0 x 3.6 m. The smaller dimensions in the 2021 data suggest the wreck may have since degraded further or become further buried by mobile sediments. Located outside the GSA but has been recommended a 50 m AEZ which will fall inside the GSA.	Backscatter Mosaic, MBES	Xocean 2021	Humber Pipeline	UKHO 6605

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7189	Debris	358337	6012188	A2_h	2.4	1.6	-	-	Identified as a small indistinct angular dark reflector, situated 22.0 m south of wreck **7188** and may be related. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris. Located outside the GSA but is likely associated wreck debris and so it has been retained in this gazetteer.	Backscatter Mosaic	Xocean 2021	Humber Pipeline	-
7190	Magnetic	357322	6011482	A2_h	-	-	-	70	Identified as a medium, sharp positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-
7191	Debris field	357386	6011403	A2_h	109.9	0.7	0.3	14	Identified as a long, thin, and slightly curvilinear dark reflector with a slight shadow in places. The feature is orientated north-west to south-east on the seabed and has dark reflectors attached measuring approximately 2.0 x 1.2 m. No anomalous features were identified in the MBES data at this location. Associated with a small, broad positive monopole with peak and trough on one profile line in the Mag. data at its north-west end, indicating some ferrous material is present. Interpreted as a possible partially ferrous debris field, and may be modern such as fishing gear however, this can't be confirmed without visual inspection.	SSS, Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7192	Dark reflector	359421	6011194	A2_l	5.1	1.4	0.3	-	Identified as an elongate slightly curvilinear dark reflector that has a dark reflector attached at one end, the object measures 1.6 x 1.4 m. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Humber Pipeline	-
7193	Debris	360605	6011532	A2_h	15.7	7.8	1.2	-	Identified as an oval area of low reflectivity, lying perpendicular to the sand waves. Also identified in the MBES data as a distinct mound situated within the crest of a large sand wave. The mound is elongate and orientated approximately north-west to south-east, the tallest point of the mound is its south-east end. Very small slightly angular indistinct mounds are visible on the southern edge of the feature, suggesting it may be multiple objects. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as possible debris.	Backscatter Mosaic, MBES	Xocean 2021	Humber Pipeline	-
7194	Magnetic	362275	6011910	A2_l	-	-	-	15	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7195	Dark reflector	364312	6012270	A2_I	3.5	1.1	0.8	-	Identified as a distinct and isolated sub-angular dark reflector with a bright uneven shadow, possibly suggesting uneven height. The feature is situated in a depression and within large mobile sand waves. Also identified in the MBES dataset as a distinct rounded mound with steeply sloping sides and a pointed peak, the southern side of the mound is slightly"" shaped. This position was not directly covered by the Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS, MBES	Gardline 2021, Xocean 2021	Humber Pipeline, Teesside Pipeline	-
7196	Magnetic	366386	6011819	A2_I	-	-	-	29	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Humber Pipeline, Teesside Pipeline, Endurance Store	-

Appendix 5: Seabed anomalies of archaeological potential: Teesside Pipeline GSA

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7197	Recorded Wreck	236310	6060858	A3	-	-	-	-	The recorded position of the wreck of the Spanish steam ship *Santiago,* built in 1888 with a triple expansion engine and two boilers, it was sunk after collision whilst travelling between Newcastle and Pauillac with a cargo of coal. The wreck was dispersed in the 1920s and was not identified in a MBES survey in 2018. No anomalous features were identified in the Pseudo SSS Mosaic or MBES data at this location. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. As remains have been found at this location previously it has been retained as a precaution in this gazetteer.	-	-	Teesside Pipeline	UKHO 66499
7198	Debris	236403	6061910	A2_h	2.1	1.7	0.3	-	Identified as a slightly indistinct, broad curved dark reflector within some possible scour. Also identified in the MBES data as a distinct oval mound with a rounded peak, situated in a depression measuring 8.5 x 7.9 x 0.6 m. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for an Obstruction described as foul ground, possibly a power cable identified in 2018 with dimensions of 4.8 x 1.0 x 0.7 m. Interpreted as possible debris and may be modern however, this can't be confirmed without visual inspection.	Pseudo SSS Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 89495

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7199	Mound	236790	6061101	A2_I	5.1	4.4	1.0	-	Identified as a rectangular mound with steep, slightly angular sides and an uneven peak. The feature is situated close to an area of outcropping geology. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7200	Mound	237198	6061341	A2_I	3.3	2.3	0.3	-	Identified as a distinct angular mound with steep sides and a pointed peak. The feature is situated in a depression measuring 9.5 x 5.5 m and north of an area of outcropping geology. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7201	Seabed disturbance	237262	6061282	A2_I	4.1	3.7	-	-	Identified as a small, irregular area of seabed disturbance comprising possible linear darker reflectors aligned east to west with some additional darker areas to the south. No anomalous features were identified in the MBES data at this location; however this is situated within an area of outcropping geology. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7202	Dark reflector	237416	6061323	A2_l	3.8	2.6	-	-	Identified as a sub-rounded, elongate dark reflector orientated approximately north-east to south-west, the feature tapers slightly to the north-east. No anomalous features were identified in the MBES data at this location; however this is situated within an area of outcropping geology. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7203	Debris field	238799	6062414	A2_h	12.1	5.3	0.2	-	Identified as an elongate and slightly angular dark reflector with a possible small, rounded shadow or scour. Also identified in the MBES data as an area of disturbed seabed comprising two low-lying mounds within depressions. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO position for an obstruction last surveyed in 2018 and described as being two cylindrical objects with measurements of 8.4 x 1.7 x 0.5 m. Interpreted as a possible debris field and may be modern however, this can't be confirmed without visual inspection.	Pseudo SSS Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 89496
7204	Dark reflector	238819	6062419	A2_l	1.4	0.4	-	-	Identified as a small, linear dark reflector with a short shadow, situated 20.0 m ENE of debris field **7203** and may be related. Visible as a depression in the MBES dataset. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7205	Recorded Obstruction	239580	6062526	A3	-	-	-	-	The recorded position of an obstruction in the UKHO data. A piece of debris measuring 15.3 x 1.9 x 0.5 m was identified in 2000. An ROV survey in 2001 identified a large engine block and possible remains of a small vessel in a large section of fishing net with buoys attached. In 2019 a standalone engine of a small bus engine was found and the feature was not located by MBES survey in 2016. No anomalous features were identified in the Pseudo SSS Mosaic or MBES data at this location. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris not visible in the 2021 data and may be modern however, this can’t be confirmed without visual inspection.	-	-	Teesside Pipeline	UKHO 60766
7206	Mound	239847	6063165	A2_I	6.1	4.9	0.1	-	Identified as a roughly circular area of slightly darker and more textured seabed within an area of relatively featureless seabed. Also identified in the MBES data as a low-lying angular mound in a slight depression, large and anomalous to the surrounding seabed. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic, MBES	Xocean 2021	Teesside Pipeline	-
7207	Dark reflector	239939	6063773	A2_I	1.9	0.8	-	-	Identified as a small, elongate dark reflector with a short shadow, the feature is isolated and slightly anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is	Pseudo SSS Mosaic	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									present at this location. Interpreted as a possible natural feature or may be possible debris.				
7208	Recorded Wreck	240669	6063095	A3	-	-	-	-	The recorded position of a wreck identified in 2017 measuring 10.8 x 5.6 x 1.0 m. No anomalous features were identified in the Pseudo SSS Mosaic or MBES data at this location. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. As remains have been identified at this position previously, it has been retained in this gazetteer.	-	-	Teesside Pipeline	UKHO 87228
7209	Recorded Obstruction	240706	6062879	A3	-	-	-	-	The recorded position of foul ground, an anchor reported in the Kingfisher fortnightly bulletin in 2004. The feature was not located during a survey in 2016 and the record was amended to dead. No anomalous features were identified in the Pseudo SSS Mosaic or MBES data at this location. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris not visible in the 2021 data and may be modern however, this can’t be confirmed without visual inspection.	-	-	Teesside Pipeline	UKHO 63999

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7210	Wreck	243520	6063523	A1	80.4	29.3	3.0	-	Identified as an irregular area of disturbed seabed comprising a large bright reflector which is distorted in the data. Also visible in the Backscatter data as an indistinct and intermittent spread of dark reflectors. Also identified in the MBES data as a large wreck visible as a spread of distinct and indistinct mounds. The wreck is orientated north-west to south-east and appears upright. The south-east end of the wreck comprises two tall mounds measuring approximately 6.2 x 6.1 x 2.5 individually. At the north-western end of the wreck a group of multiple angular low-lying mounds with pointed peaks is visible. The hull of the wreck is not discernible and internally very indistinct, low-lying mounds are visible in-between the interpreted bow and stern, suggesting it is highly degraded and may be buried. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. The wreck is situated at the edge of the MBES data extents and so the dimensions should be considered a minimum. Associated with a UKHO record for *Teesdale* (Possibly), a steam ship built in 1904 and sunk in 1917. It survived a torpedo attack but then foundered on its way for repairs. The wreck was last surveyed in 2017 and described as being upright and intact, but mostly flattened and geophysical dimensions of 80.0 x 15.1 x 4.9 m. Interpreted as a large, mostly intact but degraded wreck.	Pseudo SSS Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 6389

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7211	Mound	244626	6061182	A2_I	7.0	4.6	0.4	-	Identified as an elongate angular mound with steeply sloping sides and an uneven peak, slightly anomalous to the surrounding uneven seabed. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7212	Mound	244817	6062942	A2_I	4.2	3.1	0.7	-	Identified as a distinct angular mound with uneven sides and a pointed peak, the feature is anomalous to the surrounding seabed. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7213	Mound	245748	6061581	A2_I	8.7	4.7	0.9	-	Identified as an elongate mound with steeply sloping sides at its north-west end. The feature decreases in height at its south-east end and may be two objects close to one another. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7214	Seabed disturbance	246585	6061053	A2_I	9.8	7.2	-	-	Identified as two curved, irregular dark reflectors that are roughly parallel to one another. Some short shadows or scour are apparent. Visible as an uneven area of seabed in the MBES data. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Teesside Pipeline	-
7215	Mound	247360	6062192	A2_I	3.6	3.2	0.6	-	Identified as a small, rounded mound with no visible scour and located on a relatively flat seabed. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7216	Mound	248968	6061244	A2_I	3.8	3.8	0.9	-	Identified as a distinct and angular mound with steep sides and a double peak. The feature looks anomalous to the surrounding seabed. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7217	Wreck	249133	6061305	A1	46.4	10.7	3.3	-	Identified as an area of seabed disturbance comprising two small elongate dark reflectors with a bright area in-between orientated NNE to SSW. Also identified in the MBES data as an upright and intact wreck. Internally, multiple irregular low-lying mounds are visible within the interpreted hull. The majority of the wreck does not stand proud of the seabed. A large and prominent mound at the	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 6063; HOB UID 908830

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									south-west end is visible, that may be a boiler or other large feature of the superstructure. The bow appears to be to the north-east end. The wreck is situated within an area of large geological outcrops and escarpments. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for *John Miles*, a steam ship built in 1908 with one boiler and triple expansion engine, the vessel sank after striking a mine in 1917. The wreck was last surveyed in 2017 and described as being upright and intact but severely disintegrated, with geophysical dimensions of 45.9 x 9.2 x 4.3 m. Interpreted as an intact but degraded wreck.				
7218	Mound	249794	6059977	A2_I	12.4	7.8	0.6	-	Identified as a distinct angular mound with steep sides and a very flat peak. The feature is distinct and anomalous to the surrounding seabed. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7219	Dark reflector	249855	6060932	A2_I	3.2	1.0	-	-	Identified as an irregular and angular dark reflector, possibly comprising a cluster of objects. Some short shadows or scour are faintly visible. No anomalous features were identified in the MBES data at this location. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Pseudo SSS Mosaic	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7220	Mound	250248	6060207	A2_I	3.8	3.7	1.0	-	Identified as a distinct tall mound with steeply sloping sides and a very flat peak, anomalous to the surrounding seabed. No anomalous features were identified in the Pseudo SSS Mosaic data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7221	Dark reflector	250455	6060802	A2_I	4.1	1.1	-	-	Identified as an elongate, sub-angular dark reflector with a bright reflector to the north. Located adjacent to a large escarpment. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7222	Mound	250932	6060457	A2_I	2.8	2.3	0.5	-	Identified as a distinct mound with steeply sloping sides and a pointed peak, the feature is relatively tall for the area. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7223	Magnetic	251603	6060708	A2_h	-	-	-	55	Identified as a medium, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7224	Mound	251733	6059675	A2_I	3.1	2.9	1.0	-	Identified as a distinct angular mound, with steeply sloping, slightly stepped sides and a pointed peak, the feature is anomalous to the surrounding seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7225	Mound	251726	6059862	A2_I	3.2	3.0	1.0	-	Identified as a distinct angular mound, one edge is steep and the other slightly irregular. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7226	Magnetic	251892	6060731	A2_I	-	-	-	26	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7227	Mound	252107	6061089	A2_I	4.2	2.7	0.8	-	Identified as a small, slightly elongate mound with no visible scour situated on a relatively featureless seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7228	Mound	252337	6061155	A2_l	2.7	1.7	0.8	-	Identified as a small, slightly elongate mound with no visible scour and located adjacent to an area of outcropping geology. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7229	Mound	252542	6060535	A2_l	2.6	2.0	1.0	-	Identified as a small, round and relatively prominent mound with no visible scour and located adjacent to an area of outcropping geology. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7230	Mound	252699	6061271	A2_l	3.8	2.1	0.7	-	Identified as a small, slightly elongate mound with no visible scour and located on a relatively featureless seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7231	Rope/chain	252752	6060628	A2_h	57.1	0.7	0.2	-	Identified as a long and thick linear dark reflector with a short shadow, lying perpendicular to the sand waves orientated north-west to south-east. An angular dark reflector with a short, bright tapered shadow is visible at one end, measuring 1.7 x 1.6 x 0.2 m. No anomalous features were identified in the MBES or Mag. Data at this	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									location. Interpreted as a possible length of non-ferrous rope or chain.				
7232	Rope/chain	252776	6060591	A2_h	10.6	0.4	0.2	-	Identified as a distinct linear dark reflector with a shadow, situated within an area of mobile sediments. Possibly a continuation of rope/chain **7231**, situated 13.0 m north-west. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible short length of rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-
7233	Mound	252764	6060857	A2_l	3.8	3.6	1.4	-	Identified as a distinct, round and prominent mound with no visible scour situated adjacent to an area of outcropping geology. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7234	Magnetic	253020	6060696	A2_l	-	-	-	31	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7235	Mound	253939	6059749	A2_I	2.5	2.4	0.3	-	Identified as a small, rounded mound with no visible scour and located on a relatively flat seabed. One of a line of three (**7236**, **7237**) that are similar in size and form, running east-west approximately 45.0 m apart that may be associated. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris, and may be fishing gear however, this can't be confirmed without visual inspection.	MBES	Xocean 2021	Teesside Pipeline	-
7236	Mound	253985	6059739	A2_I	2.7	2.0	0.3	-	Identified as a small, rounded mound with no visible scour and located on a relatively flat seabed. One of a line of three (**7235**, **7237**) that are similar in size and form, running east-west approximately 45.0 m apart that may be associated. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris, and may be fishing gear however, this can't be confirmed without visual inspection.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7237	Mound	254030	6059732	A2_I	2.7	2.6	0.5	-	Identified as a tall, rounded mound with no visible scour and located on a relatively flat seabed. One of a line of three (**7235**, **7236**) that are similar in size and form, running east-west approximately 45.0 m apart that may be associated. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris, and may be fishing gear however, this can't be confirmed without visual inspection.	MBES	Xocean 2021	Teesside Pipeline	-
7238	Mound	254225	6059907	A2_I	4.0	1.9	0.5	-	Identified as a small, elongate mound with no visible scour and located on a relatively featureless seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7239	Magnetic	254276	6060571	A2_I	-	-	-	16	Identified as a small symmetric dipole with peak and trough on one profile line. Possibly associated with Mag. Anomaly **7240** situated 27.0 m south-east. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7240	Magnetic	254289	6060548	A2_I	-	-	-	48	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7241	Magnetic	254614	6060469	A2_I	-	-	-	23	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7242	Dark reflector	254728	6061081	A2_I	22.5	1.3	-	-	Identified as a slightly curvilinear dark reflector set within some scour to the south. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7243	Mound	254953	6061185	A2_I	4.8	4.5	0.6	-	Identified as a small, rounded mound with no visible scour and located on a relatively featureless seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7244	Mound	254970	6059242	A2_I	2.2	2.6	0.8	-	Identified as a small, rounded mound with no visible scour and located on a relatively featureless seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7245	Mound	255141	6058945	A2_I	2.9	2.4	0.7	-	Identified as a small, rounded mound with no visible scour and located on a relatively featureless seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7246	Mound	255785	6060382	A2_I	18.0	10.7	1.1	-	Identified as a large, slightly elongate, rounded mound located in an area of relatively featureless seabed. This feature is distinct and isolated with visible scour. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7247	Mound	255969	6059836	A2_I	3.9	2.5	1.2	-	Identified as a small, elongate but relatively prominent mound with no visible scour and located on a relatively flat seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7248	Magnetic	256140	6059999	A2_I	-	-	-	25	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7249	Mound	256166	6059274	A2_l	4.6	2.1	0.5	-	Identified as a small, elongate mound with no visible scour and situated on a relatively featureless seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7250	Magnetic	257002	6059667	A2_l	-	-	-	24	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7251	Magnetic	257238	6059479	A2_l	-	-	-	43	Identified as a small symmetric dipole with peak and trough on one profile line, slightly complex with small double peak. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7252	Mound	257305	6060000	A2_l	2.9	2.7	1.6	-	Identified as a tall, rounded mound with no visible scour and located on a relatively featureless seabed. More prominent and anomalous than other mounds in this area. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7253	Wreck	258712	6059647	A1	75.3	21.9	4.3	-	Identified as a large and elongate area of seabed disturbance comprising an indistinct group of dark and bright reflectors orientated approximately north-west to south-east on the seabed. Also identified in the MBES data as a likely upright wreck. The north-west end of the wreck is characterised by a depression surrounded by a slight perimeter representing interpreted hull, with some angular mounds at the extreme end. Three very tall mounds are visible in the south-east section of the wreck, which may represent boilers, engines, or other large features of the superstructure. No debris is visible in the surrounding, relatively flat seabed, and as such the wreck appears mostly intact. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for the steam ship *Earl Percy*, a single screw steamer that sank in 1888 after a collision. The wreck was last surveyed in 2016 and was described as being upright and intact but severely disintegrated and geophysical dimensions of 74.0 x 8.2 x 5.0 m. Interpreted as a mostly intact but highly degraded wreck.	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 6018; HOB UID 908827
7254	Mound	258854	6058224	A2_I	10.9	9.0	1.0	-	Identified as a relatively large, square mound with a rounded top and steep sides, located adjacent to a large area of outcropping geology, however the feature is distinct and prominent. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7255	Magnetic	258863	6058739	A2_I	-	-	-	48	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7256	Magnetic	259358	6058296	A2_I	-	-	-	11	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7257	Magnetic	259618	6058313	A2_I	-	-	-	8	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7258	Magnetic	259672	6058276	A2_I	-	-	-	21	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7259	Magnetic	259804	6058208	A2_I	-	-	-	19	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. The anomaly is cut by the end of the line and could be larger than visible in the data. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7260	Wreck	259927	6056931	A1	61.6	23.1	1.1	-	Identified as an area of seabed disturbance comprising an indistinct area of very high reflectivity with a distinct roughly square shaped dark reflector visible in the centre. Also identified in the MBES data as a large spread of uneven seabed comprising a number of highly angular mounds, the largest of which is in the centre of the wreck and measures 8.2 x 5.0 m. The wreck appears to be upright, although the hull is not clear and it is not prominent above the seabed, suggesting it may be buried or highly degraded. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for an unknown wreck first identified in 1987, the wreck was last surveyed in 2017 and described as being well broken up with geophysical dimensions of 53.1 x 6.8 x 4.0 m. The NRHE states the wreck may be *Miranda*, sunk in 1899. Interpreted as a highly degraded wreck.	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 6353; HOB UID 908606
7261	Dark reflector	260082	6056805	A2_I	3.6	2.5	0.5	-	Identified as an elongate dark reflector with a brighter area to the north. Also identified in the MBES dataset as a small, rounded mound with no visible scour and located on a relatively featureless seabed. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7262	Wreck	260730	6058476	A1	102.6	30.2	4.6	-	Identified as a large, elongate area of seabed disturbance comprising dark and bright reflectors in an approximate ellipse, orientated north-west to south-east. Also identified in the MBES data as a distinct, very large upright wreck located on a flat and relatively featureless area of seabed. The wreck appears mostly intact, though there is evidence of collapse around the interpreted hull. Internally multiple angular mounds are visible and likely represent broken up deck and debris features. Three very prominent mounds are located at the centre of the wreck which may be parts of the engine or boiler. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for the steam ship *Afrique*, sunk by *UC 40* in 1918. The wreck was last surveyed in 2016 and described as being upright and intact but severely disintegrated with geophysical dimensions of 95.7 x 19.8 x 4.7 m. Interpreted as a large, highly degraded wreck.	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 6057; HOB UID 909237
7263	Wreck	261810	6057750	A1	72.2	19.9	3.3	-	Identified as a distinct, slightly elongate, and irregular area of disturbed seabed comprising dark reflectors with some brighter areas, suggesting multiple objects. Also identified in the MBES data as a distinct, likely upright wreck orientated approximately east to west and lying on a relatively featureless area of seabed. Internally, slightly irregular linear mounds are visible and two large mounds are visible at either end of the wreck, which are likely remnant boilers or other parts of the superstructure. Some minor disturbed seabed and scour is present surrounding the hull. The majority of the wreck is only 0.1 – 0.5 m above the	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 6351, HOB UID 936953

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									surrounding seabed level, suggesting it is heavily degraded or buried. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for *Audax*, a steam ship built in 1903, it was torpedoed in 1918 by *UB-80*. The wreck was last surveyed in 2016 and described as being severely disintegrated with geophysical dimensions of 70.0 x 11.5 x 5.6 m. Interpreted as a large, highly degraded wreck.				
7264	Wreck	261883	6056726	A1	51.5	15.7	3.1	874	Identified as a large wreck that appears to be mostly intact with a thick curvilinear dark reflector interpreted to be the hull. Internally, linear, and small angular dark reflectors are visible with some very tall objects. The wreck is orientated approximately north-west to south-east on the seabed, the south-western edge of the wreck is not coherent and may have collapsed. Also identified in the MBES dataset as a very large, distinct, and upright wreck with taller mounds of possible superstructure visible at both ends of the interpreted hull. The wreck has multiple associated items of debris in the vicinity (**7265**, **7266** and **7268**). Sediment build-up is visible surrounding all sides of the wreck up to a distance of 10.0 m and a height of 0.5 m, which may contain further buried debris. Associated with a very large, sharp asymmetric dipole with peak and trough on one profile line in the Mag data, also visible on adjacent profile lines, indicating ferrous material is present. Associated with a UKHO record for the steam ship *Rutil*, the vessel was presumed sunk by mine in 1916. The wreck was last surveyed in 2016 and described as being upright and intact but well	SSS, Backscatter Mosaic, MBES, Mag.	Gardline 2021, Xocean 2021	Teesside Pipeline	UKHO 6355, HOB UID 908603

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									disintegrated with geophysical dimensions of 63.9 x 12.0 x 2.9 m. Interpreted as a large, highly degraded wreck.				
7265	Debris field	261892	6056699	A1	7.9	7.3	1.4	-	Identified as a small debris field comprising three sub-angular dark reflectors, with a maximum size of 2.2 x 1.4 m, with shadows and smaller dark reflectors surrounding these. The feature is situated at the south-east end of wreck **7264**. Also identified in the MBES dataset as a distinct sub-angular mound. No anomalous features were identified in the Mag. Data at this location, however the large Mag. anomaly associated with wreck **7264** may also be associated with this. Interpreted as a possible debris field associated with wreck **7264**.	SSS, MBES	Gardline 2021, Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7266	Debris	261900	6056703	A2_h	1.7	0.5	0.2	-	Identified as a small, angular dark reflector with a bright shadow, situated 8.0 m east of wreck **7264** and is possibly related. No anomalous features were identified in the MBES or Mag. Data at this location, however the large Mag. Anomaly associated with wreck **7264** may also be associated with this. Interpreted as a possible item of debris associated with wreck **7264**.	SSS	Gardline 2021	Teesside Pipeline	-
7267	Seabed disturbance	261902	6056690	A2_l	9.6	7.8	0.5	-	Identified as an area of disturbed seabed comprising indistinct dark reflectors some with slight shadows and depressions, situated within an area of mobile sediments and 13.0 m south-east of wreck **7264**. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible natural feature or may be possible debris associated with wreck **7264.**	SSS	Gardline 2021	Teesside Pipeline	-
7268	Debris	261961	6056703	A2_h	2.2	0.8	1.2	-	Identified as a distinct curvilinear dark reflector with a bright, uneven shadow, possibly suggesting uneven height. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible item of debris.	SSS	Gardline 2021	Teesside Pipeline	-
7269	Mound	262068	6055264	A2_l	3.7	2.3	0.3	-	Identified as a distinct low-lying oval mound, the feature is situated 43.0 m south-west of wreck **7270** and may be related. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris associated with wreck **7270.**	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7270	Wreck	262099	6055310	A1	57.5	17.7	3.6	-	Identified as an indistinct area of higher reflectivity orientated north-west to south-east. Identified in the MBES data as a large, upright and mostly intact wreck. The interpreted hull of the wreck is distinct and internally, linear mounds are visible which are interpreted to be surviving deck structure. At the north-west end (likely bow) a large mound is visible measuring 9.8 x 6.7 x 3.6 m. Indistinct mounds are visible directly on either side of the hull that might be collapsed structure and the wreck has significant scour at both ends. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for an unknown steam ship, first identified in 1987, the wreck was last surveyed in 2016 and described as being upright and intact, but severely disintegrated with geophysical dimensions of 55.5 x 9.3 x 4.6 m. Interpreted as a large, mostly intact but degraded wreck.	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 6362; HOB UID 908602
7271	Mound	262263	6056143	A2_I	4.3	3.0	0.4	-	Identified as a small, rounded mound with no visible scour and located on a relatively featureless seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7272	Magnetic	262728	6056184	A2_I	-	-	-	36	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7273	Magnetic	262778	6056034	A2_l	-	-	-	24	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7274	Magnetic	262843	6056039	A2_l	-	-	-	18	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7275	Rope/chain	263386	6055673	A2_h	48.8	0.4	0.2	-	Identified as a long and thin distinct dark reflector with a shadow situated within an area of mega ripples and orientated east to west on the seabed. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible long length of non-ferrous rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-
7276	Rope/chain	263479	6055622	A2_h	36.1	0.4	0.1	-	Identified as a long, thin and slightly curvilinear dark reflector with a short shadow in places, orientated north-west to south-east on the seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible long length of rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-
7277	Mound	263527	6055687	A2_l	4.0	2.6	0.5	-	Identified as a small but relatively prominent, sub-angular mound with no visible scour and located on a relatively featureless seabed. No anomalous features were identified in the SSS or Backscatter data at this location. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7278	Magnetic	263652	6054261	A2_I	-	-	-	31	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7279	Mound	263896	6056251	A2_I	2.7	1.9	0.6	-	Identified as a small but distinct, rounded mound with no visible scour and located on a relatively flat seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7280	Dark reflector	264209	6055233	A2_I	1.9	0.3	0.4	-	Identified as a thin and straight dark reflector with a bright bulbous shadow, the feature looks slightly anomalous to the wider boulder field. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7281	Magnetic	264301	6055108	A2_I	-	-	-	10	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7282	Magnetic	264320	6055095	A2_I	-	-	-	5	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7283	Magnetic	264459	6053956	A2_l	-	-	-	35	Identified as a small, sharp symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7284	Magnetic	264840	6054527	A2_l	-	-	-	18	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7285	Mound	264873	6054008	A2_l	3.4	3.1	0.2	-	Identified as a small angular mound that appears to be 'U' shaped in plan. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7286	Magnetic	264962	6053649	A2_h	-	-	-	69	Identified as a medium, sharp positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7287	Magnetic	265000	6054505	A2_l	-	-	-	10	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7288	Dark reflector	265067	6054242	A2_l	5.1	0.3	0.2	-	Identified as a long, thin, and straight dark reflector with a bright slightly uneven shadow, possibly suggesting uneven height. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7289	Dark reflector	265211	6053523	A2_l	1.7	0.8	0.6	-	Identified as a distinct elongate dark reflector with a large bright shadow. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7290	Magnetic	265700	6053827	A2_h	-	-	-	106	Identified as a large asymmetric dipole with peak and trough on one profile line. A highly complex feature with a double peak. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7291	Magnetic	265860	6053397	A2_l	-	-	-	11	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7292	Magnetic	266062	6053546	A2_l	-	-	-	21	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7293	Dark reflector	266083	6053234	A2_l	4.6	0.6	1.2	-	Identified as a distinct slightly curvilinear dark reflector with a bright shadow and significant height. Also identified in the MBES dataset as a distinct, slightly angular mound with steep sides. The south edge is slightly stepped, or may be a second object. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS, MBES	Gardline 2021, Xocean 2021	Teesside Pipeline	-
7294	Dark reflector	266423	6053168	A2_l	1.2	0.4	0.9	-	Identified as a distinct straight dark reflector with a bright tapered shadow, situated in a slight depression. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.	SSS	Gardline 2021	Teesside Pipeline	-
7295	Magnetic	266456	6053366	A2_l	-	-	-	8	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7296	Mound	266504	6054327	A2_l	4.1	2.2	0.4	-	Identified as a small, sub-angular mound with no visible scour and located on a relatively flat seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7297	Mound	266517	6054360	A2_l	4.2	4.0	0.2	-	Identified as a small, rounded mound with no visible scour and located on a relatively flat seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7298	Rope/chain	266592	6053401	A2_h	76.4	0.3	0.2	-	Identified as a very long thin and distinct curvilinear dark reflector with a short, bright shadow. The feature is orientated approximately north to south and curls back on itself at the southern end. It possibly has a very small angular object attached at this end measuring 1.5 x 0.6 m. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible long length of rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-
7299	Rope/chain	266688	6053332	A2_h	32.8	0.2	0.1	-	Identified as a very indistinct, long, and thin slightly curvilinear dark reflector with a short shadow in parts orientated north-west to south-east on the seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible length of rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7300	Mound	266825	6051893	A2_I	3.8	3.8	0.5	-	Identified as a distinct angular mound, one edge is steep and the other slightly irregular. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7301	Mound	266994	6052423	A2_I	4.1	2.5	0.4	-	Identified as an elongate and angular mound, very distinct to the surrounding seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7302	Magnetic	267128	6052878	A2_I	-	-	-	37	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7303	Mound	267434	6051674	A2_I	2.8	2.5	0.5	-	Identified as a distinct mound with steeply sloping sides and a pointed peak, the feature is slightly anomalous to the surrounding seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7304	Debris	267610	6052602	A2_h	1.6	0.2	0.1	-	Identified as a distinct thin dark reflector with a short bright shadow, situated 5.0 m west of wreck **7308** and possibly associated debris. No anomalous features were identified in the MBES or Mag. Data at this location, however the Mag. Anomaly associated with wreck **7308** may be masking smaller anomalies in this area. Interpreted as possible debris associated with wreck **7308**.	SSS	Gardline 2021	Teesside Pipeline	-
7305	Debris	267609	6052543	A1	1.3	0.2	0.3	-	Identified as an indistinct, short, and straight dark reflector with a very small shadow, situated at the south-western edge of wreck **7308** and possibly associated debris. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as possible debris associated with wreck **7308**.	SSS	Gardline 2021	Teesside Pipeline	-
7306	Debris field	267608	6052609	A1	5.3	3.0	0.6	-	Identified as three straight dark reflectors with bright shadows aligned on the seabed, individually these measure a maximum of 2.2 x 0.5 m. Situated on the north-western edge of wreck **7308** and possibly associated debris. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a small debris field	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7307	Debris	267614	6052537	A1	5.1	0.3	0.3	-	Identified as an indistinct straight and thin dark reflector with a very small shadow at one end, situated at the south-western edge of wreck **7308** and possibly associated debris. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as possible debris associated with nearby wreck **7308**.	SSS	Gardline 2021	Teesside Pipeline	-
7308	Wreck	267616	6052571	A1	88.2	25.3	4.8	8847	Identified as a large, upright wreck comprising a thick curvilinear dark reflector interpreted to be the hull. This appears disjointed in places suggesting it is degraded. Internally multiple linear, angular, and rounded dark reflectors with shadows are visible, interpreted as surviving deck structure and superstructure. The wreck is orientated approximately north to south, the northernmost end of the wreck has come away from the main structure with a 4.0 m gap between. This section of bow or stern measures 15.9 x 15.0 x 4.8 m. In the MBES dataset the wreck has multiple distinct mounded features within the interpreted hull and some linear features are also visible. In the centre of the wreck a large mound measuring 11.3 x 10.1 x 2.8 m is visible indicating surviving superstructure. The southern end of the vessel is also highly degraded and there are multiple items of associated debris identified in the vicinity (**7304** – **7307**). The wreck is surrounded by sediment accumulation, that may periodically bury the wreck and associated debris. Associated with a very large, sharp asymmetric dipole with peak and trough on one profile line in the Mag data, also visible on other profiles, indicating ferrous material	SSS, Backscatter Mosaic, MBES, Mag.	Gardline 2021, Xocean 2021	Teesside Pipeline	UKHO 6039; HOB UID 908594

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									is present. Associated with a UKHO record for *Gwalia* (Possibly), a steam ship built in 1881 which sank after a collision off Whitby in 1907. The wreck was last surveyed in 2016 and was described as being severely disintegrated and broken up into three pieces, with the bow and the stern having fallen onto the seabed, but the midship section still upright and geophysical dimensions of 85.3 x 15.2 x 4.9 m. The larger width measurement in the 2021 geophysical data suggests the wreck has degraded further. Interpreted as a large, broken up wreck.				
7309	Debris	267613	6052651	A2_h	2.3	0.7	0.2	-	Identified as a distinct straight dark reflector with a bright shadow situated within an area of mega ripples, situated 35.0 m north of wreck **7308** and may be associated. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7310	Mound	267839	6052964	A2_l	3.7	3.3	0.7	-	Identified as a distinct, tall mound with steeply sloping sides and a pointed peak. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7311	Mound	267956	6053183	A2_l	3.1	3.0	0.6	-	Identified as a distinct and isolated mound with steeply sloping sides and a flat peak. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									material is present at this location. Interpreted as a possible natural feature or may be possible debris.				
7312	Magnetic	268156	6052352	A2_h	-	-	-	62	Identified as a medium, sharp symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7313	Magnetic	268187	6052340	A2_l	-	-	-	13	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7314	Magnetic	268487	6052217	A2_l	-	-	-	25	Identified as a small, sharp symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7315	Magnetic	268888	6052155	A2_l	-	-	-	47	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7316	Magnetic	269387	6051959	A2_h	-	-	-	84	Identified as a medium positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7317	Magnetic	269398	6051900	A2_l	-	-	-	15	Identified as a small, broad positive monopole with peak and trough on one profile line. Possibly related to larger anomaly (**7316**) 60.0 m to the NNW. No anomalous features were identified in the SSS or MBES data at this location. Interpreted	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									as possible ferrous debris either buried or with no surface expression.				
7318	Magnetic	269835	6051773	A2_I	-	-	-	31	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7319	Wreck	270387	6050868	A1	42.3	16.7	3.0	-	Identified as a very indistinct area of seabed disturbance visible as an area of high reflectivity with no defined edge. Also identified in the MBES data as a compact and mostly intact wreck visible as a large irregular oval-shaped mound, orientated north-west to south-east on the seabed. The northern section of the wreck is more prominent and distinct than the southern end, which has little height off the surrounding seabed, suggesting it is highly degraded or buried at this end. The south-east edge of the wreck is situated within an area of scour up to 0.4 m deep. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for an unknown wreck, first identified in 2017 and described as being upright but severely disintegrated with geophysical dimensions of 38.4 x 12.2 x 4.5 m. Interpreted as a highly degraded and possibly partially buried wreck.	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 87230; HOB UID 909229

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7320	Debris field	270549	6052378	A2_h	16.8	13.5	1.2	-	Identified as a distinct area of disturbed seabed comprising an irregular area of dark and bright reflectors, which are highly anomalous for the area of seabed. Also identified in the MBES data as a very distinct angular mound, irregularly shaped and with steep sides and an undulating peak. The feature is isolated and distinct to the surrounding featureless seabed. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for an uneven pile of cut stone blocks identified by divers in 2004, with no other evidence of a wreck. The pile measures 20.1 x 16.3 x 1.65 m. Interpreted as a possible debris field and may be modern, however this can't be confirmed without visual inspection.	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 64547; HOB UID 937079
7321	Mound	271181	6051648	A2_l	4.2	2.7	0.3	-	Identified as a small oval shaped mound with a very slight scour. The feature has gently sloping sides and a rounded peak. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7322	Magnetic	271219	6051201	A2_l	-	-	-	21	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7323	Recorded Wreck	271454	6050820	A3	-	-	-	-	The recorded position of the wreck *Hetty* (Possibly), a steam ship built in 1875 and sunk following a collision in 1894. Divers in 1996 reported an iron hulled vessel with 3 anchors at the bow and a boiler and previous geophysical dimensions from 1989 are recorded as 50.0 m length. No anomalous features were identified in the Pseudo SSS Mosaic or MBES data at this location. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. As remains have been found at this location previously it has been retained as a precaution in this gazetteer.	-	-	Teesside Pipeline	UKHO 73382; HOB UID 1603291
7324	Mound	271889	6051922	A2_I	5.8	3.2	0.7	-	Identified as a sub-circular mound with a slight scour on the southern edge. The feature has gently sloping sides and a flat peak. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7325	Mound	271973	6051928	A2_I	3.8	3.3	0.7	-	Identified as a sub-angular mound triangular in plan with steep sides and a pointed peak. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7326	Dark reflector	272211	6050687	A2_l	8.0	0.2	0.2	-	Identified as a long, thin and indistinct linear dark reflector with a slight shadow. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.	SSS	Gardline 2021	Teesside Pipeline	-
7327	Magnetic	272289	6050664	A2_l	-	-	-	11	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7328	Magnetic	273454	6050213	A2_l	-	-	-	15	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7329	Magnetic	273489	6050198	A2_l	-	-	-	12	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7330	Magnetic	274154	6050016	A2_l	-	-	-	24	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7331	Magnetic	274250	6049977	A2_h	-	-	-	81	Identified as a medium, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7332	Mound	274955	6048897	A2_I	4.6	4.5	0.8	-	Identified as a distinct, sub-angular mound, with steep irregular sides and a pointed peak. The feature is situated within an area of mega ripples. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7333	Seabed disturbance	275346	6048495	A2_I	24.3	12.0	-	-	Identified as an area of seabed disturbance comprising an elongate, textured area of higher reflectivity orientated approximately north-west to south-east on the seabed. Visible as an uneven area of seabed in the MBES data. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7334	Magnetic	276969	6048816	A2_I	-	-	-	9	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7335	Magnetic	277048	6048749	A2_I	-	-	-	12	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7336	Magnetic	277127	6048697	A2_I	-	-	-	10	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7337	Magnetic	277292	6048737	A2_h	-	-	-	96	Identified as a medium, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7338	Mound	278035	6049388	A2_l	2.9	2.6	0.2	-	Identified as a low-lying oval shaped mound within a slight scour, the feature has steep, uneven sides and a pointed peak. The surrounding seabed is flat but with occasional mega ripples. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7339	Wreck	278244	6048535	A1	65.4	20.2	4.1	-	Identified as an indistinct area of seabed disturbance comprising an elongate dark reflector, with some possible more distinct features within. A distinct bright reflector is visible on the west edge of the wreck measuring 4.8 x 2.6 m. Also identified in the MBES data as a large upright and mostly intact wreck orientated north-south on the seabed. Internally the wreck is an uneven surface, with two distinct mounds visible in the centre of the wreck, measuring approximately 4.0 x 3.5 x 2.5 m, indicating surviving superstructure. There is no apparent scouring or sediment build up surrounding the wreck, though the southern end of the wreck may be buried or very degraded. This location was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Associated with a UKHO record for *Black Prince* (Possibly) a sailing vessel built of wood in 1838	Backscatter Mosaic, MBES	Xocean 2021	Teesside Pipeline	UKHO 6226, UKHO 66452, HOB UID 909221

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									which sank following a collision in 1890. The wreck was last surveyed in 2016 and described as being upright and intact but severely disintegrated with geophysical dimensions of 63.4 x 10.6 x 5.0 m. Identified as a large, intact but degraded wreck.				
7340	Magnetic	278398	6048286	A2_h	-	-	-	74	Identified as a medium, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7341	Magnetic	278418	6048176	A2_h	-	-	-	94	Identified as a medium positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7342	Debris field	278969	6048039	A2_h	16.9	3.5	0.9	-	Identified as a spread of short curvilinear and very small angular dark reflectors with shadows. The southern end of the feature has a very large shadow and significant height. Highly anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field.	SSS	Gardline 2021	Teesside Pipeline	-
7343	Dark reflector	279421	6047779	A2_l	1.4	0.2	0.2	-	Identified as a very thin, slightly elongate dark reflector with a short, bright shadow. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7344	Magnetic	279819	6047602	A2_l	-	-	-	22	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7345	Dark reflector	279873	6047561	A2_l	3.1	1.8	1.3	-	Identified as a very distinct sub-angular dark reflector with a very large shadow and significant height, situated within an area of disturbed seabed and scouring measuring approx. 12.7 x 7.8 m. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7346	Magnetic	279968	6047592	A2_l	-	-	-	17	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7347	Debris field	279998	6047635	A2_h	10.8	5.3	1.0	32	Identified as an area of disturbed seabed containing angular and sub-angular dark reflectors with some shadows or depressions. The feature is situated within sand waves and the full extent may be buried. The largest object measures 2.2 x 1.2 m. No anomalous features were identified in the MBES data at this location. Also identified in the Mag. Data as a small asymmetric dipole with peak and trough on one profile line, indicating some ferrous material is present. Interpreted as a possible ferrous debris field.	SSS, Mag.	Gardline 2021	Teesside Pipeline	-
7348	Dark reflector	279999	6047609	A2_l	1.4	1.0	0.7	-	Identified as a distinct sub-angular dark reflector with a bright shadow, situated in a distinct depression. Possibly related to debris field **7347** situated 20.0 m north. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7349	Magnetic	280660	6047316	A2_l	-	-	-	21	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7350	Dark reflector	281932	6046796	A2_l	3.5	1.5	1.5	-	Identified as a large and distinct angular dark reflector with a very long, bright, and tapered shadow, with significant height. Also identified in the MBES dataset as a sub-rounded mound with steep sides and a pointed peak. There is some surrounding scour for 3.0 m wide and 0.1 m deep. No anomalous features were identified in the Mag. data at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.	SSS, MBES	Gardline 2021, Xocean 2021	Teesside Pipeline	-
7351	Dark reflector	282047	6046877	A2_l	2.2	1.3	1.2	-	Identified as a distinct angular dark reflector with a long bright and tapered shadow, slightly flared at the north end of the object. Also identified in the MBES dataset as a small, sub-rounded mound with a rounded peak. There is some associated scour surrounding the feature for 3.0 m and 0.1 m deep. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris	SSS, MBES	Gardline 2021, Xocean 2021	Teesside Pipeline	-
7352	Debris	282770	6046397	A2_h	13.4	0.6	0.3	163	Identified as a distinct straight linear dark reflector with a bright short shadow. Associated with a large, sharp asymmetric dipole with peak and trough on one profile line in the Mag. Data, indicating ferrous material is present. No anomalous features were identified in the MBES data at this location. Interpreted as ferrous debris.	SSS, Mag.	Gardline 2021	Teesside Pipeline	-
7353	Magnetic	282820	6046433	A2_l	-	-	-	35	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7354	Magnetic	282941	6046439	A2_h	-	-	-	87	Identified as a medium, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7355	Magnetic	283040	6046288	A2_h	-	-	-	64	Identified as a medium positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7356	Mound	284019	6046252	A2_l	4.3	3.5	0.6	-	Identified as an irregular sub-angular mound, with steep sides and a double peak. The feature is anomalous to the surrounding seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7357	Dark reflector	284182	6045907	A2_l	2.8	1.2	1.2	-	Identified as a distinct sub-angular dark reflector with a very bright, tapered shadow. Also identified in the MBES dataset as a low-lying sub-rounded mound with a double peak. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS, MBES	Gardline 2021, Xocean 2021	Teesside Pipeline	-
7358	Magnetic	284177	6045882	A2_l	-	-	-	16	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7359	Debris field	284452	6045704	A2_h	8.6	3.2	0.1	35	Identified as an indistinct group of dark reflectors, two small angular objects are visible possibly connected by a very short length of rope or chain. Possibly associated with rope or chain **7360** situated 20.0 m south-east. No anomalous features were identified in the MBES data at this location. Associated with a small asymmetric dipole with peak and trough on one profile line in the Mag. data at its northern end, indicating ferrous material is present. Interpreted as a possible ferrous debris field.	SSS, Mag.	Gardline 2021	Teesside Pipeline	-
7360	Rope/chain	284480	6045697	A2_h	79.7	0.4	0.1	97	Identified as a long and thin, curvilinear dark reflector with a slight shadow in places. Orientated approximately north-west to south-east on the seabed. Possibly associated with debris field **7359** situated 20.0 m north-west and may be an extension of rope or chain **7361** situated 31.0 m south-east. No anomalous features were identified in the MBES data at this location. Associated with a medium, sharp symmetric dipole with peak and trough on one profile line in the Mag. Data. Indicating ferrous material is present. Interpreted as a possible long length of partially ferrous rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-
7361	Rope/chain	284526	6045632	A2_h	17.9	0.3	0.1	-	Identified as a long thin and slightly curvilinear dark reflector with a slight shadow. May be an extension of rope or chain **7360** situated 31.0 m north-west and rope or chain **7362** situated 14.0 m south-east. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible short length of rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7362	Rope/chain	284544	6045596	A2_h	33.7	0.6	0.1	-	Identified as a long thin and slightly curvilinear dark reflector with a slight shadow. May be an extension of rope or chain **7361** situated 14.0 m north-west. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible long length of rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-
7363	Magnetic	284930	6045520	A2_l	-	-	-	24	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7364	Magnetic	285254	6045387	A2_l	-	-	-	13	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7365	Magnetic	285706	6045257	A2_l	-	-	-	21	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7366	Magnetic	286103	6045147	A2_l	-	-	-	25	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7367	Mound	287045	6044157	A2_I	5.1	4.1	0.3	-	Identified as a sub-rounded mound, with gently sloping sides and a double pointed peak within slight scour. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7368	Magnetic	287112	6044735	A2_I	-	-	-	32	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7369	Magnetic	287120	6044683	A2_I	-	-	-	37	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7370	Magnetic	287236	6044578	A2_I	-	-	-	7	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7371	Magnetic	287256	6044676	A2_I	-	-	-	19	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7372	Magnetic	287782	6044356	A2_I	-	-	-	9	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7373	Bright reflector	287843	6044278	A2_I	1.8	1.0	-	-	Identified as a distinct rectangular bright reflector, isolated on a featureless seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7374	Magnetic	288008	6044319	A2_I	-	-	-	9	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7375	Magnetic	288411	6044101	A2_I	-	-	-	16	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7376	Magnetic	288440	6044139	A2_I	-	-	-	29	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7377	Magnetic	288466	6044079	A2_I	-	-	-	22	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7378	Magnetic	288784	6043949	A2_I	-	-	-	9	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7379	Magnetic	289355	6043715	A2_I	-	-	-	18	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7380	Magnetic	290081	6043473	A2_I	-	-	-	13	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7381	Mound	290222	6042718	A2_I	4.2	4.1	0.5	-	Identified as a sub-angular mound with steep sides and pointed peak. The feature has slight scouring and is anomalous to the surrounding featureless seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7382	Magnetic	290640	6043244	A2_I	-	-	-	38	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7383	Magnetic	290803	6043179	A2_I	-	-	-	8	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7384	Magnetic	292191	6042666	A2_I	-	-	-	6	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7385	Dark reflector	292736	6042933	A2_l	3.6	2.6	-	-	Identified as a small, rounded dark reflector with a possible shadow, very distinct to the surrounding seabed. Visible as a small mound in a depression in the MBES data. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7386	Magnetic	292781	6042372	A2_l	-	-	-	17	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7387	Dark reflector	292778	6041390	A2_l	6.5	3.1	-	-	Identified as a small dark reflector with a likely shadow or scour represented by a bright area, distinct to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7388	Debris field	292967	6042338	A2_h	13.9	8.1	1.6	166	Identified as a compact group of very small dark reflectors, some of which have slight shadows, but the general area has a very large, tapered shadow and significant height. Also identified in the MBES dataset as a distinct and isolated sub-angular mound, with steep sides and a rounded peak. Associated with a large negative monopole with peak and trough on one profile line in the Mag. Data, also visible on the adjacent line, indicating ferrous material is present. Interpreted as a ferrous debris field.	SSS, MBES, Mag.	Gardline 2021, Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7389	Magnetic	292996	6042285	A2_l	-	-	-	14	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7390	Rope/chain	293480	6042116	A2_h	21.4	0.2	0.1	-	Identified as a long thin and slightly curvilinear dark reflector with a short bright shadow, situated within an uneven area of seabed and orientated east to west. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible long length of rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-
7391	Magnetic	294237	6041783	A2_l	-	-	-	48	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7392	Magnetic	294376	6041778	A2_l	-	-	-	13	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7393	Magnetic	294483	6041686	A2_l	-	-	-	29	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7394	Magnetic	294997	6041522	A2_l	-	-	-	49	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7395	Seabed disturbance	295581	6041371	A2_l	28.5	22.9	-	-	Identified as a large area of seabed disturbance comprising a distinct, rounded area of dark reflectors, the edge of which is well defined. The feature is isolated and very anomalous. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7396	Debris	295903	6041128	A2_h	4.8	1.7	0.9	-	Identified as an irregularly shaped dark reflector with a bright uneven shadow, indicating uneven height. Possibly represents a cluster of multiple features. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7397	Debris	296324	6040741	A2_h	11.5	10.8	0.5	-	Identified as a very distinct angular mound, with irregular sides and an uneven peak. Highly anomalous to the surrounding seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris.	MBES	Xocean 2021	Teesside Pipeline	-
7398	Magnetic	298002	6040185	A2_l	-	-	-	48	Identified as a small, sharp positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7399	Mound	298148	6041084	A2_I	4.0	3.1	0.5	-	Identified as a small sub-rounded mound, with steep sides and a pointed peak. The feature is slightly anomalous to the surrounding seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7400	Magnetic	298605	6040052	A2_I	-	-	-	30	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7401	Debris	298870	6039819	A2_h	3.9	1.1	1.4	-	Identified as a distinct sub-angular dark reflector with a very bright, bulbous shadow and significant height. Also identified in the MBES dataset as a sub-rounded mound with steep sides and an uneven peak There is a possible scour on the south-west edge and sediment build up on the north-east edge. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as possible debris.	SSS, MBES	Gardline 2021, Xocean 2021	Teesside Pipeline	-
7402	Dark reflector	298905	6039785	A2_I	2.8	1.2	1.3	-	Identified as a distinct angular dark reflector with a long, bright, and tapered shadow, with significant height. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7403	Magnetic	298948	6039814	A2_l	-	-	-	13	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7404	Magnetic	299475	6039694	A2_l	-	-	-	16	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7405	Magnetic	299740	6039586	A2_l	-	-	-	33	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7406	Dark reflector	301021	6039116	A2_l	2.7	0.5	0.7	-	Identified as a distinct elongate dark reflector with a very bright, long shadow, anomalous and tall for area. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7407	Magnetic	301440	6038792	A2_l	-	-	-	10	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7408	Magnetic	302758	6038303	A2_l	-	-	-	23	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7409	Dark reflector	303039	6038325	A2_l	3.9	0.8	0.1	-	Identified as a distinct curvilinear dark reflector with a short, bright shadow and located within a depression. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7410	Magnetic	303571	6038030	A2_l	-	-	-	29	Identified as a small positive monopole with peak and trough on one profile line. Possibly related to large Mag. Anomaly **7411**, situated 50.0 m south. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7411	Magnetic	303567	6037980	A2_h	-	-	-	149	Identified as a large negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7412	Magnetic	303752	6037903	A2_l	-	-	-	31	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7413	Magnetic	303895	6037898	A2_h	-	-	-	54	Identified as a medium negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7414	Dark reflector	305646	6037101	A2_I	3.1	1.2	0.9	-	Identified as a distinct sub-angular dark reflector with a bright uneven shadow, possibly suggesting uneven height. Also identified in the MBES dataset as a small oval shaped mound with gently sloping sides and rounded peak, slightly anomalous to the surrounding seabed. This position was not directly covered by the Mag. Dataset, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS, MBES	Gardline 2021, Xocean 2021	Teesside Pipeline	-
7415	Magnetic	306381	6036828	A2_I	-	-	-	17	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7416	Magnetic	306371	6036886	A2_I	-	-	-	5	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7417	Magnetic	306726	6036635	A2_I	-	-	-	44	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7418	Magnetic	307291	6036503	A2_I	-	-	-	25	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7419	Dark reflector	307378	6036476	A2_I	4.0	0.7	0.4	-	Identified as an elongate dark reflector with a bright, variable shadow, suggesting uneven height, with scour to the north and south. No anomalous features were identified in the MBES or Mag. Data	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.				
7420	Dark reflector	308477	6035861	A2_I	0.8	0.8	0.4	-	Identified as a distinct slightly angular dark reflector with a bright shadow, in an alignment orientated north-east to south-west containing **7420 – 7425**. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris. They also may be fishing gear; however, this can't be confirmed without visual inspection.	SSS	Gardline 2021	Teesside Pipeline	-
7421	Dark reflector	308505	6035872	A2_I	1.1	1.0	0.3	-	Identified as a distinct slightly angular dark reflector with a bright shadow, in an alignment orientated north-east to south-west containing **7420 – 7425**. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris. They also may be fishing gear; however, this can't be confirmed without visual inspection.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7422	Dark reflector	308530	6035884	A2_I	0.7	0.6	0.5	-	Identified as a distinct slightly angular dark reflector with a bright shadow, in an alignment orientated north-east to south-west containing **7420 – 7425**. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris. They also may be fishing gear; however, this can't be confirmed without visual inspection.	SSS	Gardline 2021	Teesside Pipeline	-
7423	Dark reflector	308589	6035918	A2_I	1.0	0.8	0.5	-	Identified as a distinct slightly angular dark reflector with a bright shadow, in an alignment orientated north-east to south-west containing **7420 – 7425**. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris. They also may be fishing gear; however, this can't be confirmed without visual inspection.	SSS	Gardline 2021	Teesside Pipeline	-
7424	Dark reflector	308614	6035928	A2_I	1.0	0.7	0.5	-	Identified as a distinct slightly angular dark reflector with a bright shadow, in an alignment orientated north-east to south-west containing **7420 – 7425**. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris. They also	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									may be fishing gear; however, this can't be confirmed without visual inspection.				
7425	Dark reflector	308650	6035935	A2_I	0.9	0.4	0.1	-	Identified as a distinct slightly angular dark reflector with a bright shadow, in an alignment orientated north-east to south-west containing **7420 – 7425**. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a trend of possible natural features or may be a trend of individual, but likely associated, pieces of possible debris. They also may be fishing gear; however, this can't be confirmed without visual inspection.	SSS	Gardline 2021	Teesside Pipeline	-
7426	Dark reflector	309388	6034560	A2_I	2.0	0.7	-	-	Identified as a slightly elongate, rounded dark reflector with brighter areas surrounding, orientated north-south. Isolated and anomalous. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7427	Magnetic	314837	6033392	A2_I	-	-	-	17	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7428	Dark reflector	315743	6033065	A2_I	2.1	1.3	0.7	-	Identified as a distinct, angular and elongate dark reflector with a bright tapered shadow and scour to the north and south. No anomalous features were identified in the MBES or Mag. Data at this	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									location. Interpreted as a possible natural feature or may be possible non-ferrous debris.				
7429	Magnetic	315957	6032872	A2_I	-	-	-	144	Identified as a large, sharp positive monopole with peak and trough on one profile line. One of three in an alignment orientated north-east to south-west (**7429** – **7431**). No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression, or may be a natural trend or modern feature not charted.	Mag.	Gardline 2021	Teesside Pipeline	-
7430	Magnetic	316007	6032904	A2_I	-	-	-	117	Identified as a large positive monopole with peak and trough on one profile line. One of three in an alignment orientated north-east to south-west (**7429 – 7431**). No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression, or may be a natural trend or modern feature not charted.	Mag.	Gardline 2021	Teesside Pipeline	-
7431	Magnetic	316055	6032936	A2_I	-	-	-	177	Identified as a large negative monopole with peak and trough on one profile line. One of three in an alignment orientated north-east to south-west (**7429 – 7431**). No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression, or may be a natural trend or modern feature not charted.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7432	Mound	316171	6032983	A2_l	6.9	5.2	0.3	-	Identified as a short, slightly elongate mound orientated approximately north-east to south-west, situated within an area of sand waves. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7433	Magnetic	317880	6032089	A2_l	-	-	-	13	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7434	Debris field	319450	6031498	A2_h	379.6	0.8	0.1	15	A long and indistinct linear dark reflector, there is a slight shadow in places but not along all segments. The feature is orientated east to west and has regular spaced small, angular dark reflectors attached approximately every 30.0 m, measuring approximately 1.0 x 0.8 x 0.4 m individually. Associated with a small negative monopole with peak and trough on one profile line in the Mag. Data, indicating some ferrous material is present. No anomalous features were identified in the MBES data at this location. Interpreted as a partially ferrous debris field, and may be fishing gear however, this can't be confirmed without visual inspection.	SSS, Mag.	Gardline 2021	Teesside Pipeline	-
7435	Magnetic	319689	6031405	A2_l	-	-	-	49	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7436	Mound	320000	6030942	A2_I	6.5	4.8	0.2	-	Identified as a short, slightly elongate mound orientated approximately north-east to south-west, set within an area of sand waves. A broad area of scour is present. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7437	Magnetic	321682	6030648	A2_h	-	-	-	132	Identified as a large, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7438	Mound	323842	6030018	A2_I	5.7	5.0	0.3	-	Identified as an elongate mound orientated approximately north-east to south-west and tapering to the north-east end. The feature is distinct and located on a featureless. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7439	Magnetic	324798	6029272	A2_I	-	-	-	13	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7440	Magnetic	324848	6029251	A2_I	-	-	-	26	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7441	Magnetic	325644	6028978	A2_l	-	-	-	21	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7442	Dark reflector	325974	6028776	A2_l	1.3	1.0	1.0	-	Identified as a very distinct sub-angular dark reflector with a long bright shadow and significant height. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7443	Magnetic	326223	6028814	A2_l	-	-	-	6	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7444	Mound	326285	6028312	A2_l	5.5	5.4	0.4	-	Identified as a small, sub-angular mound located in an area of relatively flat seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7445	Rope/chain	326426	6028708	A2_h	28.4	0.3	0.0	-	Identified as a very indistinct linear dark reflector with no shadow orientated east to west. The feature appears to be attached to a small, sub-angular dark reflector with a long, bright shadow measuring 1.3 x 0.7 x 0.6 m. The eastern end of this feature is possibly attached to rope or chain **7446**. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									possible to ascertain whether ferrous material is present at this location. Interpreted as a possible length of rope or chain				
7446	Rope/chain	326424	6028715	A2_h	34.9	0.4	0.1	-	Identified as a long and thin dark reflector with a short shadow along its length orientated north-west to south-east on the seabed. The south-eastern end of this feature is possibly attached to rope or chain **7445**. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible long length of rope or chain.	SSS	Gardline 2021	Teesside Pipeline	-
7447	Magnetic	326490	6028631	A2_l	-	-	-	21	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7448	Magnetic	326527	6028616	A2_l	-	-	-	12	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7449	Magnetic	326568	6028600	A2_l	-	-	-	23	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7450	Mound	326611	6028885	A2_l	6.1	4.2	0.3	-	Identified as an elongate, low-lying mound located within an area of sand waves. Part of a cluster of similar objects **7450 – 7452** within 10.0 m of one another that may be associated. No anomalous features were identified in the Backscatter data at	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.				
7451	Mound	326590	6028883	A2_I	7.0	2.6	0.1	-	Identified as a low-lying elongate mound. Part of a cluster of similar objects **7450 - 7452** within 10.0 m of one another that may be associated. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7452	Mound	326596	6028878	A2_I	8.9	6.6	0.3	-	Identified as a sub-angular, low-lying mound located within an area of sand waves. Part of a cluster of similar objects **7450 – 7452** within 10.0 m of one another that may be associated. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7453	Bright reflector	326761	6028494	A2_I	6.4	3.3	-	-	Identified as an elongate bright reflector that is right-angled at its west end, the feature looks anomalous on an uneven area of seabed. Possibly associated with similar anomaly (**7454**) situated 11.0 m south-west. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7454	Bright reflector	326752	6028487	A2_l	5.6	3.1	-	-	Identified as a distinct irregularly shaped bright reflector. Possibly associated with similar anomaly (**7453**) situated 11.0 m north-east. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7455	Magnetic	326771	6028511	A2_h	-	-	-	195	Identified as a large negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7456	Dark reflector	327157	6029106	A2_l	10.0	1.3	-	-	Identified as a highly angular linear dark reflector with a ring of bright reflectivity surrounding. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7457	Mound	328392	6027125	A2_l	5.5	4.8	0.2	-	Identified as a small ,slightly elongate mound set within a relatively flat seabed. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7458	Dark reflector	328709	6027687	A2_I	4.7	2.5	0.8	-	Identified as a distinct, large sub-angular dark reflector with a very bright, tapered shadow, situated within sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7459	Magnetic	329041	6027545	A2_I	-	-	-	31	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7460	Magnetic	329531	6027450	A2_I	-	-	-	15	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7461	Dark reflector	331077	6026719	A2_I	3.4	0.8	0.3	-	Identified as an indistinct dark reflector with a bright bulbous shadow. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.	SSS	Gardline 2021	Teesside Pipeline	-
7462	Magnetic	331390	6026694	A2_I	-	-	-	12	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7463	Dark reflector	331718	6026614	A2_I	3.6	1.3	0.3	-	Identified as an elongate dark reflector with a bright and large, squared-off shadow. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									this location. Interpreted as a possible natural feature or may be possible debris.				
7464	Debris field	331929	6026330	A2_h	8.6	1.4	0.5	-	Identified as a distinct group of elongate dark reflectors with bright shadows that appear to be attached to one another, situated within a wider boulder field. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field.	SSS	Gardline 2021	Teesside Pipeline	-
7465	Dark reflector	332640	6026152	A2_l	1.7	0.6	0.4	-	Identified as a distinct slightly elongate dark reflector with a bright shadow, situated within a wider boulder field but slightly anomalous. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7466	Dark reflector	333086	6025960	A2_l	5.9	0.3	0.1	-	Identified as a distinct, thick, and slightly curvilinear dark reflector with a slight shadow, lying perpendicular to the sand waves. Possibly related to dark reflector **7467**, situated 13.0 m south-east. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7467	Dark reflector	333094	6025943	A2_l	10.7	0.6	0.3	-	Identified as a distinct, thick linear dark reflector with a slight shadow, lying perpendicular to the sand waves. Possibly related to dark reflector **7466**, situated 13.0 m north-west. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.	SSS	Gardline 2021	Teesside Pipeline	-
7468	Magnetic	333426	6025865	A2_l	-	-	-	5	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7469	Magnetic	333900	6025620	A2_l	-	-	-	20	Identified as a small, complex, negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7470	Debris field	333919	6025510	A2_h	45.1	0.3	0.2	-	Identified as four small angular dark reflectors at either end of an indistinct linear dark reflector, likely to be a rope or chain. The objects have shadows, the largest object measures 1.6 x 1.0 x 0.2. The feature is situated in sand waves and orientated north to south. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field, and may be fishing gear however, this can’t be confirmed without visual inspection.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7471	Dark reflector	333983	6026605	A2_I	7.4	1.2	-	-	Identified as an elongate, slightly curved dark reflector orientated approximately north-east to south-west, with a brighter area to the east. The feature is isolated and anomalous to the surrounding sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7472	Seabed disturbance	334550	6025278	A2_I	24.8	1.6	0.3	-	Identified as an area of seabed disturbance comprising an elongate dark reflector with shadow or possibly a compact alignment of small angular dark reflectors. The shadow is slightly uneven suggesting uneven height and the feature is lying perpendicular to sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7473	Dark reflector	334609	6025297	A2_I	3.7	2.3	0.9	-	Identified as a distinct angular dark reflector with a bright tapered shadow. Visible as a very distinct mound within sand waves in the MBES data. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7474	Mound	334860	6024321	A2_l	4.2	3.4	0.3	-	Identified as a small, sub-angular mound set within a larger area of scour and situated within an area of sand waves. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7475	Mound	334852	6024618	A2_l	4.4	3.5	0.3	-	Identified as a small, sub-angular mound set within a larger area of scour, within an area of sand waves. No anomalous features were identified in the Backscatter data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	MBES	Xocean 2021	Teesside Pipeline	-
7476	Debris	335225	6024999	A2_h	6.0	5.2	0.2	-	Identified as an indistinct feature comprising thin, elongate and linear dark reflectors, the feature has a slight shadow. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris.	SSS	Gardline 2021	Teesside Pipeline	-
7477	Magnetic	335524	6025012	A2_l	-	-	-	6	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7478	Magnetic	337303	6024177	A2_I	-	-	-	6	Identified as a small, broad symmetric dipole with peak and trough on one profile line. Also visible on the adjacent profile. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7479	Dark reflector	338156	6023833	A2_I	1.6	0.4	0.0	-	Identified as a thin and straight dark reflector with no shadow, very distinct and isolated. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.	SSS	Gardline 2021	Teesside Pipeline	-
7480	Magnetic	338282	6023887	A2_I	-	-	-	29	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7481	Dark reflector	340885	6022645	A2_I	3.9	0.9	0.3	-	Identified as a very distinct, elongate dark reflector with a bright shadow in a depression. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7482	Magnetic	340898	6022816	A2_I	-	-	-	21	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7483	Magnetic	340925	6022751	A2_h	-	-	-	71	Identified as a medium, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
									ferrous debris either buried or with no surface expression.				
7484	Debris	342249	6022278	A2_h	3.8	1.3	0.5	-	Identified as a distinct angular dark reflector with a bright shadow on the edge of a sand wave. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible item of debris.	SSS	Gardline 2021	Teesside Pipeline	-
7485	Magnetic	342342	6022176	A2_l	-	-	-	38	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7486	Magnetic	344714	6021213	A2_l	-	-	-	21	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7487	Dark reflector	345530	6020765	A2_l	1.7	1.1	0.3	-	Identified as a distinct angular dark reflector with a short, bright, slightly flared shadow. The feature is isolated within an area of sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7488	Magnetic	346014	6020688	A2_h	-	-	-	101	Identified as a large, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7489	Magnetic	347036	6020263	A2_l	-	-	-	9	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7490	Magnetic	347065	6020196	A2_l	-	-	-	6	Identified as a small, broad symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7491	Magnetic	347154	6020264	A2_l	-	-	-	5	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7492	Magnetic	348455	6019633	A2_l	-	-	-	25	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7493	Magnetic	348631	6019611	A2_h	-	-	-	60	Identified as a medium, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7494	Bright reflector	348621	6019070	A2_l	12.2	1.4	-	-	Identified as an indistinct, linear bright reflector orientated north-west to south-east, which is intermittent. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7495	Magnetic	348908	6019552	A2_l	-	-	-	6	Identified as a small, complex, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7496	Magnetic	349191	6019387	A2_l	-	-	-	17	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7497	Magnetic	349831	6019127	A2_l	-	-	-	43	Identified as a small, sharp symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7498	Magnetic	350806	6018779	A2_h	-	-	-	74	Identified as a medium negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7499	Magnetic	351010	6018645	A2_l	-	-	-	8	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7500	Magnetic	351225	6018500	A2_l	-	-	-	36	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7501	Magnetic	351311	6018525	A2_l	-	-	-	5	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7502	Magnetic	351782	6018274	A2_h	-	-	-	67	Identified as a medium negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7503	Magnetic	352788	6017861	A1	-	-	-	1460	Identified as a very large, sharp positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7504	Magnetic	353418	6017607	A2_l	-	-	-	11	Identified as a small, broad positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7505	Magnetic	354358	6017224	A2_l	-	-	-	10	Identified as a small, broad asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7506	Magnetic	354687	6017091	A2_I	-	-	-	16	Identified as a small negative monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7507	Seabed disturbance	355880	6015798	A2_I	6.6	5.1	-	-	Identified as an area of seabed disturbance comprising a dark and bright reflector with a slightly darker reflector at the north-west end, located within sand waves. Visible as an angular mound within sand waves in the MBES data. This position was not directly covered by the SSS or Mag. Datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter Mosaic	Xocean 2021	Teesside Pipeline	-
7508	Seabed disturbance	357759	6015883	A2_I	33.5	12.6	0.2	-	Identified as an area of seabed disturbance comprising slightly curvilinear dark reflectors with indistinct shadows, the feature is within an area of large sand waves and looks very anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the Mag. Dataset so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	SSS	Gardline 2021	Teesside Pipeline	-
7509	Magnetic	358242	6015745	A2_I	-	-	-	17	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7510	Magnetic	358475	6015598	A2_I	-	-	-	19	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7511	Dark reflector	361450	6014388	A2_I	2.7	0.7	0.3	-	Identified as a distinct elongate dark reflector with a bright shadow, situated within an area of mobile sediments. No anomalous features were identified in the MBES or Mag. Data at this location. Interpreted as a possible natural feature or may be possible non-ferrous debris.	SSS	Gardline 2021	Teesside Pipeline	-
7512	Magnetic	362024	6014209	A2_I	-	-	-	45	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7513	Magnetic	362316	6014039	A2_I	-	-	-	32	Identified as a small positive monopole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7514	Magnetic	362795	6013894	A2_I	-	-	-	18	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-
7515	Magnetic	363929	6013438	A2_I	-	-	-	35	Identified as a small, sharp asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7516	Magnetic	365210	6012678	A2_h	-	-	-	58	Identified as a medium, sharp asymmetric dipole with peak and trough on one profile line. Possibly part of an east to west linear alignment with **7517** and **7519**. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline, Humber Pipeline, Endurance Store	-
7517	Magnetic	365261	6012674	A2_h	-	-	-	54	Identified as a medium negative monopole with peak and trough on one profile line. Possibly part of an east to west linear alignment with **7516** and **7519**. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline, Humber Pipeline, Endurance Store	-
7518	Magnetic	365266	6012743	A2_l	-	-	-	9	Identified as a small symmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline, Humber Pipeline, Endurance Store	-
7519	Magnetic	365346	6012691	A2_l	-	-	-	43	Identified as a small asymmetric dipole with peak and trough on one profile line. Possibly part of an east to west linear alignment with **7516** and **7517**. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline, Humber Pipeline, Endurance Store	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7520	Magnetic	366548	6011770	A2_I	-	-	-	13	Identified as a small asymmetric dipole with peak and trough on one profile line. No anomalous features were identified in the SSS or MBES data at this location. Interpreted as possible ferrous debris either buried or with no surface expression.	Mag.	Gardline 2021	Teesside Pipeline, Endurance Store	-

Appendix 6: Seabed anomalies of archaeological potential: Endurance Store GSA

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7521	Bright reflector	366172	6010473	A2_I	14.4	1.4	-	-	Identified as a distinct, long, and straight bright reflector lying perpendicular to the sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7522	Bright reflector	367329	6012304	A2_I	7.2	2.1	-	-	Identified as an elongate bright reflector, lying perpendicular to the sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7523	Dark reflector	368065	6014141	A2_I	10.3	3.4	-	-	Identified as a curvilinear dark reflector with a bright reflector to the north, distinct to the surrounding sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7524	Dark reflector	369666	6007572	A2_I	25.7	2.2	-	-	Identified as a long and thick linear dark reflector, slightly kinked in the centre. Visible as a slightly curvilinear mound in the MBES dataset. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be a possible length of rope or chain.	Backscatter	Xocean 2021	Endurance Store	-
7525	Seabed disturbance	372957	6012861	A2_I	35.3	24.7	-	-	Identified as a large area of seabed disturbance comprising areas of low and high reflectivity, distinct to the surrounding seabed and to the west of large mobile sand waves. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7526	Dark reflector	370795	6005888	A2_I	5.8	3.1	-	-	Identified as an indistinct, elongate dark reflector situated within some slight scour. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7527	Dark reflector	370975	6007059	A2_I	5.0	3.2	0.3	-	Identified as a distinct sub-rounded dark reflector. Visible as a slight mound in the MBES dataset within an area of outcropping geology. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7528	Bright reflector	371647	6008070	A2_I	7.9	3.2	-	-	Identified as a bright reflector distinct to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7529	Dark reflector	374307	6011042	A2_I	8.3	3.7	-	-	Identified as a distinct oval dark reflector situated within large mobile sand waves. Visible as an uneven area of seabed in the MBES data. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7530	Dark reflector	374852	6012034	A2_I	14.2	2.6	0.3	-	Identified as a distinct slightly curvilinear dark reflector, lying perpendicular to the sand waves. Visible as an elongate mound with an uneven peak in the MBES dataset. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7531	Dark reflector	372707	6006550	A2_I	4.4	3.0	0.3	-	Identified as a distinct sub-rounded dark reflector, situated 13.0 m west of **7532** and may be related. Visible as a low-lying mound in the MBES dataset. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7532	Dark reflector	372720	6006547	A2_I	4.0	1.3	0.2	-	Identified as a distinct sub-rounded dark reflector, situated 13.0 m east of **7531** and may be related. Visible as a low-lying mound in the MBES dataset. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7533	Debris field	373117	6004887	A2_h	32.4	11.0	0.6	-	Identified as an elongate, slightly angular dark reflector that is indistinct in places, possibly suggesting multiple objects. The feature is orientated north-west to south-east. Also identified in the MBES data as a distinct elongate, mound, with gently sloping sides and an uneven peak. The mound tapers to the north-east and appears more irregular in the south-east. The feature is orientated approximately north-west to south-east and narrows in at the north-west section. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible debris field.	Backscatter, MBES	Xocean 2021	Endurance Store	-
7534	Bright reflector	376554	6009664	A2_l	7.0	2.6	-	-	Identified as an oval bright reflector distinct to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7535	Bright reflector	376378	6010568	A2_l	10.6	3.2	-	-	Identified as an irregular bright reflector, distinct and slightly anomalous to the surrounding seabed. Visible as a slight depression in the MBES dataset. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7536	Wreck	376037	6011477	A1	31.4	7.3	1.3	-	Identified as an area of seabed disturbance comprising dark and bright reflectors. There is a distinct linear dark reflector (**7537**) 23.0 m to the west that may be related to this anomaly or a natural feature. Also identified in the MBES dataset as a distinct, elongate mound with an uneven peak . Associated with a UKHO record for an unknown wreck, first identified in 1981 and last surveyed in 1986, described as being in two parts, the smaller part to the south-east and geophysical dimensions of 40.0 x 12.0 x 2.6 m. The appearance in the MBES data suggests the wreck may be upright and it is orientated north-east to south-west with no visible surrounding debris. The tallest point of the wreck is situated at the south-west end, with a slightly taller central area of surviving superstructure visible. There are large mobile sand waves to the west of the wreck, which may indicate it is partially buried and so the dimensions should be considered a minimum. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a partially buried wreck.	Backscatter, MBES	Xocean 2021	Endurance Store	UKHO 6832

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7537	Seabed disturbance	375982	6011477	A2_I	35.5	6.2	-	-	Identified as an area of seabed disturbance comprising a distinct linear dark reflector situated within large mobile sand waves. The feature is situated 23.0 m west of wreck **7536**, that may be sediment build-up or further buried structure associated with the wreck. Visible in the MBES data as a large mound situated on a sand wave crest. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris associated with wreck **7536**.	Backscatter	Endurance-Block04	Endurance Store	-
7538	Dark reflector	374076	6002989	A2_I	21.9	11.2	-	-	Identified as an irregularly shaped dark reflector, almost oval shaped. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7539	Seabed disturbance	374159	6003986	A2_I	21.0	15.6	-	-	Identified as an area of seabed disturbance comprising bright reflectors and very small dark reflectors that may indicate multiple small objects. The feature is anomalous to the surrounding seabed. No anomalous features were identified in the MBES data at this location. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-

ID	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic amplitude (nT)	Description	Anomaly type	Dataset	Section	External references
7540	Dark reflector	375689	6006329	A2_I	11.9	1.9	0.2	-	Identified as a curvilinear dark reflector, slightly distorted by the nadir but distinct and anomalous to the surrounding seabed. Visible in the MBES data as a curvilinear mound, possibly part of a sand wave crest but slightly more distinct than the surrounding natural features. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location. Interpreted as a possible natural feature or may be possible debris.	Backscatter	Xocean 2021	Endurance Store	-
7541	Wreck	377671	6005054	A1	28.5	8.1	1.8	-	Identified as a large area of seabed disturbance comprising areas of low and high reflectivity, distinct to the surrounding seabed and situated within large mobile sand waves. A possible object is visible in the southern end of the feature measuring 5.3 x 2.9 m. Also identified in the MBES data as a large, elongate mound orientated approximately north-east to south-west, with a slightly uneven peak, distinct and prominent in an area of large sand waves. The tallest point is at the south-west end, with a least depth of 50.2 m below CD though it is unclear if it is upright. The wreck has some very minor scour surrounding it and appears to be intact. Associated with a UKHO record for an unknown wreck, first identified in 1981 and last surveyed in 1986 with geophysical dimensions of 36.0 x 16.0 x 2.6 m. The smaller geophysical dimensions from the 2021 survey suggests the wreck is buried by large mobile sand waves.	Backscatter, MBES	Xocean 2021	Endurance Store	UKHO 6830

Appendix 7: Maritime recorded losses

UKHO ID	HOB UID	SMR	Name	Type	Year of loss	Description
	1450810		Unknown	Cargo vessel	1281	Vessel stranded at Salt Scar, carrying corn and other goods.
	1448220		Unknown	Cargo vessel	1313	A vessel foundered off Redcar evidenced by goods cast ashore over a relatively wide but localised area at Coatham, Marske-by-the-Sea, and Wilton, near Redcar.
	1450152		Unknown	Cargo vessel	1352	Flemish cargo vessel which stranded near Coatham bound either to or from Aberdeen, possibly out of her home port of Lescluse (modern Sluis in the Netherlands).
	1450184		Unknown	Cargo vessel	1357/8	Flemish cargo vessel stranded near Coatham on passage to Scotland with an unspecified cargo.
	1456003		Unknown	Cargo vessel	1359	Stranded at Coatham. There is also reference to goods salved from a wreck at "Cotum", circa 1359.
	936640		*Mary Ann*	Unknown	1801	Unknown.
	973332		*Industry*	Brigantine	1804	Vessel grounded on Salt Scar while on passage with coal. Later recovered.
	937837		*Farmers Increase*	Craft	1807	Crew saved by lifeboat.
	1340862		*Catharine*	Cargo vessel	1808	Sunk off Redcar after being on shore. Cargo of coal.
	936596		*Caledonia*	Cargo vessel	1808	Vessel stranded on Salt Scar, en route from Aberdeen to London with cargo of granite, other goods and passengers.
	1309582		Unknown	Craft	1809	Sank, the crew were saved.
	937828		Unknown	Brig	1809	Stranded on the Salt Scar. This may possibly be Neptune which grounded on passage from Newcastle-upon-Tyne with coal, but was then recovered.
	937829		Unknown	Brig	1810	Unknown.
	937830		*John*	Cargo vessel	1814	Lost at Salt Scar.
		1904	*Resolution*	Sailing vessel	1814	Stranded at Redcar
	1344682		*Thomas*	Unknown	1816	Foundered near Dimlington en route from London to Perth.
	973157		*Rifleman*	Sloop	1817	Stranded near Redcar after grounding on rocks. On passage from Newcastle-upon-Tyne with coal, possibly for Portsmouth, or from Portsmouth back to Sheilds, without coal.

UKHO ID	HOB UID	SMR	Name	Type	Year of loss	Description
	937833		*Riff*	Sloop	1819	Lost at Salt Scar.
		2646	Unknown	Sloop	1819	Wrecked at Coatham
	973155		*Mary*	Brig	1821	Foundered off Redcar during a gale with a cargo of coal.
	1310981		Unknown	Collier	1822	Five light colliers went ashore on West Coatham Sands, two being refloated later.
	1310987		Unknown	Collier	1822	Five light colliers went ashore on West Coatham Sands, two being refloated later.
	937844		Unknown	Collier	1822	Five light colliers went ashore on West Coatham Sands, two being refloated later.
	970836		*Barbara*	Cargo vessel	1824	Stranded on Coatham Sands while en route from Perth to London.
		1846	*Anns Resolution*	Sailing vessel	1824	Stranded at Redcar
		1855	*Confederacy*	Sailing vessel	1824	Stranded at Redcar
	970842		*Courier/Courieren*	Cargo vessel	1825	Swedish cargo vessel stranded on Coatham Sand en route from Gothenburg to Leith with a cargo of iron and battens.
	984086		*Elbe*	Snow	1825	Stranded at Out Newton during a gale, on passage from St. Petersburg to London with cargo of tallow and wool.
		3200	*Betsy and Ann*	Sailing vessel	1825	Vessel of Stockton, ran ashore on Coatham sands and was a total wreck.
		2000	*Scotia*	Brig	1825	Vessel of Aberdeen, 240 tons burthen, from London to Sunderland, wrecked on Coatham Sands.
	937642		*Esk*	Whaler	1826	Stranded on the High on returning to Whitby via Cullercoats and Shields from Greenland. Cargo of whale oil and blubber.
	1304753		*Renown*	Cargo vessel	1827	Stranded on Salt Scar whilst travelling from Sunderland with a cargo of coal.
	1357091		*Mary*	Wooden sailing vessel	1830	Abandoned to founder off Dimlington after springing a leak.
	937797		*Newcastle*	Cargo vessel	1830	Stranded on Coatham Sands during a gale whilst in ballast.
	937798	3016	*Pavilion*	Cargo vessel	1830	Stranded on Coatham Sands during a gale whilst in ballast.

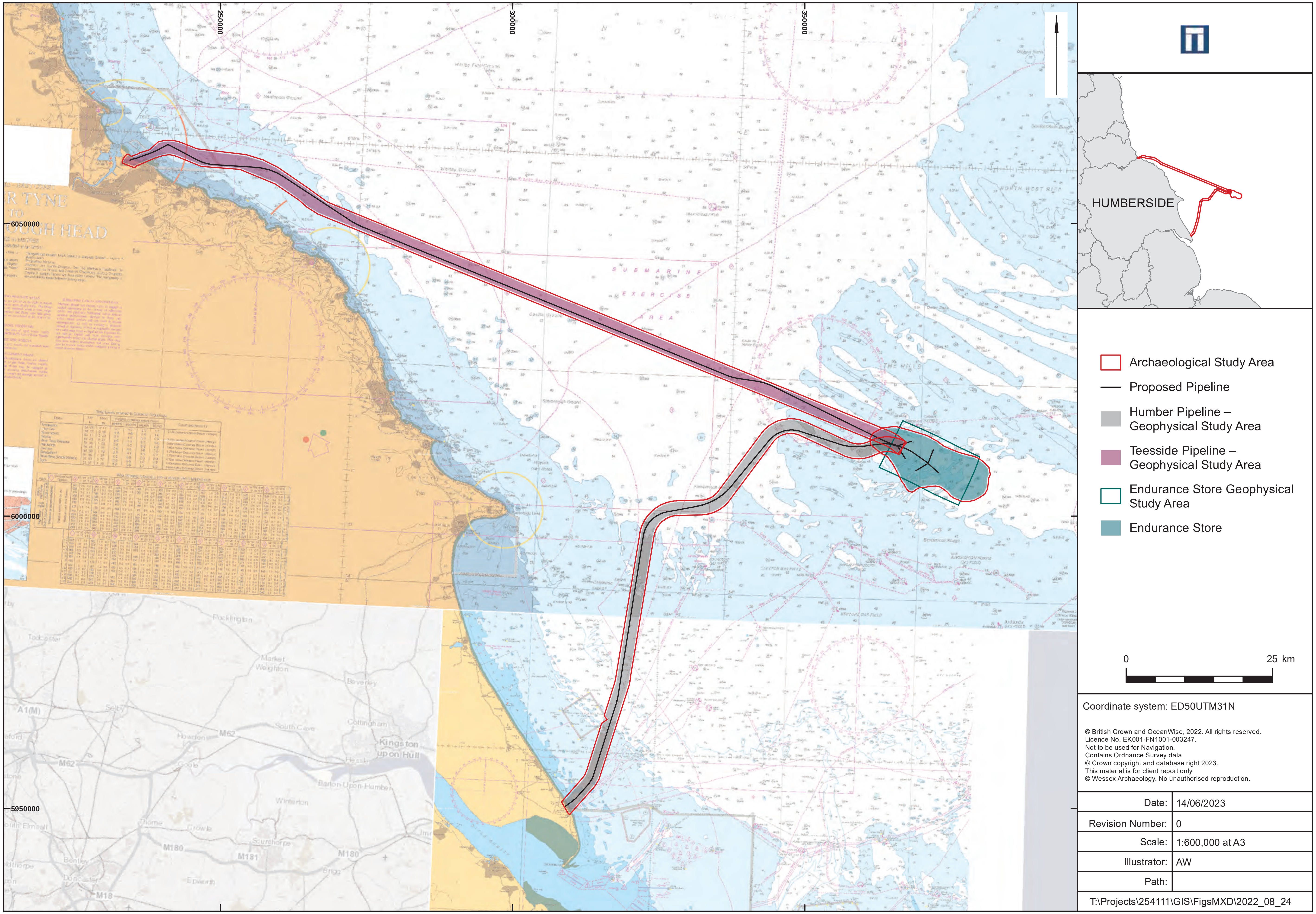
UKHO ID	HOB UID	SMR	Name	Type	Year of loss	Description
	1357100		*Jane And Ann*	Cargo vessel	1831	Driven ashore near Umpton along with several casks of ale and porter.
	1047773		*George*	Cargo vessel	1831	Collision with the Pearl and sunk off Dimlington or off Flamborough Head, while on passage from Newcastle to London.
	936597		*Caroline*	Brig	1836	A Danish collier, stranded on Salt Scar.
		2382	*Reform*	Schooner	1839	Wrecked on Coatham Sands
		2742		Cargo	1841	A quantity of red herrings found on Coatham Sands with broken barrels.
		2743		Cargo	1841	Two hogsheads of porter picked up on Coatham Sands.
	1056862		*Commerce*	Schooner	1845	Stranded on Coatham Sands while attempting to make for the River Tees in a storm. Cargo of coal.
	937630		*Britannia*	Steam Tug	1851	Driven ashore near Redcar.
	937143		Unknown	Brig	1851	Unknown.
		2522	*Maria*	Galliot	1851	Wrecked on Coatham Sands
		2662	*Victory*	Sailing vessel	1851	Went to pieces on Coatham sands.
	1359174		*Mervin*	Snow	1853	Vessel foundered and lost after springing a leak.
	1363259	2684	*Blossom*	Brig	1854	Foundered offshore after springing a leak, 7 miles ESE of Hartlepool.
	978157		*Walborg*	Schooner	1855	Vessel foundered and lost.
	1311041		*Brothers*	Fishing vessel	1856	Capsized and sank. Vessel may have been a coble.
	936787		*Ann*	Brig	1857	Stranded on Marske Sand.
	936638	1890	*Margarethe*	Sloop	1857	German sloop which stranded on Coatham Sands en route from Carolinensiel to Kingston-upon-Hull with a cargo of beans.
	1311216		*Merchant*	Brig	1858	Vessel struck Shields Bar.
	1360258		*Delphine*	Schooner	1860	French vessel that was lost after striking rocks.
		1957	*Boyer*	Sailing vessel	1860	Foundered at Marske
		2579	*Guard*	Schooner	1860	Driven ashore near the Tees and wrecked.
		2598	*Flora*	Schooner	1860	Went ashore near Boulby and sold as a wreck.

UKHO ID	HOB UID	SMR	Name	Type	Year of loss	Description
		2706	*Hannah*	Schooner	1860	Struck by a heavy sea 10 miles north of Staithes and began making water.
	1363211		*Johanna And Isabella*	Schooner	1862	Vessel foundered and lost on the Saltscar Rock.
	983840		*Blakeney*	Schooner	1862	Unknown.
	937859		Unknown	Schooner	1864	Crew saved by local cobles.
	1047797		*Perseverance*	Lugger	1865	Struck Salt Scar Rocks while running for land after fishing.
	1047796		*Leipsic*	Schooner	1865	Unknown.
	936617		*Gipsey*	Sloop	1866	Stranded Saltscars.
		2807	*Integrity*	Steam Vessel	1866	Run down by large screw steamer while lying-to 5 miles off Redcar, and completely cut in two
	1056857		*Vesper*	Brig	1869	Struck the breakwater and was lost.
		3173	*Perseverence*	Sailing vessel	1870	Vessel sprang a leak while running down the coast and foundered 10 miles WNW of Hartlepool.
	1363635		*Frances*	Steam cargo vessel	1872	Steam ship, driven ashore.
	936619	1873	*Griffin*	Brig	1874	Stranded on Coatham Sands after smashing through Coatham Pier.
	936601		*Corrymbus*	Schooner	1874	Collided with a pier and was driven ashore further up the coast.
	1312026		*Emily*	Unknown	1876	Wrecked off Redcar.
	997009		*Charles Batters*	Steam Cargo Vessel	1877	Vessel stranded and lost.
	1368592		*Kelpie*	Brigantine	1878	Lost following collision with SS Osborne.
	1312033		*William*	Unknown	1879	Unknown.
	936626	1880	*Jane*	Barque	1880	Canadian barque, stranded and lost.
	936636	1888	*Luna*	Brig	1880	Vessel stranded and lost.
	936641		*Minna*	Barque	1880	German vessel (Danzig) stranded at West Scar.
	936648		*Paragon*	Sloop	1884	Vessel stranded and lost.

UKHO ID	HOB UID	SMR	Name	Type	Year of loss	Description
67167			*Bonnie Lass*	Sailing vessel	1884	Sank after collision with Telesilla, 25 miles SSE of Flamborough Head.
	936632		*John And Edwin*	Brig	1885	Vessel stranded and lost.
	936603		*Elizabeth*	Brig	1886	Vessel stranded and lost.
	936608		*Englands Rose*	Barquentine	1887	Stranded on Salt Scar.
	936665		*William*	Schooner	1888	Stranded at Salt Scar
	937870	3086	*Goteborg*	Steam Cargo Vessel	1889	Swedish cargo vessel that ran aground and was wrecked on Salt Scar Rocks, Redcar.
	1311658	2460	*Lydia*	Schooner	1889	Russian vessel sunk by collision off Hartlepool with the steamer Santorin.
	937587		*Gannet*	Trawler	1893	Stranded and lost. Steam trawler.
	936620	1874	*Harriett*	Brigantine	1893	Stranded on Coatham Sands during a gale, while en route from Newhaven for Sunderland with chalk.
		1896	*Norfolk*	Schooner	1893	Driven on the rocks not far from the 'Jim Crow', Salt Scar.
		1901	*Peace*	Sailing vessel	1893	Stranded at Redcar
	1373933		*Saxon Prince*	Tug	1907	Wooden steam vessel. Stranded on Salt Scar Rock in fog.
	1312360		Unknown	Barge	1910	Collision with the steam tug Athlete.
	937865	3081	*Aphrodite*	Steam Cargo Vessel	1921	Greek vessel, stranded on West Scar and broken up.
	936618		*Grace*	Ketch	1925	Lost a short distance from Westscar.
6060			*Castle Eden*	Fishing vessel	1968	Caught fire and sank off Redcar
67188			*Fawn*	Fishing vessel	Unknown	A sailing vessel built in 1868 and sunk after collision with SS Medway 15 miles SE by E of Flamborough Head.

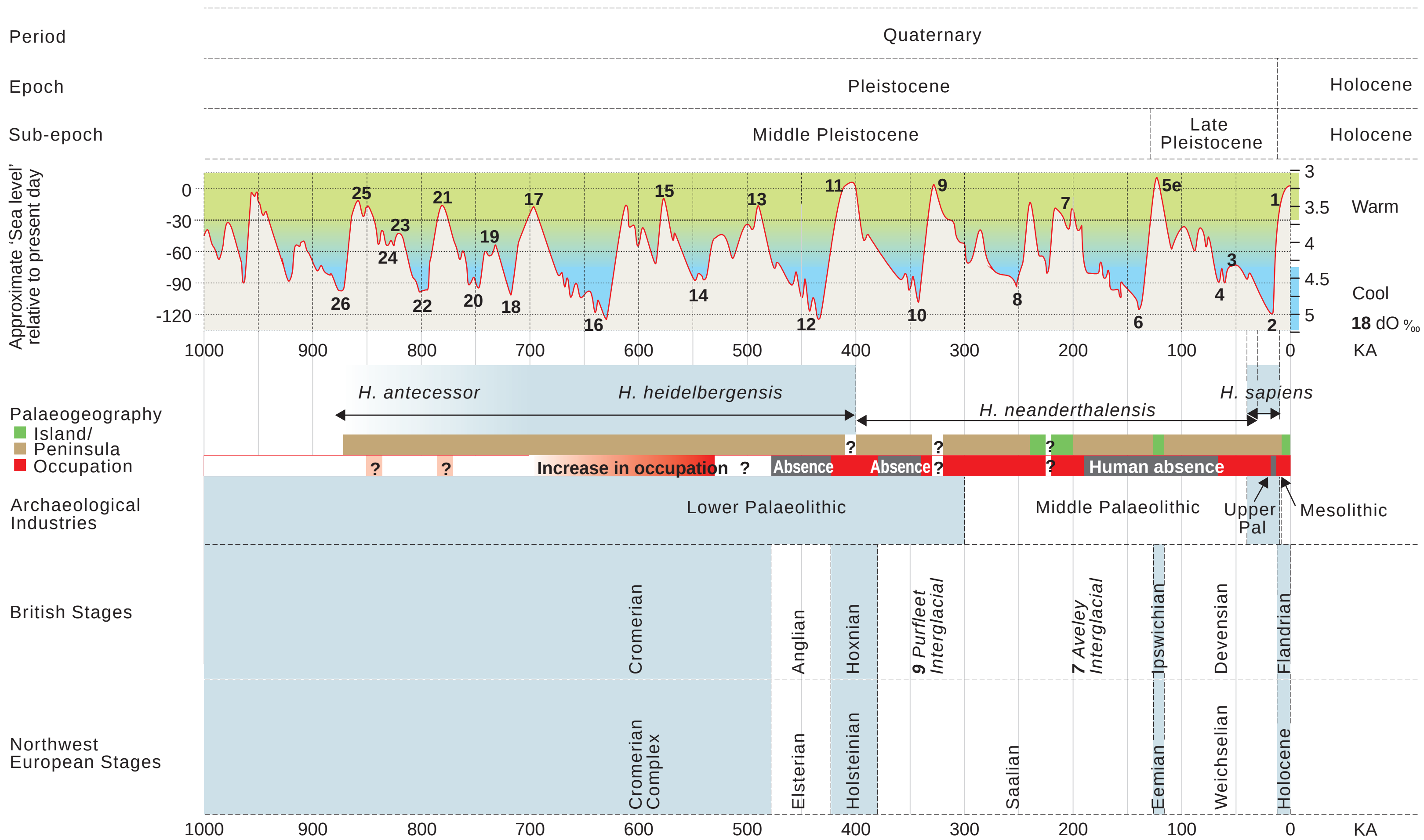
Appendix 8: Aviation recorded losses

HOB UID	Name	Type	Year of loss	Description
1400197	H-4 1H+FS	Heinkel He 111	1940	German Heinkel He 111 bomber which was shot down 30 miles off Middlesbrough, while on a raid from Stavanger, originally bound for Lincolnshire, but then diverted to Northumberland. It was part of Squadron 8/KG26.
1399817	H-3 1H+AC	Heinkel He 111	1940	German Heinkel He 111 bomber which ditched off Redcar. It was part of StabII/KG26.
1321771	P5151	Hudson MK I	1941	A British Lockheed Hudson Mk.I general reconnaissance aircraft ditched off Redcar



Project Development Area Location

Figure 1

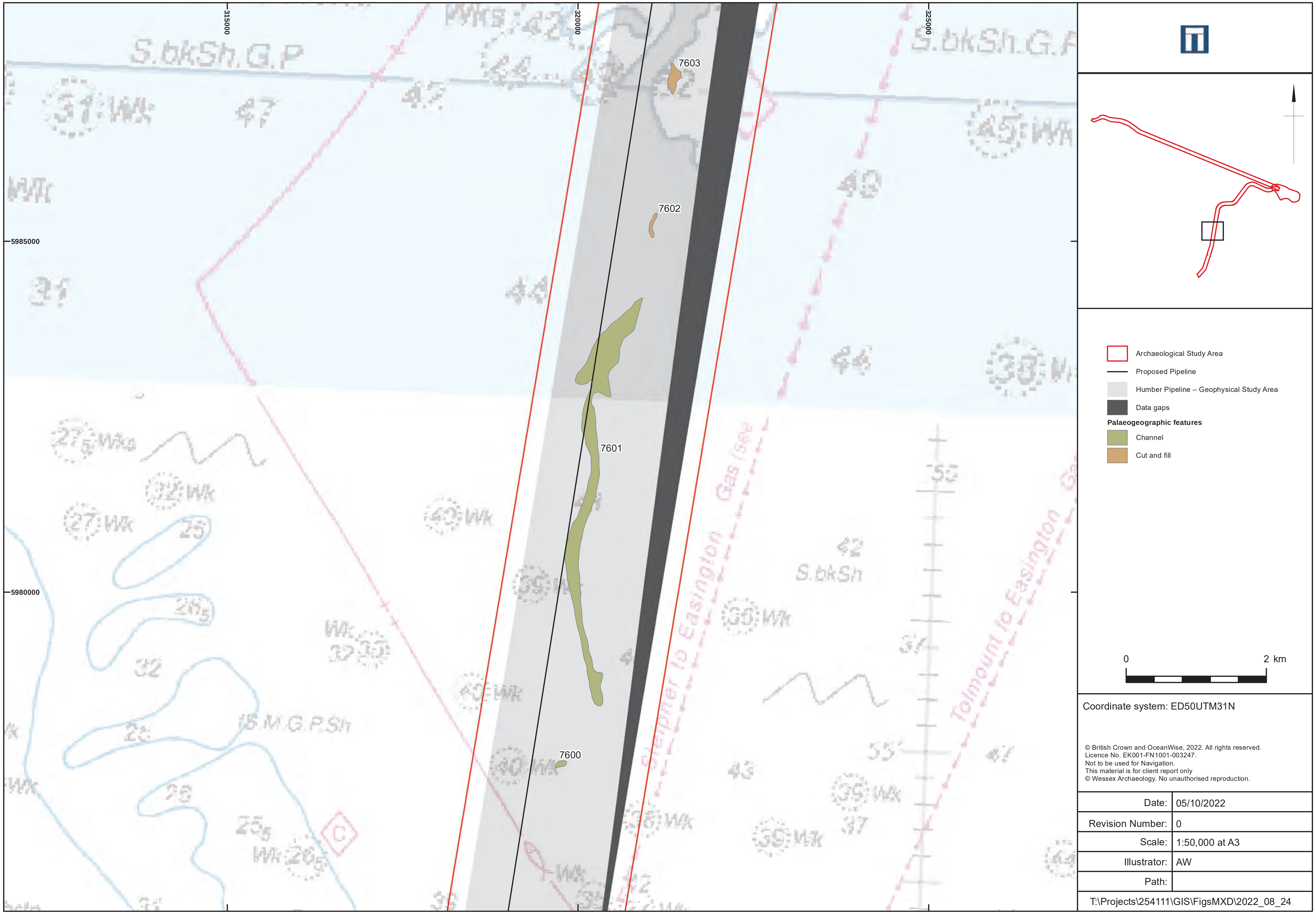


The figure presents information derived from several references: the global sea-level curve is from Lisiecki and Raymo (2005) and Jelgersma (1979). Details on the geology and archaeology were provided by Dix and Westley (2004); Funnel (1995); Gibbard and van Kolfschoten (2004); Kukla et al. (2002); Lee et al. (2006); Lowe and Walker (1997) and Wymer (1999).

Date:	15/09/2022	Revision Number:	0
Scale:	NTS at A4	Illustrator:	AW
Path:	T:\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

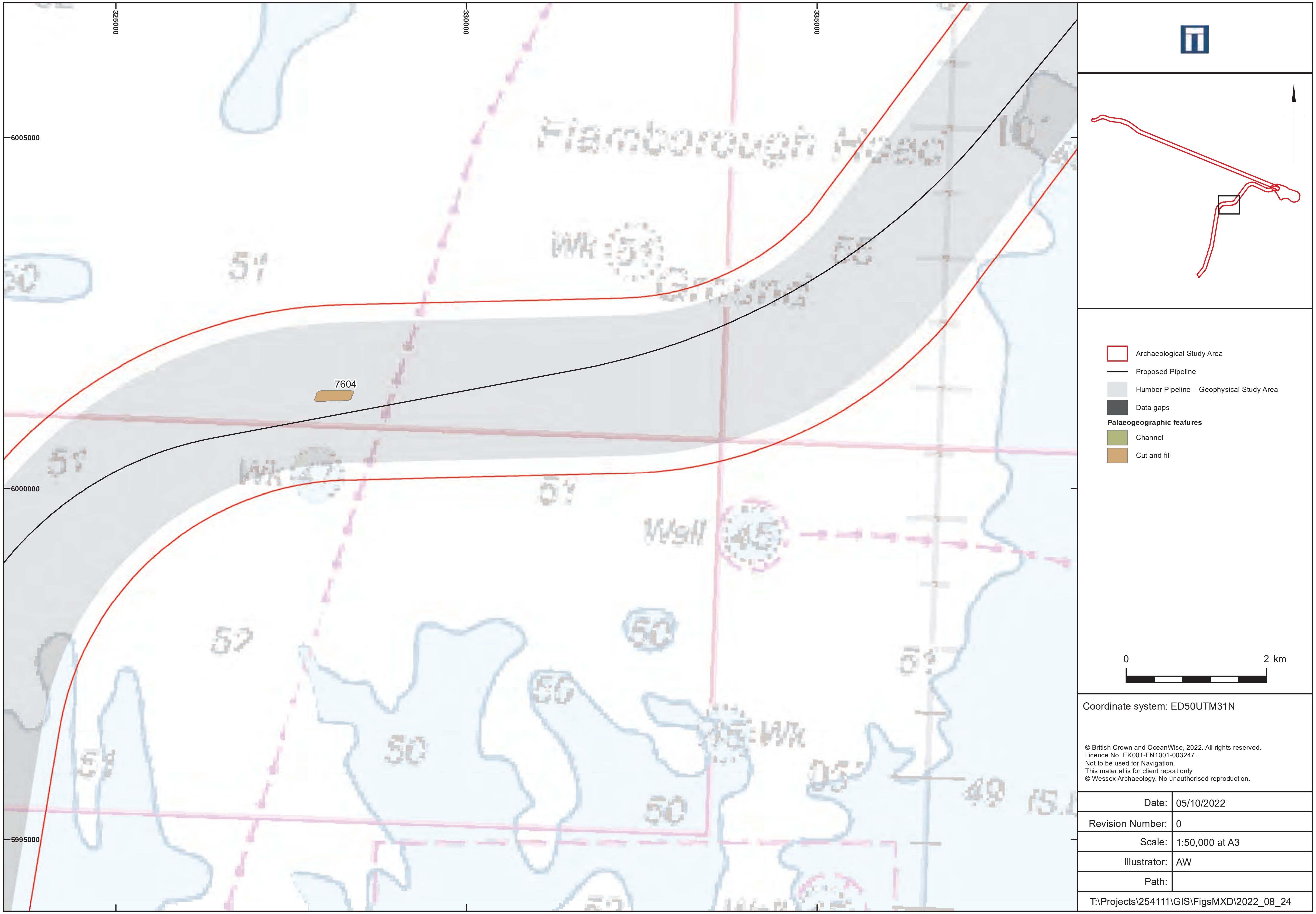
Sea level curve and chronology of the southern North Sea

Figure 2



Palaeolandscape features of archaeological potential

Figure 3 A



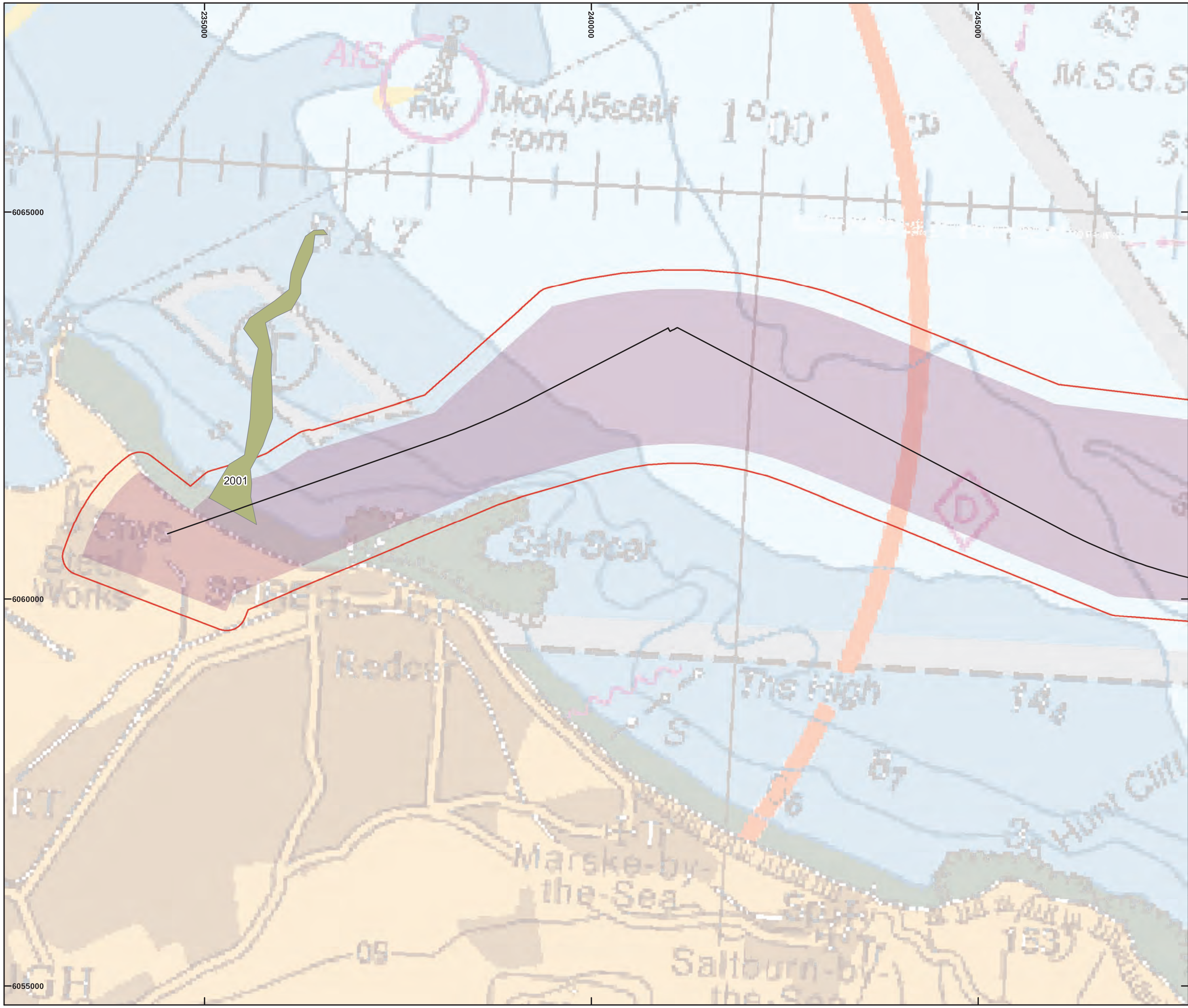
Coordinate system: ED50UTM31N

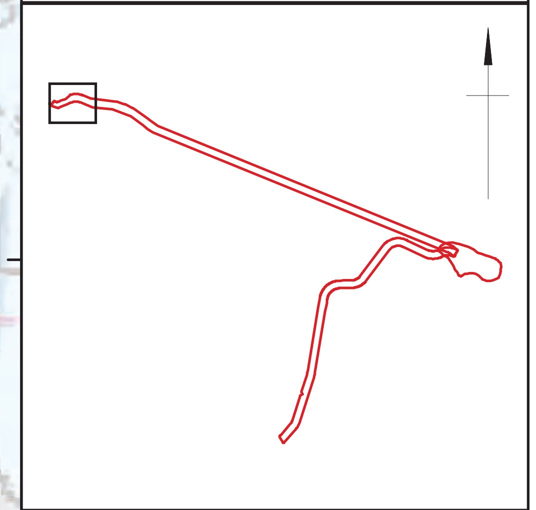
Date:	05/10/2022
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

T:\Projects\254111\GIS\FigsMXD\2022_08_24

Palaeolandscape features of archaeological potential

Figure 3 B





- Archaeological Study Area
- Proposed Pipeline
- Teesside Pipeline – Geophysical Study Area
- Data gaps

Palaeogeographic features

- Channel
- Cut and fill

0 2 km

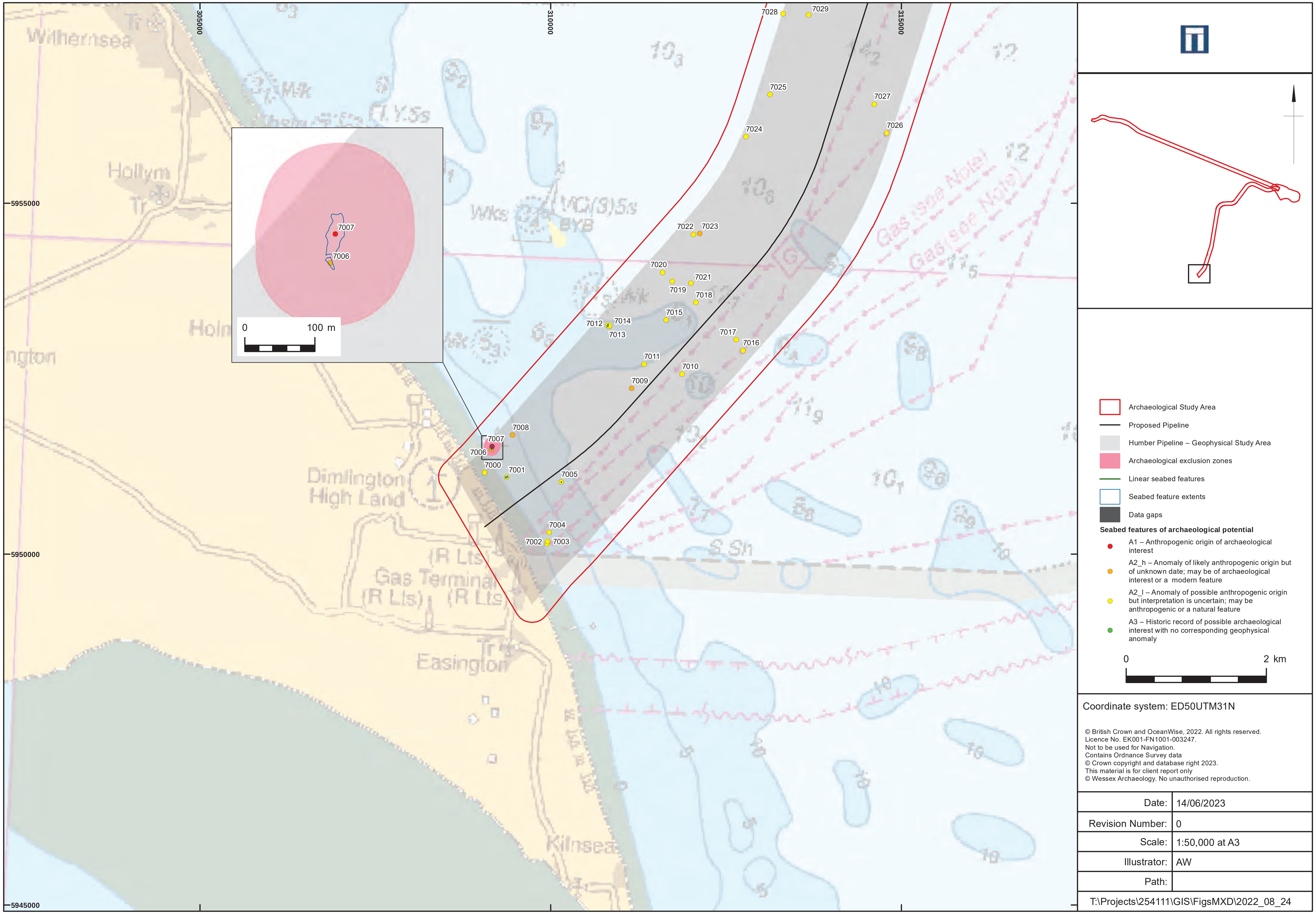
Coordinate system: ED50UTM31N

Date:	05/10/2022
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

T:\Projects\254111\GIS\FigsMXD\2022_08_24

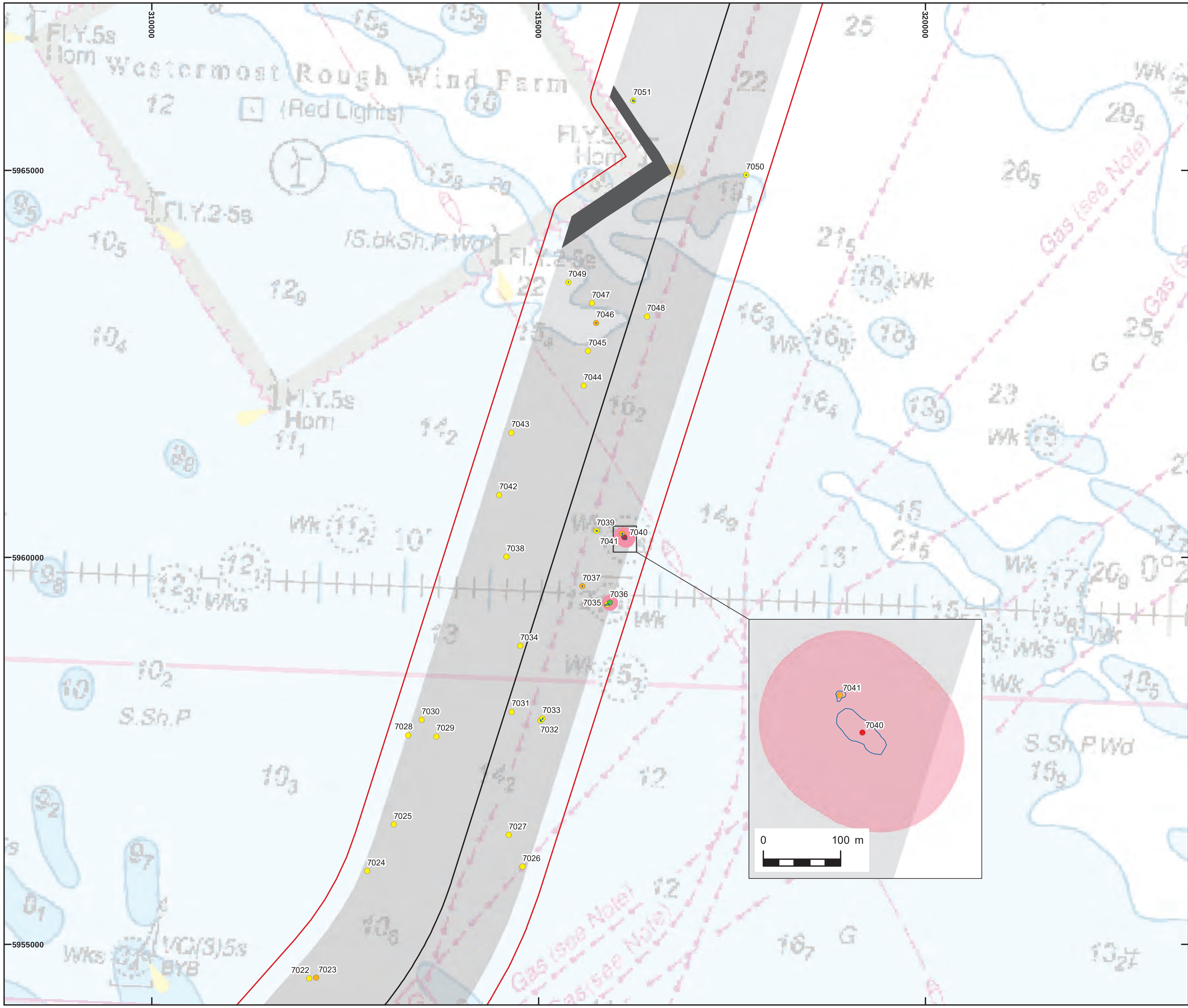
Palaeolandscape features of archaeological potential

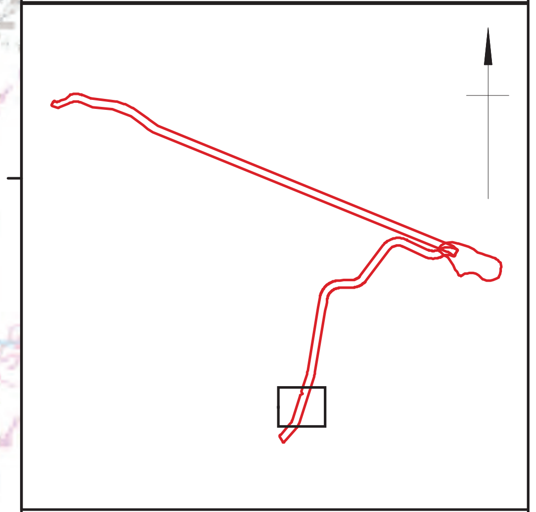
Figure 3 C



Seabed features of archaeological potential

Figure 4 A





	Archaeological Study Area
	Proposed Pipeline
	Humber Pipeline – Geophysical Study Area
	Archaeological exclusion zones
	Linear seabed features
	Seabed feature extents
	Data gaps

Seabed features of archaeological potential

- A1 – Anthropogenic origin of archaeological interest
- A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
- A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
- A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

0 2 km

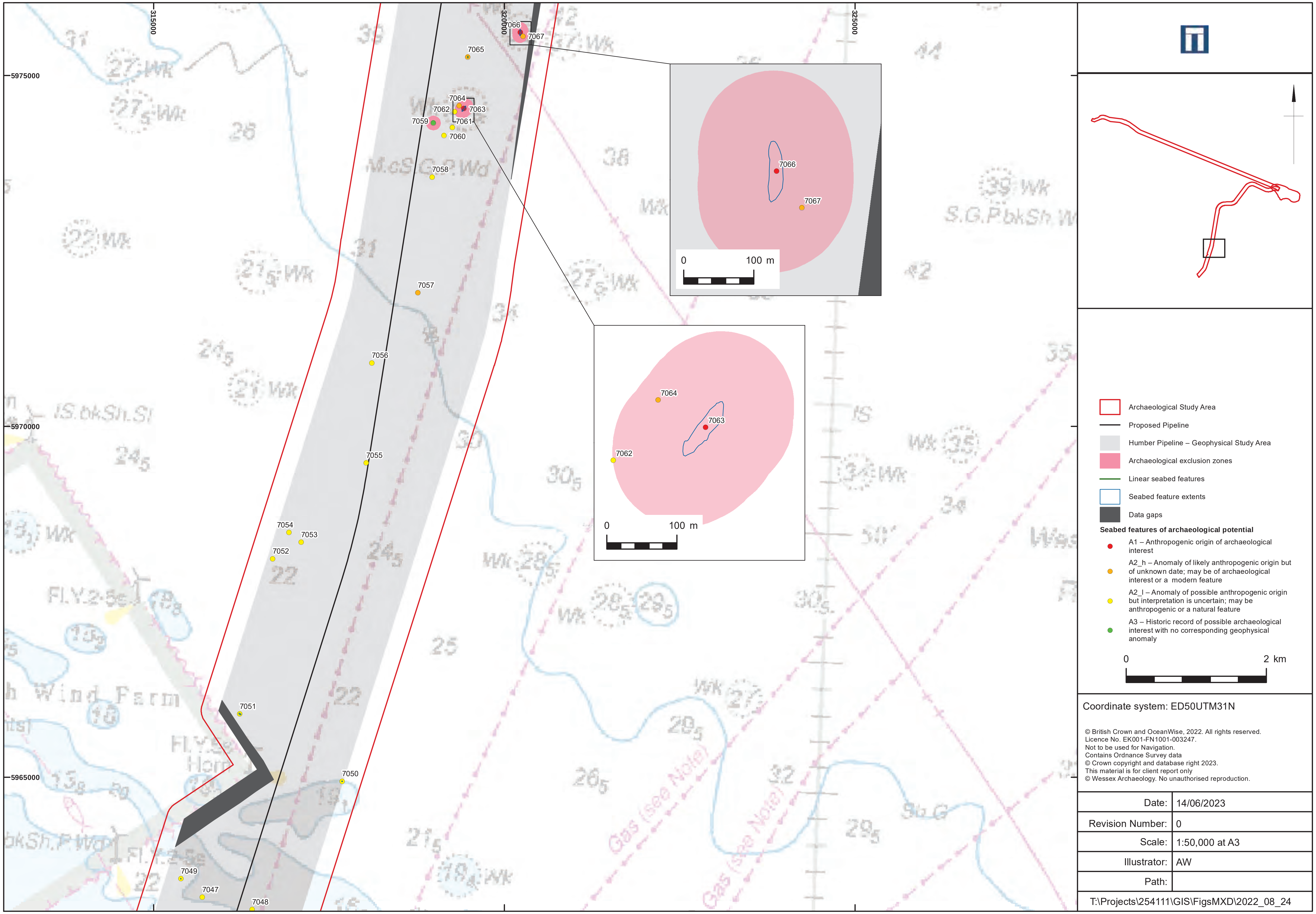
Coordinate system: ED50UTM31N

Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

T:\Projects\254111\GIS\FigsMXD\2022_08_24

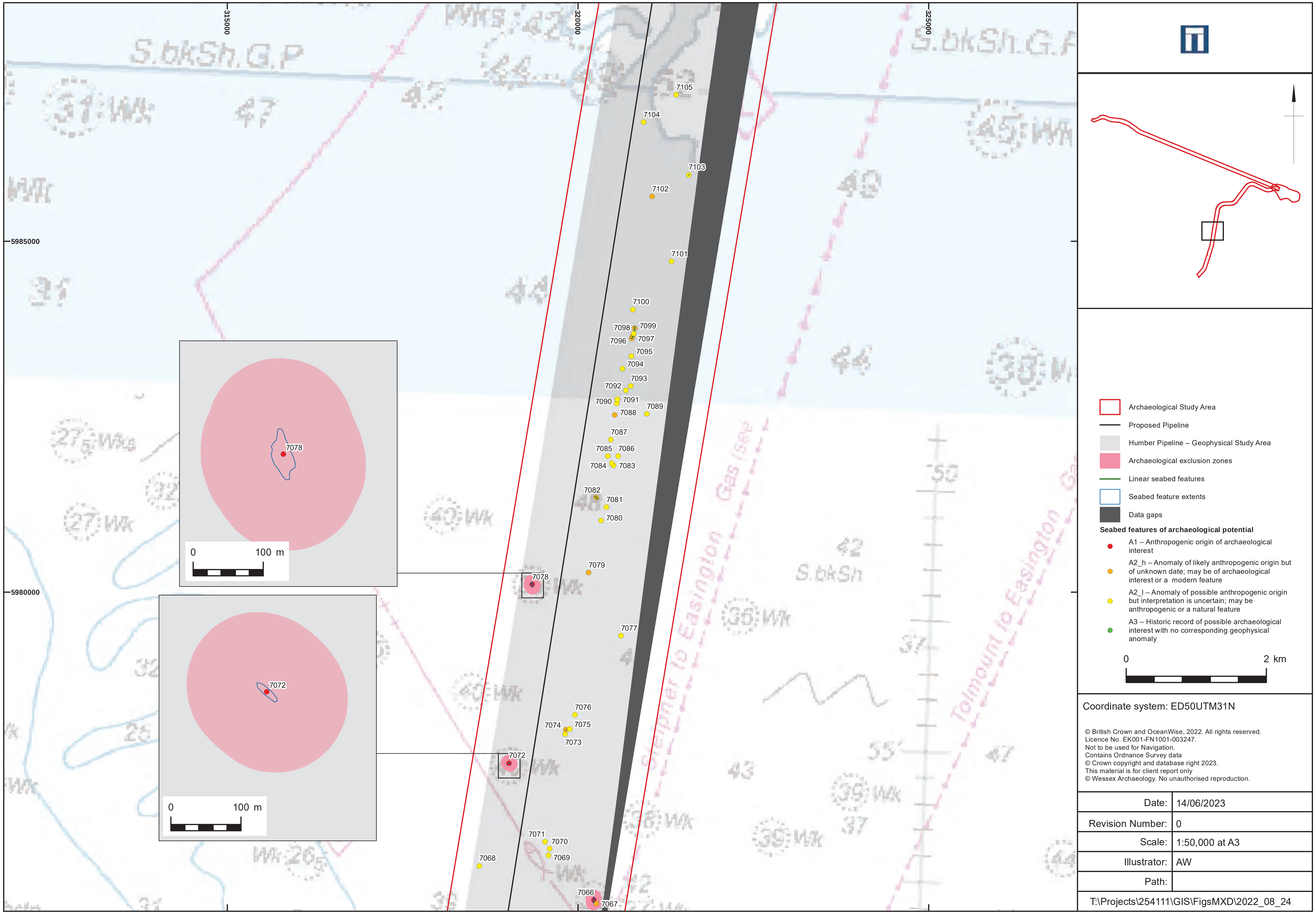
Seabed features of archaeological potential

Figure 4 B



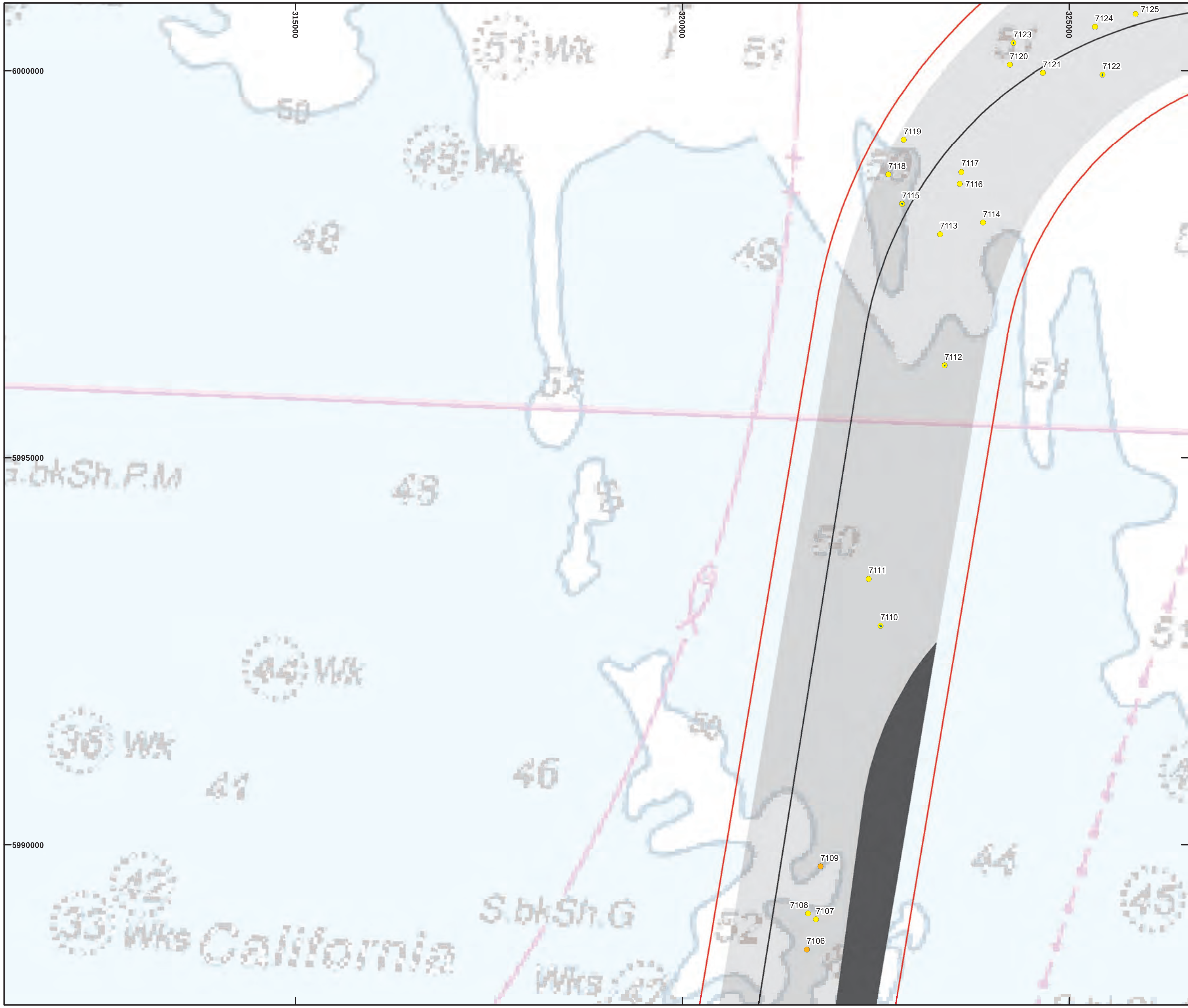
Seabed features of archaeological potential

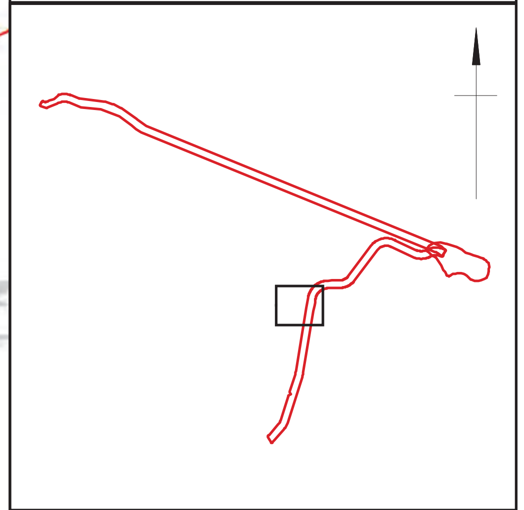
Figure 4 C



Seabed features of archaeological potential

Figure 4 D





- Archaeological Study Area
- Proposed Pipeline
- Humber Pipeline – Geophysical Study Area
- Archaeological exclusion zones
- Linear seabed features
- Seabed feature extents
- Data gaps

Seabed features of archaeological potential

- A1 – Anthropogenic origin of archaeological interest
- A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
- A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
- A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

0 2 km

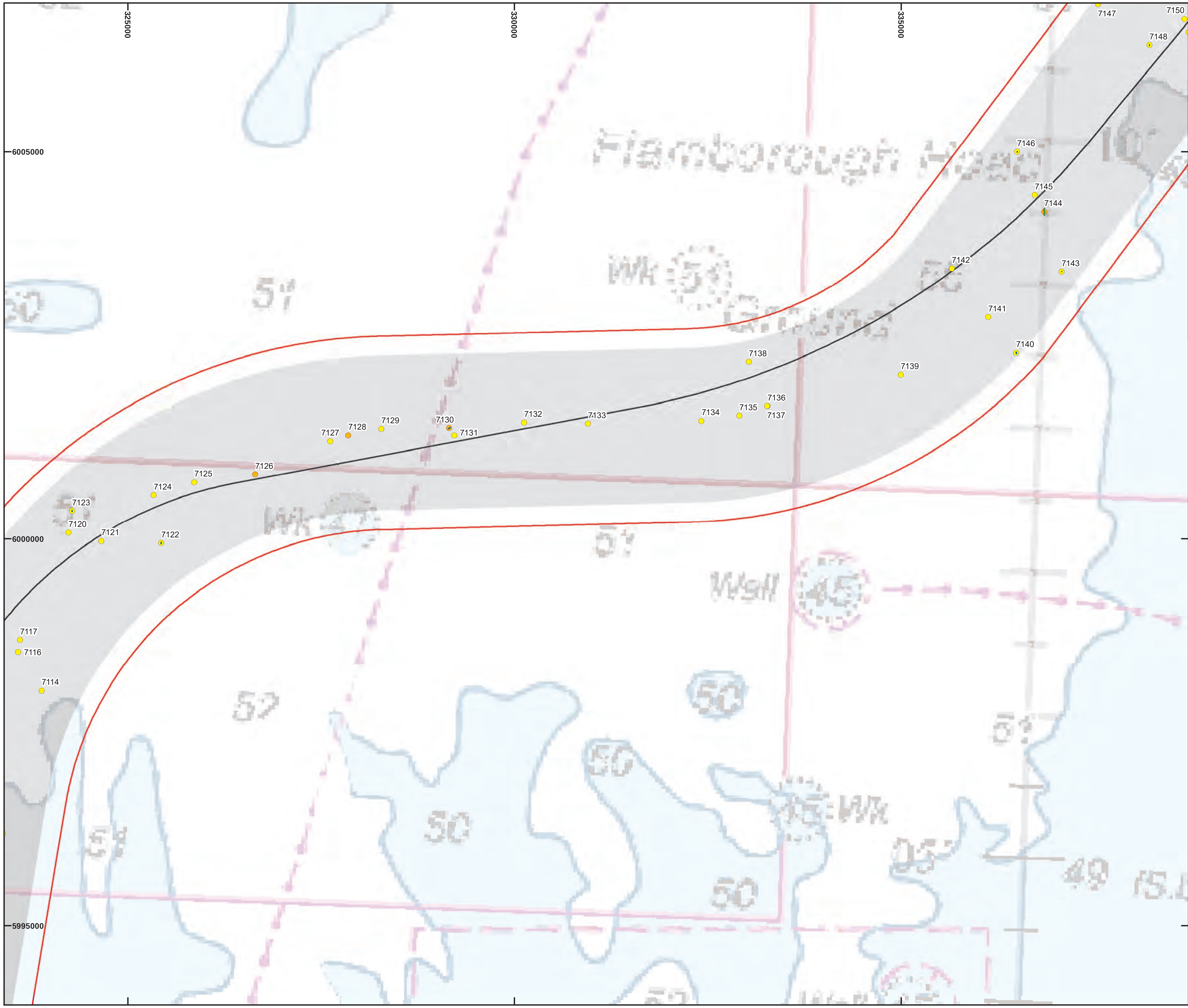
Coordinate system: ED50UTM31N

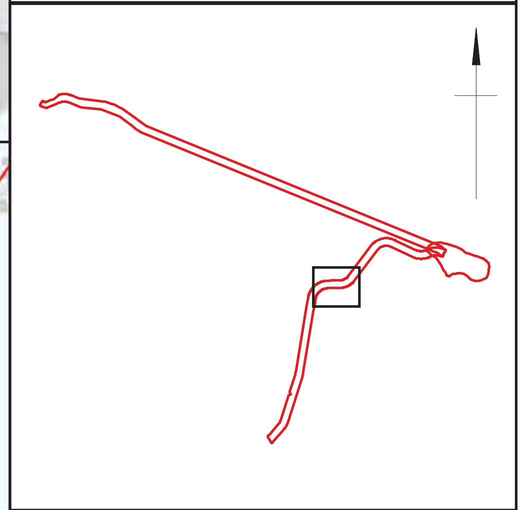
Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

X:\Projects\265330\GIS\FigsMXD\2022_08_18

Seabed features of archaeological potential

Figure 4 E





Archaeological Study Area
Proposed Pipeline
Humber Pipeline – Geophysical Study Area
Archaeological exclusion zones
Linear seabed features
Seabed feature extents
Data gaps

Seabed features of archaeological potential

- A1 – Anthropogenic origin of archaeological interest
- A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
- A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
- A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

0 2 km

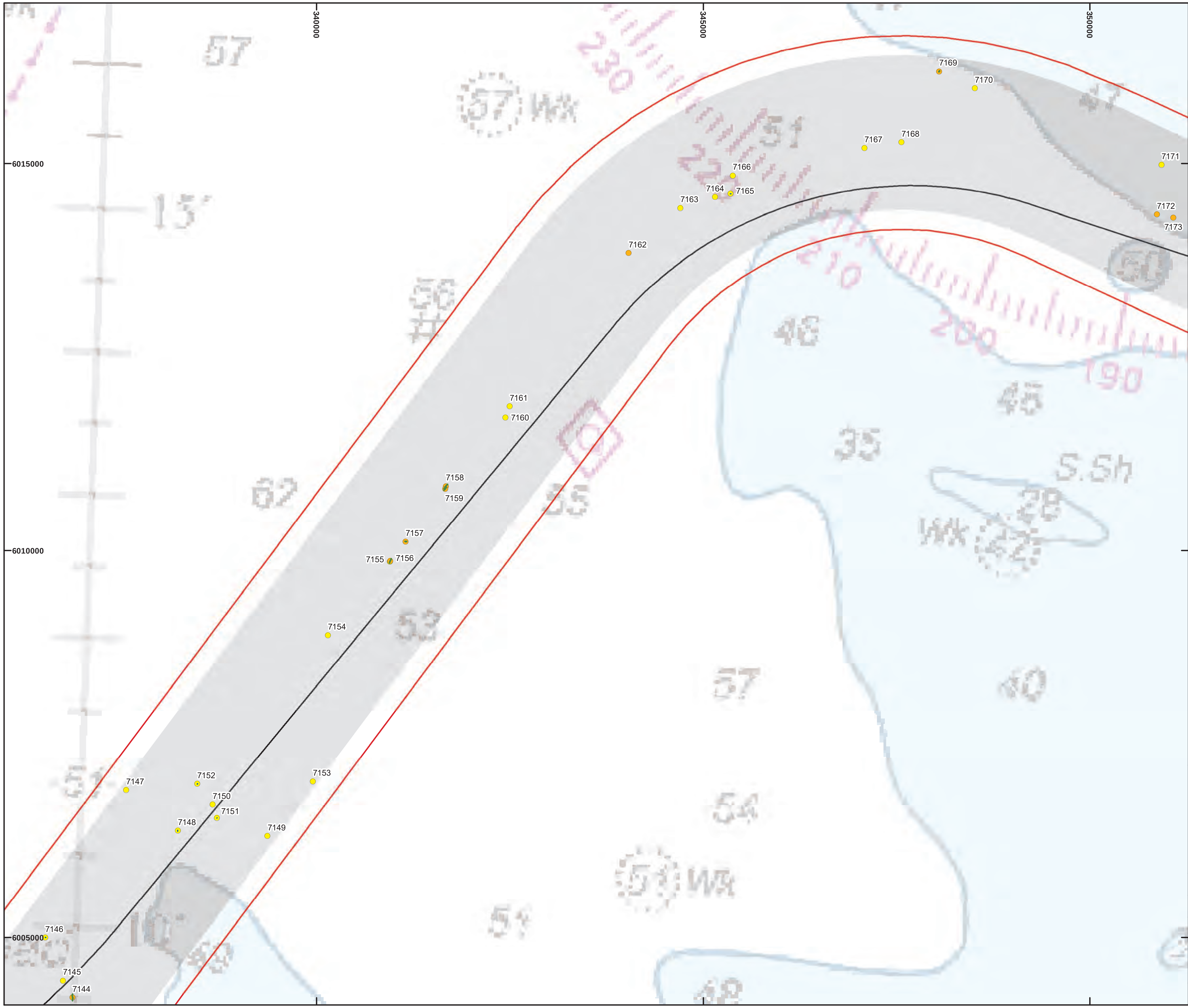
Coordinate system: ED50UTM31N

Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

X:\Projects\265330\GIS\FigsMXD\2022_08_18

Seabed features of archaeological potential

Figure 4 F



Archaeological Study Area
Proposed Pipeline
Humber Pipeline – Geophysical Study Area
Archaeological exclusion zones
Linear seabed features
Seabed feature extents
Data gaps

Seabed features of archaeological potential

- A1 – Anthropogenic origin of archaeological interest
- A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
- A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
- A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

0 2 km

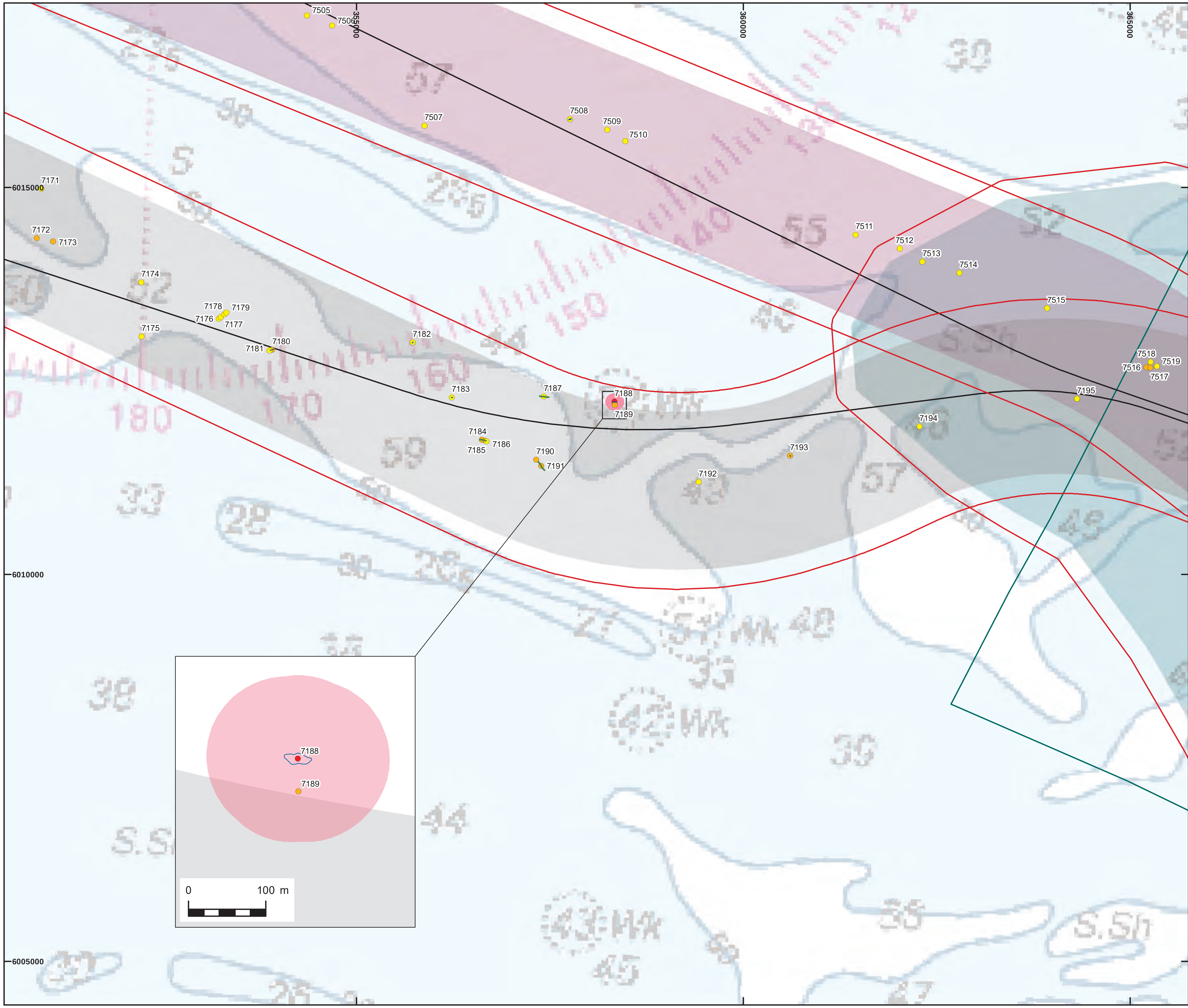
Coordinate system: ED50UTM31N

Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

X:\Projects\265330\GIS\FigsMXD\2022_08_18

Seabed features of archaeological potential

Figure 4 G



Archaeological Study Area
Proposed Pipeline
Humber Pipeline – Geophysical Study Area
Teesside Pipeline – Geophysical Study Area
Endurance Store Geophysical Study Area
Endurance Store
Archaeological exclusion zones
Linear seabed features
Seabed feature extents
Data gaps

Seabed features of archaeological potential

A1 – Anthropogenic origin of archaeological interest
A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

0 2 km

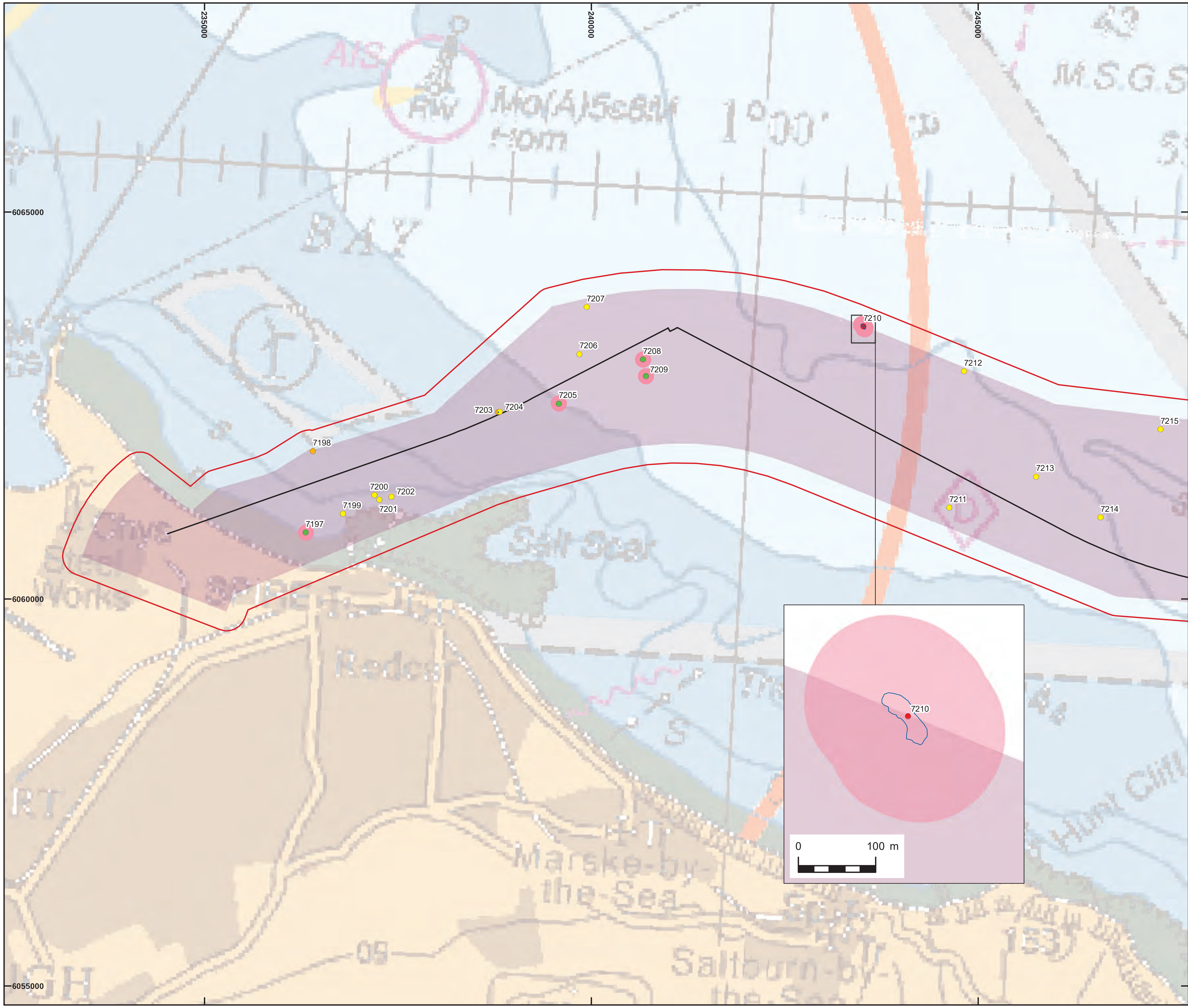
Coordinate system: ED50UTM31N

Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

T:\Projects\254111\GIS\FigsMXD\2022_08_24

Seabed features of archaeological potential

Figure 4 H



Archaeological Study Area
Proposed Pipeline
Teesside Pipeline – Geophysical Study Area
Archaeological exclusion zones
Linear seabed features
Seabed feature extents
Data gaps

Seabed features of archaeological potential

- A1 – Anthropogenic origin of archaeological interest
- A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
- A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
- A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

0 2 km

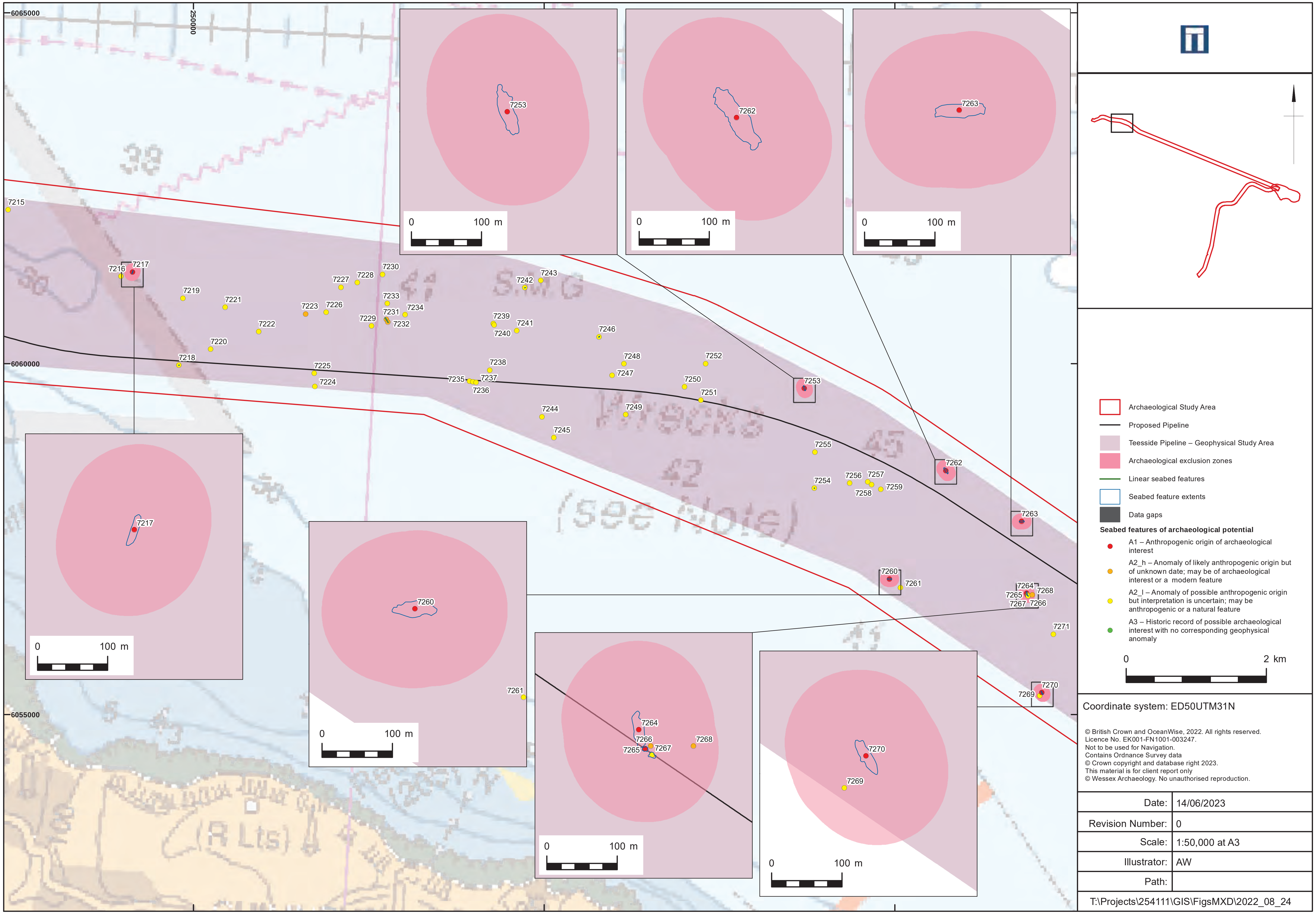
Coordinate system: ED50UTM31N

Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

T:\Projects\254111\GIS\FigsMXD\2022_08_24

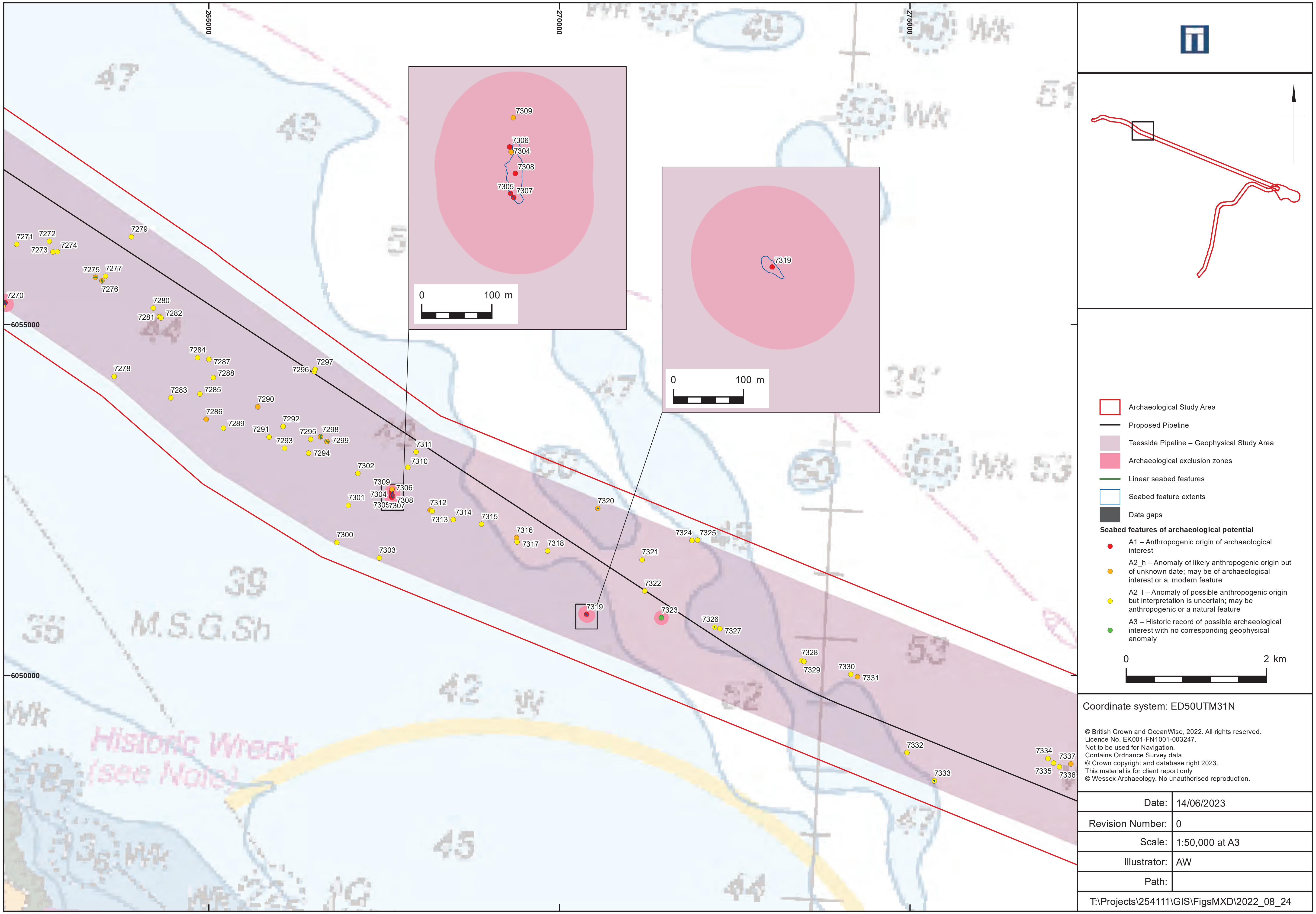
Seabed features of archaeological potential

Figure 4 I



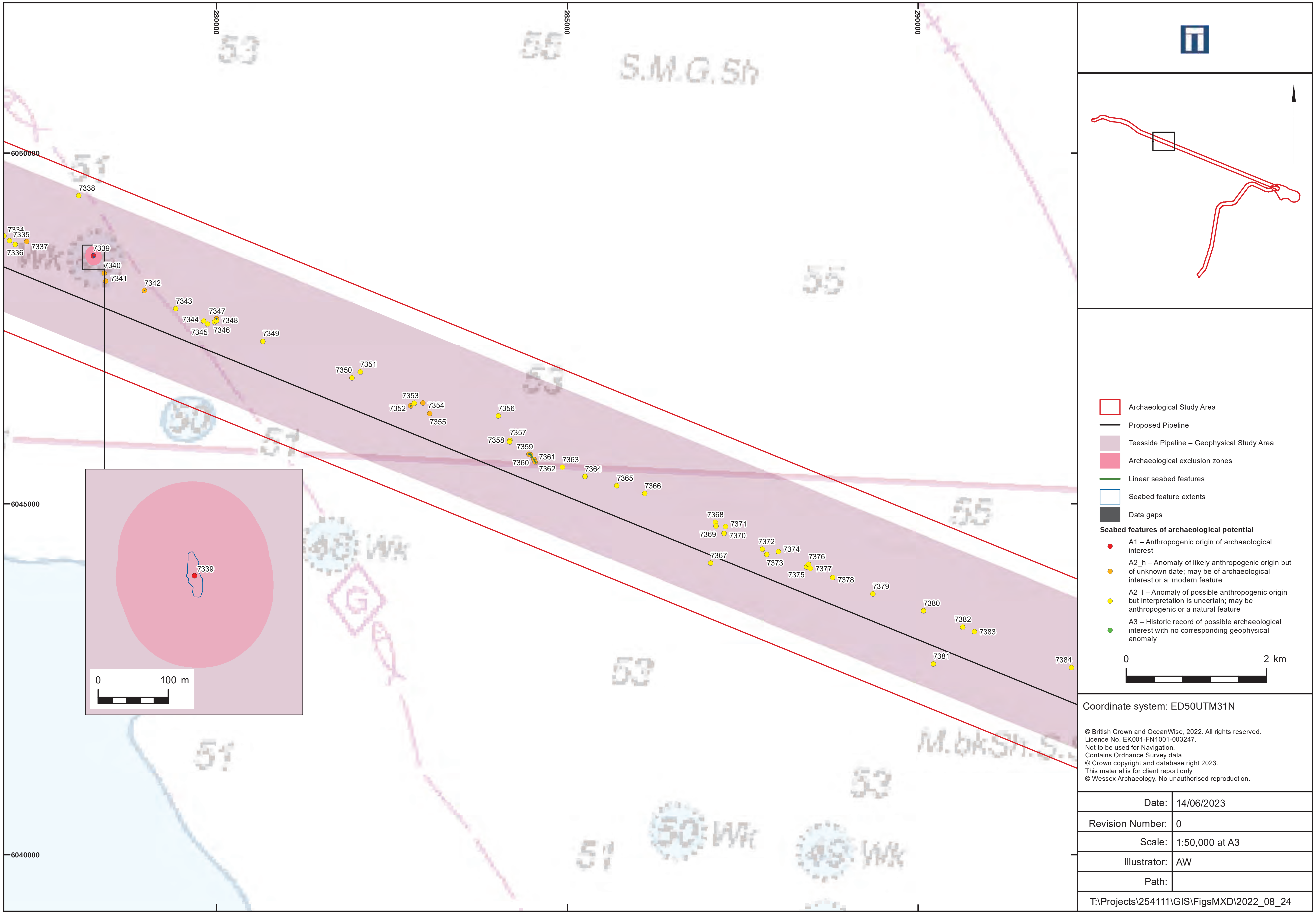
Seabed features of archaeological potential

Figure 4 J



Seabed features of archaeological potential

Figure 4 K



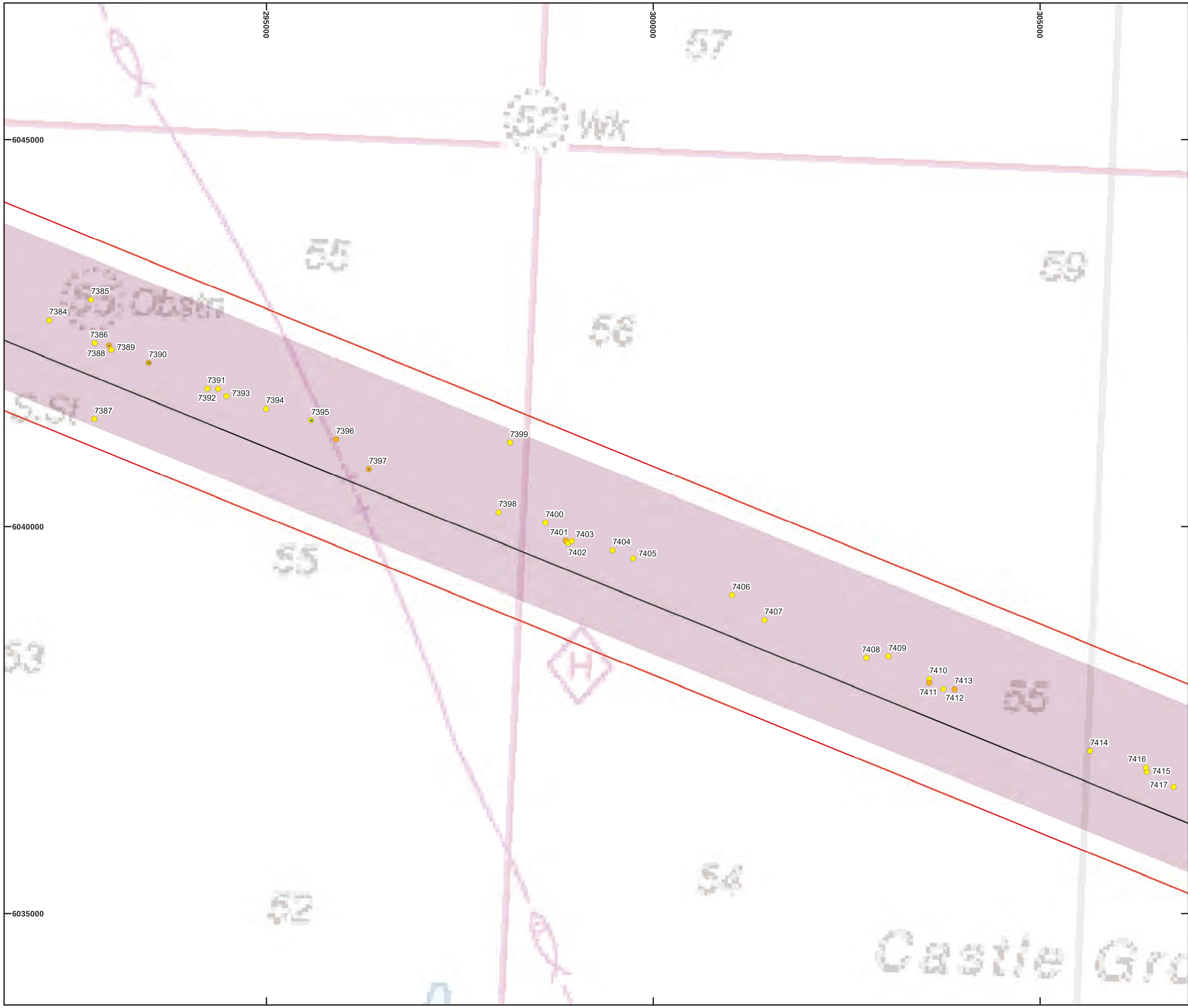
Coordinate system: ED50UTM31N

Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

T:\Projects\254111\GIS\FigsMXD\2022_08_24

Seabed features of archaeological potential

Figure 4 L



Archaeological Study Area
Proposed Pipeline
Teesside Pipeline – Geophysical Study Area
Archaeological exclusion zones
Linear seabed features
Seabed feature extents
Data gaps

Seabed features of archaeological potential

- A1 – Anthropogenic origin of archaeological interest
- A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
- A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
- A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

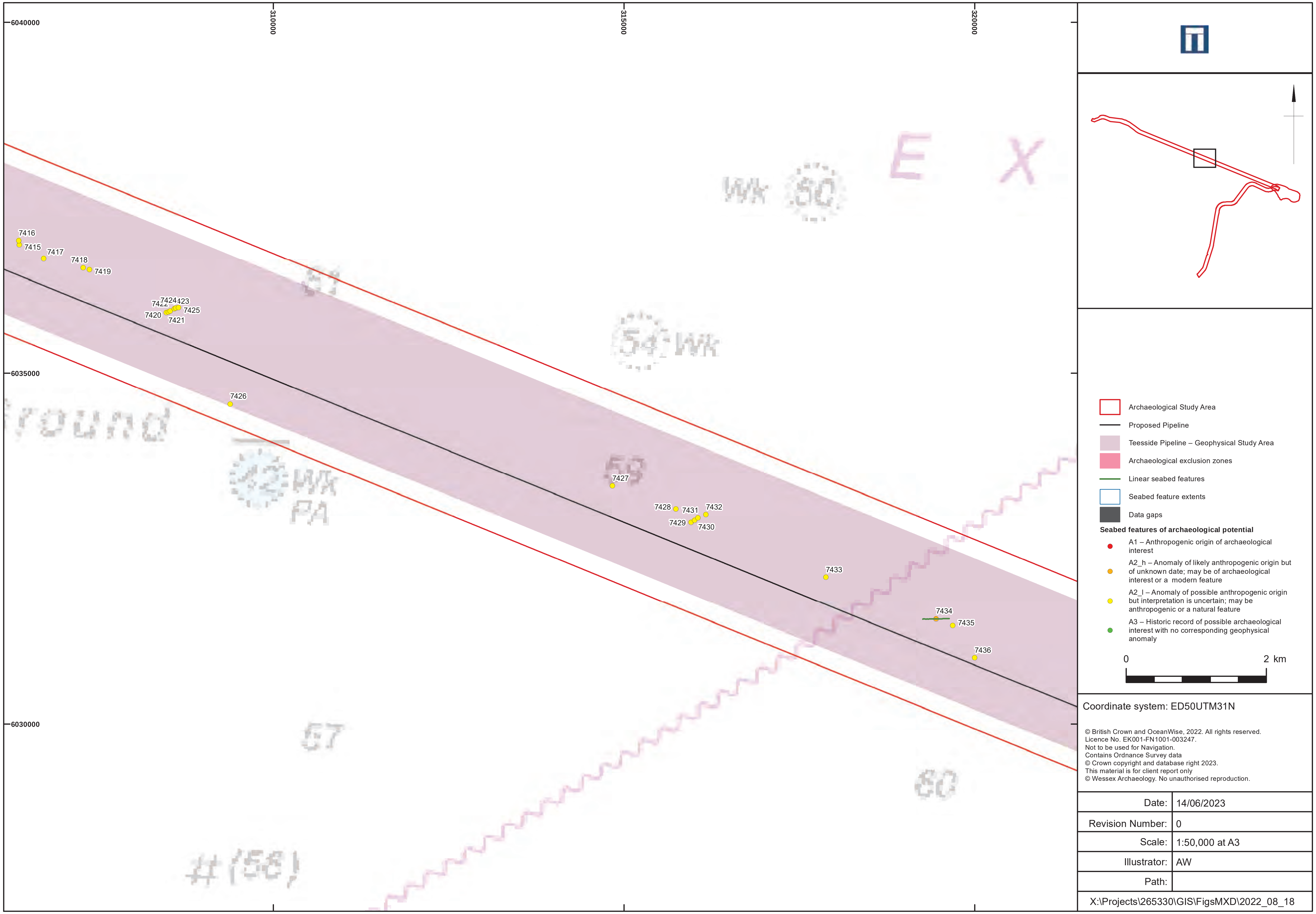
0 2 km

Coordinate system: ED50UTM31N

Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

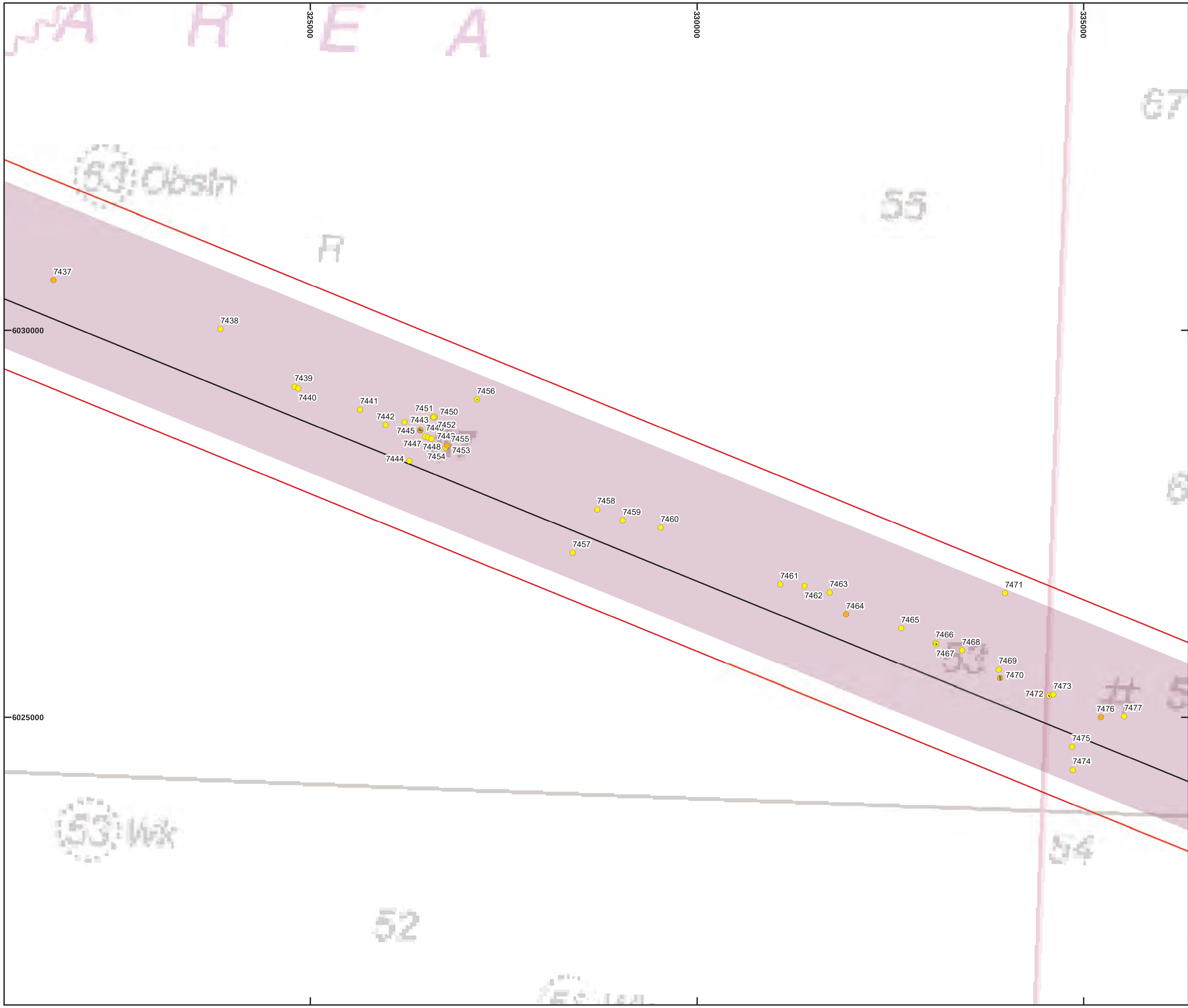
X:\Projects\265330\GIS\FigsMXD\2022_08_18

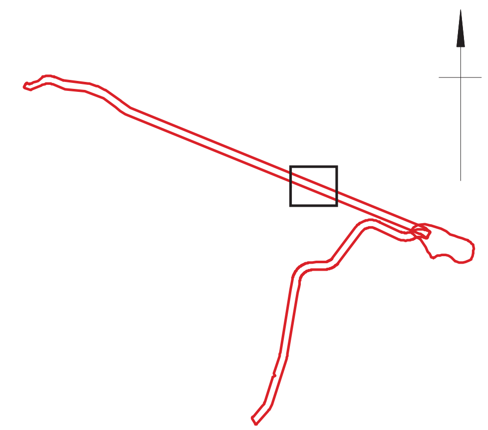
Seabed features of archaeological potential



Seabed features of archaeological potential

Figure 4 N





- Archaeological Study Area
- Proposed Pipeline
- Teesside Pipeline – Geophysical Study Area
- Archaeological exclusion zones
- Linear seabed features
- Seabed feature extents
- Data gaps

Seabed features of archaeological potential

- A1 – Anthropogenic origin of archaeological interest
- A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
- A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
- A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

0 2 km

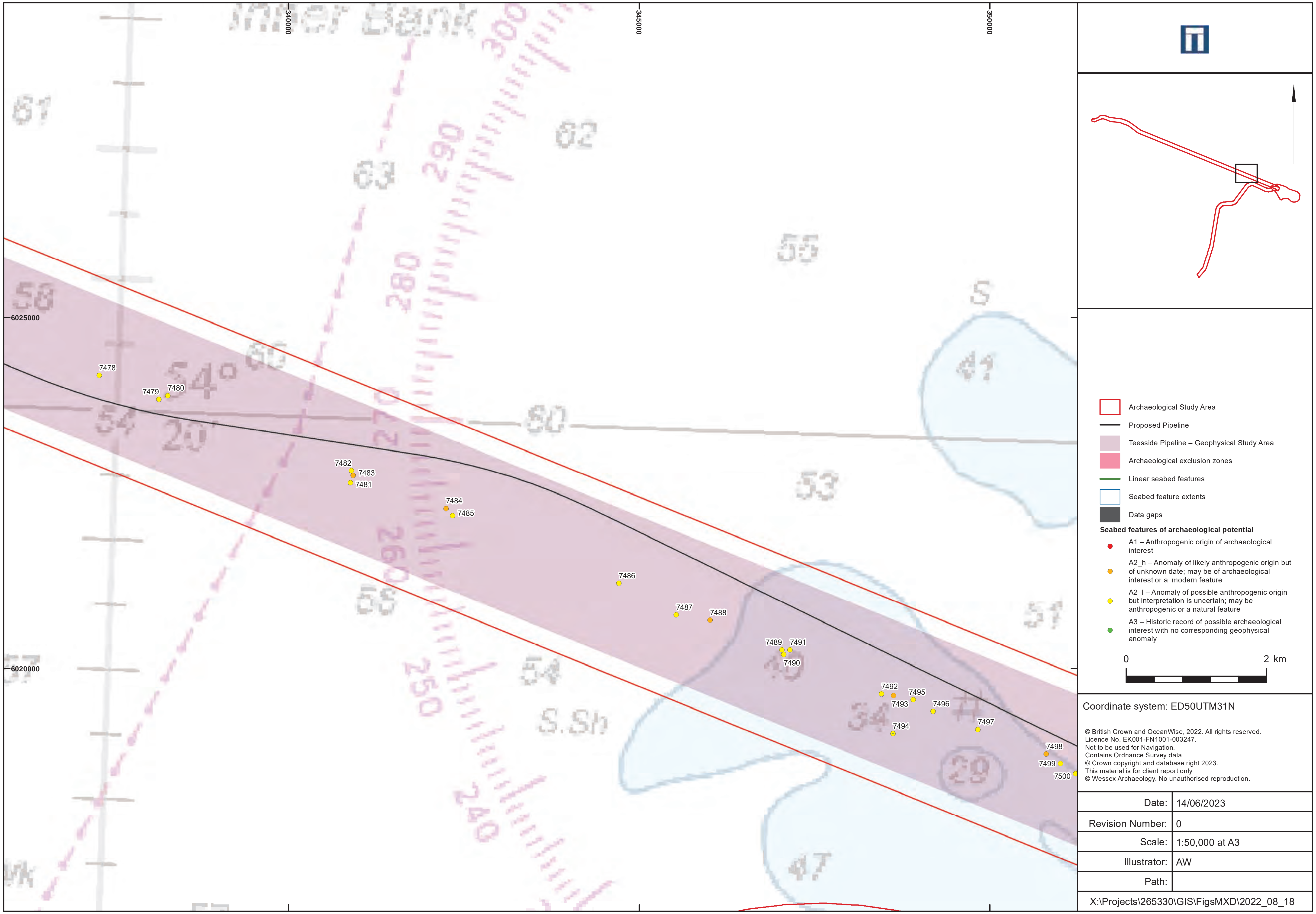
Coordinate system: ED50UTM31N

Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

X:\Projects\265330\GIS\FigsMXD\2022_08_18

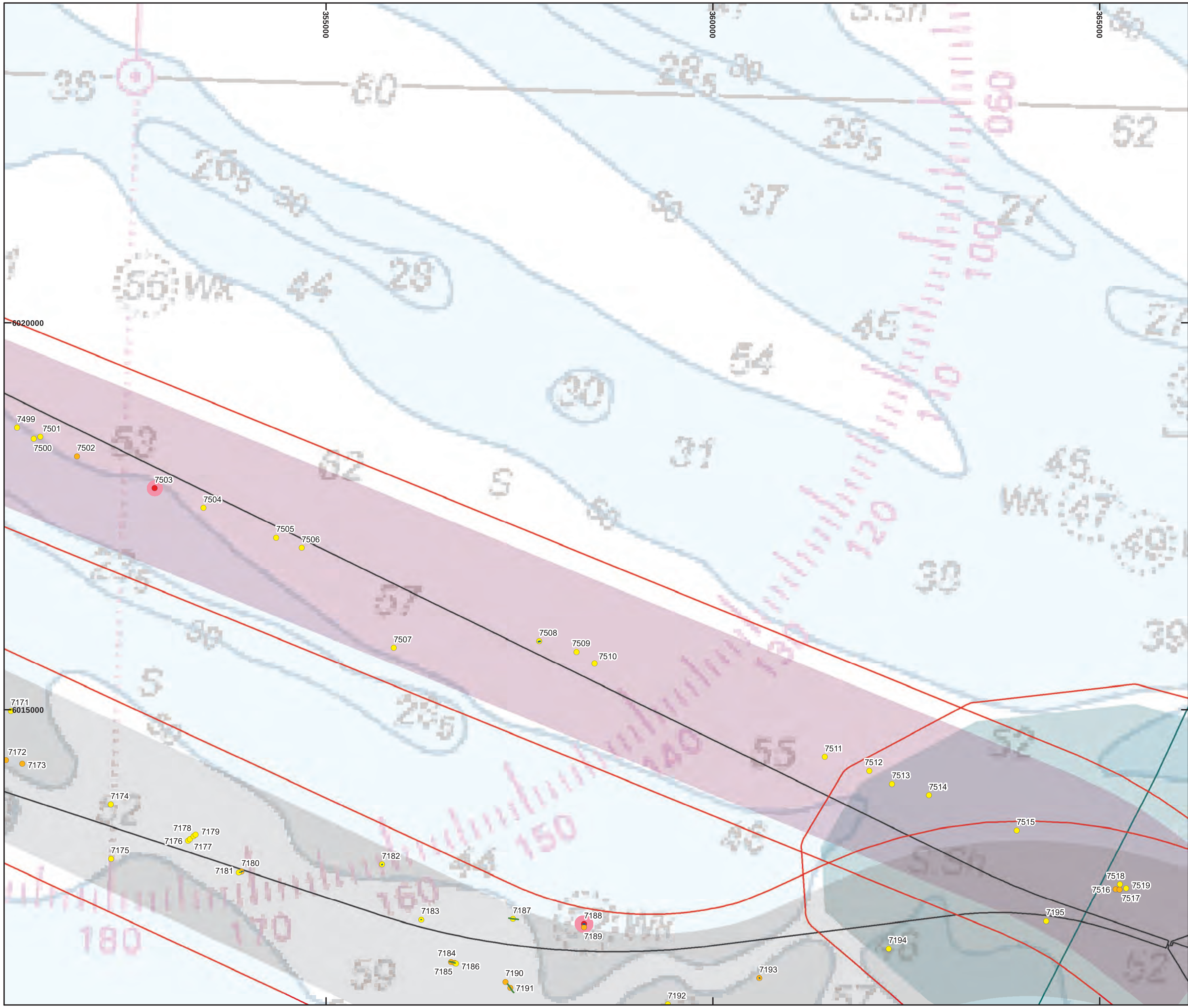
Seabed features of archaeological potential

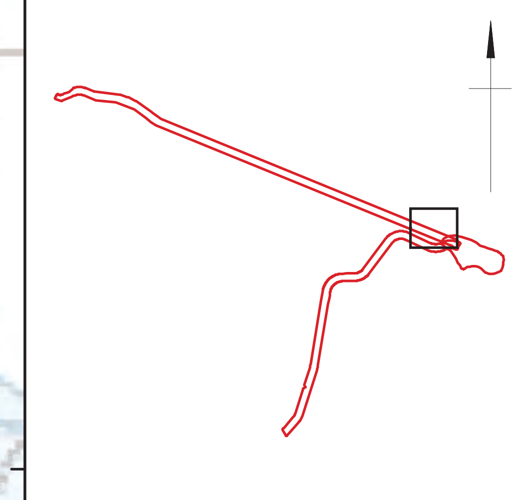
Figure 4 O



Seabed features of archaeological potential

Figure 4 P





Archaeological Study Area

Proposed Pipeline

Humber Pipeline – Geophysical Study Area

Teesside Pipeline – Geophysical Study Area

Endurance Store Geophysical Study Area

Endurance Store

Archaeological exclusion zones

Linear seabed features

Seabed feature extents

Data gaps

Seabed features of archaeological potential

A1 – Anthropogenic origin of archaeological interest

A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature

A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature

A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

0 2 km

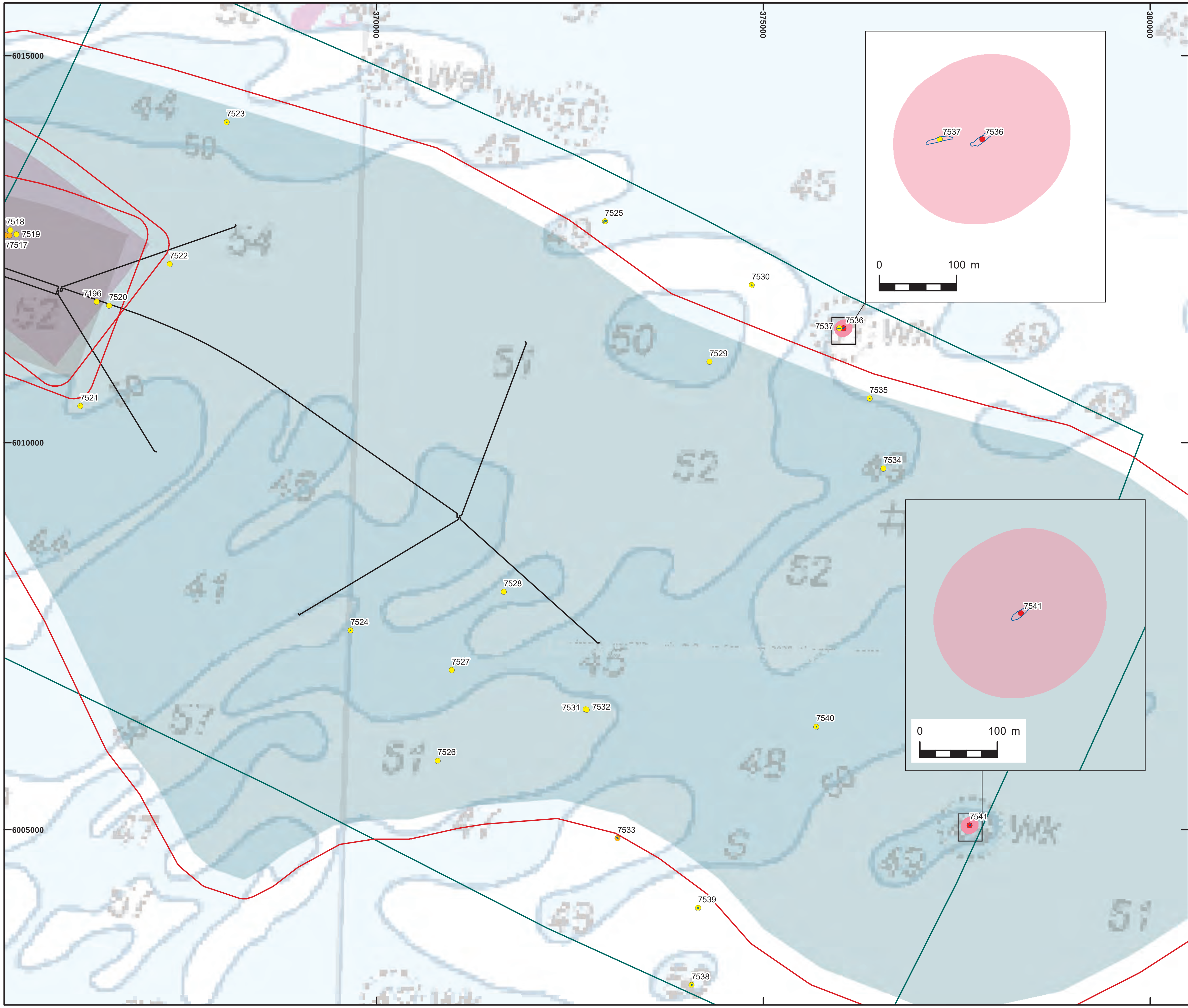
Coordinate system: ED50UTM31N

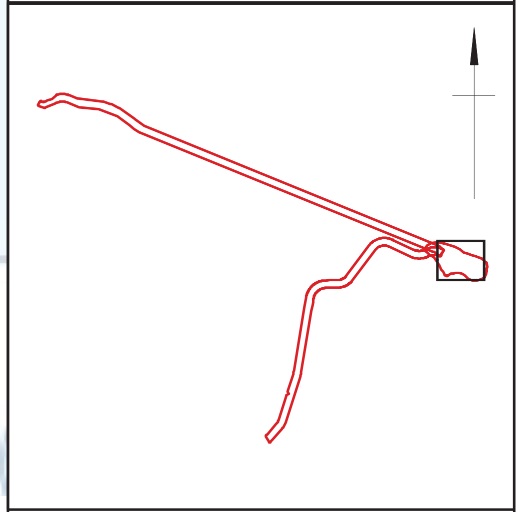
Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

X:\Projects\265330\GIS\FigsMXD\2022_08_18

Seabed features of archaeological potential

Figure 4 Q





Archaeological Study Area
Proposed Pipeline
Humber Pipeline – Geophysical Study Area
Teesside Pipeline – Geophysical Study Area
Endurance Store Geophysical Study Area
Endurance Store
Archaeological exclusion zones
Linear seabed features
Seabed feature extents
Data gaps

Seabed features of archaeological potential

- A1 – Anthropogenic origin of archaeological interest
- A2_h – Anomaly of likely anthropogenic origin but of unknown date; may be of archaeological interest or a modern feature
- A2_l – Anomaly of possible anthropogenic origin but interpretation is uncertain; may be anthropogenic or a natural feature
- A3 – Historic record of possible archaeological interest with no corresponding geophysical anomaly

0 2 km

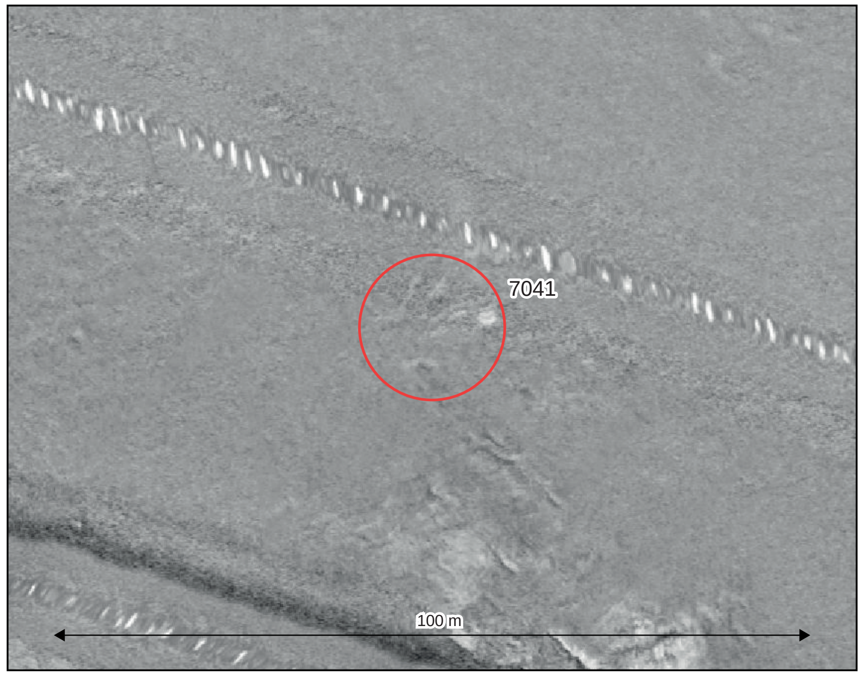
Coordinate system: ED50UTM31N

Date:	14/06/2023
Revision Number:	0
Scale:	1:50,000 at A3
Illustrator:	AW
Path:	

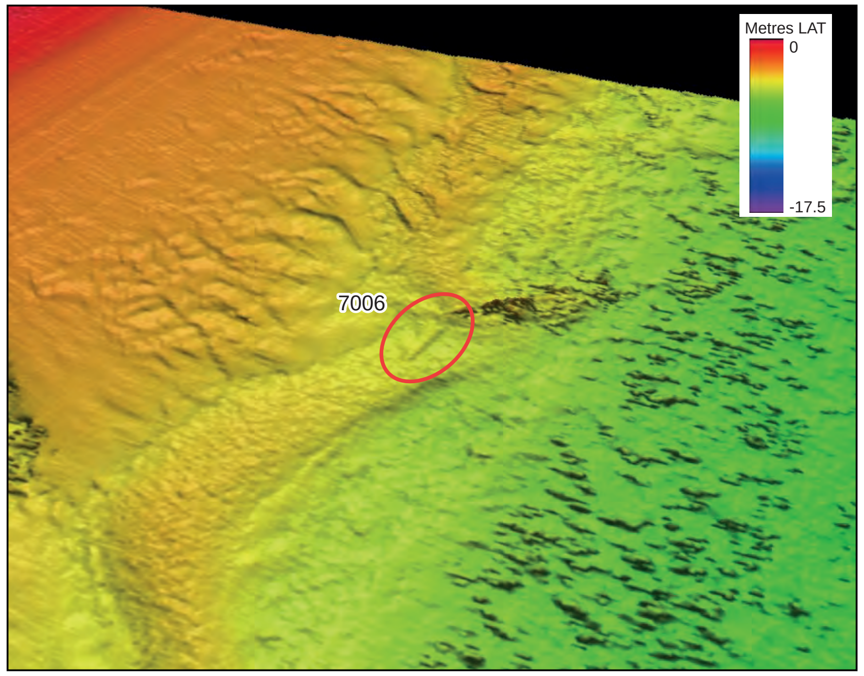
T:\Projects\254111\GIS\FigsMXD\2022_08_24

Seabed features of archaeological potential

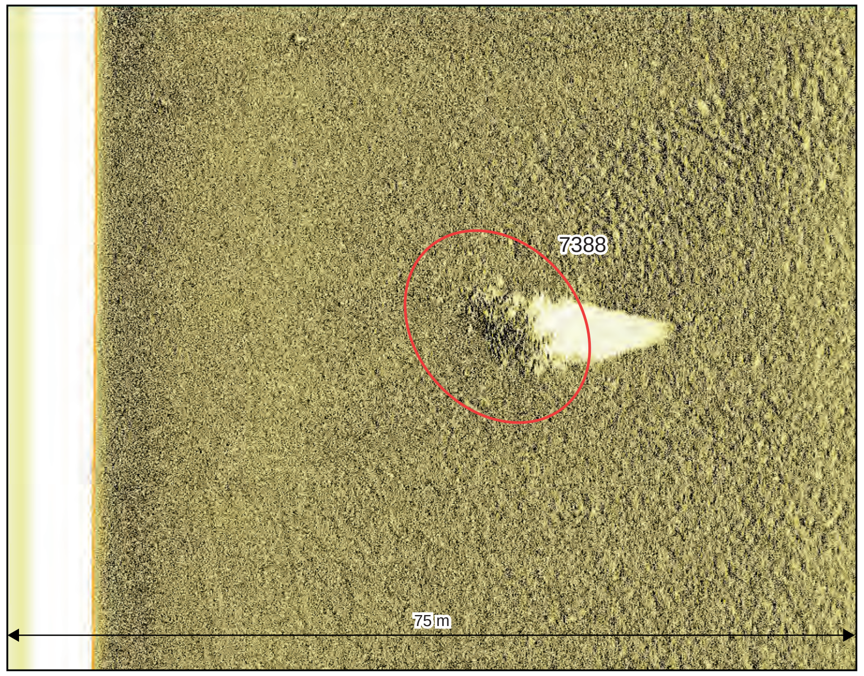
Figure 4 R



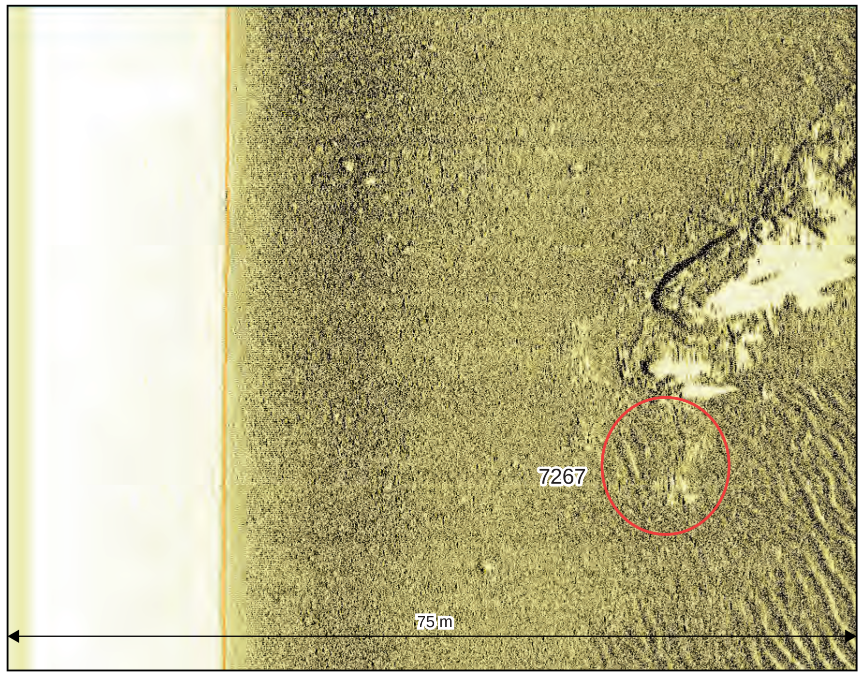
Pseudo SSS mosaic image of debris field **7041**, measuring 14.5 x 10.4 m, looking north



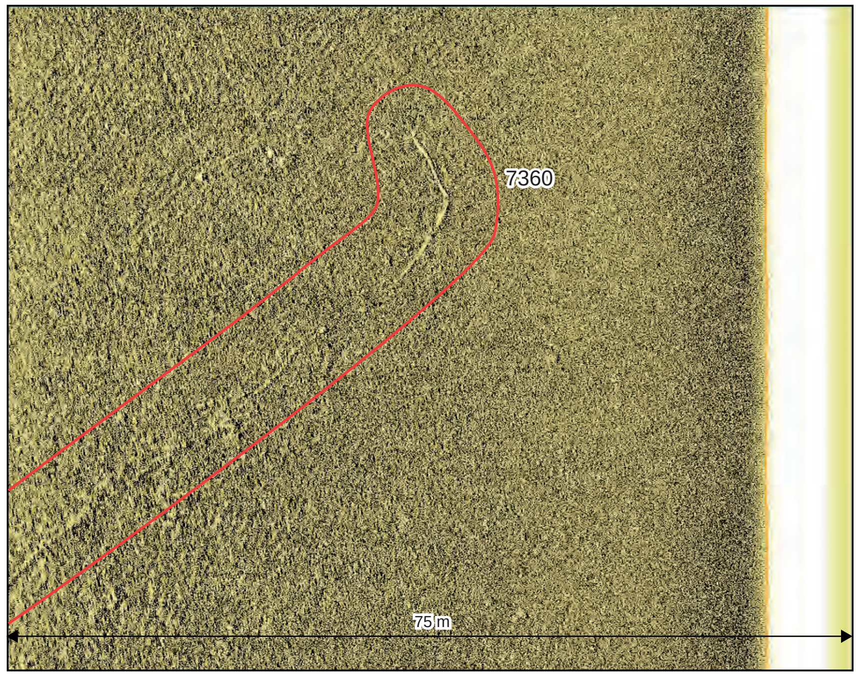
MBES grid image of debris **7006**, measuring 18.7 x 7.4 x 0.3 m, looking north-west



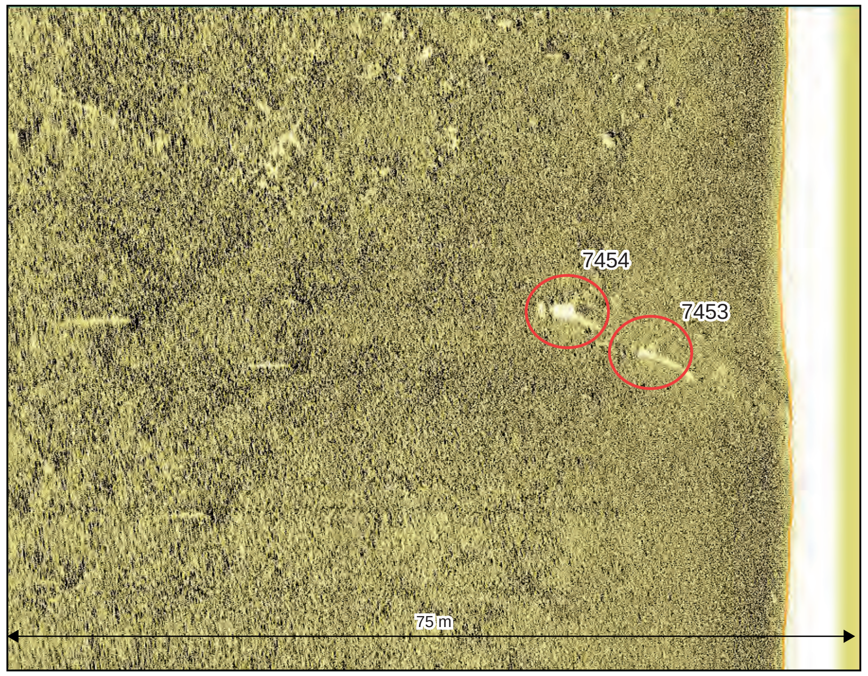
SSS waterfall image of debris field **7388**, measuring 13.9 x 8.1 x 1.6 m, looking north-west, 75 m range per channel



SSS waterfall image of seabed disturbance **7267**, measuring 9.6 x 7.8 x 0.5 m, looking north-west, 75 m range per channel



SSS waterfall image of rope/chain **7360**, measuring 79.7 x 0.4 x 0.1 m, looking north-west, 75 m range per channel



SSS waterfall image of bright reflector **7453**, measuring 6.4 x 3.3 and bright reflector **7454**, measuring 5.6 x 3.1 m, looking north-west, 75 m per channel

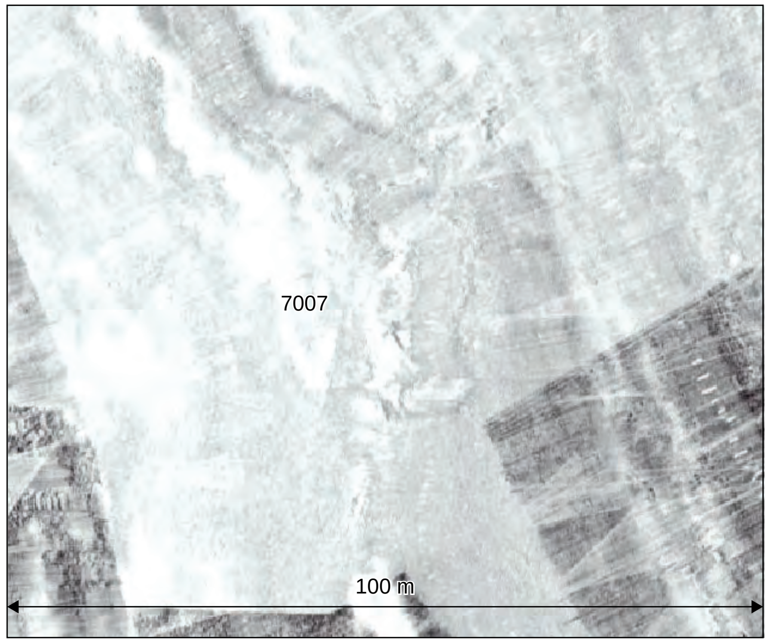
Date:	25/08/2022	Revision Number:	0
Scale:	NTS at A3	Illustrator:	KJF
Path:	T:\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

Seabed features of archaeological potential data examples

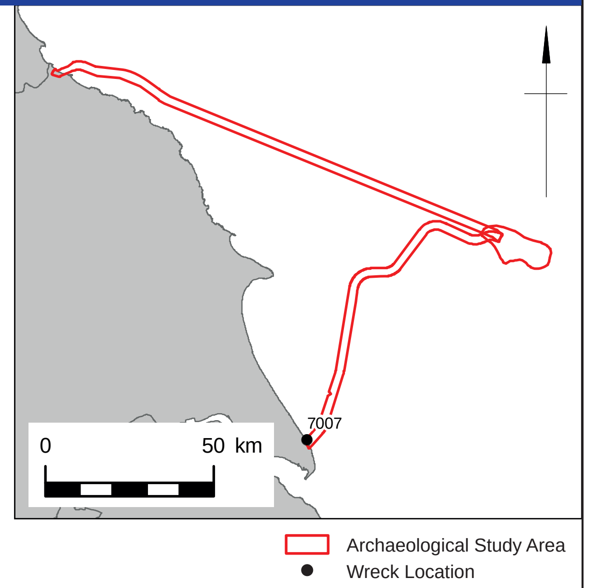
Figure 5

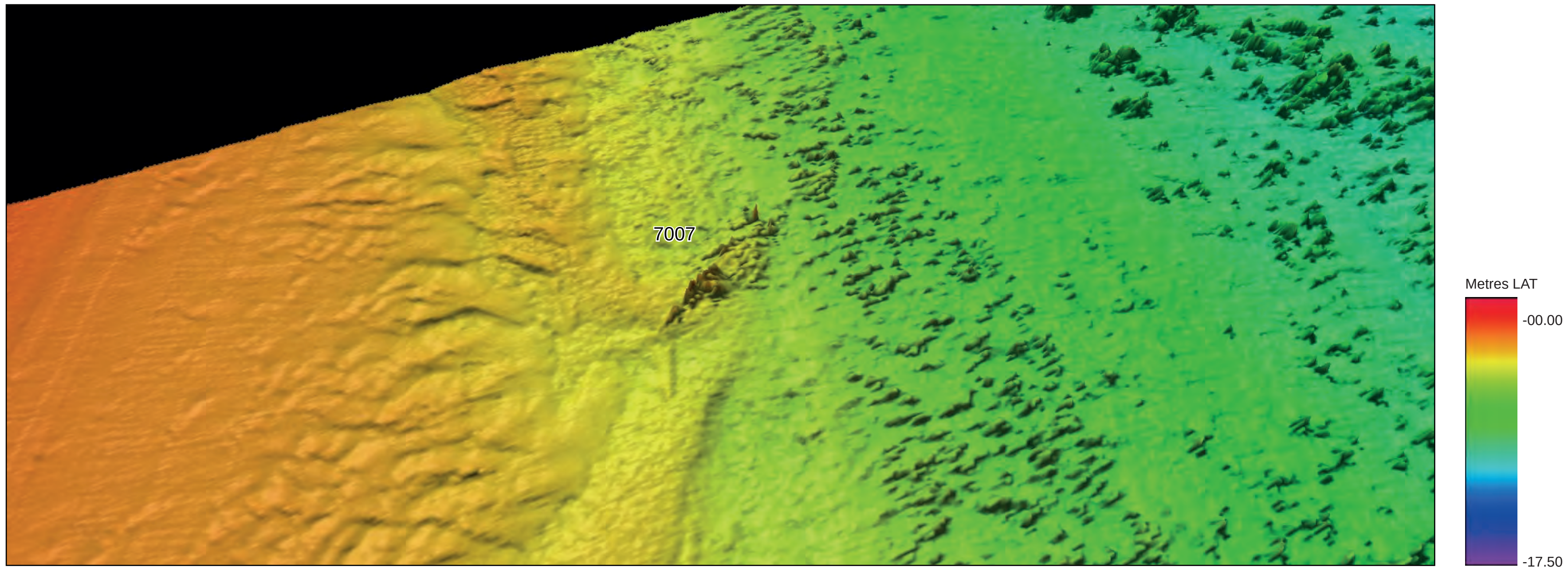
ID 7007 – UKHO 8870/8869 – *Francis*

Location	309166 E 5951536 N	**Area**	Humber
Archaeological Importance		High	
Geophysical survey dimensions and notes		Wreck **7007** corresponds with two charted UKHO records (**8870** and **8869**) for *Francis*. In the Pseudo SSS mosaic the wreck is visible as a large spread of angular and elongate dark reflectors with bright shadows, orientated approximately NNE to SSW. The wreck measures 62.7 x 27.0 x 2.0 m. In the MBES dataset the wreck is visible as a compact sub-elliptical group of angular mounds. The SSW end is pointed and the NNE end appears to merge into the outcropping geology, meaning the full extent of the wreck is unclear and the dimensions may be exaggerated or a minimum. The mounds are generally low-lying, however some objects have been measured up to 2.0 m at the centre of the wreck. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location, however the UKHO record suggests that it would have a large Mag. anomaly associated.	
Build	**Type**	Steam ship	
	Construction	Unknown, likely ferrous	
	Dimensions (m)	Unknown	
	Shipyard	Unknown	
Loss	**Cause**	Driven ashore and wrecked in heavy seas in 1872	
Extent of Survival		Recorded as the steam ship *Francis* in the UKHO reports; built of iron in Amsterdam in 1856. The vessel was on passage from London to Gothenburg and was wrecked in strong winds and heavy seas. The wreck was last surveyed in 2020 with geophysical dimensions of 60.3 x 21.6 x 3.5 m, and described as being broken down with an associated debris field included in the measurements. In the 2021 geophysical data, the wreck appears to be highly degraded, and it is not possible to tell which end is bow or stern. The wreck is possibly upright, though no identifiable internal superstructure is visible.	



Pseudo SSS mosaic image of wreck **7007**, looking north



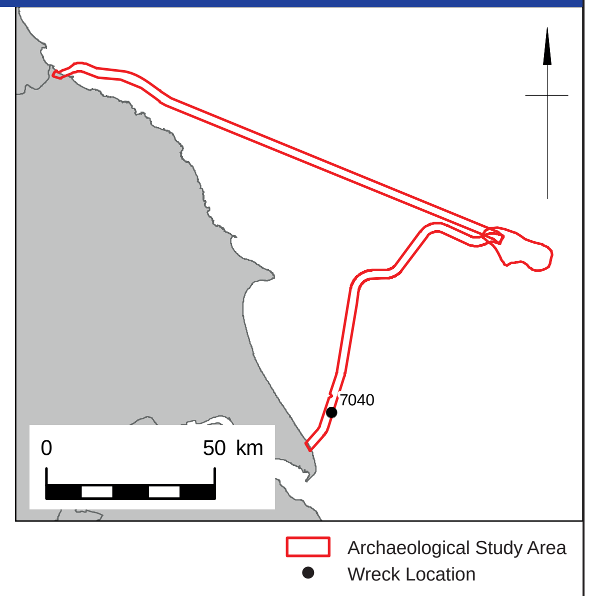


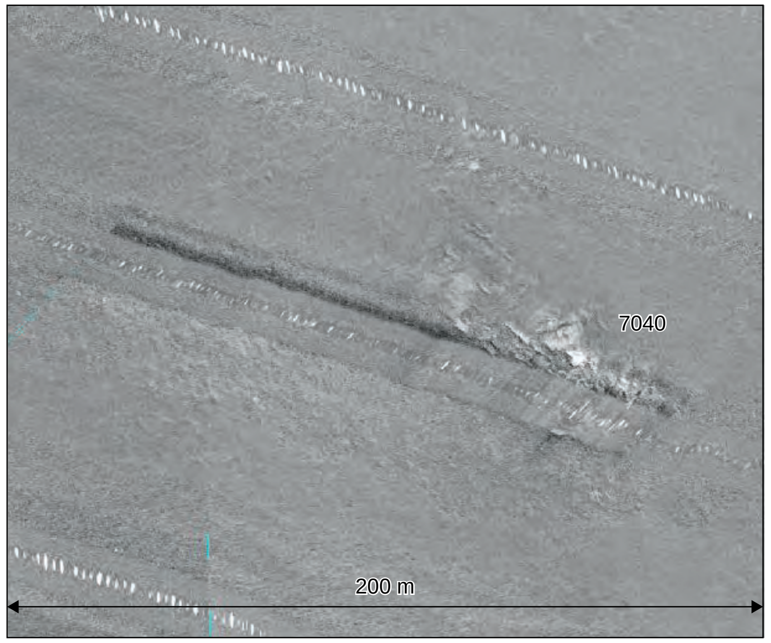
MBES grid image, x 3 vertical exaggeration, looking north-west

Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0	
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW	
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23			

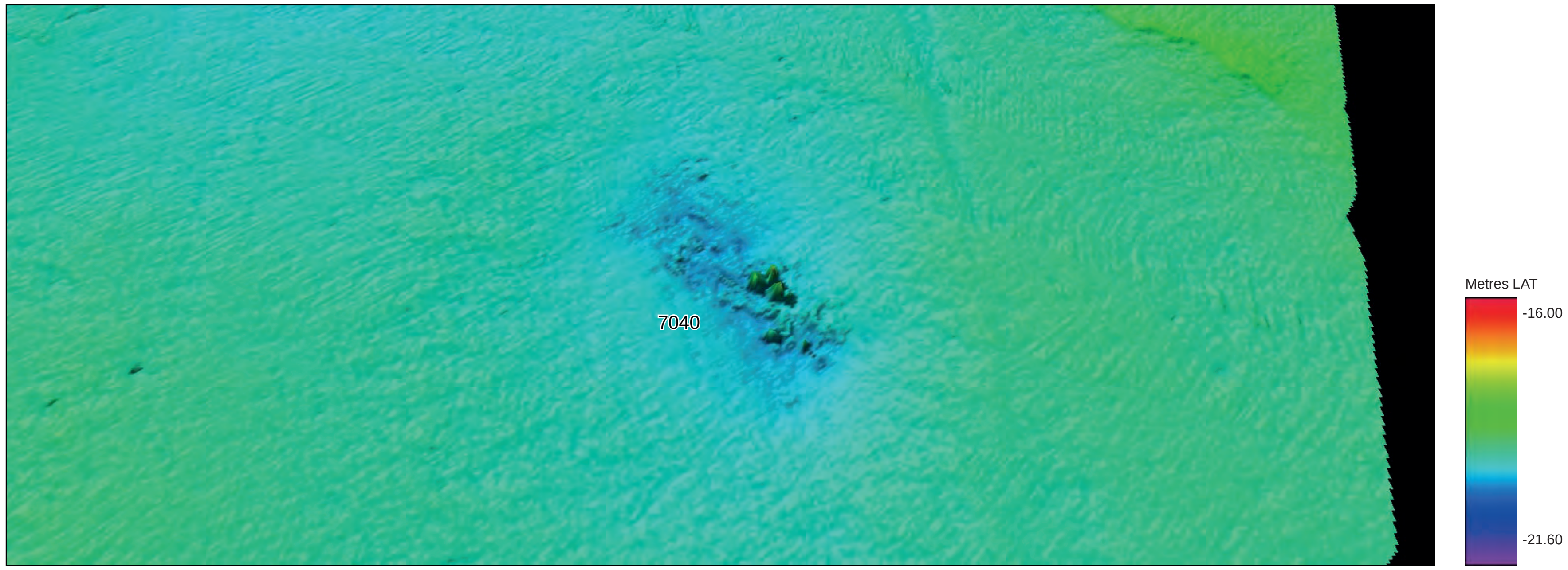
ID 7040 – UKHO 8911 – *Paraciers*

Location		316112 E 5960258 N	**Area**	Humber
Archaeological Importance		High		
Geophysical survey dimensions and notes		Wreck **7040** is a charted wreck and corresponds with a UKHO record (8911) for *Paraciers*. In the Pseudo SSS mosaic the wreck is visible as a large spread of dark reflectors measuring 74.3 x 27.8 x 1.6 m. Some features have shadows, and a number of straight linear dark reflectors are visible, with the longest measuring 8.7 x 0.9 m. The wreck is orientated north-west to south-east and is situated on a relatively featureless seabed. The wreck has little/no discernible structure, however some possible slatted features are visible. In the MBES data the wreck is visible as a large spread of uneven seabed, comprising mainly angular mounds, though some smaller rounded objects are visible. The largest mound is situated in the centre of the wreck, measuring 6.8 x 3.7 m, and which may be a boiler. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.		
Build	**Type**	Steam ship		
	Construction	Unknown		
	Dimensions (m)	97.8 x 12.2 x 7.3 m		
	Shipyard	Unknown		
Loss	**Cause**	Torpedoed by *UC-46* in 1917		
Extent of Survival		Associated with a UKHO record for *Paraciers*, a steam ship sunk in 1917. The wreck was last surveyed in 2020 with geophysical dimensions of 74.5 x 21.7 x 3.2 m, and described as being very broken up with two boilers visible. In the 2021 data this wreck appears broken up and degraded with some associated debris identified in the vicinity. The slight increase in the width and decrease in the height may suggest further degradation or collapse.		





Backscatter mosaic image of wreck **7040**, looking north

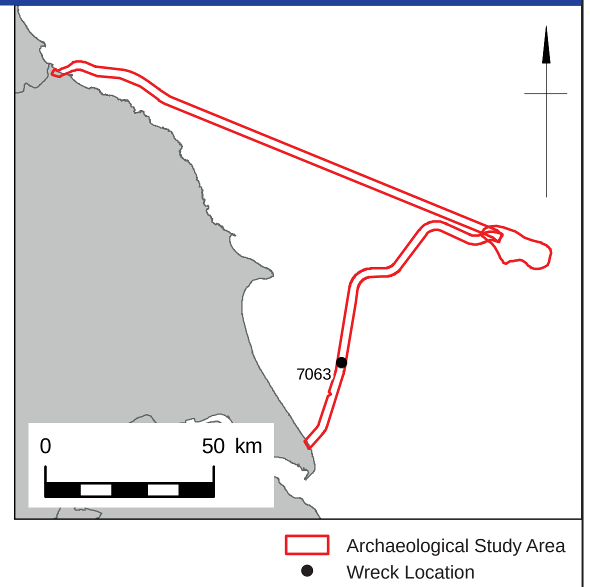


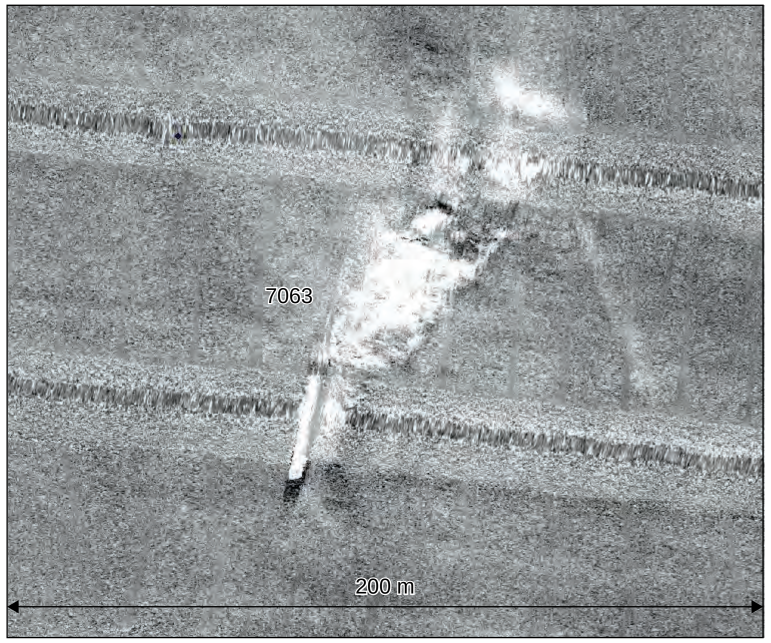
MBES grid image, x 3 vertical exaggeration, looking north

Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

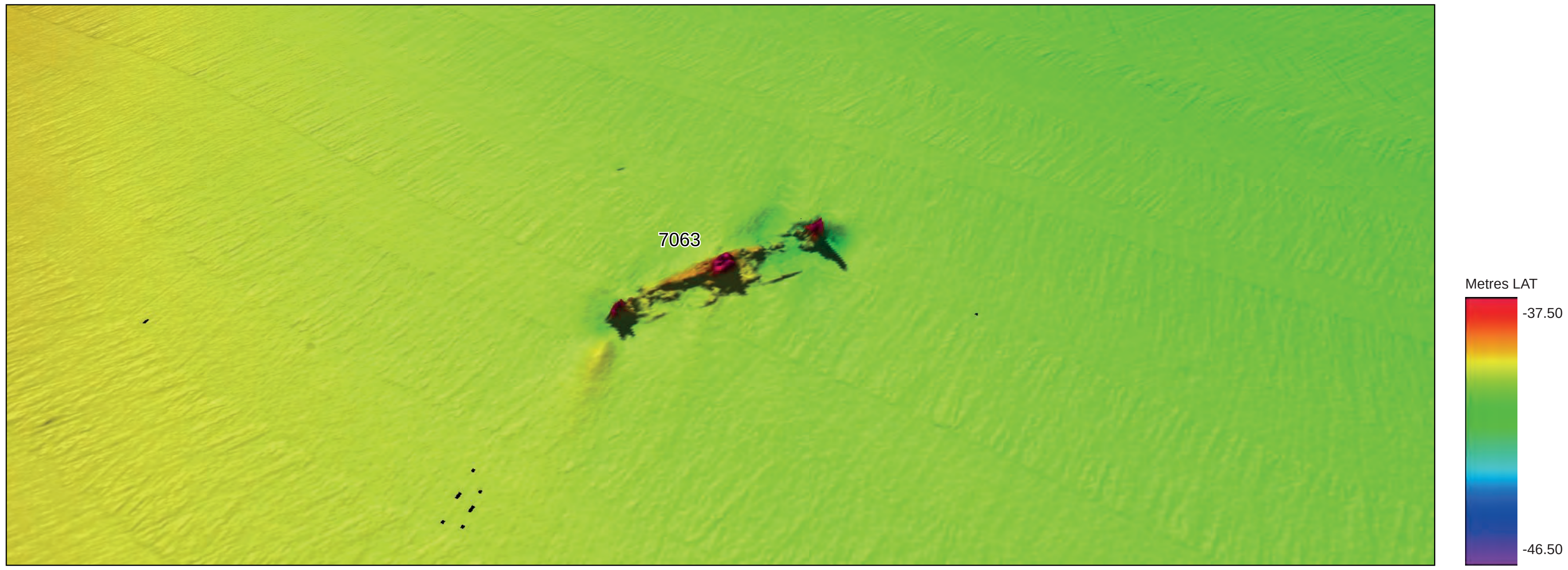
ID 7063 – UKHO 8945 – *John Rettig* (Probably)

Location	319425 E 5974528 N	**Area**	Humber
Archaeological Importance	High		
Geophysical survey dimensions and notes	Wreck **7063** is a charted wreck that corresponds with UKHO record (**8945**) for the steam ship *John Rettig* (Probably). The wreck is visible in the Pseudo SSS mosaic data as a group of bright reflectors and very small, indistinct dark reflectors with shadows. The wreck is orientated north-east to south-west and measures 93.2 x 22.3 x 6.5 m. At the south-west end of the feature a large dark reflector with a bright shadow is visible, measuring 11.9 x 4.8 m. The NNE end of the wreck has a rectangular dark reflector measuring 5.4 x 3.0 m. In the MBES dataset the wreck appears generally intact and upright on the seabed, but slightly tilted on its eastern edge. Internal rounded and angular mounds are visible, indicating some possible surviving superstructure, and a tall mound visible in the centre measuring 11.5 x 5.3 x 3.5 m, that may be a boiler. The interpreted hull looks slightly disjointed and may be partially buried or broken up. There is scouring around the south-east end of the wreck up to 1.5 m deep and 9.0 m in length and slight scouring and sediment accumulation to the north of the wreck. This location was not directly covered by the SSS or Mag. datasets, however there is a small, very broad, Mag. anomaly on the closest Mag. line 100 m to the south-west, that may be a halo response of nearby ferrous material and the UKHO record suggests it is ferrous.		
Build – **Type**	Steam ship		
Build – **Construction**	Unknown, likely steel		
Build – **Dimensions (m)**	80.8 x 12.8 x 6.1 m		
Build – **Shipyard**	Unknown		
Loss – **Cause**	Torpedoed in 1918 by *UB-107*		
Extent of Survival	Associated with a UKHO record for *John Rettig* (Probably), a steam ship built in 1915 and sunk on passage from Gothenburg to Hull. The wreck was last surveyed in 2016 with geophysical dimensions of 93.7 x 9.5 x 9.5 m and a strong magnetic anomaly associated. It was described as being broken up, with the centre sections disintegrated. In the 2021 geophysical data the wreck appears mostly intact with some surviving superstructure visible. The lower height measurement since 2016 suggests the wreck has collapsed or degraded. The wreck has surrounding sediment accumulation which may periodically bury and uncover it, and any associated debris.		





Pseudo SSS mosaic image of wreck **7063**, looking north

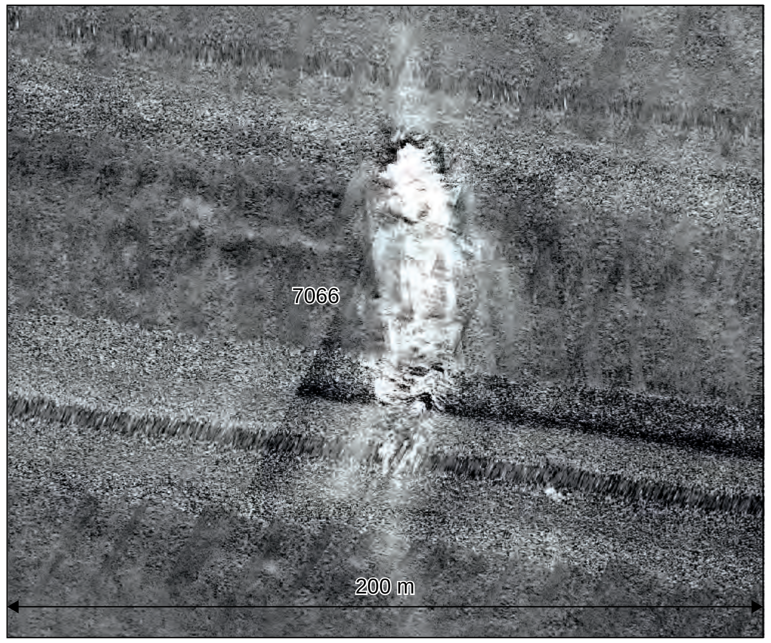


MBES grid image, x 1 vertical exaggeration, looking NNW

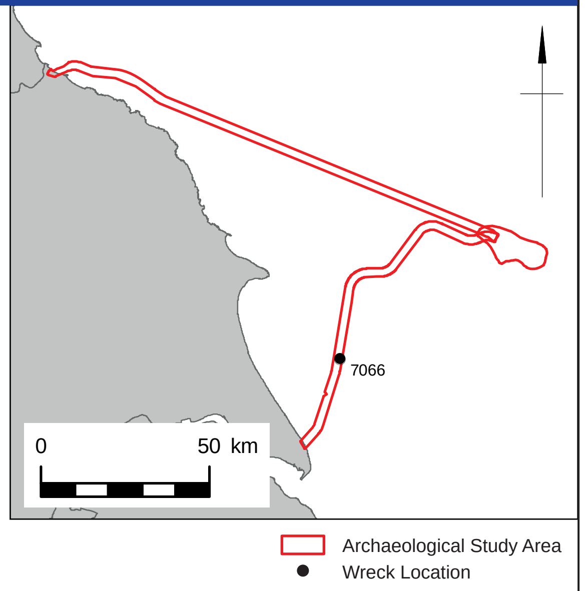
Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

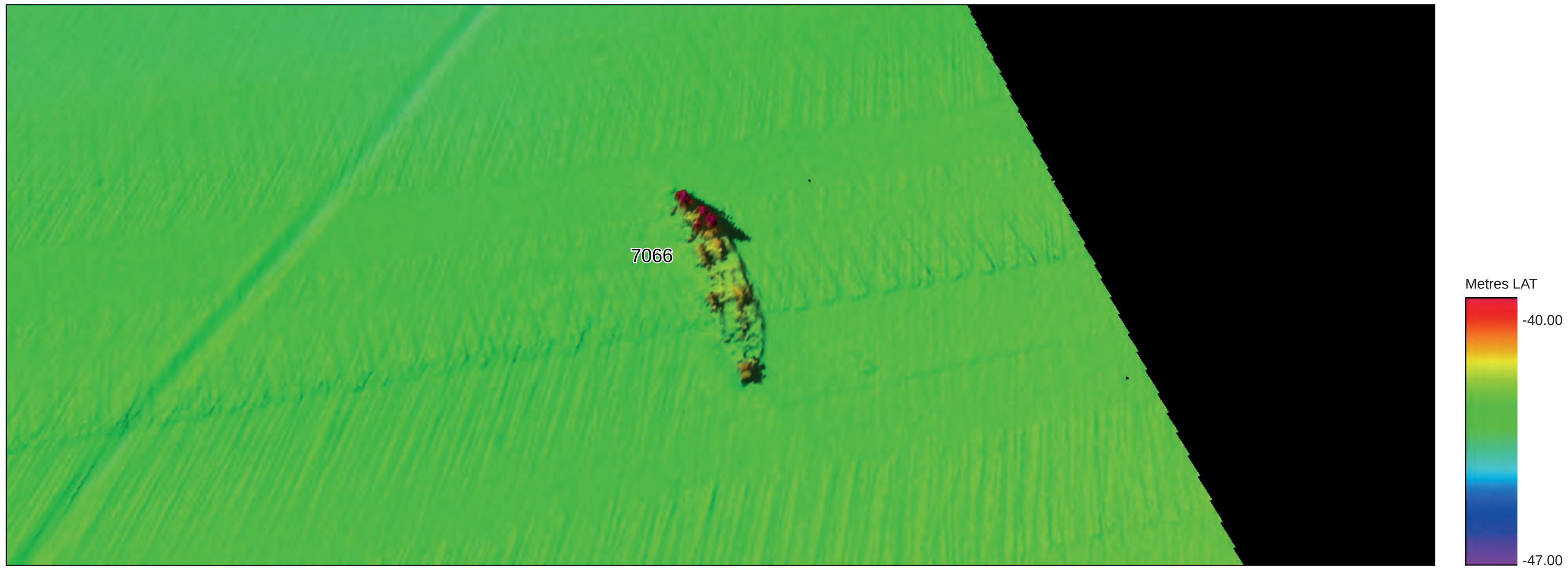
ID 7066 – UKHO 8951 – *Horsted*

Location	320229 E 5975612 N	**Area**	Humber
Archaeological Importance	High		
Geophysical survey dimensions and notes	Wreck **7066** is a charted wreck that corresponds with a UKHO record (8951) for the steam ship *Horsted*. In the Pseudo SSS mosaic, the wreck is visible as an ovoid area of mainly bright reflectors, orientated north to south and measuring 87.9 x 19.2 x 4.5 m, with dark reflectors visible at the northern and southern ends. In the southern part of the wreck, curvilinear and rounded dark reflectors with shadows are visible and at the northern end, a thick curvilinear dark reflector is visible which is interpreted to be surviving hull. Significant scouring is present to the north and south of the wreck. Also identified in the MBES data as an upright, possibly tilted and mostly intact wreck. Internal, multiple rounded and angular mounds are visible, with larger angular mounds located at its northern end, which may be boilers. The interpreted hull does not protrude high above the seabed and there is evidence of sediment accumulation around the wreck, possibly indicating it may be collapsed or buried. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location, however the UKHO record suggests it is ferrous.		
Build — **Type**	Steam ship		
Build — **Construction**	Unknown, likely steel		
Build — **Dimensions (m)**	78.0 x 11.3 x 4.9 m		
Build — **Shipyard**	Burntisland		
Loss — **Cause**	Mine or torpedo		
Extent of Survival	Associated with a UKHO record for *Horsted*, a steam ship built in 1936 and sunk in 1939 by a large explosion either from a mine or torpedo. The wreck was last surveyed in 2016 with geophysical dimensions of 88.1 x 21.1 x 6.7 m, and was described as being upright but broken up with two boilers visible near the stern and a strong Mag. anomaly associated. In the 2021 geophysical data the wreck appears mostly intact but may be partially buried, the lower recorded height measurement suggests it has collapsed or degraded since the 2016 survey.		



Pseudo SSS mosaic image of wreck **7066**, looking north





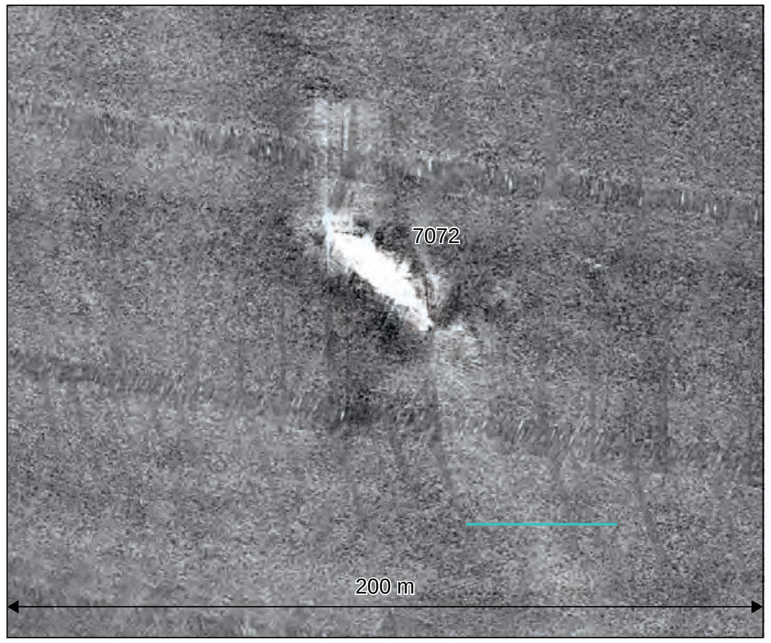
MBES grid image, x 1 vertical exaggeration, looking NNE

Coordinate system: ED50UTM31N

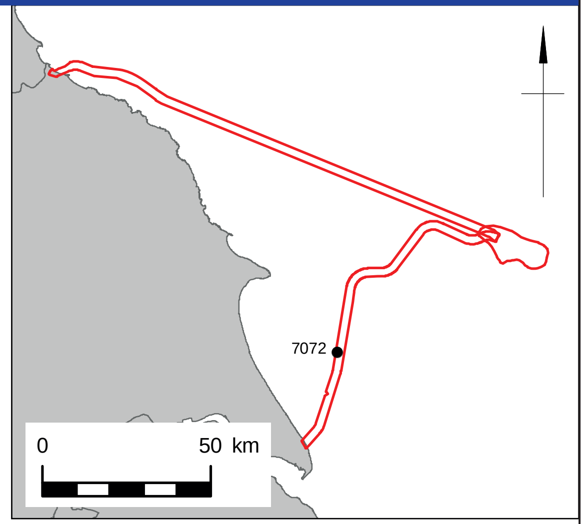
Date:	23/08/2022	Revision Number:	0
Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

ID 7072 – UKHO 8958 – *Helmsman* (Probably)

Location		319021 E 5977560 N	**Area** Humber
Archaeological Importance		High	
Geophysical survey dimensions and notes		Wreck **7072** is a charted wreck that corresponds with UKHO record (**8958**) for *Helmsman* (Probably). The wreck is visible in the Pseudo SSS mosaic as a distinct ovoid bright reflector orientated north-west to south-east on the seabed. Some indistinct, dark reflectors are visible at the north-west and south-east ends of the wreck and a small number of internal, indistinct linear dark reflectors are visible. The wreck measures 38.4 x 9.3 x 3.6 m and has scouring to the north and south. In the MBES data the wreck appears intact and upright, with multiple internal low-lying mounds visible. The tallest mound is situated in the centre of the wreck and measures 8.3 x 5.2 m. The wreck is situated within an area of scour up to 0.2 m deep and is isolated on the seabed. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location, although the UKHO record suggests it is ferrous.	
Build	**Type**	Tanker	
	Construction	Unknown, likely steel	
	Dimensions (m)	36.8 x 6.6 x 2.8 m	
	Shipyard	Smith's Dock Company, Limited	
Loss	**Cause**	Foundered in severe gale	
Extent of Survival		Recorded by the UKHO as *Helmsman* (Probably), a tanker built in 1905. The vessel sunk in 1927 and was last surveyed in 2016, with geophysical dimensions of 40.9 x 9.2 x 4.7 m and a strong Mag. anomaly associated. It was described as being upright and intact. In the 2021 geophysical data the wreck appears intact within an area of scour which may periodically bury and uncover the wreck and any associated debris.	



Pseudo SSS mosaic image of wreck 7072, looking north



Archaeological Study Area
Wreck Location

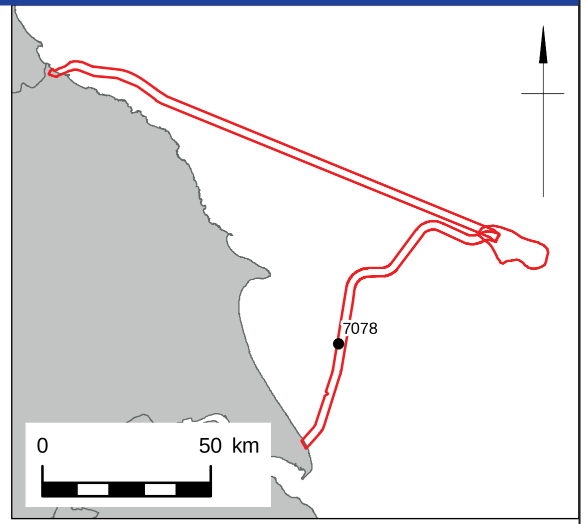
MBES grid image, x 1 vertical exaggeration, looking north

Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

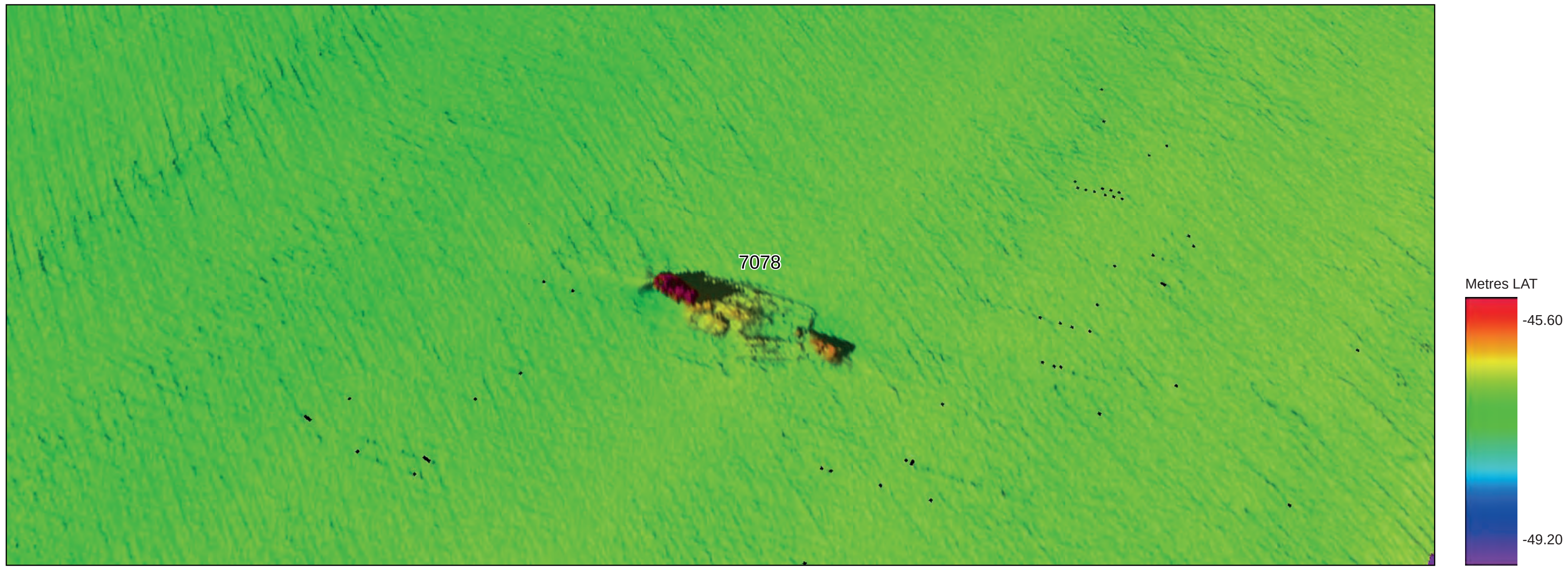
ID 7078 – UKHO 8967 – *Onward* (Possibly)

Location		319348 E 5980106 N	**Area**	Humber
Archaeological Importance		High		
Geophysical survey dimensions and notes		Wreck **7078** is a charted wreck that corresponds with UKHO record (**8967**) for the steam ship *Onward* (Possibly). In the Backscatter mosaic data, the wreck is visible as a large oval dark reflector orientated north to south, interpreted to represent the hull, measuring 73.8 x 29.2 x 2.9 m. Some indistinct, internal linear dark reflectors are discernible with a square shaped dark reflector measuring 10.4 x 7.8 m visible at the northern end of the wreck. There is some scour to the NNW of the wreck. In the MBES data the interpreted hull of the wreck appears to be disjointed with little height off the seabed, indicating possible collapse. Numerous, internal small angular and linear mounds are visible. At the southern end of the wreck a large mound measuring 13.9 x 7.2 x 1.0 m is present, which may be a boiler. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location, although the UKHO record suggests it is ferrous.		
Build	**Type**	Steam ship		
	Construction	Unknown, likely steel		
	Dimensions (m)	61.7 x 8.0 x 5.3 m		
	Shipyard	Unknown		
Loss	**Cause**	Heavy seas		
Extent of Survival		Associated with a UKHO record for the steam ship *Onward* (Possibly), built in 1861 with build dimensions of 61.7 x 8.0 x 5.3 m, and sunk in heavy seas in 1862. The wreck was last surveyed in 2016 with geophysical dimensions of 75.5 x 25.3 x 7.5 m and a strong Mag. anomaly associated. It was described as being disintegrated with just the aft section intact, and the boilers still visible. In the 2021 geophysical data the wreck is relatively compact but appears degraded and the increase in width and decrease in height may be evidence of collapse since 2016.		

Backscatter mosaic image of wreck **7078**, looking north



Archaeological Study Area
Wreck Location

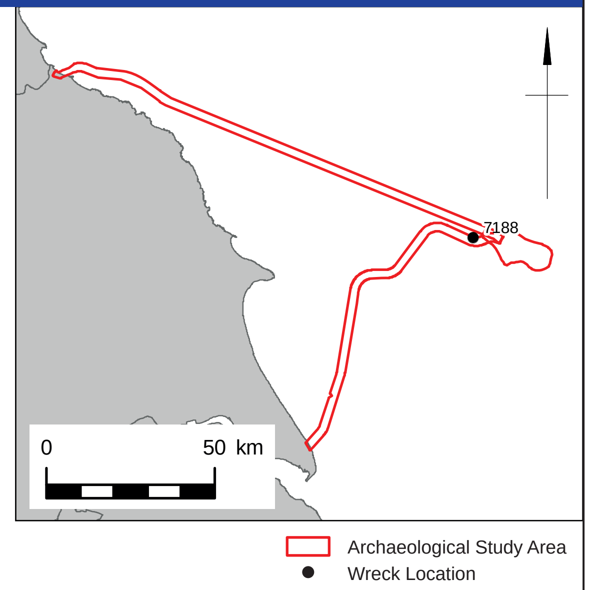


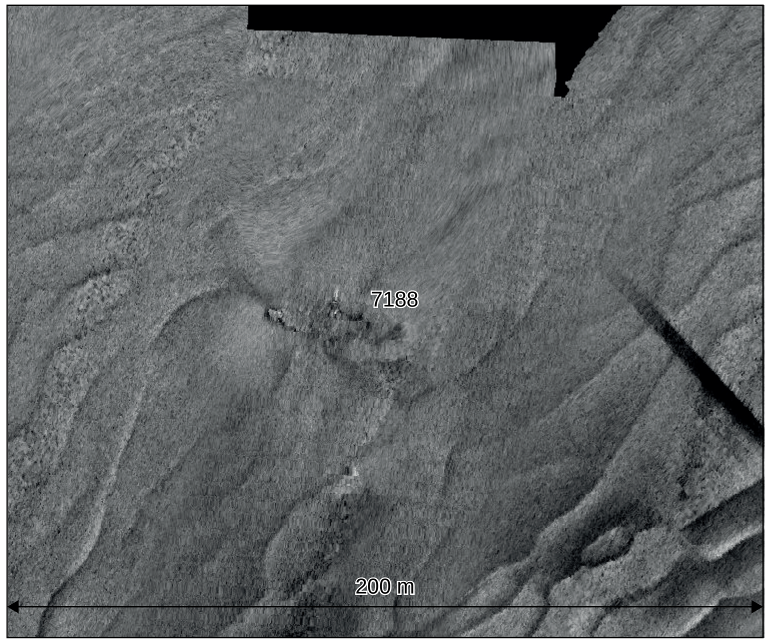
MBES grid image, x 1 vertical exaggeration, looking north-east

Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

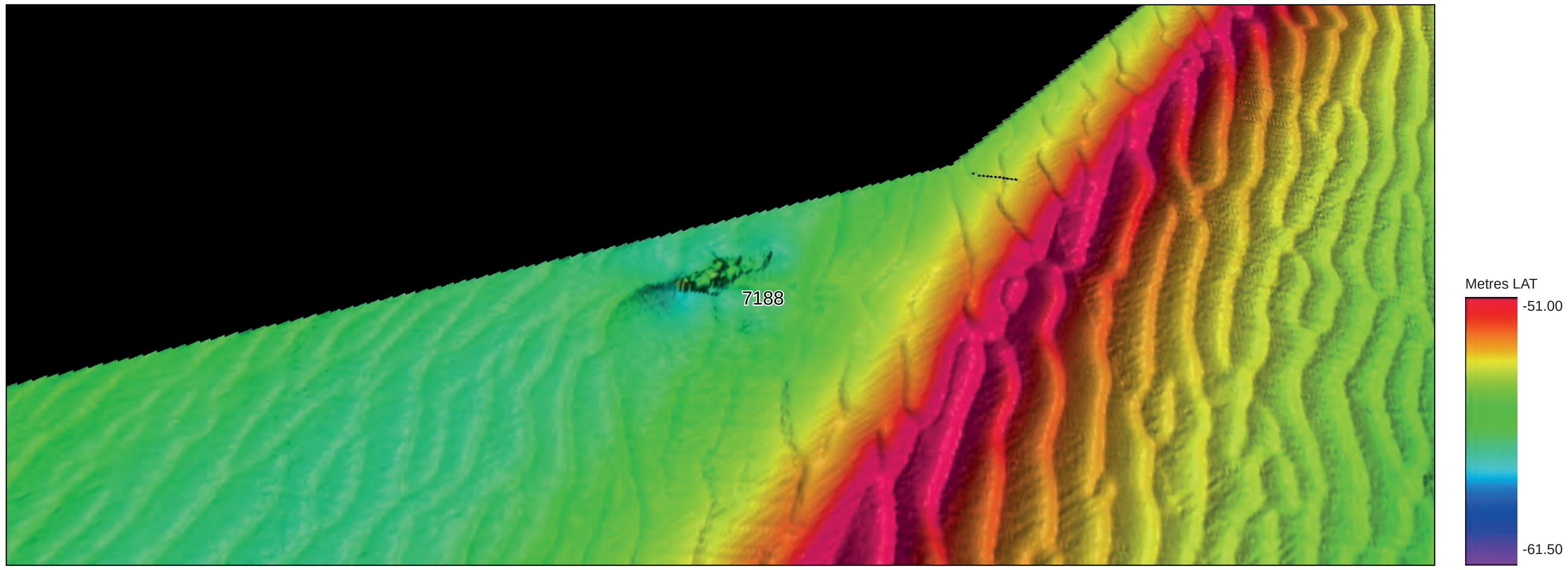
ID 7188 – UKHO 6605 – Unknown

Location		358336 E 6012230 N	**Area** Humber
Archaeological Importance		High	
Geophysical survey dimensions and notes		Wreck **7188** is a charted wreck associated with a UKHO record (**6605**) for an unknown wreck. In the Backscatter Mosaic the wreck is visible as an irregular area of seabed disturbance comprising indistinct dark and bright reflectors measuring 35.6 x 13.2 x 3.0 m within an area of large mobile sand waves. One very distinct dark reflector is visible at the western extent of the wreck. In the MBES dataset the wreck is visible as an ovoid group of angular mounds. Multiple internal, straight-edged, rectangular and angular mounds are visible, with the tallest mounds in the centre and east end of the wreck. It is orientated east to west and appears to be upright on the seabed, and appears mostly intact, however the hull is not discernible. The wreck has some surrounding scour, with the largest area of scour measuring 20.0 m in length and -1.0 m deep at the south-west side of the wreck. This position was not directly covered by the SSS or Mag. dataset, so it is not possible to ascertain whether ferrous material is present at this location.	
Build	**Type**	Unknown	
	Construction	Unknown	
	Dimensions (m)	Unknown	
	Shipyard	Unknown	
Loss	**Cause**	Unknown	
Extent of Survival		Associated with a UKHO record (**6605**) for an unknown wreck last surveyed in 1987, with geophysical dimensions of 52.0 x 10.0 x 3.6 m, and described as being partially buried in the flank of a sand wave. The smaller dimensions in the 2021 data suggest the wreck may have degraded further or become further buried by mobile sediments since 1987. A piece of associated debris has been identified 35.0 m south of the wreck and there is potential for further debris to be buried in the vicinity.	





Backscatter mosaic image of wreck **7188**, looking north

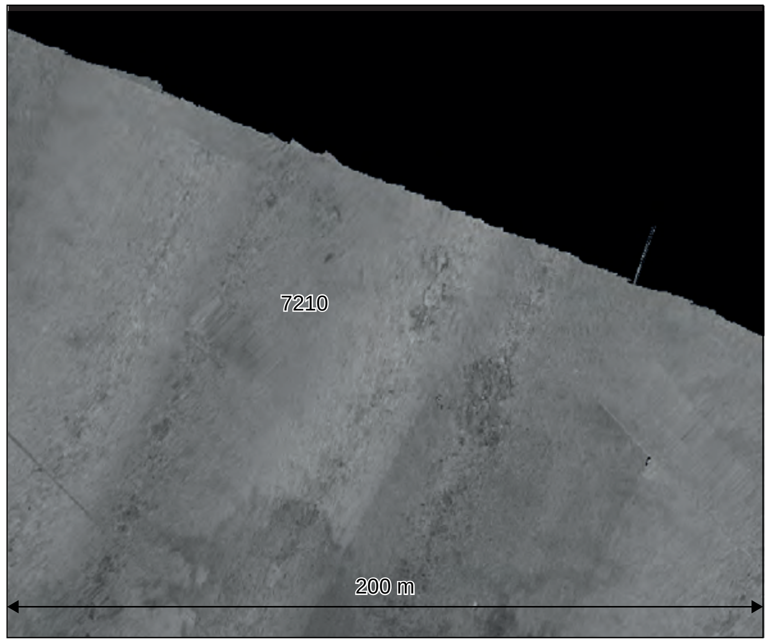


MBES grid image, x 1 vertical exaggeration, looking north-east

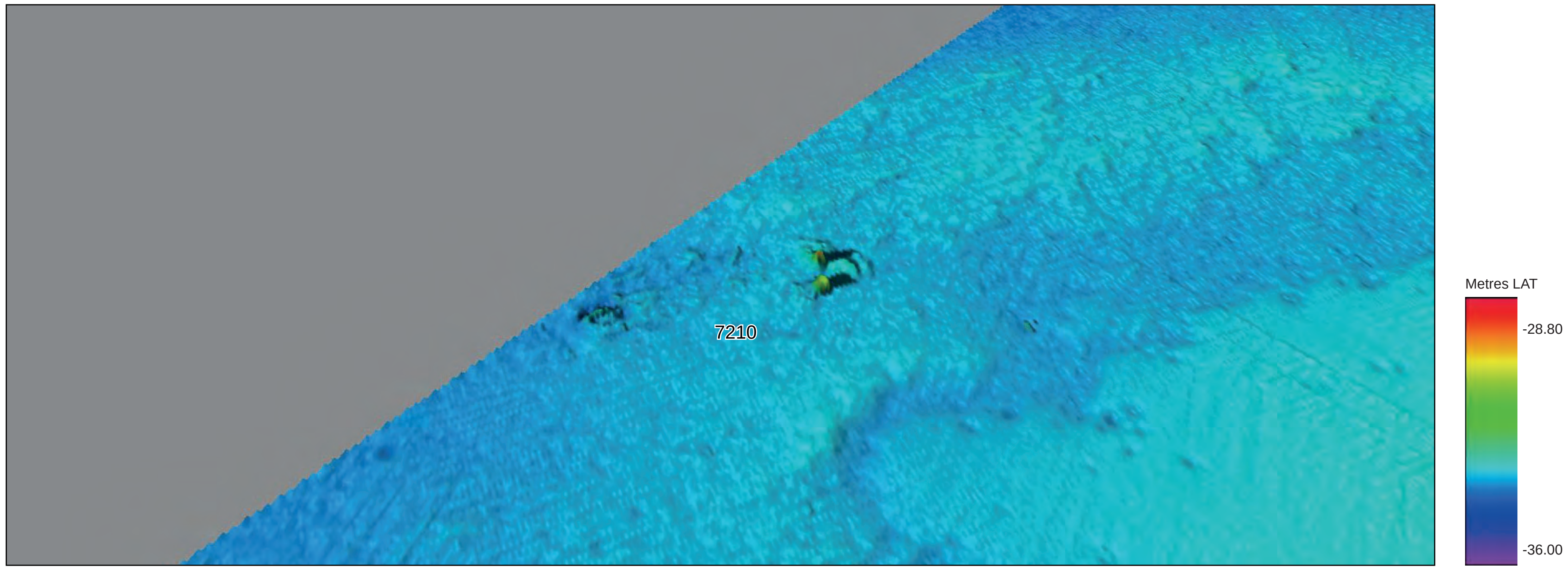
Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

ID 7210 – UKHO 6389 – *Teesdale* (Possibly)

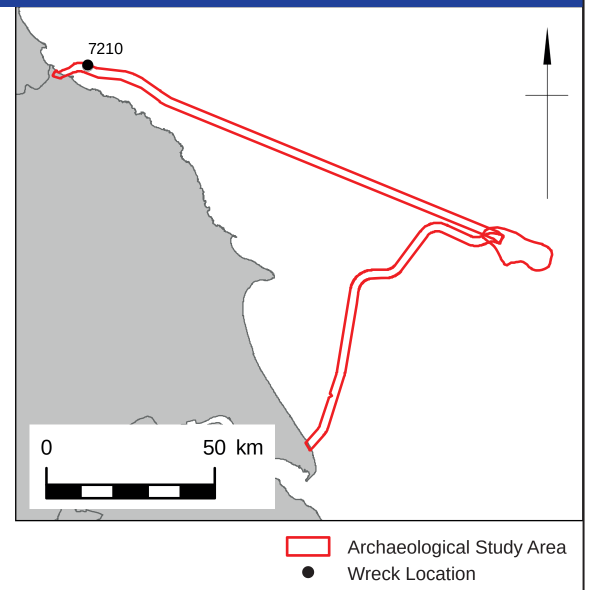
Location		243520 E 6063523 N	**Area** Teesside
Archaeological Importance		High	
Geophysical survey dimensions and notes		Wreck **7210** is a charted wreck and corresponds with a UKHO record (**6389)** for *Teesdale* (Possibly). In the Pseudo SSS mosaic wreck is visible as a large irregular area of seabed disturbance comprising a highly irregular bright reflector measuring 80.4 x 29.3 x 3.0 m. The wreck was also visible in the Backscatter mosaic as an indistinct and intermittent spread of dark reflectors. In the MBES data the wreck appears to be upright and is visible as a spread of distinct and indistinct mounds orientated north-west to south-east on the seabed. The south-east end of the wreck comprises two tall mounds measuring approximately 6.2 x 6.1 x 2.5 m individually. At the north-western end of the wreck a group of multiple angular low-lying mounds with pointed peaks is visible. The hull of the wreck is not discernible and internally very indistinct, low-lying mounds are visible in-between the interpreted bow and stern, suggesting it is highly degraded and may be buried. The wreck is situated at the edge of the MBES data extents and so the dimensions should be considered a minimum. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.	
Build	**Type**	Steam ship	
	Construction	Unknown, likely steel	
	Dimensions (m)	94.5 x 13.5 x 6.2 m	
	Shipyard	Unknown	
Loss	**Cause**	Torpedoed by a submarine on 15 June 1917. It survived the attack, having been beached to prevent sinking and undergone temporary repairs; however, it foundered while on passage to the Tees for docking and repair, and sank on 2 August 1917.	
Extent of Survival		Associated with a UKHO record for the steam ship *Teesdale* (Possibly), built in 1904 with two boilers powering a single shaft triple expansion engine. It had a gross tonnage of 2470 and at the time of loss was carrying a ballast cargo on its return from Plymouth. The wreck was last surveyed in 2017 with geophysical dimensions of 80.0 x 15.1 x 4.9 m and was described as being upright and intact, but mostly flattened. In the 2021 geophysical data the hull of the wreck is not discernible and internally indistinct low-lying mounds are visible between the interpreted bow and stern, suggesting it is highly degraded and may be buried.	



Backscatter mosaic image of wreck **7210**, looking north



MBES grid image, x 1 vertical exaggeration, looking ENE

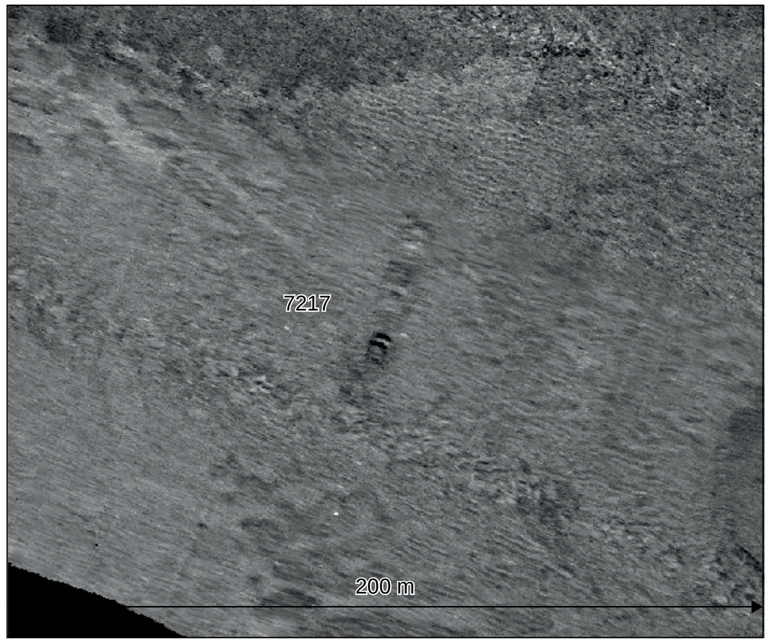


Coordinate system: ED50UTM31N

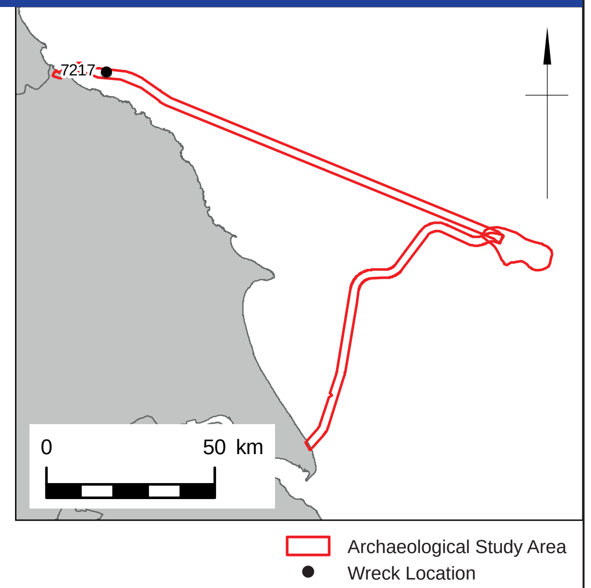
Date:	23/08/2022	Revision Number:	0
Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

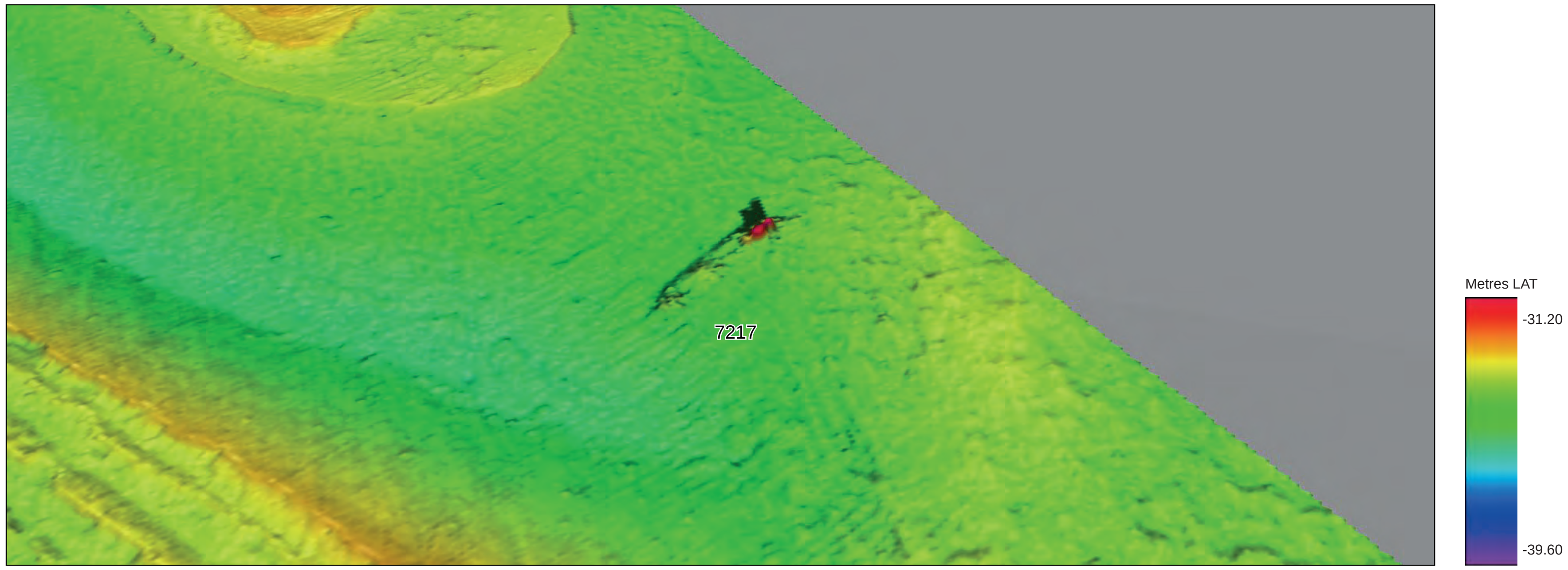
ID 7217 – UKHO 6063 – *John Miles*

Location		249133 E 6061305 N	**Area**: Teesside
Archaeological Importance		High	
Geophysical survey dimensions and notes		Wreck **7217** is a recorded wreck that corresponds with a UKHO (6063) and NRHE (908830) record for the steam ship *John Miles*. In the Backscatter mosaic the wreck is visible as an area of seabed disturbance comprising two small elongate dark reflectors with a bright reflector in-between. The wreck is orientated NNE to SSW and measures 46.4 x 10.7 x 3.3 m. In the MBES data the wreck appears mostly intact and upright. Internally multiple irregular low-lying mounds are visible within the interpreted hull. The bow appears to be to the NNE and a large and prominent mound is visible at the south-western end of the wreck, which may be a boiler or other large feature of the superstructure. The majority of the wreck does not stand proud of the seabed and it is situated within an area of large geological outcrops and escarpments. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.	
Build	**Type**	Steam ship	
	Construction	Unknown, likely steel	
	Dimensions (m)	50.0 x 9.1 x 3.7 m	
	Shipyard	Unknown	
Loss	**Cause**	Struck a mine in 1917.	
Extent of Survival		Associated with a UKHO and NRHE record for the steam ship *John Miles*, built in 1908 with one boiler and a single shaft triple expansion engine. It had a gross tonnage of 687 and at the time of loss was carrying a cargo of coal to Shoreham. The wreck was last surveyed in 2017 with geophysical dimensions of 45.9 x 9.2 x 4.3 m and described as being upright and intact, but severely disintegrated. In the 2021 geophysical data the wreck appears mostly intact and upright with some possible surviving superstructure visible at the south-western end, however, the majority of the wreck does not stand proud of the seabed.	



Backscatter mosaic image of wreck **7217**, looking north



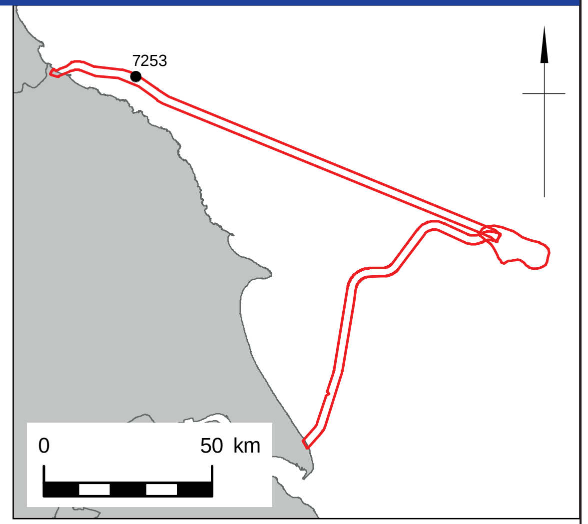


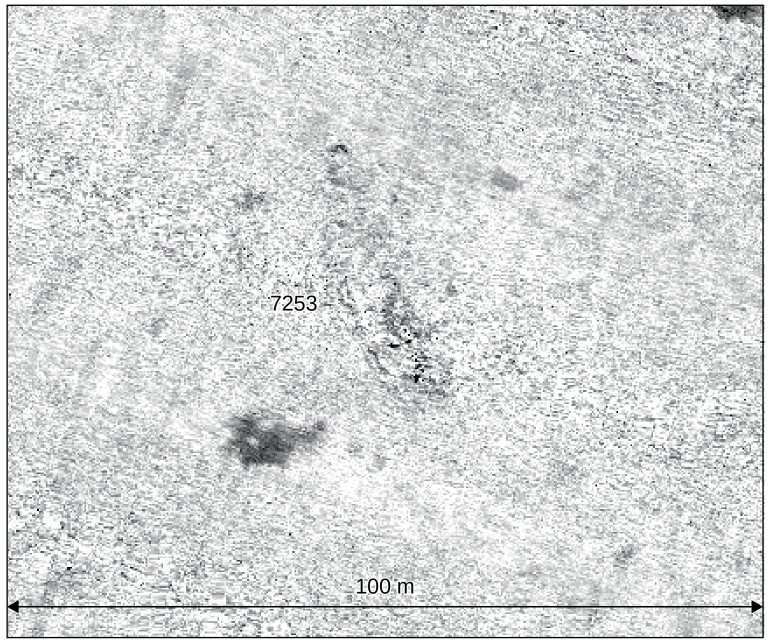
MBES grid image, x 1 vertical exaggeration, looking south-east

Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0	
	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW	
	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23			

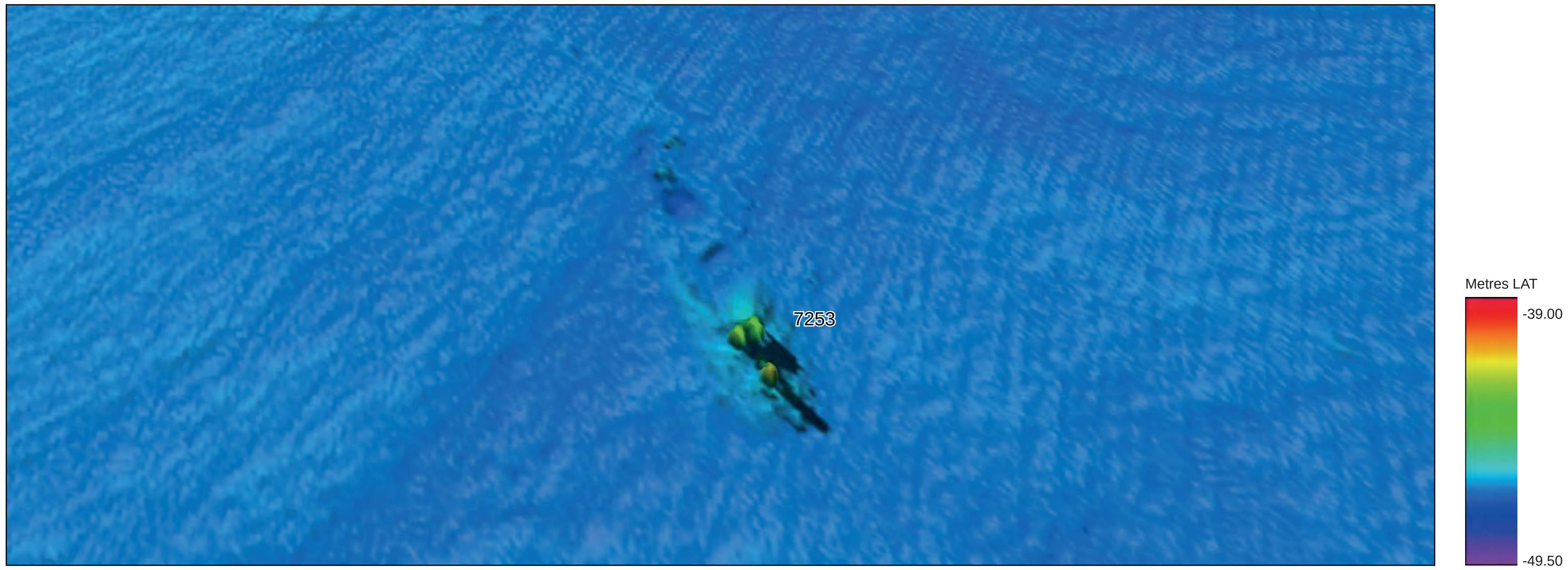
ID 7253 – UKHO 6018 – *Earl Percy*

Location		258712 E 6059647 N	**Area** Teesside
Archaeological Importance		High	
Geophysical survey dimensions and notes		Wreck **7253** is a recorded wreck that corresponds with a UKHO (6018) and NRHE (908827) record for the steam *Earl Percy*. In the backscatter mosaic data, the wreck is visible as an elongate area of seabed disturbance comprising an indistinct group of dark and bright reflectors orientated approximately north-west to south-east and measuring 75.3 x 21.9 x 4.3 m. In the MBES data the wreck appears upright and is visible as a compact, elongate area of mounds. The north-west end of the wreck is characterised by a depression surrounded by a slight perimeter representing interpreted hull, with some angular mounds at the extreme end. Three very tall mounds are visible in the south-east section of the wreck, which may represent boilers, engines or other large features of the superstructure. No debris is visible in the surrounding, relatively flat seabed. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.	
Build	**Type**	Steam ship	
	Construction	Iron	
	Dimensions (m)	72.2 x 8.6 m	
	Shipyard	Unknown	
Loss	**Cause**	Collided with *SS Gainsborough* and sank on 15 September 1888.	
Extent of Survival		Associated with a UKHO and NRHE record for *Earl Percy*, a steam ship built by Palmer Bros & Co from Jarrow. The vessel had two boilers powering a single shaft compound engine. The wreck was last surveyed in 2016 with geophysical dimensions of 74.0 x 8.2 x 5.0 m, and described as being upright and intact, but severely disintegrated. In the 2021 geophysical data the wreck appears to be upright and mostly intact but highly degraded.	





Backscatter mosaic image of wreck **7253**, looking north



MBES grid image, x 1 vertical exaggeration, looking north

Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

ID 7260 – UKHO 6353 – Unknown

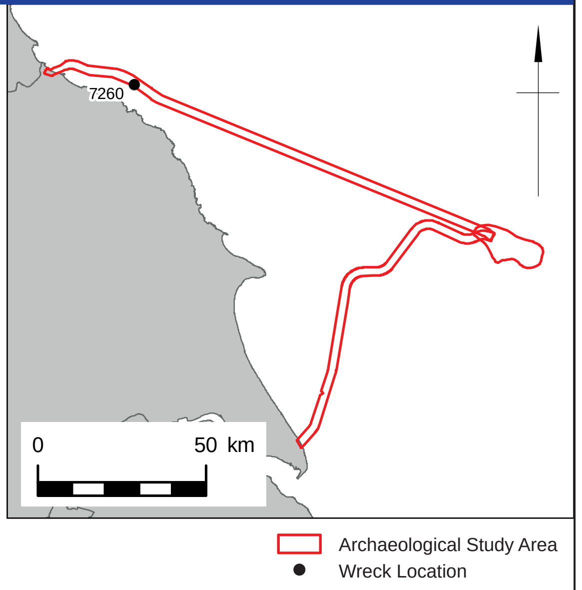
<table>
<tr><td colspan="2">Location</td><td>259927 E 6056931 N</td></tr>
<tr><td colspan="2">Area</td><td>Teesside</td></tr>
<tr><td colspan="2">Archaeological Importance</td><td>High</td></tr>
<tr><td colspan="2">Geophysical survey dimensions and notes</td><td>Wreck 7260 corresponds with a UKHO (6353) and NRHE (908606) record for an unknown wreck.

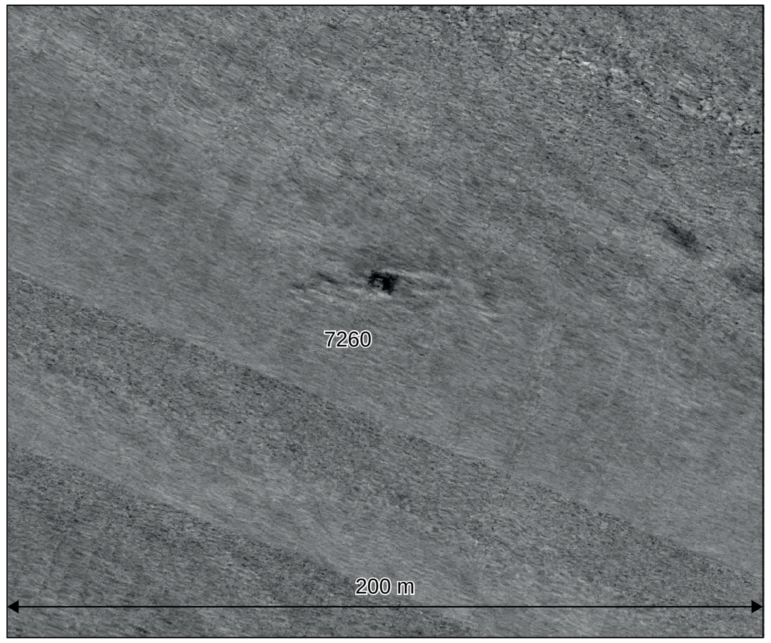
In the Backscatter mosaic data, the wreck is visible as an area of seabed disturbance comprising an indistinct area of very high reflectivity, with a distinct, roughly square shaped dark reflector visible in the centre. The wreck measures 61.6 x 23.1 x 1.1 m and is orientated approximately east to west.

In the MBES data the wreck is visible as a large spread of uneven seabed comprising a number of highly angular mounds. The largest mound measure 8.2 x 5.0 m and is situated in the centre of the wreck.

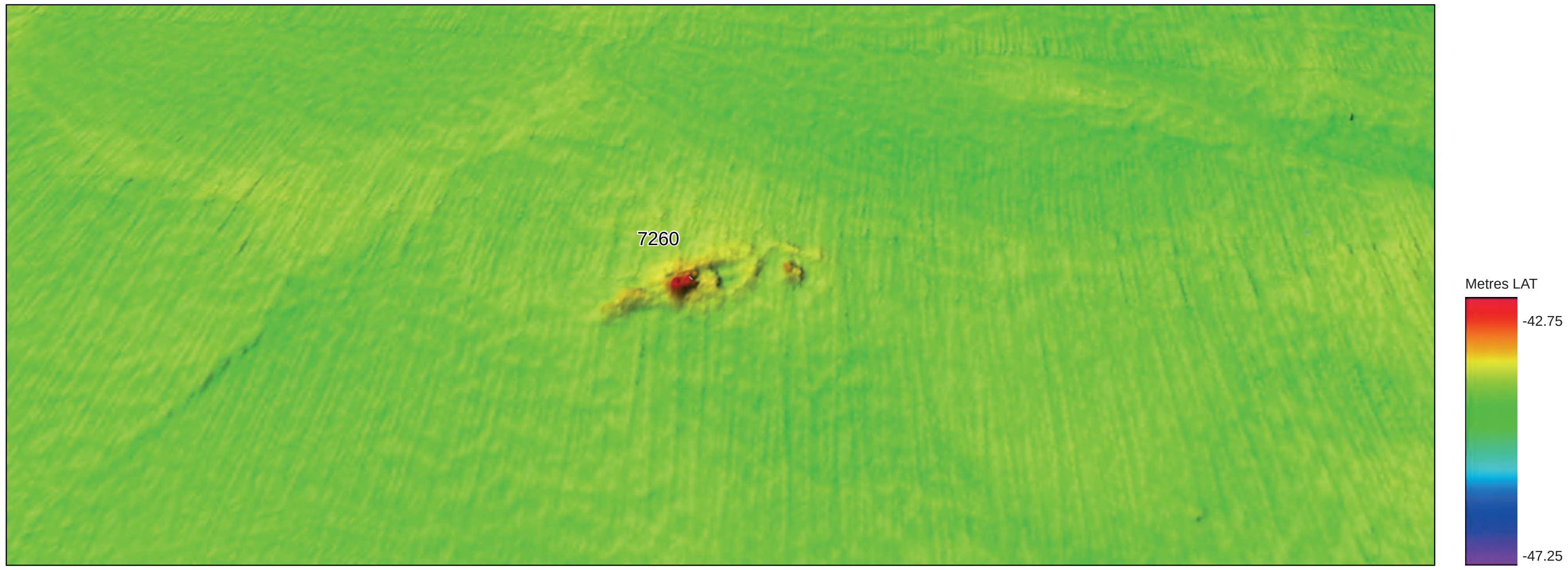
This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.</td></tr>
<tr><td rowspan="4">Build</td><td>Type</td><td>Unknown</td></tr>
<tr><td>Construction</td><td>Unknown</td></tr>
<tr><td>Dimensions (m)</td><td>Unknown</td></tr>
<tr><td>Shipyard</td><td>Unknown</td></tr>
<tr><td>Loss</td><td>Cause</td><td>Unknown</td></tr>
<tr><td colspan="2">Extent of Survival</td><td>Associated with a UKHO and NRHE record for an unknown wreck first identified in 1987. It was examined by trisponder in 1989 and described as being very decayed with a high point at the western end. It was observed again in 1995, one or two large square boilers were noted. The wreck was last surveyed in 2016 with geophysical dimensions of 53.1 x 6.8 x 4.0 m and described as being as well broken up.

In the 2021 geophysical data the wreck appears to be upright, although the hull is not defined or prominent above the seabed, suggesting it may be buried or highly degraded.</td></tr>
</table>





Backscatter mosaic image of wreck **7260**, looking north

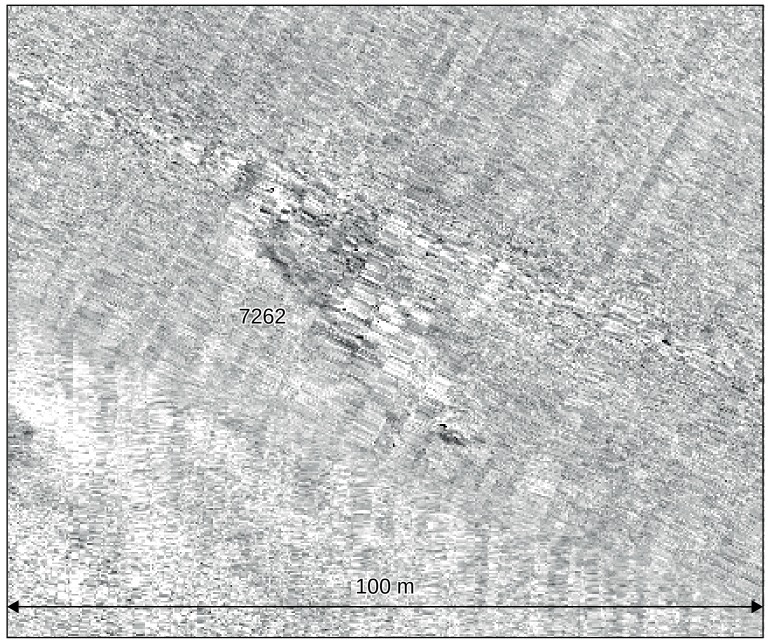


MBES grid image, x 2 vertical exaggeration, looking north

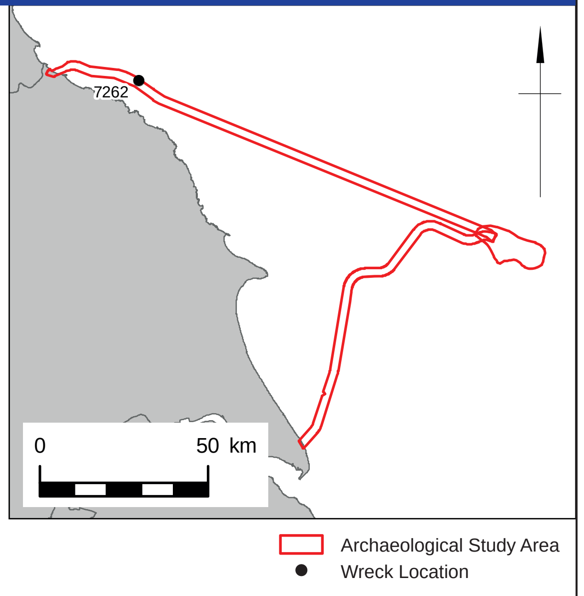
Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

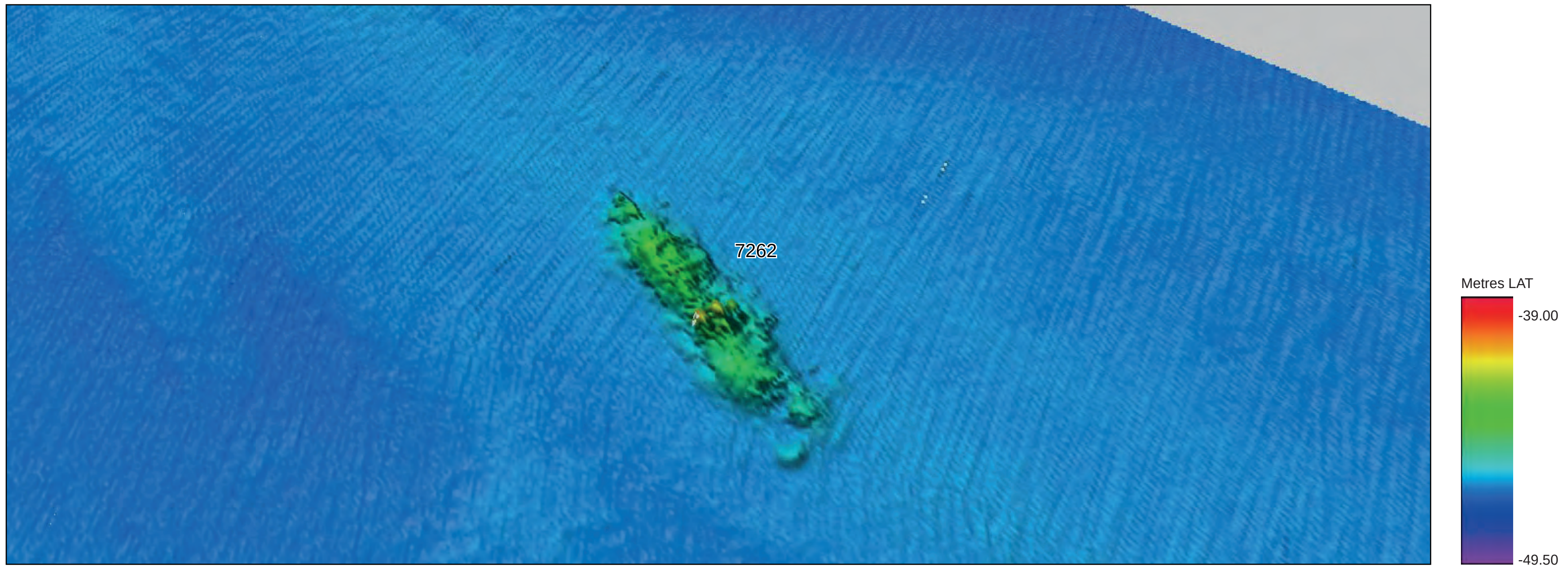
ID 7262 – UKHO 6057 – *Afrique*

Location	260730 E 6058476 N	**Area**	Teesside
Archaeological Importance	High		
Geophysical survey dimensions and notes	Wreck **7262** is a recorded wreck that corresponds with a UKHO (6057) and NRHE (909237) record for the steam ship *Afrique*. In the Backscatter mosaic data, the wreck is visible as a large, elongate area of seabed disturbance measuring 102.6 x 30.2 x 4.6 m and comprises dark and bright reflectors in an approximate oval shape. The wreck is orientated north-west to south-east. In the MBES data the wreck is visible as a very large, upright wreck located on a relatively featureless area of seabed. The wreck appears mostly intact, though there is evidence of collapse around the interpreted hull. Internally, multiple angular mounds are visible and likely represent broken up deck and debris features. Three very prominent mounds are located at the centre of the wreck which may represent engine or boiler remains. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.		
Build – **Type**	Steam ship		
Build – **Construction**	Unknown, likely steel		
Build – **Dimensions (m)**	89.9 x 12.5 x 6.1 m		
Build – **Shipyard**	Unknown		
Loss – **Cause**	Torpedoed by *UC 40* in 1918.		
Extent of Survival	Associated with a UKHO and NRHE record for *Afrique*, a steam ship with a gross tonnage of 2457. The wreck was last surveyed in 2016, with geophysical dimensions of 95.7 x 19.8 x 4.7 m and described as being upright and intact, but severely disintegrated. In the 2021 geophysical data the wreck appears mostly intact and upright, but highly degraded with evidence of collapse around the interpreted hull.		



Backscatter mosaic image of wreck **7262**, looking north



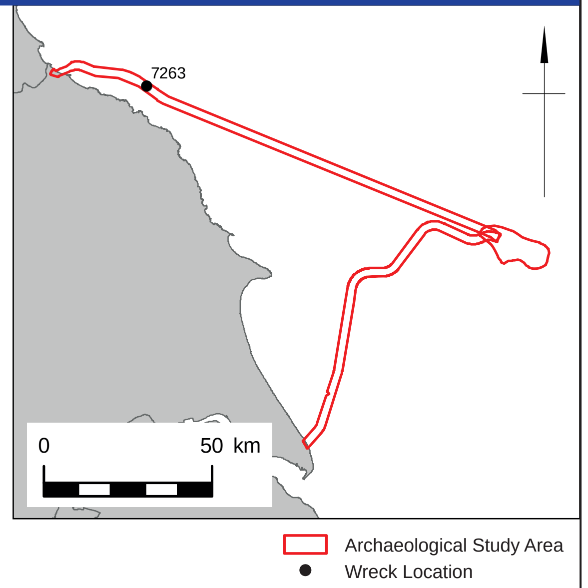


MBES grid image, x 1 vertical exaggeration, looking north

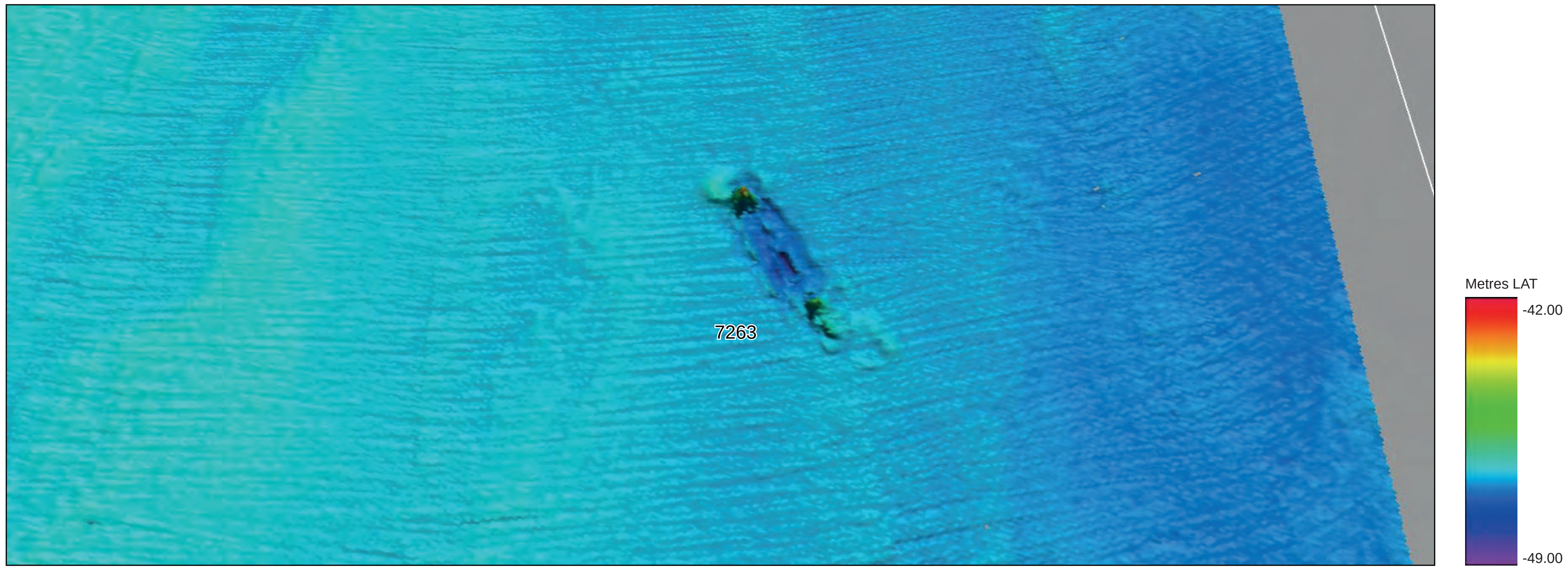
Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0	
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW	
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23			

ID 7263 – UKHO 6351 – *Audax*

Location		261810 E 6057750 N	**Area**	Teesside
Archaeological Importance		High		
Geophysical survey dimensions and notes		Wreck **7263** is recorded wreck that corresponds with a UKHO (6351) and NRHE (936953) record for the steam ship *Audax*. The wreck is visible in the Backscatter mosaic data as a distinct, slightly elongate and irregular area of disturbed seabed measuring 72.2 x 19.9 x 3.3 m. The wreck comprises indistinct dark reflectors with some bright reflectors visible, suggesting multiple objects. In the MBES dataset the wreck is visible as a distinct, likely upright wreck orientated approximately east to west and lying on a relatively featureless area of seabed. Internally, slightly irregular linear mounds are visible, two large mounds are visible at either end of the wreck, which are likely remnant boilers or other parts of the superstructure. Some minor disturbed seabed and scour is present surrounding the interpreted hull. The majority of the wreck is only 0.1 - 0.5 m above the surrounding seabed level, suggesting it is heavily degraded or buried. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.		
MBES-	**Type**	Steam ship		
	Construction	Unknown, likely steel		
	Dimensions (m)	64.2 x 10.6 x 3.9 m		
	Shipyard	Kon Maats De Schelde, Vlissingen (Flushing)		
Loss	**Cause**	Torpedoed by *UB 80*		
Extent of Survival		Associated with a UKHO and NRHE record for *Audax*, a one boiler, single-shaft triple expansion engine steam ship. The vessel was sailing for the Tyne from Rouen when it was sunk by *UB 80* in September, 1918. The wreck was last surveyed in 2016 with geophysical dimensions of 70.0 x 11.5 x 5.6 m and described as being severely disintegrated. In the 2021 data the wreck appears mostly intact but highly degraded.		



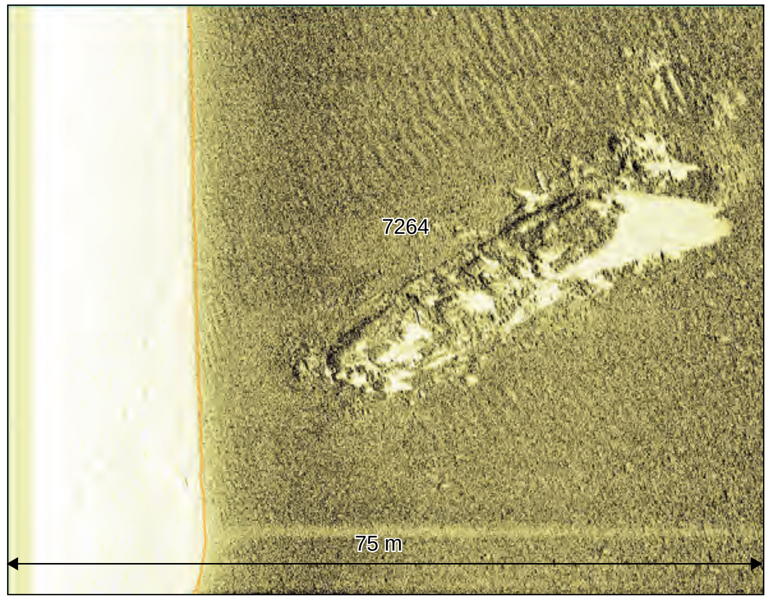
Backscatter mosaic image of wreck 7263, looking north



MBES grid image, x 1 vertical exaggeration, looking west

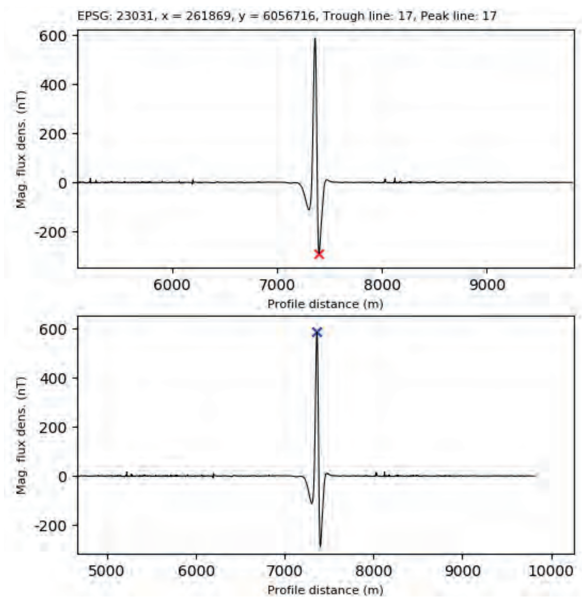
ID 7264 – UKHO 6355 – *Rutil*

Location	261883 E 6056726 N	**Area**	Teesside
Archaeological Importance	High		
Geophysical survey dimensions and notes	Wreck **7264** corresponds with a UKHO (6355) and NRHE (908603) record for the steam ship *Rutil*. In the SSS data the wreck is orientated approximately north-west to south-east on the seabed and appears to be mostly intact, measuring 51.5 x 15.7 x 3.1 m. A thick curvilinear dark reflector is visible, interpreted to be the hull, the south-western edge of the hull is not coherent and may be collapsed. Internally, linear and small angular dark reflectors are visible, some with significant height. The wreck is visible in the MBES dataset as a very large, distinct, and upright wreck. The wreck has tall mounds at the north-west and south-east ends, possibly indicating surviving superstructure. The wreck has multiple associated items of debris identified in the vicinity and sediment build-up is visible surrounding all sides of the wreck, up to a distance of 10.0 m and a height of 0.5 m. The wreck has a very large magnetic anomaly associated with it, measuring 874 nT, indicating substantial ferrous material is present.		
Build	**Type**	Steam ship	
	Construction	Steel	
	Dimensions (m)	Unknown	
	Shipyard	Unknown	
Loss	**Cause**	Disappeared, presumed sunk by mine	
Extent of Survival	Associated with a UKHO and NRHE record for *Rutil*, a steam ship with a single boiler and triple expansion engine. The vessel disappeared in September 1916 and is presumed to have struck a mine and sunk. The wreck was last surveyed in 2016 with geophysical dimensions of 63.9 x 12.0 x 2.9 m and was described as being upright and intact but well disintegrated. In the 2021 data the wreck appears upright and mostly intact with associated items of debris identified in the vicinity. The wreck is situated within an area of mobile sediments, which may periodically bury the wreck and any associated debris.		

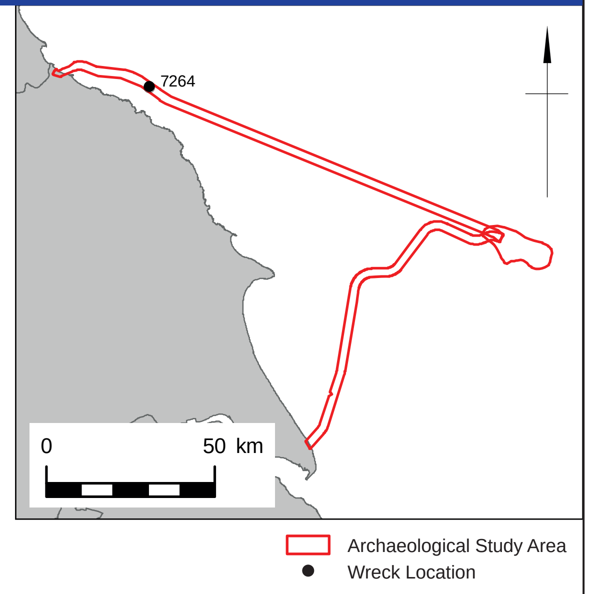


SSS waterfall image of wreck **7264**, looking south-east, 75 m range per channel

MBES grid image, x 1 vertical exaggeration, looking north-west



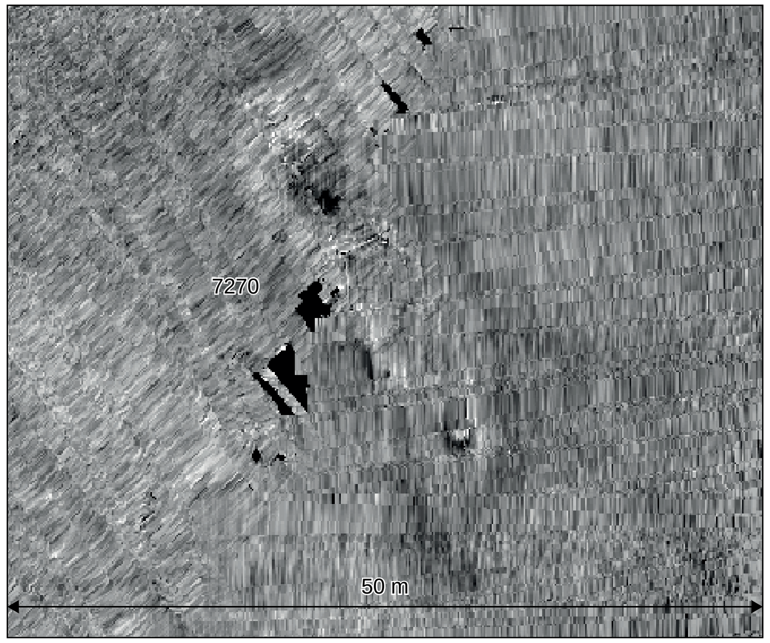
Mag profile image



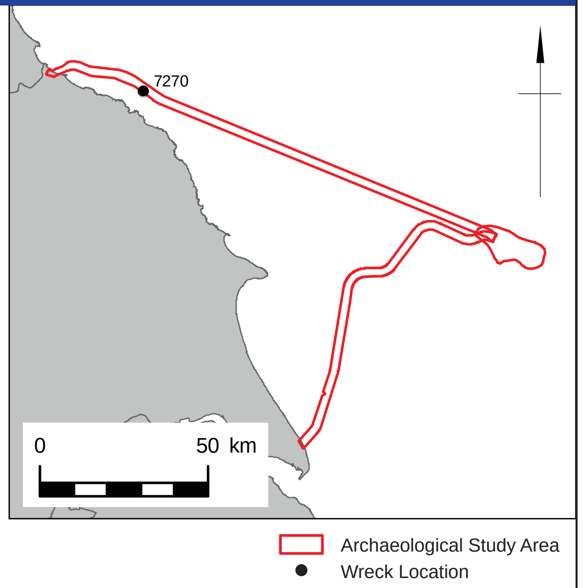
Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

ID 7270 – UKHO 6362 – Unknown

Location		262099 E 6055310 N	**Area**	Teesside
Archaeological Importance		High		
Geophysical survey dimensions and notes		Wreck **7270** is a recorded wreck that corresponds with a UKHO (6362) and NRHE (908602) record for an unknown wreck. The wreck is visible in the Backscatter mosaic data as an indistinct area of high reflectivity orientated north-west to south-east on the seabed, measuring 57.5 x 17.7 x 3.6 m. In the MBES data the wreck is visible as a large, upright and mostly intact wreck. The interpreted hull of the wreck is distinct, internally linear mounds are visible interpreted to be surviving deck structure. At the north-west end of the wreck (likely bow) a large mound is visible measuring 9.8 x 6.7 x 3.6 m. Indistinct mounds are visible directly on either side of the hull, that might be collapsed structure and the wreck has significant scour at both ends. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.		
Build	**Type**	Steam ship		
	Construction	Unknown		
	Dimensions (m)	Unknown		
	Shipyard	Unknown		
Loss	**Cause**	Unknown		
Extent of Survival		Associated with a UKHO and NRHE record for an unknown steam ship first identified in 1987. The wreck was last surveyed in 2016 with geophysical dimensions of 55.5 x 9.3 x 4.6 m and described as being upright and intact, but severely disintegrated. In the 2021 data the wreck appears upright and mostly intact, with some surviving superstructure. The wreck is situated within an area of mobile sediment, which may periodically bury the wreck and any associated debris.		



Backscatter mosaic image of wreck **7270**, looking north

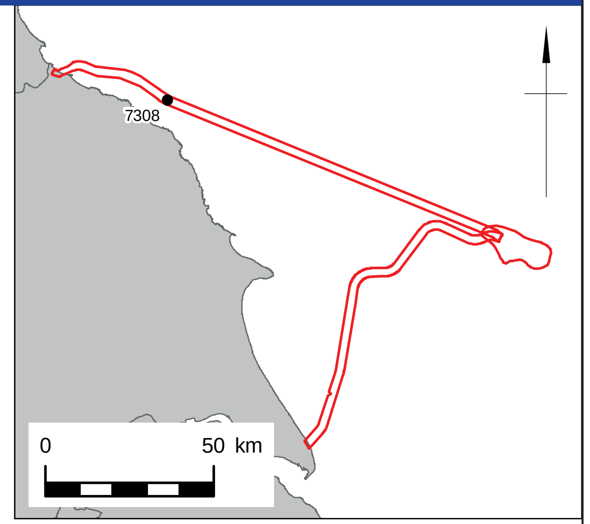


MBES grid image, x 1 vertical exaggeration, looking north

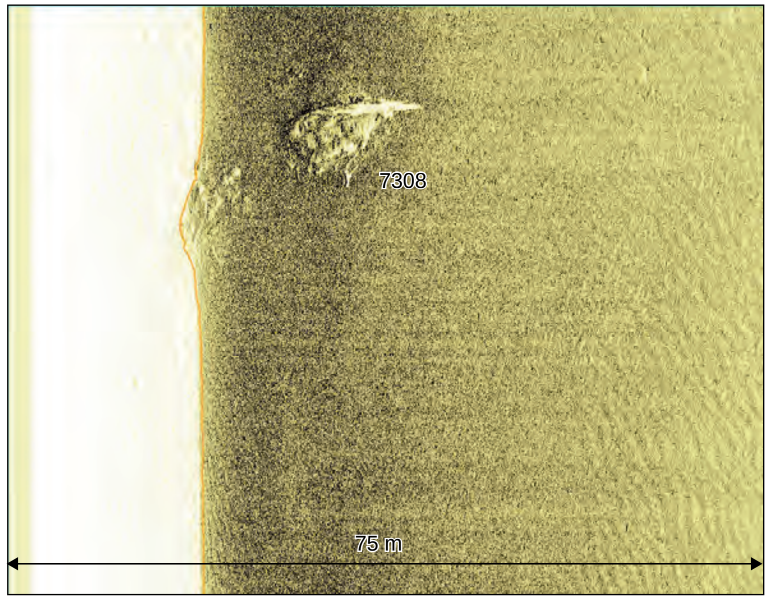
Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0	
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW	
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23			

ID 7308 – UKHO 6039 – *Gwalia* (Possibly)

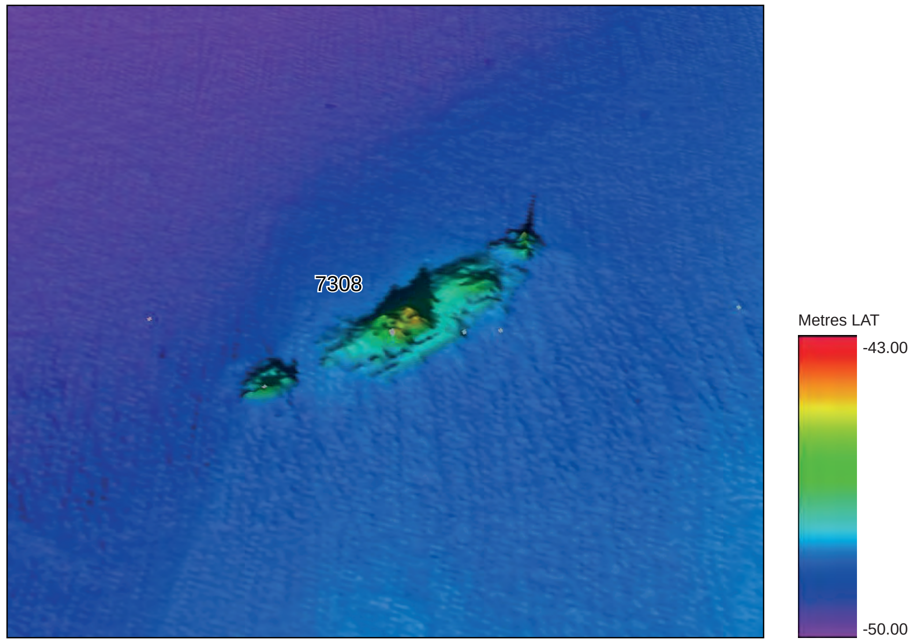
Location		267616 E 6052571 N **Area** Teesside	
Archaeological Importance		High	
Geophysical survey dimensions and notes		Wreck **7308** corresponds with a UKHO (6039) and NRHE (908594) record for the steam ship *Gwalia* (Possibly). In the SSS data the wreck is visible as a large, upright wreck comprising a thick curvilinear dark reflector interpreted to be the hull, measuring 88.2 x 25.3 x 4.8 m. The dark reflector appears disjointed in places, suggesting it is broken up or degraded. Internally multiple linear, angular and rounded dark reflectors with shadows are visible, interpreted as surviving deck structure. The wreck is orientated approximately north to south, the northern-most end of the wreck has come away from the main structure with a 4.0 m gap in-between, this section of bow or stern measures 15.9 x 15.0 x 4.8 m. In the MBES dataset the wreck has multiple distinct mounded features within the interpreted hull, some linear features are visible. In the centre of the wreck a large mound measuring 11.3 x 10.1 x 2.8 m is visible indicating surviving superstructure. The southern end of the wreck is highly degraded and there are multiple items of associated debris identified in the vicinity. The wreck has a very large Mag. anomaly associated with it, measuring 8847 nT, indicating substantial ferrous material is present.	
Build	**Type**	Steam ship	
	Construction	Unknown, likely steel	
	Dimensions (m)	73.2 x 10.1 x 5.2 m	
	Shipyard	W Pickersgill and Sons, Sunderland	
Loss	**Cause**	Sank after collision off Whitby	
Extent of Survival		Associated with a UKHO and NRHE record for *Gwalia* (Possibly), a steam ship built in 1881, the vessel sank after a collision off Whitby during passage from the Tyne to Bordeaux in 1907. The wreck was last surveyed in 2016 with geophysical dimensions of 85.3 x 15.2 x 4.9 m and was described as being severely disintegrated and broken up into three pieces, with the bow and the stern having fallen onto the seabed, but the midship section still upright. In the 2021 geophysical data the larger width measurement suggests the wreck has degraded further. The wreck is surrounded by sediment accumulation, that may periodically bury the wreck and associated debris.	



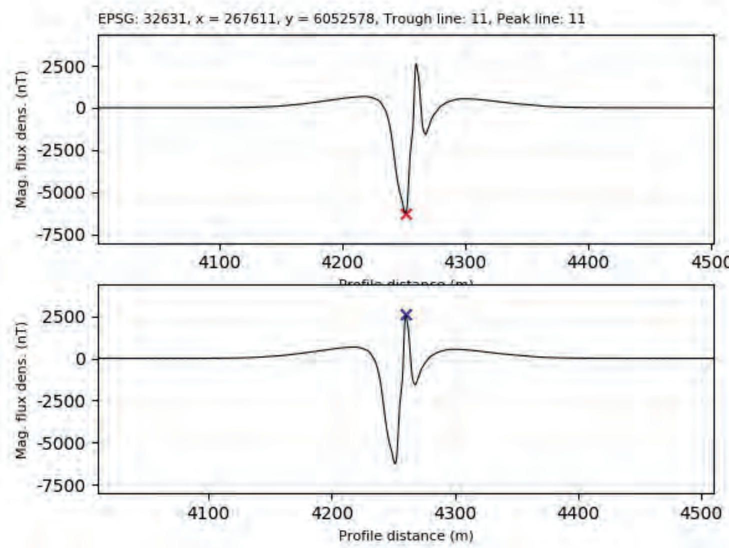
Archaeological Study Area
Wreck Location



SSS waterfall image of wreck **7308**, looking north, 75 m range per channel



MBES grid image, x 1 vertical exaggeration, looking south-east

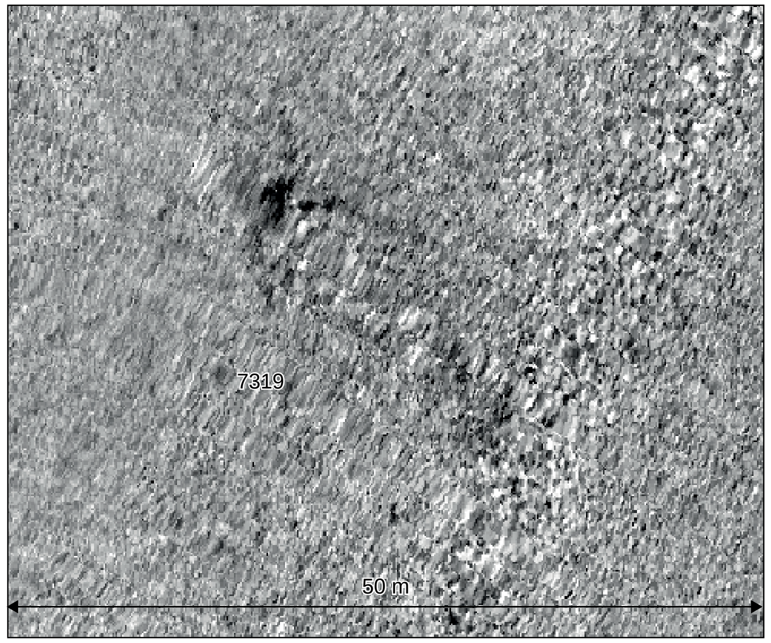


Mag profile image

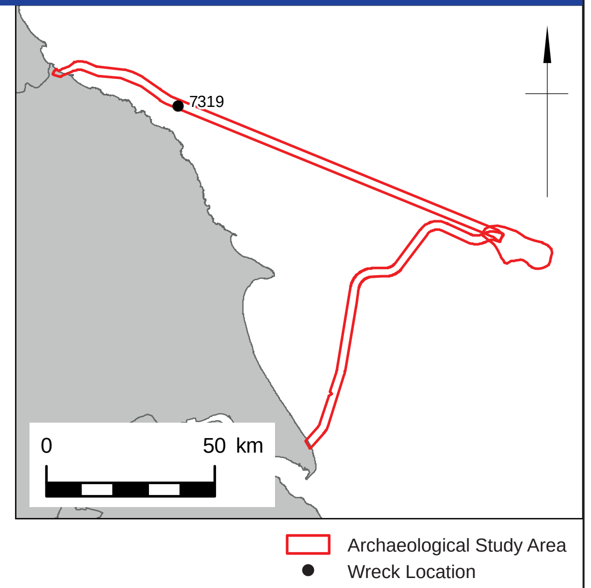
Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

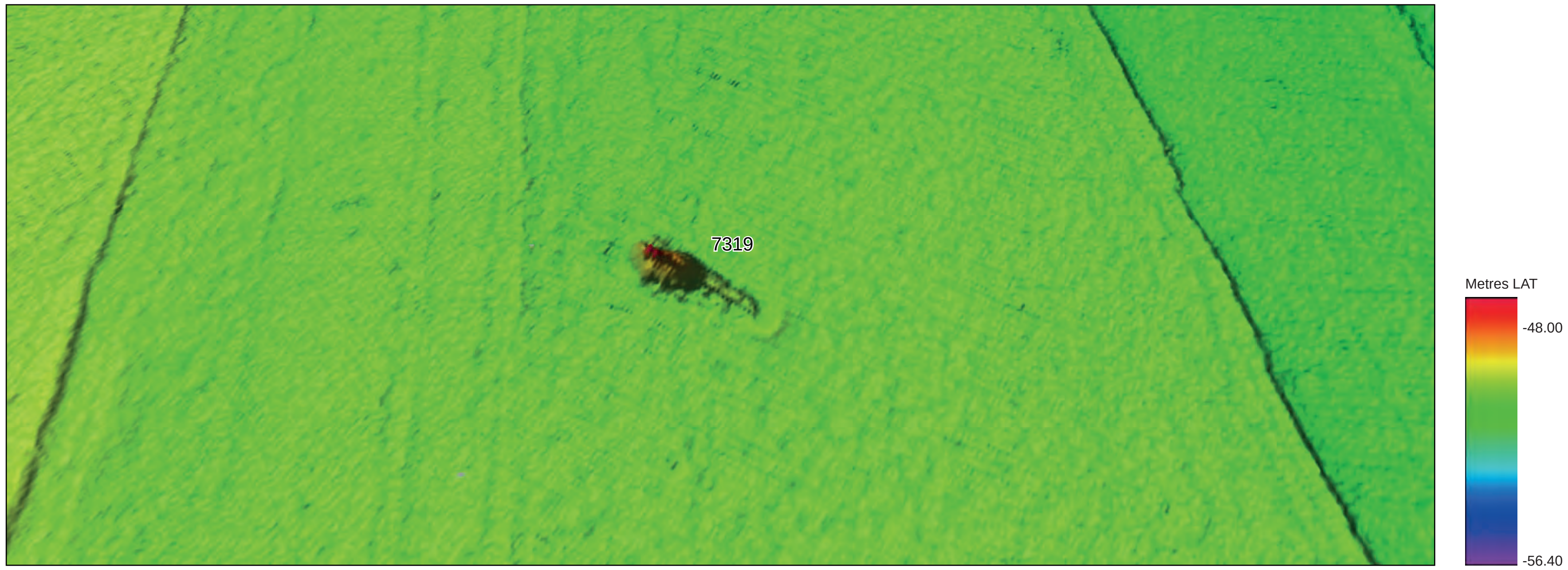
ID 7319 – UKHO 87230 – Unknown

Location	270387 E 6050868 N	**Area**	Teesside
Archaeological Importance	High		
Geophysical survey dimensions and notes	Wreck **7319** corresponds with a UKHO (87230) and NRHE (909229) for an unknown wreck. In the Backscatter mosaic data, the wreck is visible as a large and indistinct area of seabed disturbance measuring 42.3 x 16.7 x 3.0 m and comprising as an area of high reflectivity with no defined edge. In the MBES data the wreck is visible as a large irregular oval-shaped mound, orientated north-west to south-east. The north-western section of the wreck is more prominent and distinct than the southern end, which has little height off the surrounding seabed, suggesting it is highly degraded or buried. The south-east edge of the wreck is situated within an area of scour up to 0.4 m deep. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.		
Build – **Type**	Unknown		
Build – **Construction**	Unknown		
Build – **Dimensions (m)**	Unknown		
Build – **Shipyard**	Unknown		
Loss – **Cause**	Unknown		
Extent of Survival	Associated with a UKHO record for an unknown wreck first identified in 2016 with geophysical dimensions of 38.4 x 12.2 x 4.5 m and described as being upright but severely disintegrated. In the 2021 geophysical data the wreck appears upright and mostly intact but highly degraded. The wreck is situated within an area of mobile sediment that may periodically conceal the wreck and any associated debris.		



Backscatter mosaic image of wreck **7319**, looking north





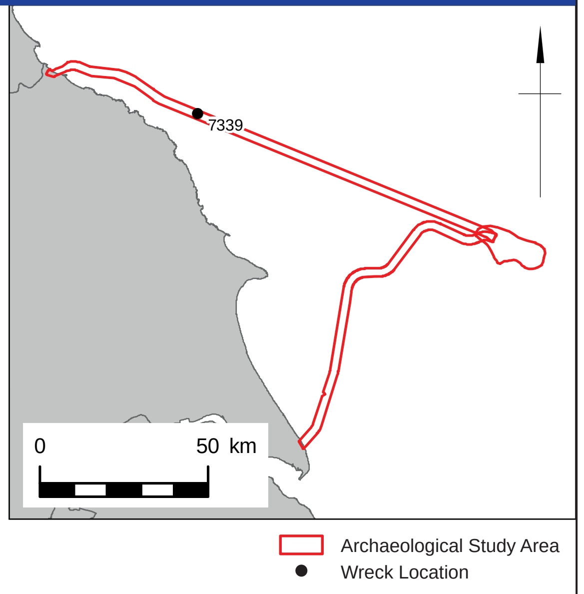
MBES grid image, x 1 vertical exaggeration, looking north

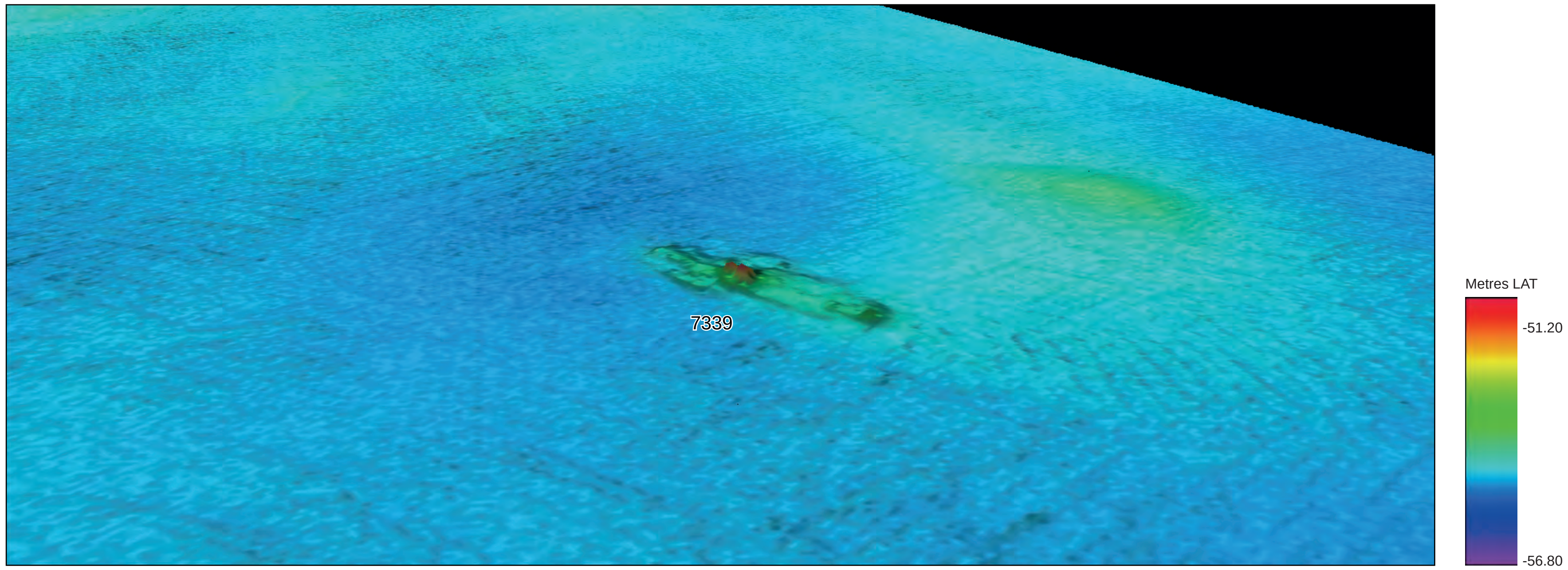
Date:	23/08/2022	Revision Number:	0
Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

ID 7339 – UKHO 6226 and 66452 – *Black Prince* (Possibly)

Location	278244 E 6048535 N	**Area**	Teesside
Archaeological Importance	High		
Geophysical survey dimensions and notes	Wreck **7339** is a recorded wreck that corresponds with a UKHO (6226 and 66452) and NRHE (909221) record for a sailing vessel, *Black Prince* (Possibly). In the Backscatter mosaic data, the wreck is visible as an indistinct area of seabed disturbance measuring 65.4 x 20.2 x 4.1 m, comprising an elongate dark reflector, with some possible more distinct features within. A distinct bright reflector is visible on the west edge of the wreck measuring 4.8 x 2.6 m. In the MBES data the wreck is visible as a large, upright and mostly intact wreck orientated north to south. Internally the wreck is an uneven surface, with two distinct mounds visible in the centre, measuring approximately 4.0 x 3.5 x 2.5 m, indicating surviving superstructure. There is no apparent scouring or sediment build up surrounding the wreck, though the southern end of the wreck does not stand proud of the seabed and may be buried or highly degraded. This location was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.		
Build	**Type**	Sailing vessel	
	Construction	Wooden	
	Dimensions (m)	29.6 x 7.0 x 5.2 m	
	Shipyard	Unknown	
Loss	**Cause**	Collision with *SS Larch* in 1890	
Extent of Survival	Associated with a UKHO and NRHE record for the *Black Prince* (Possibly), a wooden sailing vessel built in 1838. The vessel was owned at the time of loss by R. K. Smith, on passage from Hartlepool for Portsmouth it collided with *SS Larch* and sunk with a cargo of coal in 1890.The wreck was first identified in 1986 and last surveyed in 2016 with geophysical dimensions of 63.4 x 10.6 x 5.0 m, and was described as being upright and intact, but severely disintegrated. UKHO record 66452 is considered to be the same wreck as 6226. In the 2021 geophysical data the wreck is upright and mostly intact. Surviving superstructure is visible in the centre of the wreck and the southern end may be buried or highly degraded.		

Backscatter mosaic image of wreck **7339**, looking north



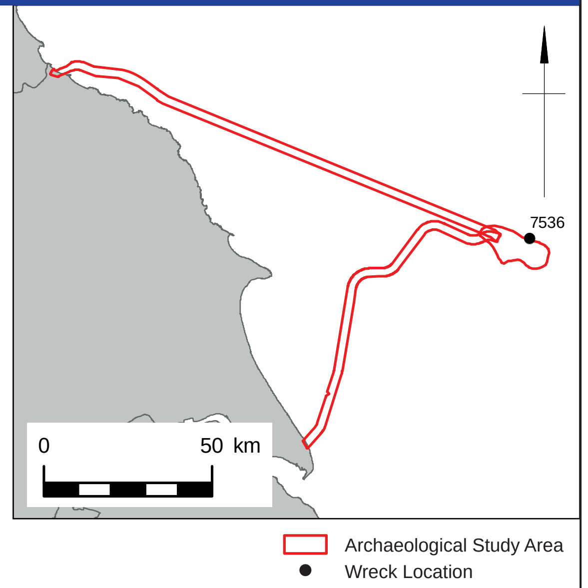


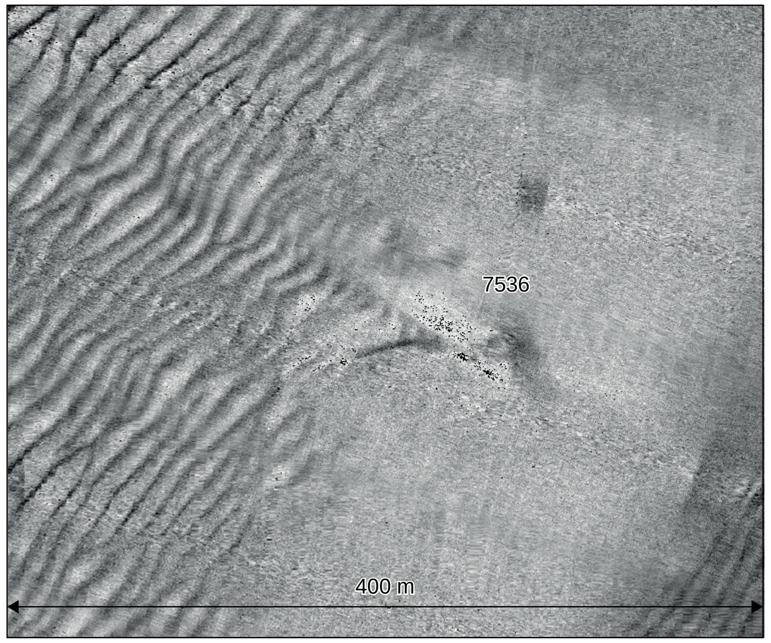
MBES grid image, x 1 vertical exaggeration, looking south-west

Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

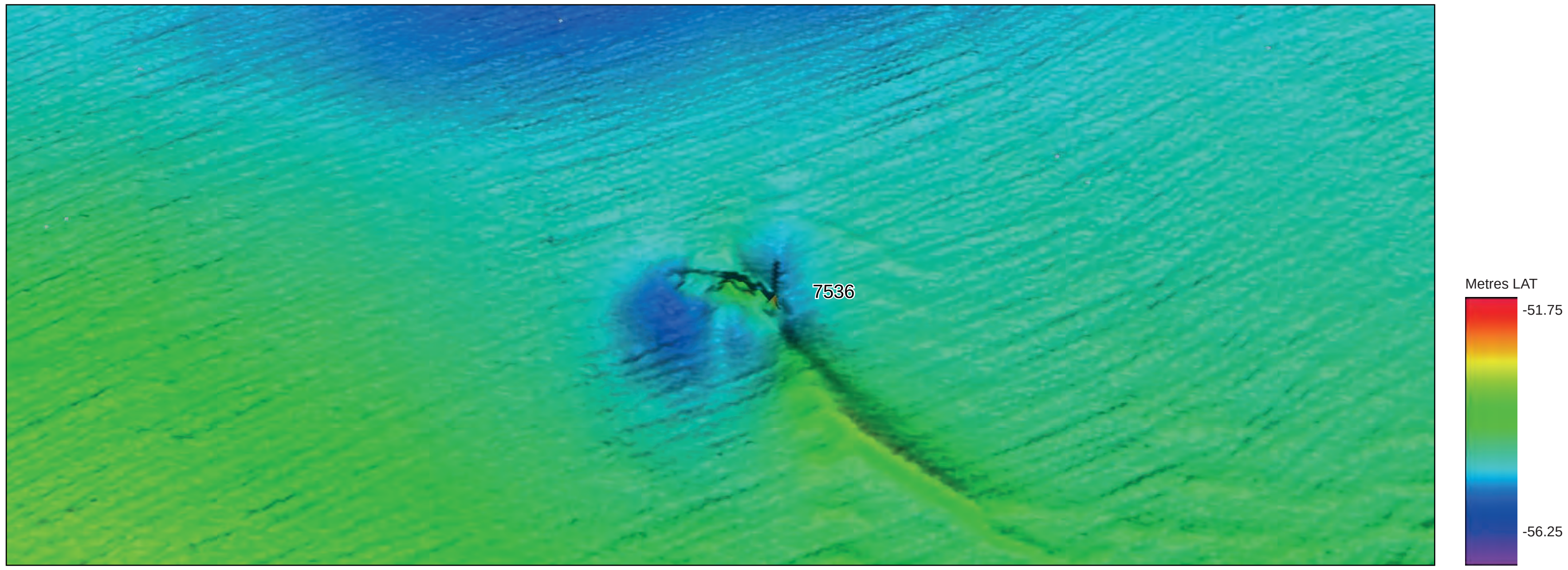
ID 7536 – UKHO 6832 – Unknown

Location		376037 E 6011477 N **Area** Endurance Store	
Archaeological Importance		High	
Geophysical survey dimensions and notes		Wreck **7536** is a charted wreck that corresponds with a UKHO record (6832) for an unknown wreck. In the Backscatter mosaic data the wreck is visible as an area of seabed disturbance comprising dark and bright reflectors measuring 31.4 x 7.3 x 1.3 m. In the MBES data the wreck appears upright and is visible as a distinct, elongate mound with an uneven peak orientated north-east to south-west. The tallest point of the wreck is situated at the south-west end, with a slightly taller central area of surviving superstructure visible. There are large mobile sand waves to the west of the wreck. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.	
Build	**Type**	Unknown	
	Construction	Unknown	
	Dimensions (m)	Unknown	
	Shipyard	Unknown	
Loss	**Cause**	Unknown	
Extent of Survival		Associated with a UKHO record first identified in 1981. The wreck was last surveyed in 1985 using hyperfix, the wreck had dimensions of 40.0 x 12.0 x 2.6 m and was described as lying in two parts with the smaller part approximately7.0 m to the south-east. In the 2021 geophysical the wreck appears upright, with some surviving superstructure visible. The wreck is situated within large mobile sand waves, which may periodically cover the wreck and any associated debris. The smaller geophysical dimensions in the 2021 survey may indicate it is partially buried and so the dimensions should be considered a minimum.	





Backscatter mosaic image of wreck **7536**, looking north

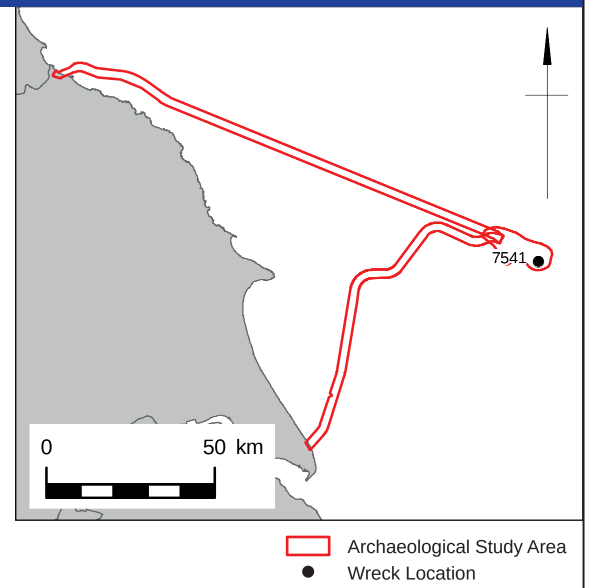


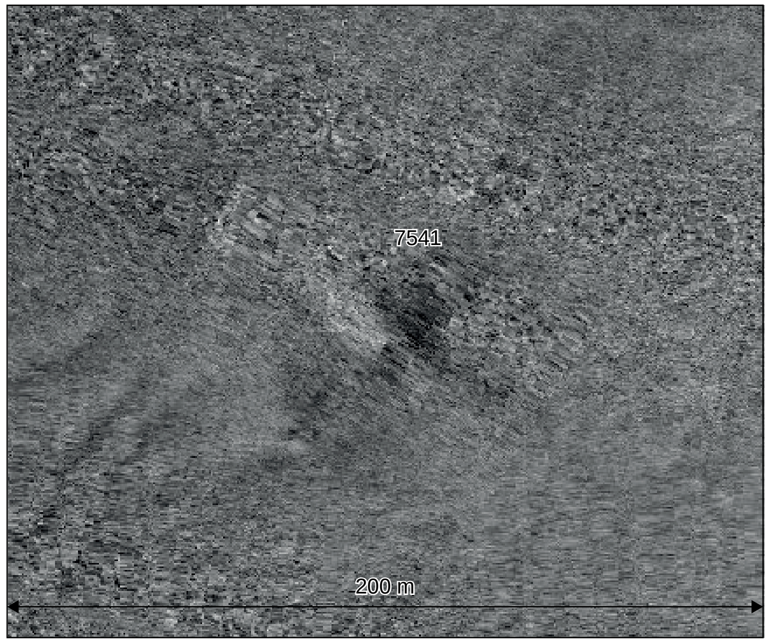
MBES grid image, x 3 vertical exaggeration, looking south-east

Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0	
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW	
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23			

ID 7541 – UKHO 6830 – Unknown

Location		377671 E 6005054 N	**Area**	Endurance Store
Archaeological Importance		High		
Geophysical survey dimensions and notes		Wreck **7541** is charted wreck that corresponds with a UKHO record (6830) for an unknown wreck. In the Backscatter mosaic data, the wreck is visible as a large area of seabed disturbance, measuring 28.5 x 8.1 x 1.8 m and comprising areas of low and high reflectivity. The wreck is distinct to the surrounding seabed and situated within large mobile sand waves. A possible dark reflector is visible in the southern end of the wreck measuring 5.3 x 2.9 m. Also identified in the MBES data a large, elongate mound with a slightly uneven peak, the tallest point of the wreck is at the south-western end. The wreck appears intact and is orientated approximately north-east to south-west, with some minor scour surrounding it. This position was not directly covered by the SSS or Mag. datasets, so it is not possible to ascertain whether ferrous material is present at this location.		
Build	**Type**	Unknown		
	Construction	Unknown		
	Dimensions (m)	Unknown		
	Shipyard	Unknown		
Loss	**Cause**	Unknown		
Extent of Survival		Associated with a UKHO record for an unknown wreck, first identified in 1981. The wreck was last surveyed in 1985 with geophysical dimensions of 36.0 x 16.0 x 2.6 m and was noted to be intact, with a sand wave located to the north-west. In the 2021 geophysical data the wreck appears intact, and may be upright though this is unclear. The smaller dimensions recorded suggests the wreck has degraded since the 1985 survey and be partially buried, and so the dimensions should be considered a minimum.		





Backscatter mosaic image of wreck **7541**, looking north

MBES grid image, x 3 vertical exaggeration, looking north

Coordinate system: ED50UTM31N	Date:	23/08/2022	Revision Number:	0
Contains Ordnance Survey data © Crown copyright and database right 2022.	Scale:	Location 1:2,250,000 @ A3	Illustrator:	AW
This material is for client report only © Wessex Archaeology. No unauthorised reproduction.	Path:	\\Edinburgh\wessex\Projects\254111\Graphics_Office\Rep figs\Geo\2022_08_23		

Appendix J: Underwater Sound Modelling

REPORT

Underwater Sound Modelling for the Northern Endurance Partnership Project

Prepared for: bp

Prepared by: Genesis
1 St Paul's Churchyard
London EC4M 8AP
Tel: +44 [0]20 7585 5555
www.genesisenergies.com

Project Title: Northern Endurance Partnership Offshore FEED
Document / Rev No.: 203154C-000-RT-1900-00005 Rev A02
Client Document No.: NS051-EV-REP-040-00005 Rev A02
Security Level: General

Rev	Date	Description	Issued by	Checked by	Approved by	Client Approval
0B1	17/06/2022	Issued for IDC	AMi	MLa		
A01	20/06/2022	Issued for client review	AMi	MLa	WPi	
A02	23/06/2022	Issued for client review	AMi	MLa	WPi	

Contents

1.0 INTRODUCTION 9
2.0 SOUND MODELLING METHODOLOGY 10
2.1 Source Characterisation 10
2.1.1 Seismic Source Array 10
2.1.2 Piling 16
2.2 Sound Propagation Model 18
2.2.1 Parabolic Equation Algorithm 19
2.2.2 Ray Tracing Algorithm 19
2.2.3 Environmental Data 20
3.0 IMPACT ASSESSMENT METHODOLOGY 23
3.1 Marine Mammals 23
3.1.1 PTS 23
3.1.2 Disturbance 25
3.2 Fish 27
3.2.1 Injury 27
3.2.2 Behavioural Disturbance 27
4.0 MODELLING RESULTS AND IMPACT ASSESSMENT 29
4.1 Seismic Survey 29
4.1.1 Marine Mammals 29
4.1.2 Fish 40
4.1.3 SNS SAC 42
4.2 Piling 43
4.2.1 Marine Mammals 43
4.2.2 Fish 56
4.2.3 SNS SAC 60
5.0 CONCLUSIONS 62
REFERENCES 63
APPENDIX A: AUDITORY WEIGHTED SEL FOR PILING 67

Figures & Tables

Figures

Figure 1-1: NEP CCS Project location 9
Figure 2-1: Modelled far-field time domain pressure signatures vertically below the arrays. 11
Figure 2-2: Modelled far-field third octave (deci-decidal) band SELs vertically below the arrays. 12
Figure 2-3: Depiction of difference between near field sound levels derived from back propagation and actual near field sound levels. 14
Figure 2-4: Predicted inline SEL spectral density directivity of the 400 cu. in source array. . 15
Figure 2-5: Predicted inline SEL spectral density directivity of the 480 cu. in source array. . 15
Figure 2-6: Predicted increase in SEL source level during soft-start of the source arrays.... 16
Figure 2-7: Third octave band SEL spectra used in the piling modelling............................ 17
Figure 2-8: Bathymetry in the region of the NEP CCS Project area.................................. 20
Figure 2-9: Seabed sediments/habitats in the region of the NEP CCS Project area. 21
Figure 2-10: Example temperature, salinity, and sound speed depth profiles used in the model. 22
Figure 3-1: Auditory weighting functions for marine mammal hearing groups. 24
Figure 4-1: Predicted zero-to-peak SPL received by marine mammals during the NEP CCS Project seismic surveys when the source arrays are operating at maximum power. 30
Figure 4-2: Predicted LF cetacean weighted SEL from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys. 31
Figure 4-3: Predicted MF cetacean weighted SEL from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys. 31
Figure 4-4: Predicted HF cetacean weighted SEL from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys. 32
Figure 4-5: Predicted phocid pinniped weighted SEL from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys.................. 32
Figure 4-6: Predicted unweighted SEL received by marine mammals from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys. 35
Figure 4-7: Predicted unweighted single pulse SEL received by marine mammals aggregated over all source points over a 24 hour period of the seismic survey. 36
Figure 4-8: Predicted unweighted single pulse SEL received by marine mammals aggregated over all source points over the complete duration of the seismic survey. 37
Figure 4-9: Predicted zero-to-peak SPL received by fish during the NEP CCS Project seismic surveys when the source arrays are operating at maximum power. 40
Figure 4-10: Predicted zero-to-peak SPL received by marine mammals during manifold piling at Endurance with the hammer operating at maximum energy of 120 kJ. 44
Figure 4-11: Predicted zero-to-peak SPL received by marine mammals during SSIV piling at Teesside with the hammer operating at maximum energy of 120 kJ.................................. 44
Figure 4-12: Predicted zero-to-peak SPL received by marine mammals during HDD trestle piling at Teesside with the hammer operating at maximum energy of 235 kJ...................... 45
Figure 4-13: Predicted zero-to-peak SPL received by marine mammals during HDD trestle piling at Humberside with the hammer operating at maximum energy of 235 kJ. 45
Figure 4-14: Predicted unweighted single-pulse SEL received by marine mammals during manifold piling at Endurance with the hammer operating at maximum energy of 120 kJ. 50
Figure 4-15: Predicted unweighted single-pulse SEL received by marine mammals during SSIV piling at Teesside with the hammer operating at maximum energy of 120 kJ. 50
Figure 4-16: Predicted unweighted single-pulse SEL received by marine mammals during HDD trestle piling at Teesside with the hammer operating at maximum energy of 235 kJ. .. 51

Figure 4-17: Predicted unweighted single-pulse SEL received by marine mammals during HDD trestle piling at Humberside with the hammer operating at maximum energy of 235 kJ. 51
Figure 4-18: Predicted zero-to-peak SPL received by fish during manifold piling at Endurance with the hammer operating at maximum energy of 120 kJ. 57
Figure 4-19: Predicted zero-to-peak SPL received by fish during SSIV piling at Teesside with the hammer operating at maximum energy of 120 kJ. 57
Figure 4-20: Predicted zero-to-peak SPL received by fish during HDD trestle piling at Teesside with the hammer operating at maximum energy of 235 kJ. 58
Figure 4-21: Predicted zero-to-peak SPL received by fish during HDD trestle piling at Humberside with the hammer operating at maximum energy of 235 kJ. 58
Figure A-1: Predicted LF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during manifold piling at Endurance. 67
Figure A-2: Predicted MF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during manifold piling at Endurance. 67
Figure A-3: Predicted HF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during manifold piling at Endurance. 68
Figure A-4: Predicted phocid pinniped weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during manifold piling at Endurance. 68
Figure A-5: Predicted LF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during SSIV piling at Teesside. 69
Figure A-6: Predicted MF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during SSIV piling at Teesside. 69
Figure A-7: Predicted HF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during SSIV piling at Teesside. 70
Figure A-8: Predicted phocid pinniped weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during SSIV piling at Teesside. 70
Figure A-9: Predicted LF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Teesside. 71
Figure A-10: Predicted MF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Teesside. 71
Figure A-11: Predicted HF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Teesside. 72
Figure A-12: Predicted phocid pinniped weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Teesside. . 72
Figure A-13: Predicted LF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Humberside. 73
Figure A-14: Predicted MF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Humberside. 73
Figure A-15: Predicted HF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Humberside. 74
Figure A-16: Predicted phocid pinniped weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Humberside. 74

Tables

Table 2-1: Source array configuration. 10
Table 2-2: Modelled far-field third octave (deci-decidal) band SELs vertically below the arrays. 12
Table 2-3: Array source levels and peak frequency. 13
Table 2-4: Piling procedures and broadband source levels assumed in the modelling 18
Table 2-5: Geo-acoustic parameters of the seabed that have been used in the model. 22
Table 3-1: Marine mammals commonly sighted in the North Sea categorised by hearing group. 23
Table 3-2: NOAA (NMFS, 2018) and Southall *et al.* (2019) thresholds for PTS to marine mammals. 24
Table 3-3: Marine mammal behavioural disturbance thresholds. 26
Table 3-4: Thresholds for potential injury to fish and fish eggs and larvae. 27
Table 3-5: Qualitative criteria for assessing risk of behavioural disturbance to fish. 28
Table 4-1: Predicted maximum distances from the source arrays where the zero-to-peak SPL sound levels decrease to below the thresholds for PTS to marine mammals. 30
Table 4-2: Predicted maximum distances from the source arrays where the single-pulse SEL sound levels decrease to below the thresholds for PTS to marine mammals. 33
Table 4-3: Predicted initial starting distances from the source arrays where sound levels will be below the cumulative SEL thresholds for PTS to marine mammals. 34
Table 4-4: Predicted maximum distances from the source arrays where sound levels decrease to below the thresholds for behavioural disturbance to marine mammals. 35
Table 4-5: Estimated number of marine mammals disturbed based on the NOAA ‘Level B harassment’ threshold for disturbance to marine mammals. 38
Table 4-6: Estimated number of marine mammals disturbed based on the Tougaard (2016) threshold for disturbance to marine mammals. 39
Table 4-7: Estimated number of marine mammals disturbed based on a 12 km EDR for disturbance to marine mammals. 39
Table 4-8: Predicted maximum distances from the source arrays where the zero-to-peak SPL sound levels decrease to below the thresholds for fish injury. 41
Table 4-9: Predicted initial starting distances from the source arrays where sound levels will be below the cumulative SEL thresholds for fish injury. 41
Table 4-10: Predicted areas of the SNS SAC that may be impacted by the NEP CCS Project seismic surveys. 43
Table 4-11: Predicted maximum distances from the piling locations where the zero-to-peak SPL sound levels decrease to below the thresholds for PTS to marine mammals. 46
Table 4-12: Predicted maximum distances from the piling locations where the single-pulse SEL sound levels decrease to below the thresholds for PTS to marine mammals. 47
Table 4-13: Predicted initial starting distances from the piling locations where sound levels will be below the cumulative SEL thresholds for PTS to marine mammals when no soft-start of the hammer is employed. 48
Table 4-14: Predicted initial starting distances from the piling locations where sound levels will be below the cumulative SEL thresholds for PTS to marine mammals when a soft-start of the hammer is employed. 49
Table 4-15: Predicted maximum distances from the piling locations where sound levels decrease to below the thresholds for behavioural disturbance to marine mammals. 52
Table 4-16: Estimated number of marine mammals disturbed based on the NOAA ‘Level B harassment’ threshold for disturbance to marine mammals. 53
Table 4-17: Estimated number of marine mammals disturbed based on the Tougaard (2016) threshold for disturbance to marine mammals. 54

Table 4-18: Estimated number of marine mammals disturbed based on a 15 km EDR for disturbance to marine mammals. 55
Table 4-19: Predicted maximum distances from the piling locations where the zero-to-peak SPL sound levels decrease to below the thresholds for fish injury. 59
Table 4-20: Predicted initial starting distances from the source arrays where sound levels will be below the cumulative SEL thresholds for fish injury. 59
Table 4-21: Predicted areas of the SNS SAC that may be impacted by the NEP CCS Project piling operations. 61

ABBREVIATIONS

°	Degrees
<	Less than
≥	Greater than or equal to
%	Percent
c.	circa
CCS	Carbon, capture and storage
cu. in	Cubic inches
dB	Decibels
dB/λ	Decibels per wavelength
dB re 1 μPa	Decibels relative to one microPascal
dB re 1 μPa-m	Decibels relative to one microPascal at one metre
dB re 1 $\mu Pa^2 s$	Decibels relative to one microPascal squared second
dB re 1 $\mu Pa^2 s$-m	Decibels relative to one microPascal squared second at one metre
ED	European Datum
EDR	Effective disturbance radii/ Effective Deterrent Range
ESD	Energy Spectral Density
EMODnet	European Marine Observation and Data Network
FARAM	Faunal Acoustic Risk Assessment Model
GWA	Greater Working Area
HDD	Horizontal Directional Drilling
Hz	Hertz
HESS	High Energy Seismic Survey
HF	High Frequency
IAMMWG	Inter-Agency Marine Mammal Working Group
JNCC	Joint Nature Conservation Committee
kg	Kilogram
kHz	Kilohertz
kJ	Kilojoules
km	Kilometre
km^2	Kilometre square

LF	Low Frequency
m	metres
m/s	Metres per second
MF	Medium Frequency
nms	Milliseconds
MU	Management Unit
NEP	Northern Endurance Partnership
NMFS	National Marine Fishery Services
NOAA	National Oceanic and Atmospheric Association
Pa	Pascals
PE	Parabolic Equation
psi	Pound-force per square inch
PTS	Permanent Threshold Shift
RAM	Range-dependent Acoustic Model
rms	Root Mean Square
s	seconds
SAC	Special Area of Conservation
SCANS	Small Cetaceans Abundance of the North Sea
SEL	Sound Energy Level
SNS	Southern North Sea
SPL	Sound Pressure Level
SSA	Seismic survey area
SSIV	Subsea Isolation Valve
TTS	Temporary threshold shift
UK	United Kingdom
UTM	Universal Transverse Mercator
VHF	Very High Frequency
WOA	World Ocean Atlas

1.0 INTRODUCTION

This report presents underwater sound modelling results for assessing potential impacts that activities associated with the Northern Endurance Partnership (NEP) carbon, capture and storage (CCS) Project may have on marine receptors in the region of the surrounding area. Underwater sound modelling has been undertaken for:

- Seismic surveys that will be conducted to monitor the geological store at Endurance;
- Piling for manifold installations at Endurance;
- Piling for Subsea Isolation Valve (SSIV) installation on the Teesside pipeline; and
- Piling for Horizontal Directional Drilling (HDD) trestle installations at Teesside and Humberside.

The locations of the Endurance seismic survey area (SSA) and associated greater working area (GWA) as well as the manifold, SSIV, and HDD trestle piling locations are shown in Figure 1-1.

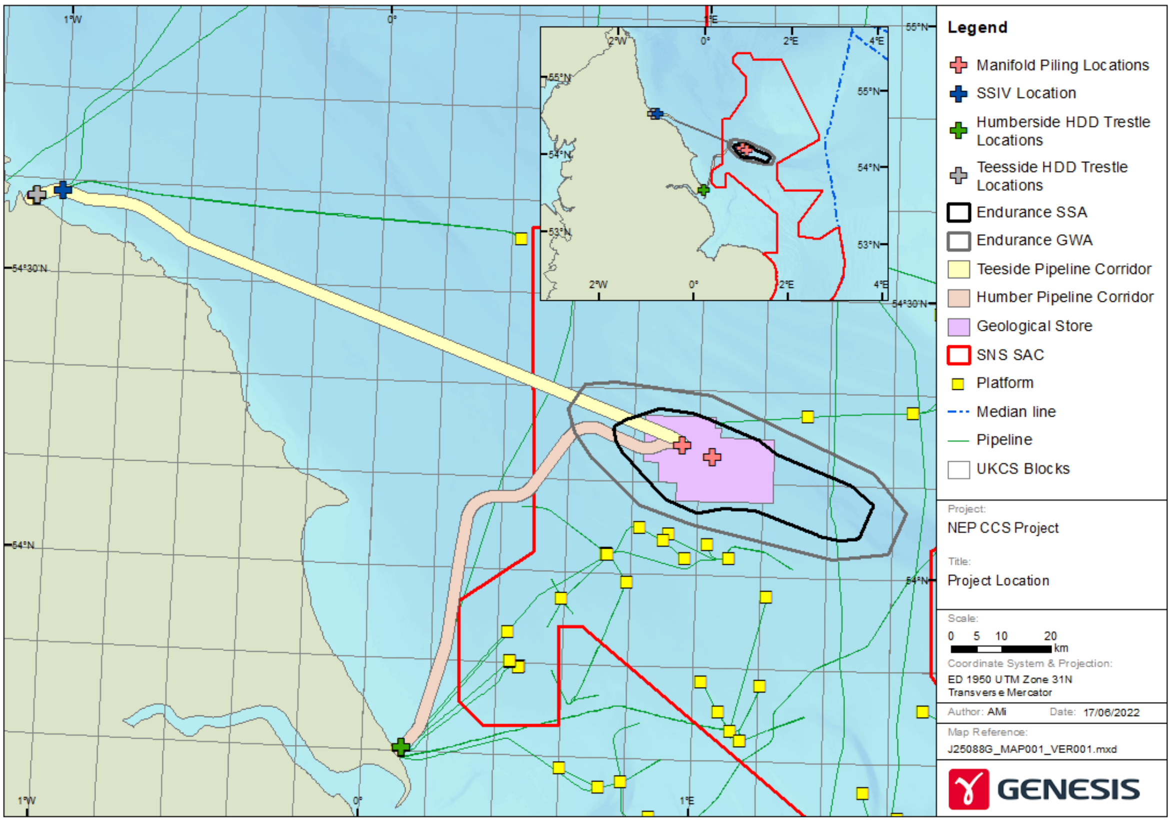


Figure 1-1: NEP CCS Project location.

2.0 SOUND MODELLING METHODOLOGY

This section discusses the underwater sound modelling methodology that has been adopted to assess potential impacts from the seismic survey and piling operations associated with the NEP CCS Project. The characterisation of the piling and seismic sources is discussed in this section followed by details of the sound propagation model.

2.1 Source Characterisation

2.1.1 Seismic Source Array

Source array modelling has been conducted using the Gundalf modelling software (revision AIR8.1n) developed by Oakwood Computing (2021) to predict source levels, frequency content, and directivity patterns of the source that is expected to be used for the seismic surveys associated with the NEP CCS Project. The Gundalf modelling software is regularly updated to calibrate the model output with new high-quality measurement data of sound generated by different airgun sources. These calibration updates are referred to as 'epochs' with different epochs being distinguished by date in the Gundalf model. This assessment has been conducted using Gundalf revision AIR8.1n, Epoch 2018-03-30. It should be noted that modelling using a different epoch version could lead to different results. The epoch version used to model the source arrays considered in this assessment predicts significantly lower energy at higher frequencies compared to previous epochs, which is a result of calibration against more accurate wide frequency band measurement data that was not available in previous epochs. This results in smaller estimated potential impacts to high frequency cetaceans (e.g. harbour porpoise) compared to assessments conducted with previous Gundalf models.

2.1.1.1 Source Configuration

A recent seismic survey at Endurance was conducted using a quad source (four airgun arrays) with each array comprising five 1900LLXT airguns with a total volume of 400 cubic inches (cu. in). However, it is possible that future surveys may be conducted with slightly larger source arrays comprising six 1900LLXT with a total volume of 480 cu. in (this source was originally planned to be used for the recent survey at Endurance). Source modelling has been conducted for both arrays. The configurations of the 400 cu. in and 480 cu. in source arrays used in the modelling are shown in Table 2-1.

Table 2-1: Source array configuration.

Airgun No.	Airgun Type	Airgun volume (cu .in)	X (m)	Y (m)	Z (m)	Pressure (psi)	Delay (s)
400 cu. in Array							
1	1900LLXT	70	3	-0.4	4.0	0	2000
2	1900LLXT	70	3	0.4	4.0	0	2000
3	1900LLXT	100	5	-0.4	4.0	0	2000
4	1900LLXT	100	5	0.4	4.0	0	2000
5	1900LLXT	60	7	0.4	4.0	0	2000

Airgun No.	Airgun Type	Airgun volume (cu .in)	X (m)	Y (m)	Z (m)	Pressure (psi)	Delay (s)
480 cu. in Array							
1	1900LLXT	150	0	0.4	4.0	0	2000
2	1900LLXT	150	0	-0.4	4.0	0	2000
3	1900LLXT	40	3	0.4	4.0	0	2000
4	1900LLXT	60	3	-0.4	4.0	0	2000
5	1900LLXT	20	6	0.4	4.0	0	2000
6	1900LLXT	60	6	-0.4	4.0	0	2000

2.1.1.2 Source Levels and Spectral Content

The array signatures over a frequency range of 0 to 50 kHz have been predicted using the Gundalf (revision AIR8.1n) modelling software (Oakwood Computing, 2021). The predicted far-field pressure signatures vertically below each array in the time domain are shown in Figure 2-1. The predicted far-field frequency domain signatures vertically below each array are shown in Figure 2-2 and Table 2-2, which show the third octave (deci-decadal) band sound exposure levels (SELs) for the arrays. Broadband sound pressure level (SPL) and SEL source levels of the arrays have been estimated by Gundalf and are summarised in Table 2-3. The predicted sources levels for the 480 cu. in array are slightly higher than the corresponding source levels for the 400 cu. in array. Therefore, the propagation modelling has only been conducted for the 480 cu. in source array.

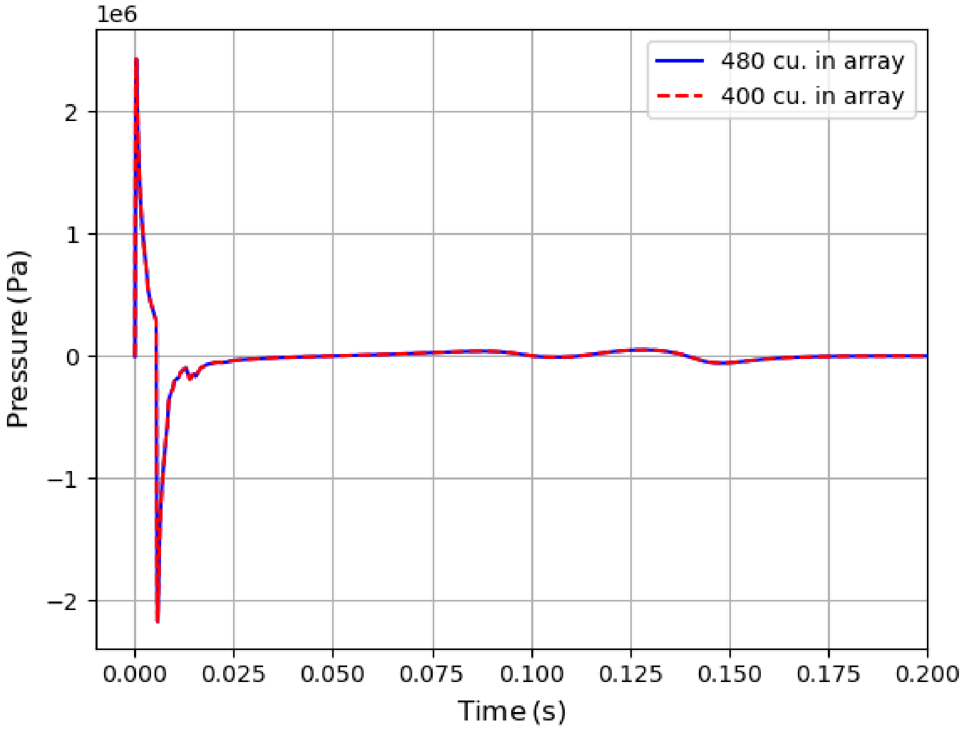


Figure 2-1: Modelled far-field time domain pressure signatures vertically below the arrays.

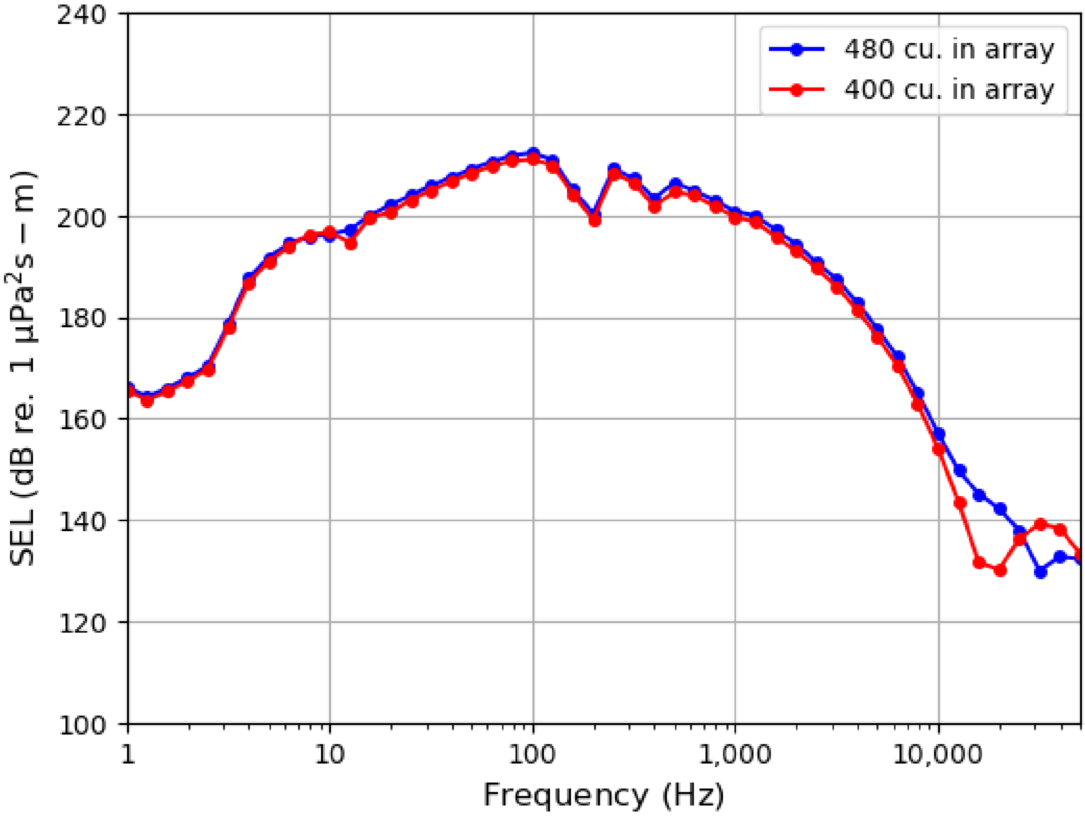


Figure 2-2: Modelled far-field third octave (deci-decidal) band SELs vertically below the arrays.

Table 2-2: Modelled far-field third octave (deci-decidal) band SELs vertically below the arrays.

Centre Frequency (Hz)	SEL (dB re 1 μPa^{2}s-m)		Centre Frequency (Hz)	SEL (dB re 1 μPa^{2}s-m)	
	480 cu. in Array	400 cu. in Array		480 cu. in Array	400 cu. in Array
1.0	166.2	165.6	251	209.2	208.3
1.26	164.3	163.6	316	207.3	206.5
1.58	165.9	165.3	398	203.4	201.8
2.0	168.0	167.4	501	206.5	204.6
2.51	170.3	169.7	631	204.8	203.9
3.16	178.7	177.8	794	203.0	201.7
3.98	187.6	186.8	1,000	200.8	199.7
6.31	191.7	190.9	1,260	199.9	198.7
5.01	194.5	193.9	1,580	197.1	195.8
6.31	195.8	196.2	2,000	194.4	193.0
7.94	196.3	196.7	2,510	190.8	189.6

Centre Frequency (Hz)	SEL (dB re 1 µPa²s-m)		Centre Frequency (Hz)	SEL (dB re 1 µPa²s-m)	
	480 cu. in Array	400 cu. in Array		480 cu. in Array	400 cu. in Array
10	197.2	194.6	3,160	187.4	186.0
12.6	200.0	199.6	3,980	182.9	181.4
15.8	202.1	200.6	5,010	177.7	176.2
20	203.9	203.1	6,310	172.1	170.3
25.1	205.9	205.0	7,940	165.0	162.8
31.6	207.5	206.7	10,000	157.1	154.1
59.8	209.2	208.3	12,600	149.7	143.6
50.1	210.6	209.7	15,800	145.1	131.6
63.1	211.8	210.7	20,000	142.2	130.1
79.4	212.3	211.1	25,100	137.9	136.2
100	211.0	209.9	31,600	130.0	139.2
126	205.0	204.2	39,800	132.7	138.3
158	200.4	199.1	50,100	132.3	133.3
200	166.2	165.6			

Table 2-3: Array source levels and peak frequency.

Parameter		480 cu. in Array	400 cu. in Array
Array elements		Six 1900LLXT airguns	Five 1900LLXT airguns
Total volume		480 cu. in.	400 cu. in.
Source level [1]	Zero-to-peak SPL	247.7 dB re 1 µPa-m	246.5 dB re 1 µPa-m
	Peak-to-peak SPL	253.2 dB re 1 µPa-m	252.1 dB re 1 µPa-m
	SEL	220.6 dB re 1 µPa²s-m	219.5 dB re 1 µPa²s-m
Peak frequency		*c.* 80 Hz	*c.* 70 Hz

[1] Source levels have been computed using Gundalf array modelling software (Oakwood Computing, 2021) over a frequency range of 0 – 50 kHz.

It is important to note that the source levels quoted in Table 2-3 (and the signatures shown in Figure 2-1 and Figure 2-2) are predicted by Gundalf based on back propagated far-field estimates of sound levels vertically below the arrays. These source levels have been obtained by modelling the array pressure waveforms vertically below the arrays in the far-field, where the peak output from individual airguns add together constructively, and then back calculating the resulting signature to a nominal distance of 1 m from the array. Calculation of source levels in this manner assumes that the array acts like a point source. However, it is important to appreciate that the source array is not a point source but is distributed over an area. Therefore, the peaks in pressure from individual airguns do not arrive synchronously within the near field of the array and do not add coherently. Back-calculated source levels derived from far field signatures in this manner over-estimate the sound levels generated in the near field of the array (see e.g. Caldwell and Dragoset, 2000; Fontana and Boukhanfra, 2018). The difference between near field sound levels derived from far field measurements/modelling and actual near field levels observed in practice is depicted graphically in Figure 2-3.

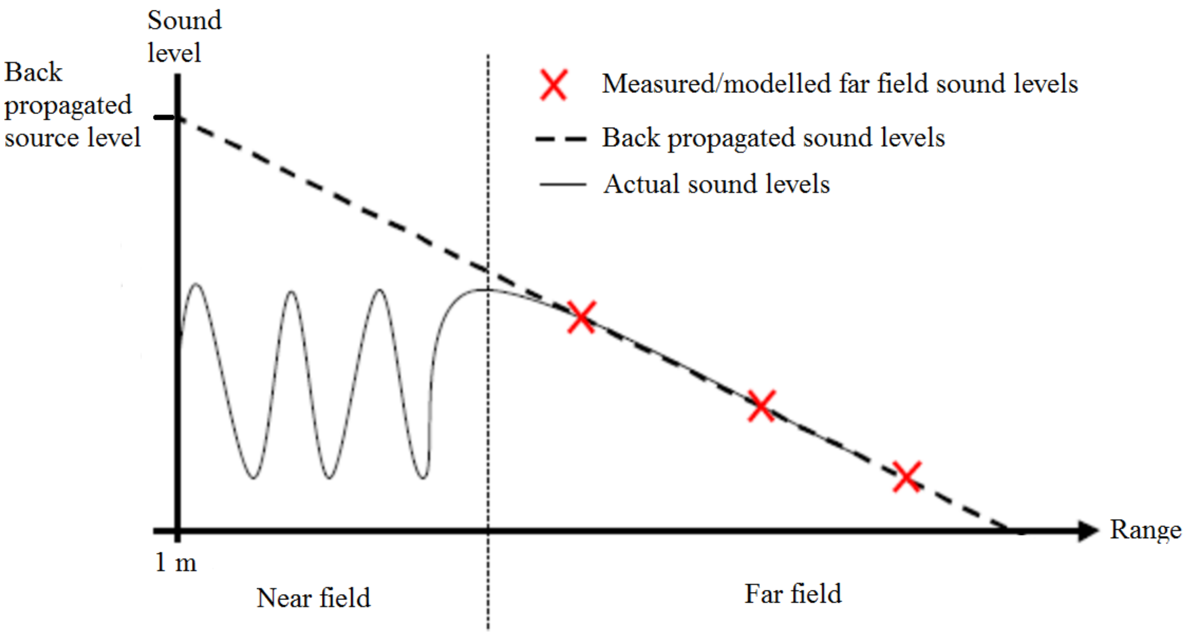


Figure 2-3: Depiction of difference between near field sound levels derived from back propagation and actual near field sound levels.

2.1.1.3 Directivity

Seismic source arrays are designed to direct a large proportion of acoustic energy vertically downwards into the water column to maximise energy into the seabed and underlying geology. Sound levels emitted in horizontal directions can therefore be significantly lower than those emitted vertically downwards (Richardson *et al.,* 1995; Duren, 1988; Caldwell and Dragoset, 2000).

Directivity effects of the modelled source array have been predicted by Gundalf for different frequencies, azimuthal angles and elevation angles, and incorporated into the propagation modelling. Example frequency-dependent directivity patterns predicted by Gundalf for the 400 cu. in and 480 cu. in source arrays are shown in Figure 2-4 and Figure 2-5, respectively. These plots show the energy spectral densities (ESDs) as a function of frequency and elevation angle for the inline (tow) directions of the source arrays. In these plots, an elevation angle of 0° corresponds to vertically below the array, whilst elevation angles of -90° and 90° correspond to horizontal directions. Gundalf has been used to compute directivity patterns for other azimuthal angles around the source to fully account for the directivity of the source array. The directivity patterns have then been incorporated into the propagation model.

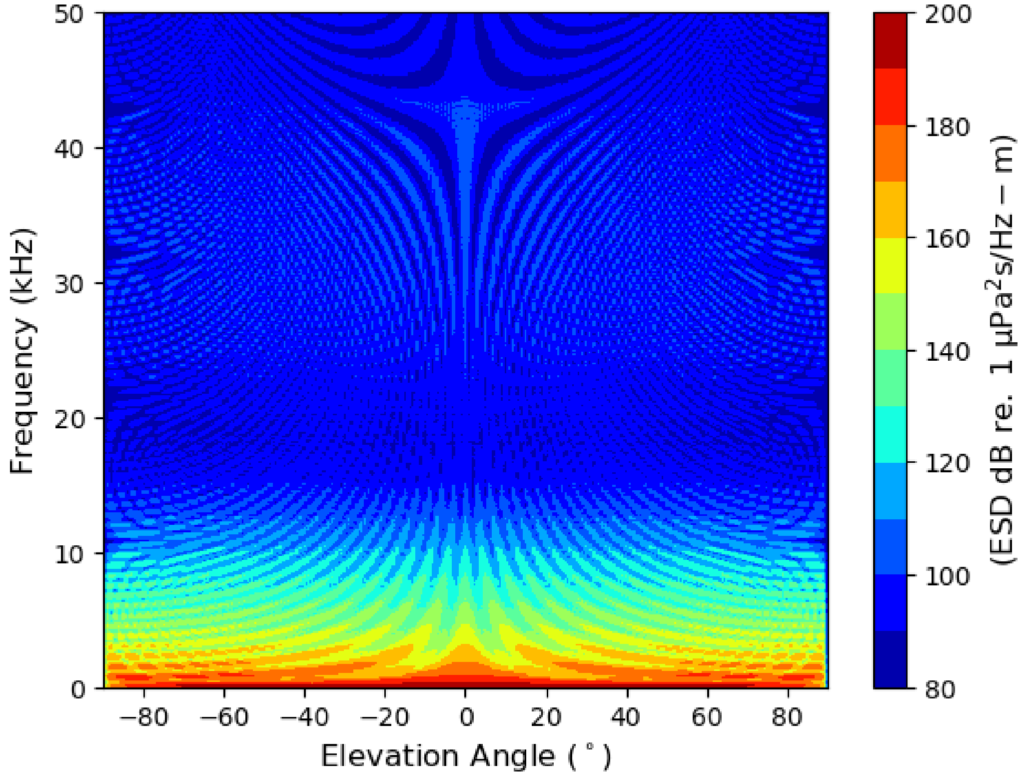


Figure 2-4: Predicted inline SEL spectral density directivity of the 400 cu. in source array.

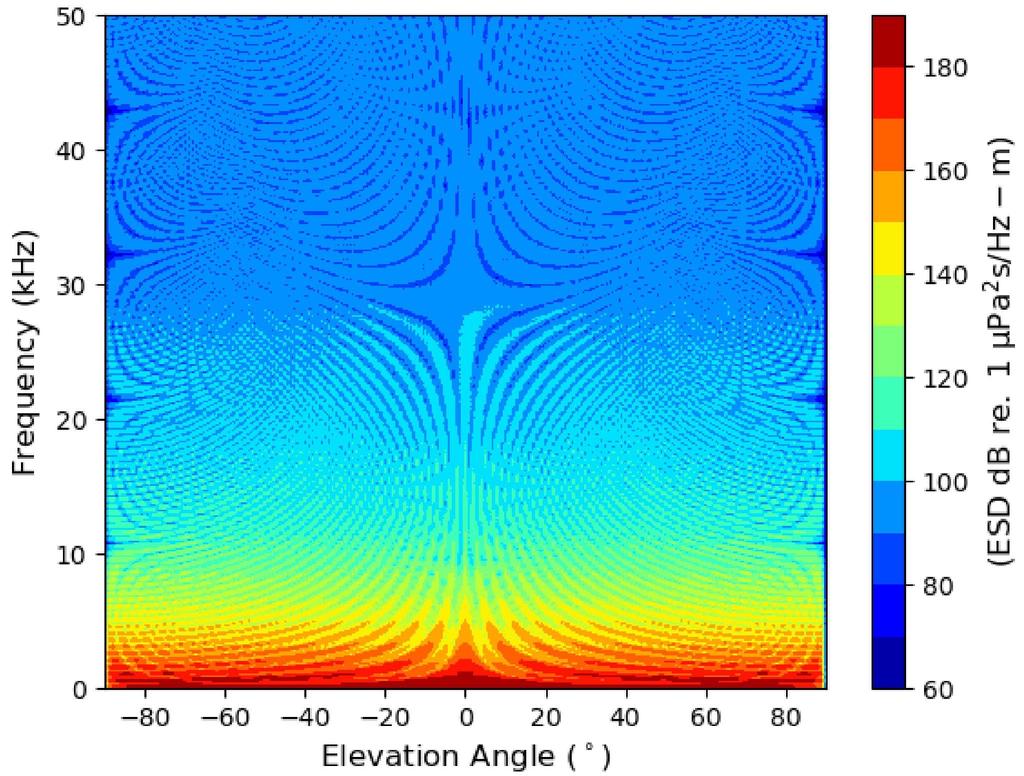


Figure 2-5: Predicted inline SEL spectral density directivity of the 480 cu. in source array.

2.1.1.4 Soft-Start

A soft-start activation of the source arrays will be employed during the proposed surveys at Endurance, whereby the source array power will be incrementally increased over a period of at least 20 minutes. In the modelling, it has been assumed that the soft-start will involve individual airguns being turned on one at a time starting from the lowest volume airgun through to the highest volume. The increase in SEL throughout the soft-start has been predicted by Gundalf modelling and is shown in Figure 2-6.

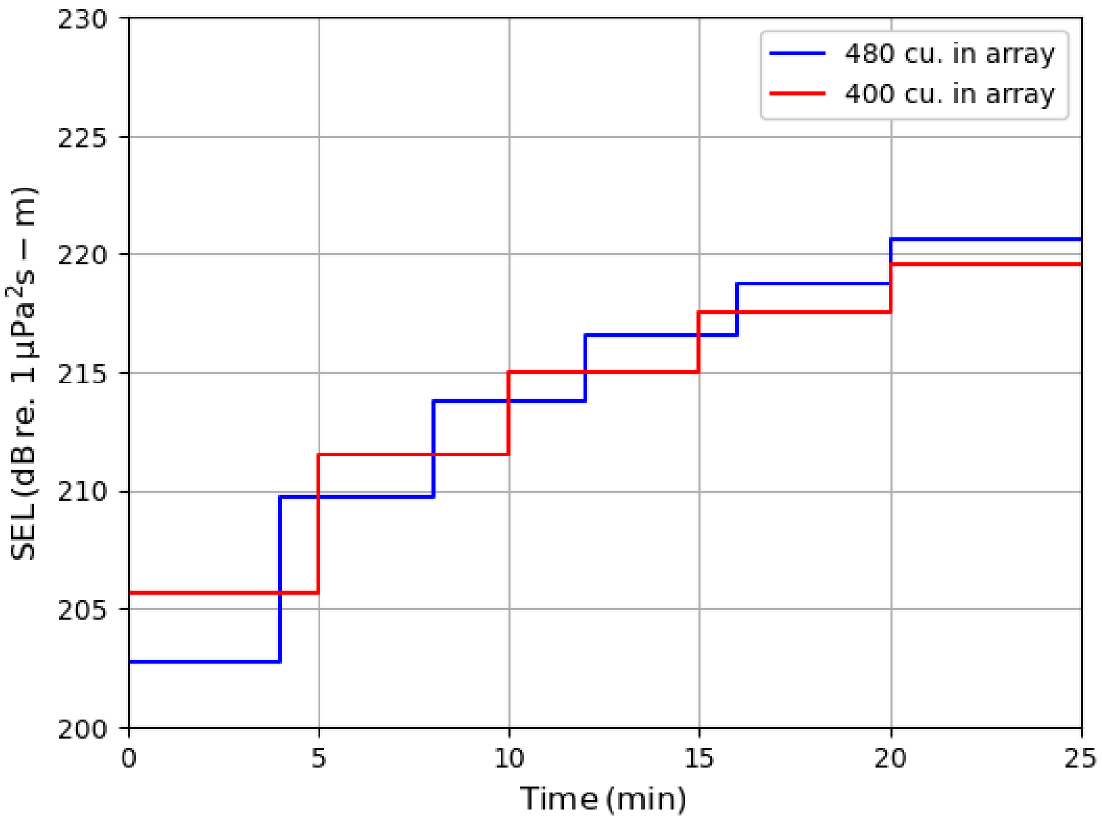


Figure 2-6: Predicted increase in SEL source level during soft-start of the source arrays.

2.1.2 Piling

A pile under percussive driving is a complex underwater acoustic source. The sound levels generated during piling depend on many factors, such as hammer energy, mechanical properties and dimensions of the pile, water depth, and seabed properties. The hammer energy has the biggest influence on the sound levels generated, with higher energy hammers typically generating higher sound levels (Robinson *et al*., 2007).

To derive source levels for use in the piling modelling, a representative third octave band SEL frequency spectrum measured during piling with an 800 kJ hammer (Ainslie *et al*., 2012) has been used. The manifold and SSIV piling for the NEP CCS Project are expected to be conducted using a hammer with maximum energy of 120 kJ, whilst the HDD trestle piling is expected to be conducted with a maximum hammer energy of 235 kJ. The measured SEL spectrum from Ainslie *et al*. (2012) has therefore been scaled to the different hammer energies that will be used during piling for the NEP CCS Project. It has been assumed that the source SEL scales linearly with hammer energy, which has been demonstrated by measurements made throughout the soft-start and energy ramp-up during piling (Robinson *et al.*, 2007). In the modelling, it has been assumed that piling will commence with a soft-start where the hammer operates at 20% of the maximum hammer energy. The soft-start is assumed to be conducted for a period of 20 minutes in line with the Joint Nature Conservation Committee (JNCC) guidelines for minimising impacts from piling (JNCC, 2010). After the soft-start, the hammer energy is assumed to increase to maximum energy. In practice, the increase in hammer energy will occur over a prolonged period of time. However, the model assumes an instant increase from the soft-start hammer energy to maximum hammer energy which is a conservative assumption. The scaled third octave band SEL spectra for the different hammer energies that have been used in the modelling are shown in Figure 2-7.

For the manifold and SSIV piling scenarios it is assumed that each pile will take four hours to install and that eight piles will be installed per day. For the HDD trestle piling scenarios it is assumed that each pile will take four hours to install and two piles will be installed per day. The piling procedures for installing individual piles for each scenario are shown in Table 2-4.

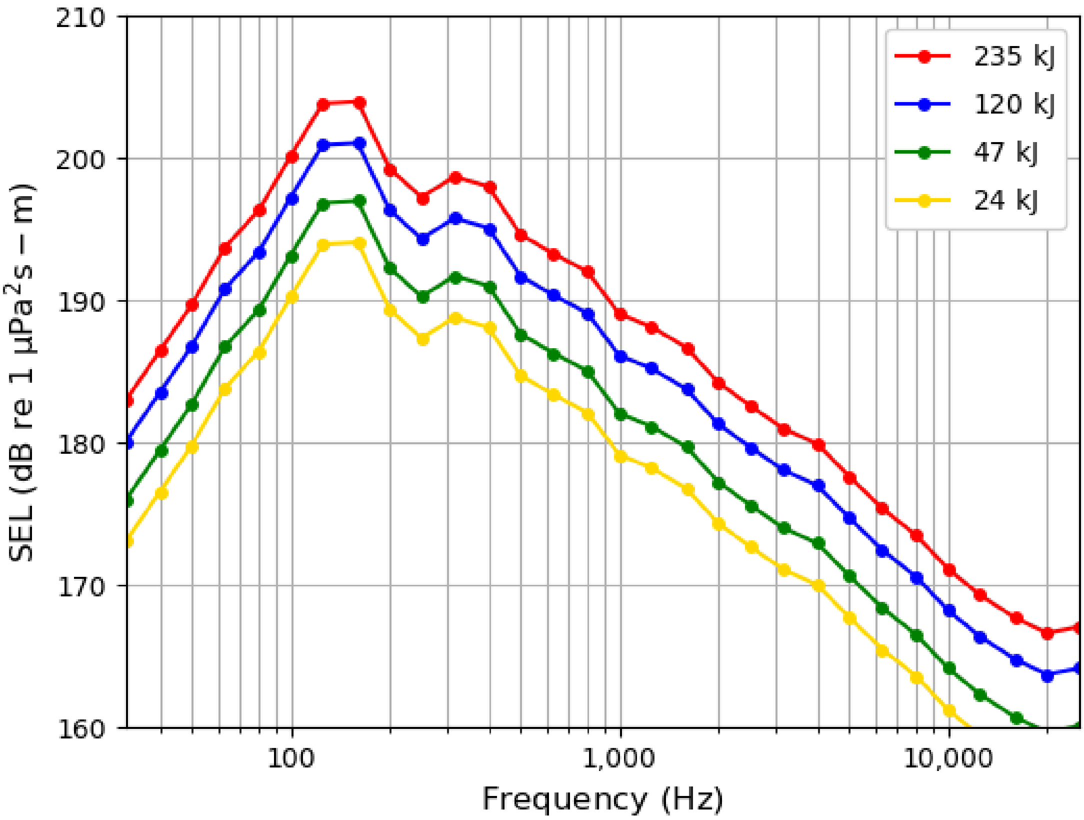


Figure 2-7: Third octave band SEL spectra used in the piling modelling.

Table 2-4: Piling procedures and broadband source levels assumed in the modelling

Hammer Energy (kJ)	Duration (minutes)	Strike Rate (blows/minute)	Source Level	
			Zero-to-peak SPL (dB re 1 µPa-m)	SEL (dB re 1 µPa^{2}s-m)
Manifold Piling				
24	20	44	200.0	226.3
120	100	44	207.2	233.2
SSIV Piling				
24	20	44	200.0	226.3
120	100	44	207.2	233.2
HDD Trestle Piling				
47	20	44	203.2	229.2
235	220	44	210.2	236.2

2.2 Sound Propagation Model

There are various algorithms that can be used for underwater sound propagation modelling e.g. parabolic equation, ray tracing, normal mode, wavenumber integration, energy flux density and semi-empirical algorithms (Jensen *et al.*, 2011). The Genesis in-house modelling software FARAM (Faunal Acoustic Risk Assessment Model) has been used in this study. FARAM employs the parabolic equation (PE) and ray tracing algorithms developed by Collins (1993) and Porter and Liu (1994), respectively, for estimating received sound levels from various sources. When estimating received sound levels, FARAM incorporates:

- A site-specific bathymetric grid to account for the influence of varying bathymetry on sound propagation;
- Site-specific range and depth dependent water column temperature, salinity, and sound speed profiles based on modelled hydrological conditions;
- Acoustic properties of the predominant seabed sediments in the modelling area;
- Frequency dependent propagation effects (e.g. volume attenuation, reflection, scattering at different frequencies);
- Specific properties of the airgun array under consideration (e.g. spectral content, directivity, pulse interval, tow speed and trajectory);
- Auditory weighting functions that characterise the hearing ability of different marine mammal hearing groups;
- Movement of mobile marine receptors (e.g. swim speed, depth and trajectory) when calculating received cumulative SEL; and
- The most up-to-date thresholds for assessing potential impacts to marine fauna.

2.2.1 Parabolic Equation Algorithm

Parabolic Equation (PE) models approximate the wave equation, allowing a solution to be found computationally (Jensen *et al.,* 2011). This is one of the most popular wave-theory techniques for modelling sound propagation in spatially varying environments (Jensen *et al.,* 2011). The computational scheme used in FARAM is based on the Range-dependent Acoustic Model (RAM) implementation of the PE (Collins, 1993). The RAM PE algorithm incorporates acoustic propagation effects resulting from varying bathymetry, range dependent sound speed depth profiles, and geo-acoustic properties.

The PE algorithm is best suited to calculation of low frequency sound propagation since the computational complexity and implementation time of the PE method significantly increases with frequency. The PE algorithm is therefore generally restricted to modelling the propagation characteristics of low frequency sound sources, since modelling of high frequencies becomes prohibitively time consuming. Furthermore, the PE algorithm does not straightforwardly allow source directionality effects to be accounted for. This is an important consideration for airgun arrays that are highly directional sound sources.

For modelling of the airgun array, the PE algorithm has been used to model the very low frequencies (< 10 Hz) that do not exhibit high levels of directionality. For higher frequencies (≥ 10 Hz), that exhibit directional effects, a ray tracing algorithm has been utilised for sound propagation, which is discussed in the following section. For modelling of the piling sound sources, which are not a highly directional sound sources, the PE algorithm has been used to model low frequencies (< 250 Hz) whilst the ray tracing algorithm has been used to model high frequencies (≥ 250 Hz).

2.2.2 Ray Tracing Algorithm

For modelling sound propagation of higher frequencies, the Bellhop Gaussian beam ray tracing algorithm (Porter and Liu, 1994) has been used. Bellhop is an efficient ray tracing program that is well suited for the modelling of higher frequency sound sources. However, it can also provide accurate results for low frequency propagation in certain circumstances. Similar to the RAM PE algorithm discussed previously, Bellhop incorporates acoustic propagation effects resulting from varying bathymetry, range dependent sound speed depth profiles, and geo-acoustic properties. Bellhop also accounts for increased sound attenuation due to volume absorption. This type of sound attenuation becomes more prominent at higher frequencies and cannot be neglected without significantly over estimating received levels at large distances from the sound source. Bellhop allows source directionality effects to be modelled, which is important for modelling airgun arrays that are highly directional sound sources.

2.2.3 Environmental Data

The implemented sound propagation model accounts for various site-specific environmental properties including a bathymetric grid, geographically and depth varying sound speed profiles and geo-acoustic properties of the sediment. To model the effects of these properties, input data is required that describes the surrounding environment.

2.2.3.1 Bathymetry

Accurate bathymetry data is important for sound propagation modelling since the seabed strongly influences the propagation characteristics of sound. In shallow water regions, there is significant interaction of the sound with the seabed through reflections and scattering effects, and strong attenuation may occur as sound penetrates the seabed. In deep water regions, there is typically less interaction of sound with the seabed and attenuation due to bottom loss is small, which can result in longer propagation distances.

The bathymetry data that has been used in the noise model (Figure 2-8) is provided by EMODnet, which is a high-resolution digital terrain model for European Seas (EMODnet, 2022a). The EMODnet bathymetry is based on almost 10,000 datasets obtained from bathymetric surveys, with data provided at a spatial resolution of 1/16 arc minutes.

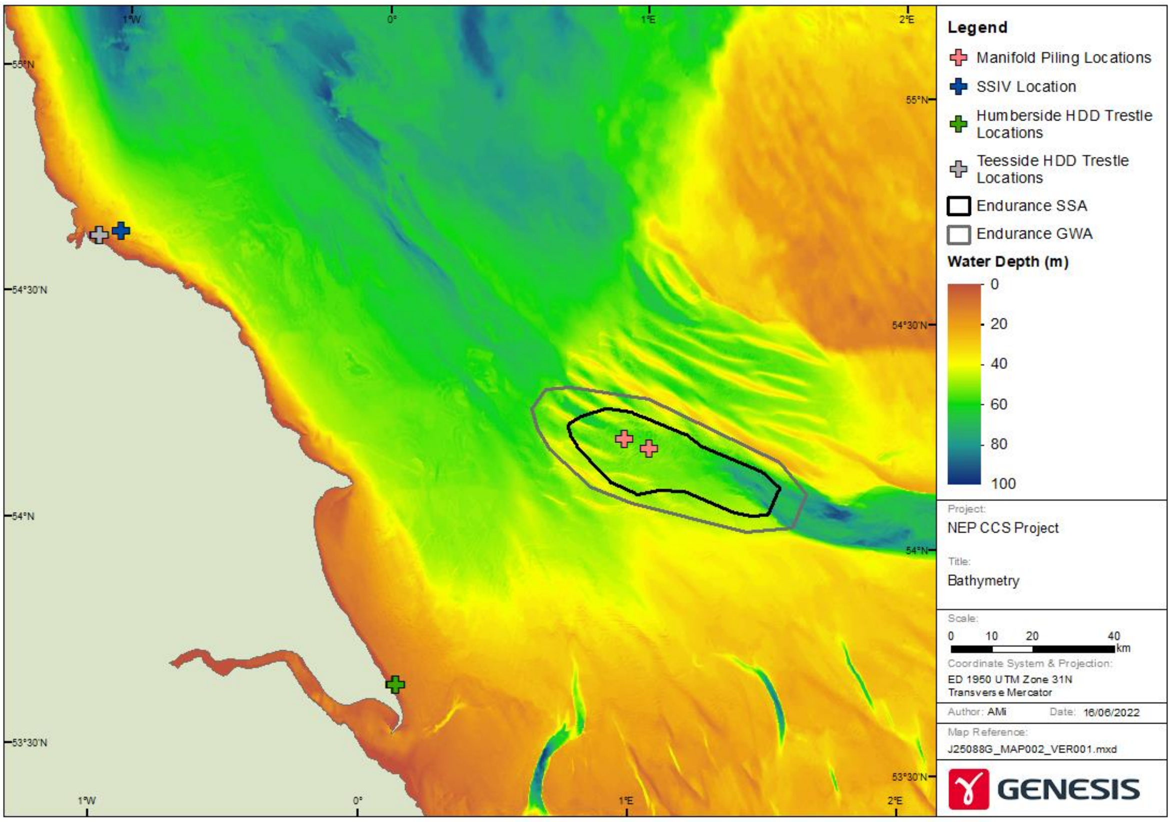


Figure 2-8: Bathymetry in the region of the NEP CCS Project area.

2.2.3.2 Seabed Properties

The implemented propagation model accounts for attenuation effects due to interactions with the seabed. However, the model is limited to a single seabed substrate for each model run. Sediments in the region of the NEP CCS Project area area are shown in Figure 2-9 (EMODnet, 2022b).

The main sediment types across the Endurance SSA and GWA are offshore circalittoral sands. A sandy seabed has therefore been used for modelling of the seismic survey and manifold piling scenarios. The SSIV and Teesside HDD trestle locations are located nearshore where there is a complex mixture of sediments in the area. In the immediate vicinity of the piling locations the sedimetns manly comprise muds comprising sands. For the SSIV and Teesside HDD trestle piling models, a sandy seabed has been assumed. This will result in conservative results since coarser sediments such as sands typically result in longer range sound propagation compared to softer sediments such as muds and clays (Jensen *et al.*, 2011). A gravel seabed has been used for modelling of the Humberside HDD trestle piling scenario which is in an area where sediments predominantly comprise coarse sediments (Figure 2-9).

The geo-acoustic properties associated with the seabed that have been used in the modelling for each scenario are shown in Table 2-5 (Jensen *et al.*, 2011).

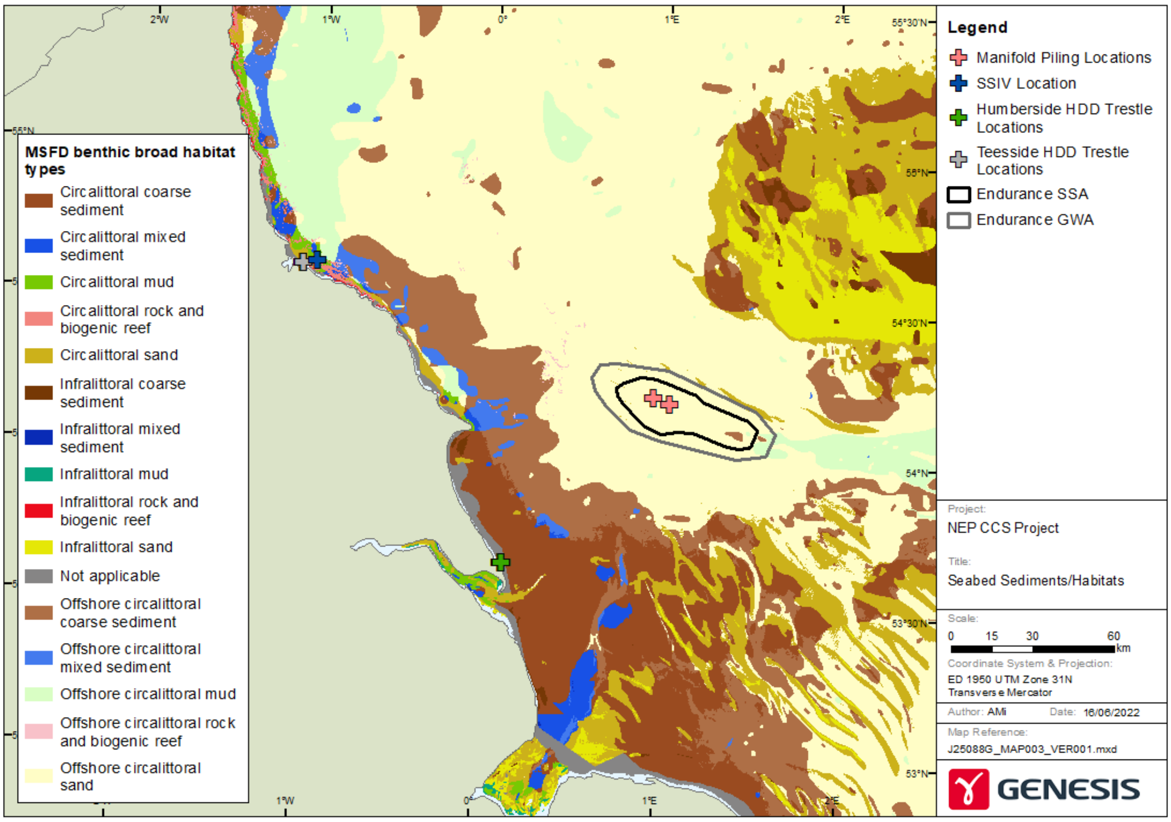


Figure 2-9: Seabed sediments/habitats in the region of the NEP CCS Project area.

Table 2-5: Geo-acoustic parameters of the seabed that have been used in the model.

Scenario	Sediment Type	Sound Speed (m/s)	Sound Attenuation (dB/λ)	Sediment Density (kg/m^3)
Seismic survey	Sand	1,650	0.8	1,900
Manifold piling	Sand	1,650	0.8	1,900
SSIV piling	Sand	1,650	0.8	1,900
Teesside HDD trestle piling	Sand	1,650	0.8	1,900
Humberside HDD trestle piling	Gravel	1,800	0.6	2,000

2.2.3.3 Sound Speed

A major factor that influences sound propagation in water is the speed of sound through the water column, which influences how sound refracts as it propagates through the water. FARAM allows for geographically and depth varying sound speed profiles, which are calculated at multiple locations over the modelling domain. These sound speed profiles are calculated from temperature and salinity profiles taken from the World Ocean Atlas (WOA) 2013 dataset (WOA, 2013). Example temperature, salinity, and sound speed profiles used in the modelling are shown in Figure 2-10. It should be noted that these profiles are for a specific nearshore and offshore location in the modelling domain and that the model calculates depth profiles at different locations across the whole model domain.

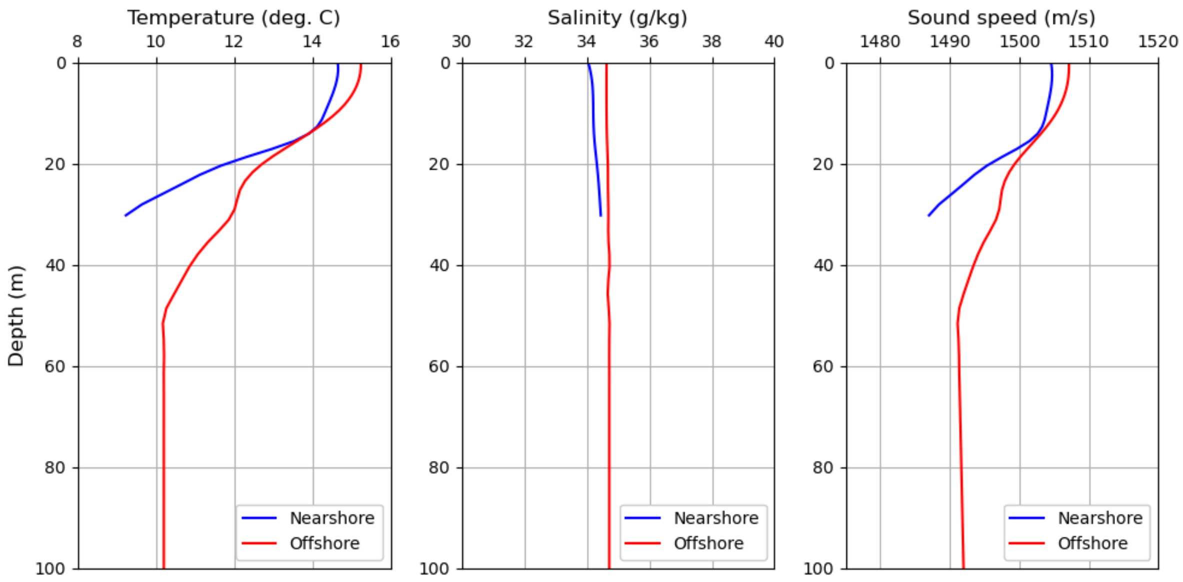


Figure 2-10: Example temperature, salinity, and sound speed depth profiles used in the model.

3.0 IMPACT ASSESSMENT METHODOLOGY

Sound is important to marine mammals and fish for navigation, communication, predator avoidance and prey detection. Underwater noise generated by human activities can therefore have an adverse impact on marine mammals and fish (Richardson *et al.,* 1995; Southall *et al.,* 2007, 2019, 2021; National Marine Fisheries Service (NMFS), 2018; Popper *et al.,* 2014). The thresholds adopted in this report for assessing potential impacts to marine mammals and fish are based on a comprehensive review of evidence of underwater sound impacts.

3.1 Marine Mammals

Potential impacts to marine mammals have been assessed in this report using thresholds for permanent threshold shift (PTS) and behavioural disturbance. PTS is a permanent change in a marine mammal's hearing sensitivity, whilst behavioural disturbance can vary from low level disturbance such as small changes in normal behaviour to higher levels of disturbance such as displacement from a favourable area.

3.1.1 PTS

PTS thresholds for marine mammals have been proposed by the National Oceanic and Atmospheric Administration (NOAA) (NMFS, 2018) and Southall *et al.* (2019) based on the most recent studies and are recognised as the appropriate criteria for assessing impacts to marine mammals from underwater sound. NOAA (NMFS, 2018) and Southall *et al.* (2019) proposed grouping marine mammals into different hearing groups when assessing potential impacts. NOAA proposed grouping marine mammals into low frequency (LF) cetaceans, mid frequency (MF) cetaceans, high frequency (HF) cetaceans, otariid pinnipeds, phocid pinnipeds and sirenians. Southall *et al.* (2019) proposed equivalent hearing groups but renamed the MF cetacean and HF cetacean hearing groups as HF cetaceans and very high frequency (VHF) cetaceans, respectively. Table 3-1 shows marine mammal species commonly sighted in the North Sea (Hammond *et al.*, 2017; Waggitt *et al.*, 2019; Reid *et al.*, 2003; Russell *et al.*, 2017) categorised according to these hearing groups.

Table 3-1: Marine mammals commonly sighted in the North Sea categorised by hearing group.

Hearing Group		Species [1]
NOAA (NMFS, 2018)	Southall *et al.* (2019)	
LF cetaceans	LF cetaceans	**Minke whale**
MF cetaceans	HF cetaceans	**White-beaked dolphin,** white-sided dolphin, bottlenose dolphin, Risso's dolphin, striped dolphin, pilot whale, beaked whale, common dolphin, killer whale
HF cetaceans	VHF cetaceans	**Harbour porpoise**
Phocid pinnipeds	Phocid pinnipeds	**Grey seal, harbour seal**

[1] Species listed are the most commonly sighted marine mammal species in the North Sea (Hammond *et al.*, 2017; Waggitt *et al.*, 2019; Reid *et al.*, 2003; Russell *et al.*, 2017). Species highlighted in bold are those that are more likely to be present in the region of the NEP CCS Project area.

The PTS thresholds proposed by NOAA (NMFS, 2018) and Southall *et al.* (2019) are shown in Table 3-2. As dual-metric criteria, the onset of PTS is considered to potentially occur when sound levels exceed either the zero-to-peak SPL or cumulative SEL thresholds (NMFS, 2018; Southall *et al.,* 2019). The zero-to-peak SPL thresholds are 'unweighted' and do not take into consideration the hearing range of any marine mammals. In contrast, the cumulative SEL threshold is 'weighted' and accounts for the hearing capabilities of marine mammals by frequency weighting received SELs using generalised auditory weighting functions. The auditory weighting functions proposed by NOAA and Southall *et al.* (2019) are shown in Figure 3-1 (note that the NOAA (NMFS, 2018) nomenclature for marine mammal hearing groups is used in this figure).

Table 3-2: NOAA (NMFS, 2018) and Southall *et al.* (2019) thresholds for PTS to marine mammals.

Hearing Group		PTS Threshold	
NOAA (NMFS, 2018)	Southall *et al.* (2019)	Zero-to-peak SPL (dB re 1 µPa)	Cumulative SEL (dB re 1 µPa²s)
LF cetaceans	LF cetaceans	219	183
MF cetaceans	HF cetaceans	230	185
HF cetaceans	VHF cetaceans	202	155
Phocid pinnipeds	Phocid pinnipeds	218	185

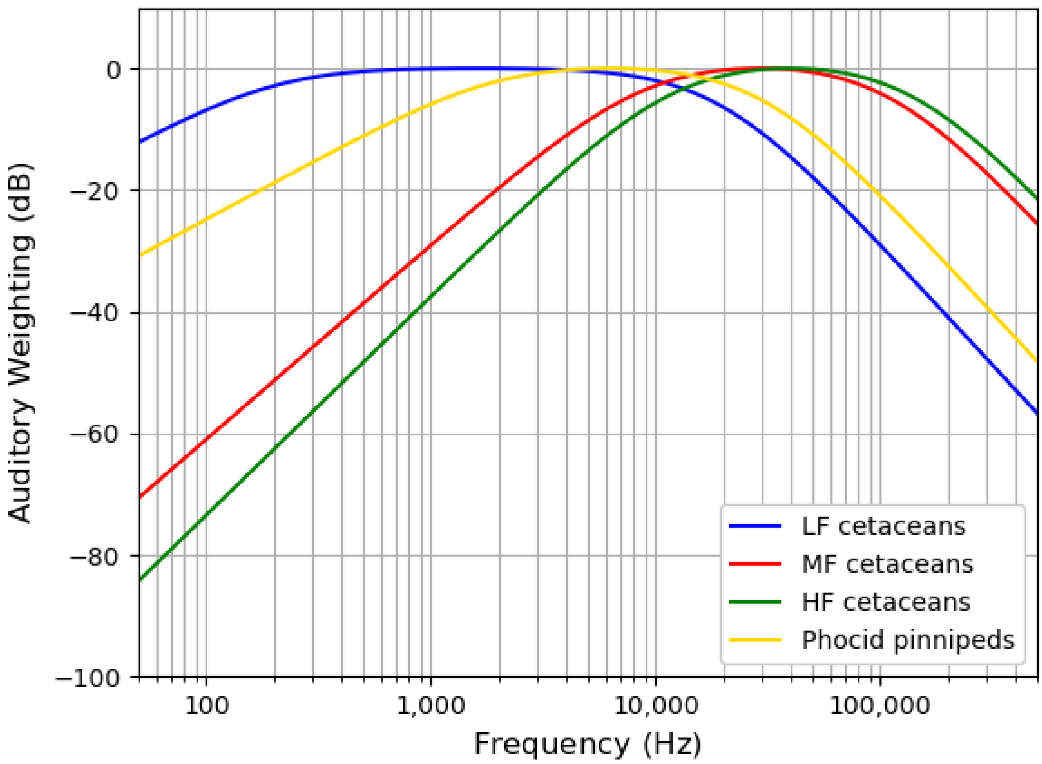


Figure 3-1: Auditory weighting functions for marine mammal hearing groups.

The PTS thresholds proposed by NOAA (NMFS, 2018) and Southall *et al.* (2019) have been estimated from temporary threshold shift (TTS) levels[1], which have been derived for a limited number of species and TTS growth rates from studies of land mammal species. Sound levels above these PTS thresholds does not necessarily mean that PTS will always occur. Furthermore, there has been no documented evidence of PTS occurring in marine mammals due to seismic survey operations.

In the remainder of this report, the NOAA (NMFS, 2018) nomenclature is used when referring to different marine mammal hearing groups. However, it is important to note that the Southall *et al.* (2019) threshold values and auditory weighting functions are the same for the comparative groups as those proposed by NOAA (NMFS, 2018) and therefore result in the same levels of estimated impacts.

3.1.2 Disturbance

Thresholds for behavioural disturbance to marine mammals are less well defined compared to PTS thresholds. Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus regarding the most appropriate metric or thresholds for assessing behavioural reactions. Southall *et al.* (2007; 2021) concluded that the available data on marine mammal behavioural responses were too variable and context-specific to justify proposing single value disturbance thresholds for all marine mammals. Instead, Southall *et al.* (2007; 2021) recommended assessing whether a sound from a specific source could cause disturbance to a particular species by comparing the circumstances of the situation with empirical studies. It is noted that NOAA (NMFS, 2018) and Southall *et al*. (2019) did not attempt to define thresholds for behavioural disturbance to marine mammals.

Guidance by Tougaard (2016) suggests that behavioural disturbance to marine mammals from seismic surveys should be assessed based on an unweighted single-pulse SEL threshold of 145 dB re 1 µPa^{2}s. This threshold is based on observations made by Thompson *et al.* (2013) and Lucke *et al.* (2009). Thompson *et al.* (2013) showed that harbour porpoises exhibited avoidance from a seismic survey in the Moray Firth at unweighted SELs of 145 – 151 dB re 1 µPa^{2}s. Lucke *et al.* (2009) also reported that a captive harbour porpoise consistently showed behavioural responses at unweighted SELs exceeding 145 dB re 1 µPa^{2}s. Based on these results, Tougaard (2016) suggested that behavioural disturbance to all marine mammals should be assessed using an unweighted SEL threshold of 145 dB re 1 µPa^{2}s. This threshold is adopted in this report for estimating potential behavioural disturbance to all marine mammals. It is noted by Tougaard (2016) that the adoption of this threshold may overestimate behavioural disturbance impacts to marine mammal species other than harbour porpoise. This is because it is thought that harbour porpoises are more sensitive to underwater sound than many other species. This is supported by the fact that the PTS thresholds for harbour porpoise (classed as HF cetaceans according to the NOAA (NMFS, 2018) hearing groups) are lower than the thresholds for all other hearing groups (see Table 3-3), suggesting that they are more sensitive to underwater sound.

NOAA currently adopt an unweighted root mean square (rms) SPL of 160 dB re 1 µPa as a threshold for signifying significant behavioural disturbance (referred to as 'Level B Harassment') to all marine mammals. This threshold was derived from the High Energy Seismic Survey (HESS) report (HESS, 1999), which was based on the responses of migrating mysticete whales (LF cetaceans) to airgun sound (Malme *et al.* 1983, 1984). The NOAA 'Level B Harassment' unweighted rms SPL threshold of 160 dB re 1 µPa is also used in this report

[1] *TTS is a temporary reduction in hearing sensitivity from which marine mammals will recover from over time, whilst PTS is permanent change in hearing sensitivity.*

for estimating behavioural disturbance to all marine mammals.

JNCC (2020) suggest using effective disturbance radii (EDR) for assessing potential impacts to harbour porpoise within the SNS SAC (JNCC, 2020). Different EDRs are suggested in JNCC (2020) for various activities. An minimum EDR of 12 km is suggested for assessing potential disturbance to harbour porpoise from seismic surveys, whilst an EDR of 15 km is suggested for assessing potential disturbance to harbour porpoise from the installation of smaller diameter piles. Whilst these EDRs are suggested for assessing disturbance to harbour porpoise, they are also adopted in this assessment for assessing disturbance to all marine mammals.

The behavioural disturbance thresholds that have been adopted in this report are summarised in Table 3-3. The NOAA 'Level B Harassment' rms SPL threshold shown in Table 3-3 has been converted to an equivalent SEL threshold because the adopted sound propagation model estimates SEL for impulsive sound sources such as airgun arrays and piling. The conversion of rms SPL to SEL is dependent on the pulse duration, which is usually considered as the duration that contains 90% of the pulse energy (Richardson *et al.,* 1995). The pulse duration of sound pulses generated by an airgun array are typically in the order of 10 – 20 ms near the source. However as the pulse propagates away from the source it elongates (i.e. the pulse duration increases) due to propagation effects. For example, measurements made in Breitzke *et al.* (2008) reported that the pulse width from an airgun array pulse elongated to 800 ms at 1 km from the source. The pulse duration of sound pulses from pile strikes is in the order of 100 – 200 ms (Richardson *et al.,* 2007) and will also elongate to increased pulse durations at further distances from the pile location. As a conservative measure, a pulse duration of 100 ms has been used to convert the NOAA 'Level B Harassment' rms SPL threshold to an equivalent SEL threshold.

Behavioural disturbance thresholds are difficult to conclusively define since different marine mammal species and even different individuals from the same species can exhibit a range of responses to the same sound (Southall *et al.*, 2007, 2021; NMFS, 2018). Furthermore, for many species there is also a lack of sufficient evidence to define appropriate thresholds (Southall *et al.,* 2021). Therefore, in this assessment two different threshold values have been adopted to assess potential disturbance (see Table 3-3). This will provide a range of distances and areas for predicted potential disturbance to marine mammals.

Table 3-3: Marine mammal behavioural disturbance thresholds.

Criteria	Behavioural Disturbance Thresholds
NOAA 'Level B Harassment' criteria for behavioural disturbance to all marine mammals	Rms SPL: 160 db re 1 µPa SEL: 150 dB re 1 µPa²s
Tougaard (2016) criteria for behavioural disturbance to all marine mammals	SEL: 150 dB re 1 µPa²s
JNCC (2020) EDRs	Seismic surveys: EDR of 12 km Piling: EDR of 15 km
[1] The NOAA 'Level B Harassment' rms SPL threshold of 160 dB re 1 µPa has been converted to an SEL threshold of 150 dB re 1 µPa²s assuming a conservative integration time of 100 ms.	

3.2 Fish

3.2.1 Injury

Popper *et al*. (2014) have defined criteria for injury to fish based on a review of publications related to impacts to fish, fish eggs, and larvae from various high-energy sources including airgun sources and piling. Popper *et al.* (2014) is the most comprehensive review available for potential impacts to fish species. The hearing capability of fish largely depends on the presence or absence of a swim bladder. Different injury thresholds are derived in Popper *et al*. (2014) for:

- Fishes with no swim bladder or other gas chamber;
- Fishes with swim bladders in which hearing involves a swim bladder or other gas volume;
- Fishes with swim bladders in which hearing does not involve the swim bladder or other gas volume; and
- Fish eggs and larvae.

The thresholds suggested in Popper *et al*. (2014) for potential injury to fish species and eggs and larvae from seismic sources and piling are the same and are shown in Table 3-4.

Table 3-4: Thresholds for potential injury to fish and fish eggs and larvae.

Fish Group	Potential Mortal Injury Thresholds	
	Zero-to-peak SPL (dB re 1 µPa)	Cumulative SEL (dB re 1 µPa^{2}s)
Fishes with no swim bladder	213	219
Fishes with swim bladder involved in hearing	207	207
Fishes with swim bladder not involved in hearing	207	210
Eggs and larvae	207	210

3.2.2 Behavioural Disturbance

Documented behavioural effects of sound on fish behaviour are variable, ranging from no discernible effect (Wardle *et al.,* 2001) to startle reactions followed by immediate resumption of normal behaviour (Wardle *et al.,* 2001; Hassel *et al.,* 2004). Avoidance of airgun array sound has also been observed (Hassel *et al.,* 2004).

Despite some documented behavioural effects there are no well-established criteria or thresholds for assessing behavioural disturbance to fish. In fact, it was concluded in Popper *et al*. (2014) that there lacked sufficient evidence to recommend specific thresholds that correspond to behavioural disturbance for fish. Therefore Popper *et al*. (2014) suggested a qualitative approach for assessing potential behavioural disturbance to fish. This approach assigns a relative risk (classified as being either High, Moderate or Low) for three relative distances from the sound source (classified as being either Near, Intermediate or Far). The suggested ranking of behavioural disturbance to fish species proposed by Popper *et al*. (2014) for airgun arrays is shown in Table 3-5. For the purposes of this assessment, a 'near' distance is assumed to be within tens of metres from the sound source, a 'moderate' distance is assumed to be within hundreds of metres from the sound source and a 'far' distance is assumed to be beyond one kilometre from the sound source (Popper *et al.*, 2014). The qualitative criteria suggested by Popper *et al.* (2014) indicates that any disturbance to fish species is likely to be very localised and therefore there is unlikely to be a significant impact to any fish populations.

Table 3-5: Qualitative criteria for assessing risk of behavioural disturbance to fish.

Fish Group	Qualitative Distance from Source	Disturbance Classification
Fishes with no swim bladder	Near	High
	Intermediate	Moderate
	Far	Low
Fishes with swim bladder involved in hearing	Near	High
	Intermediate	High
	Far	Moderate
Fishes with swim bladder not involved in hearing	Near	High
	Intermediate	Moderate
	Far	Low
Eggs and larvae	Near	Moderate
	Intermediate	Low
	Far	Low

4.0 MODELLING RESULTS AND IMPACT ASSESSMENT

This section presents the sound modelling results and assesses potential impacts that the seismic surveys and piling activities associated with the NEP CCS Project may potentially have on marine mammals, fish and protected areas (specifically the Southern North Sea (SNS) special area of conservation (SAC)).

4.1 Seismic Survey

Potential impacts from the seismic surveys associated with the NEP CCS Project have been assessed assuming that the surveys will be conducted with a source comprising 480 cu. in arrays as discussed in Section 2.1.1.

4.1.1 Marine Mammals

4.1.1.1 PTS

The potential for marine mammals to experience PTS onset due to sound from the seismic survey source has been assessed based on predicting distances from the source that have been derived by comparing modelled sound levels with the zero-to-peak SPL and cumulative SEL thresholds (Table 3-2). PTS onset is considered to occur when sound levels are above either the zero-to-peak SPL threshold or the corresponding cumulative SEL threshold (NMFS, 2018; Southall *et al.,* 2019).

Zero-to-Peak SPL

Figure 4-1 shows the maximum predicted zero-to-peak SPL from the NEP CCS Project seismic surveys when the source arrays are operating at full power. This figure shows the maximum unweighted zero-to-peak SPL over all depths and does not represent sound levels at any specific depth layer. The contours highlighted in Figure 4-1 represent the zero-to-peak SPL threshold values for potential PTS onset for different marine mammal hearing groups.

The maximum distances where the predicted zero-to-peak SPL sound levels decrease to below the thresholds for PTS onset are summarised in Table 4-1. The modelling predicts that the zero-to-peak SPL will decrease to below the PTS thresholds for all marine mammal hearing groups within the nominal 500 m mitigation zone distance employed during seismic surveys (JNCC, 2017). Therefore, if a nominal 500 m mitigation zone and associated measures are implemented during the survey, the probability of zero-to-peak SPL sound levels produced by the source arrays causing PTS onset to marine mammals is low.

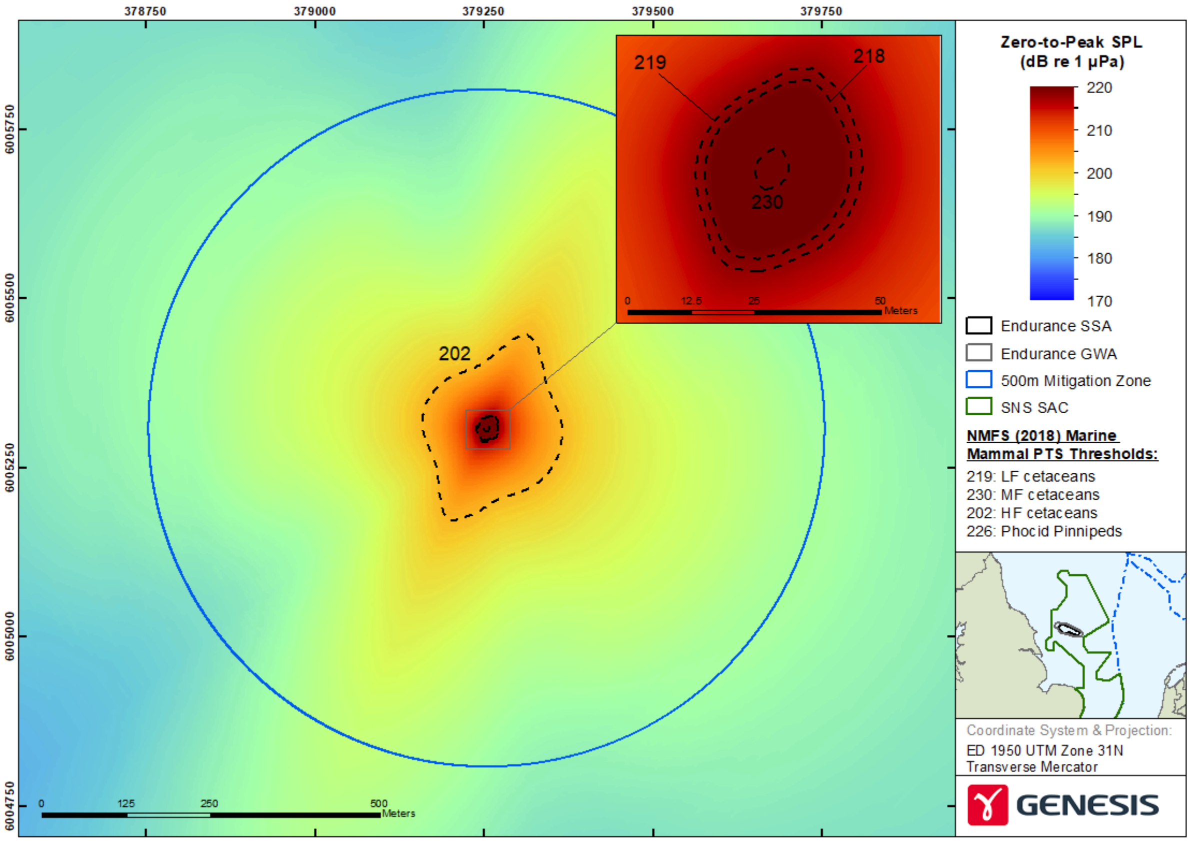


Figure 4-1: Predicted zero-to-peak SPL received by marine mammals during the NEP CCS Project seismic surveys when the source arrays are operating at maximum power.

Table 4-1: Predicted maximum distances from the source arrays where the zero-to-peak SPL sound levels decrease to below the thresholds for PTS to marine mammals.

Marine Mammal Hearing Group	Zero-to-peak SPL PTS Threshold (dB re 1 μPa)	Maximum Distance to Threshold (m) [1]
LF cetaceans	219	20
MF cetaceans	230	10
HF cetaceans	202	150
Phocid pinnipeds	218	30
[1] Predicted distances have been rounded up to the nearest 10 m.		

Single-pulse SEL

Received sound levels in terms of single-pulse auditory-weighted SEL have also been predicted for the proposed survey. Unlike the zero-to-peak SPL results presented in the previous section, the single-pulse SELs have been weighted using the auditory weighting functions shown in Figure 3-1. The auditory-weighted SEL for single pulses when the source arrays are operating at maximum power are shown in Figure 4-2 to Figure 4-5.

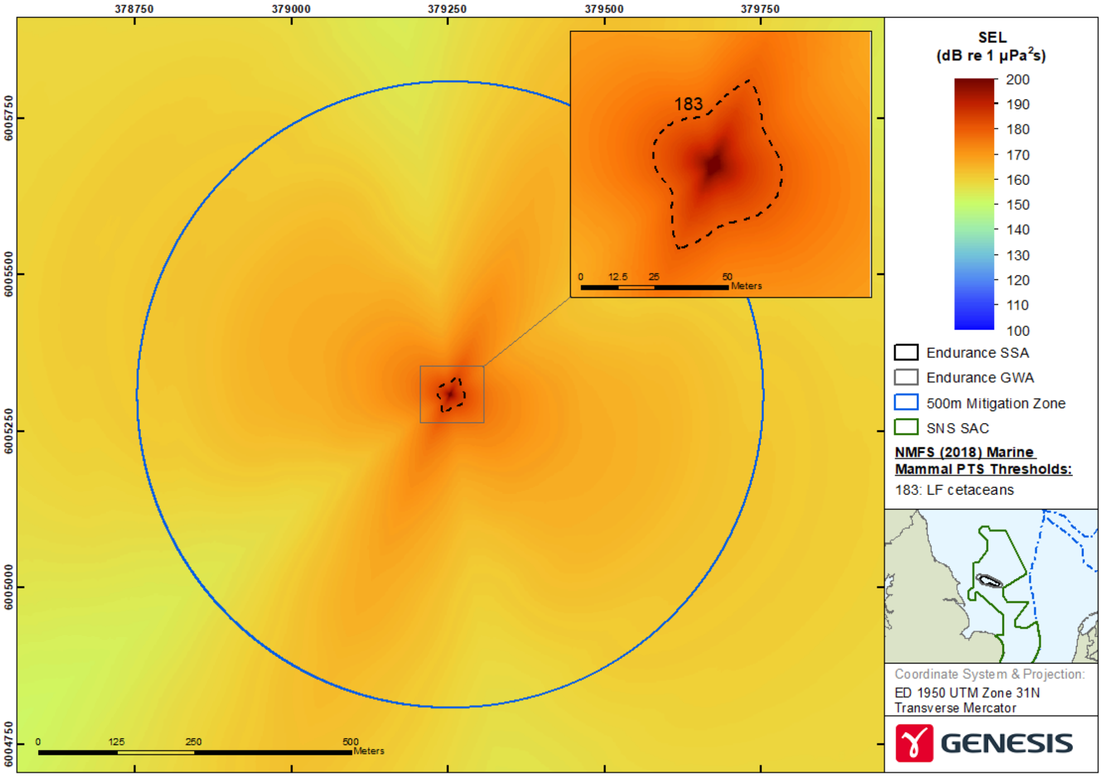


Figure 4-2: Predicted LF cetacean weighted SEL from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys.

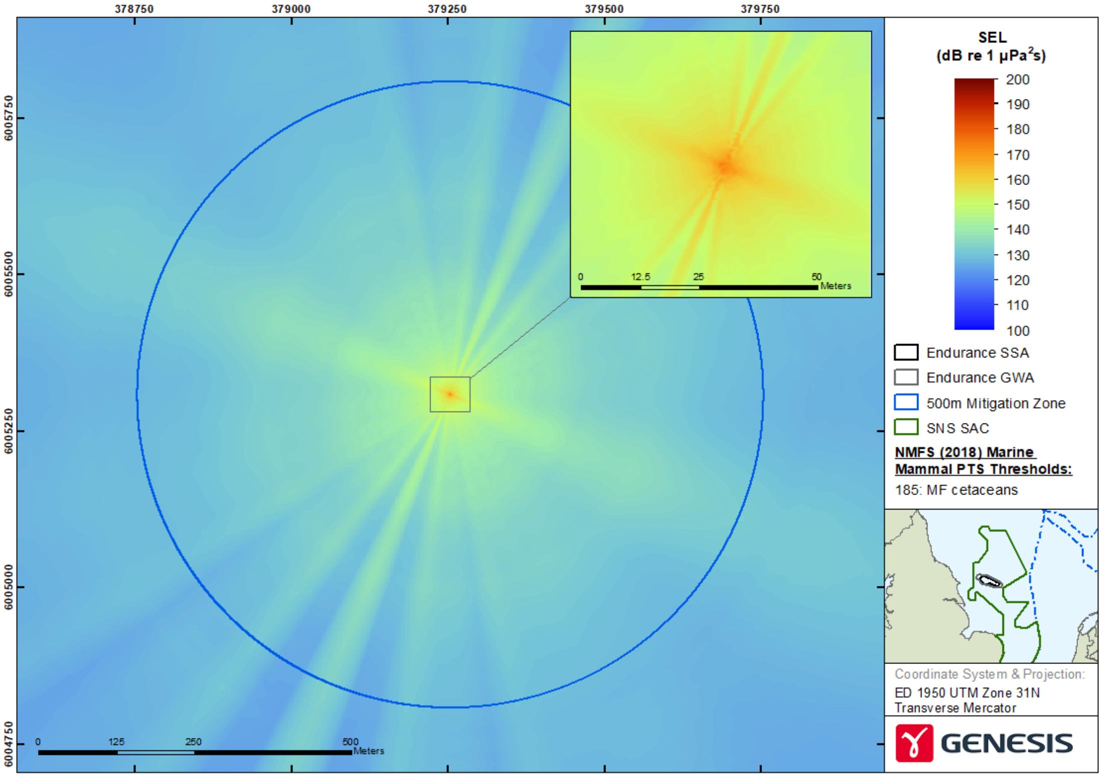


Figure 4-3: Predicted MF cetacean weighted SEL from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys.

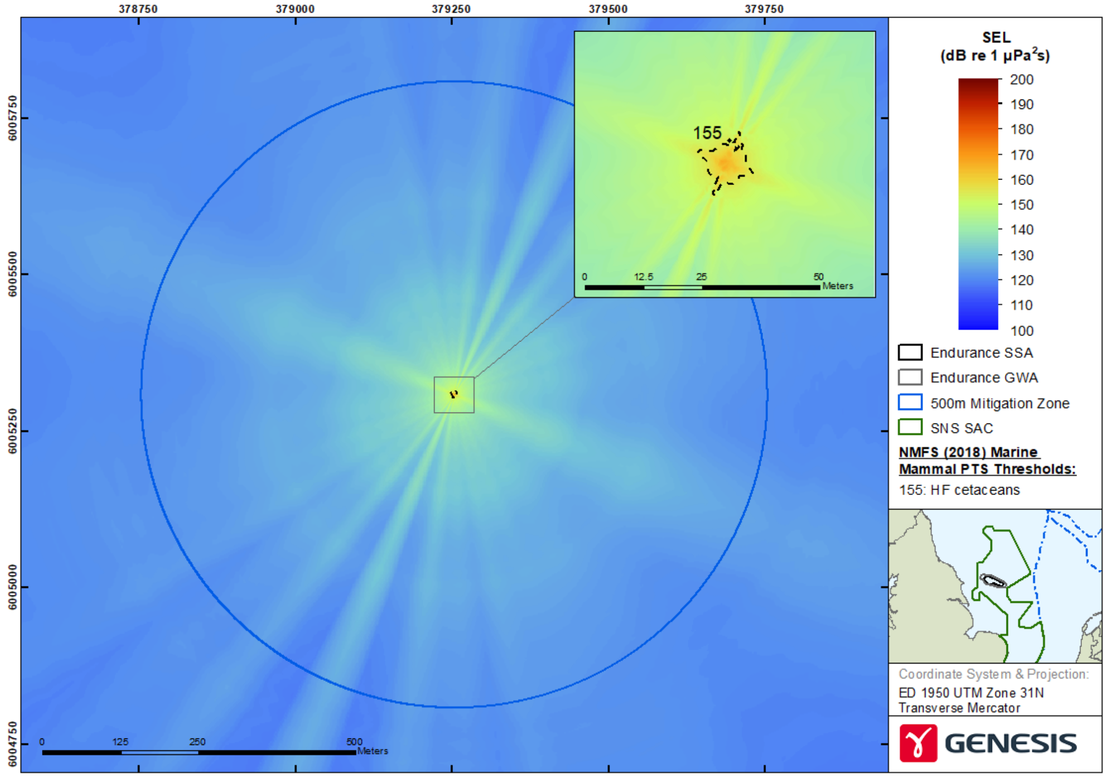


Figure 4-4: Predicted HF cetacean weighted SEL from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys.

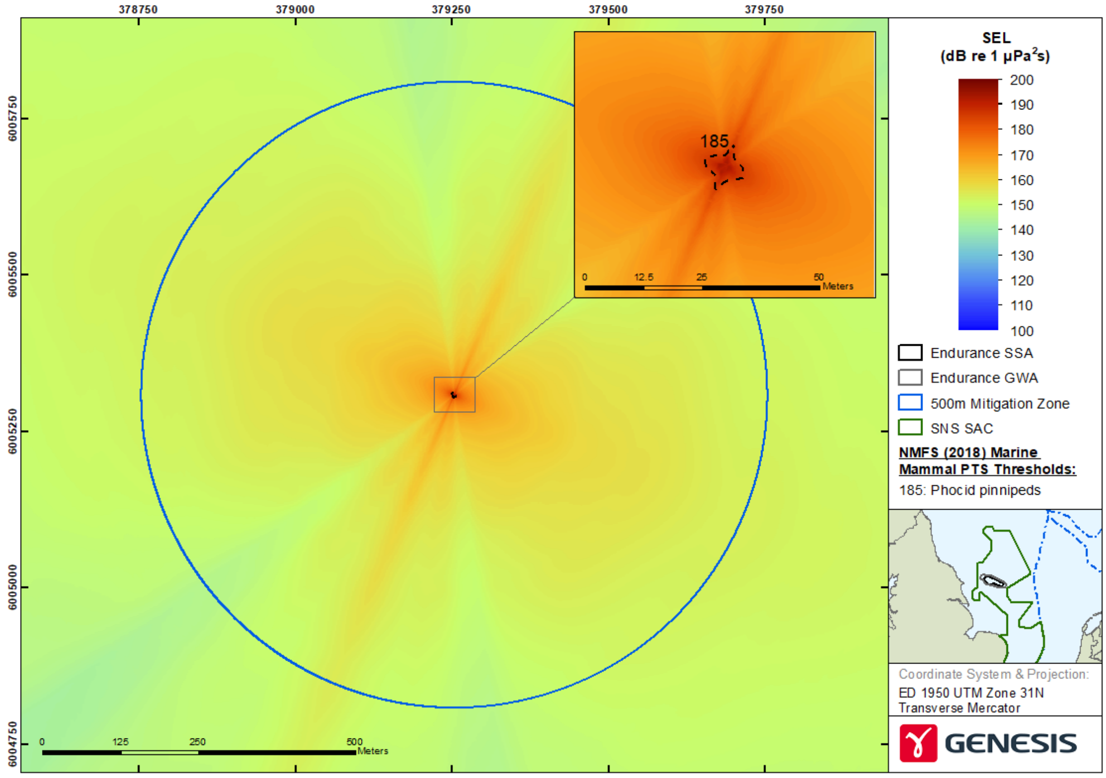


Figure 4-5: Predicted phocid pinniped weighted SEL from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys.

Distances where the auditory-weighted single-pulse SELs decrease to below the thresholds for PTS for different marine mammal hearing groups have been predicted from the modelling and are summarised in Table 4-2. Results are shown for array pulses at the beginning of the soft-start of the source arrays as well as when the arrays are operating at maximum power and sound levels will be highest.

The modelling predicts that the auditory weighted single-pulse SELs will decrease to below the PTS thresholds for all marine mammal hearing groups well within the nominal 500 m mitigation zone employed during seismic surveys (JNCC, 2017). Therefore, if a 500 m mitigation zone and associated mitigation measures are implemented during the survey, the probability of single pulses causing PTS onset to marine mammals is low.

Table 4-2: Predicted maximum distances from the source arrays where the single-pulse SEL sound levels decrease to below the thresholds for PTS to marine mammals.

Marine Mammal Hearing Group	c (dB re 1 µPa^{2}s)	Maximum Distance to Threshold (m) [1]	
		Beginning of Soft-Start	End of Soft-Start
LF cetaceans	183	Threshold not exceeded	30
MF cetaceans	185	Threshold not exceeded	Threshold not exceeded
HF cetaceans	155	Threshold not exceeded	10
Phocid pinnipeds	185	Threshold not exceeded	10

[1] Predicted distances have been rounded up to the nearest 10 m.

Cumulative SEL

The source has been modelled moving along a representative survey data acquisition line at a typical speed of 4.5 knots (2.3 m/s) and activated at a regular source point interval of 6.25 m. Marine mammals have been simulated swimming away from the source (in a direction perpendicular to the survey vessel trajectory) at different swim speeds and the cumulative SEL calculated. The cumulative SEL calculations have been repeated for marine mammals starting at different initial starting distances from the source. The simulations identify the minimum starting distances (i.e. distances at which PTS is unlikely to occur) that marine mammals must be from the source at the start of operations in order for cumulative SEL levels not to be above the thresholds for potential PTS onset as they swim away. The cumulative SEL modelling has been conducted both with and without a soft-start of the source being included. However, it should be noted that in practice a soft-start of the source will be conducted before acquisition of every seismic line. The results shown with no soft-start are only provided to demonstrate the effect that the soft-start has on minimising potential impacts to marine mammals.

The predicted minimum initial distances that marine mammals must be from the source at the start of the operations such that the cumulative SEL remains below relevant thresholds when marine mammals move away are summarised in Table 4-3 for different swimming speeds. It is important to note that a soft-start will be employed during the proposed survey, and the modelling results presented without the inclusion of a soft-start are only shown to illustrate the effectiveness of the soft-start as a mitigation measure.

Table 4-3: Predicted initial starting distances from the source arrays where sound levels will be below the cumulative SEL thresholds for PTS to marine mammals.

Marine Mammal Hearing Group	Cumulative SEL PTS Threshold (dB re 1 µPa²s)	Swim Speed (m/s)	Maximum Distance to Threshold (m) [1]	
			With soft-start	Without soft-start
LF cetaceans	183	1.5	Threshold not exceeded	1,300
		2	Threshold not exceeded	930
		3	Threshold not exceeded	460
MF cetaceans	185	1.5	Threshold not exceeded	Threshold not exceeded
		2	Threshold not exceeded	Threshold not exceeded
		3	Threshold not exceeded	Threshold not exceeded
HF cetaceans	155	1.5	Threshold not exceeded	30
		2	Threshold not exceeded	10
		3	Threshold not exceeded	10
Phocid pinnipeds	185	1.5	Threshold not exceeded	10
		2	Threshold not exceeded	10
		3	Threshold not exceeded	10

[1] Predicted distances have been rounded up to the nearest 10 m.

The cumulative SEL modelling results in Table 4-3 show that the cumulative SEL sound levels will not be above the thresholds for PTS for any marine mammal hearing group when a soft-start of the source arrays is employed. The modelling results demonstrate that the soft-start will enable time for marine mammals to move away from the source to distances where they will not be exposed to sound levels that may cause PTS. It is therefore concluded that the risk of PTS to marine mammals is low when a soft-start of the source arrays is employed along with other standard mitigation measures such as a 500 m mitigation zone.

4.1.1.2 Behavioural Disturbance

To predict distances at which potential behavioural disturbance to marine mammals may occur, received sound levels in terms of unweighted SEL for single source array pulses have been estimated and compared to the adopted behavioural disturbance threshold values shown in Table 3-3 (note that the rms SPL threshold values suggested by NMFS in Table 3-3 have been converted to SEL thresholds for comparison with the model results).

The estimated unweighted SEL for a single representative source pulse when the arrays are operating at full power is shown in Figure 4-6. The contours highlighted in this figure correspond to the adopted behavioural disturbance thresholds. A 12 km effective disturbance radius (EDR) is also shown in Figure 4-6, which is the disturbance radius suggested by JNCC for assessing potential displacement of harbour porpoise from seismic surveys (JNCC, 2020). The maximum predicted distances where sound levels decrease to below the behavioural disturbance thresholds for single array pulses are summarised in Table 4-4.

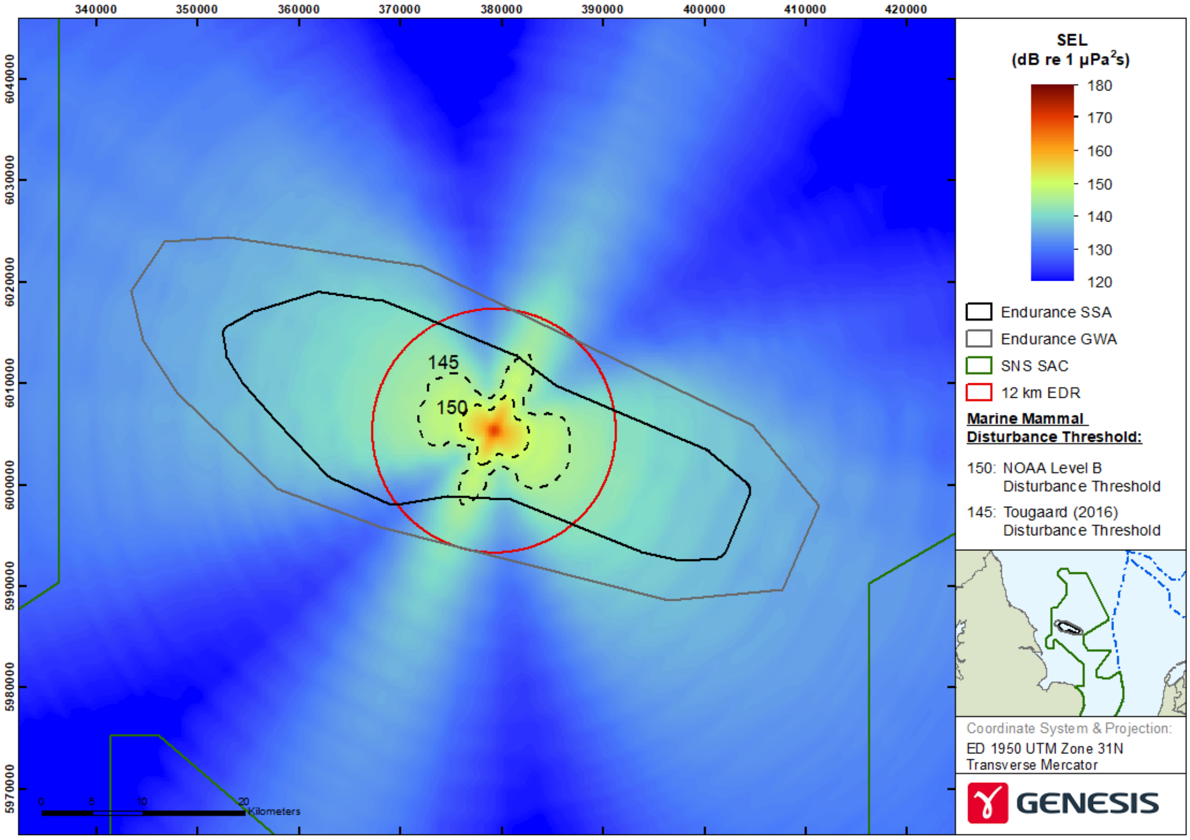


Figure 4-6: Predicted unweighted SEL received by marine mammals from a single pulse when the source arrays are operating at maximum power during the NEP CCS seismic surveys.

Table 4-4: Predicted maximum distances from the source arrays where sound levels decrease to below the thresholds for behavioural disturbance to marine mammals.

Method	Behavioural Disturbance Thresholds	Maximum Distance to Threshold (km)
Comparison of modelling results with NOAA 'Level B harassment' threshold for disturbance to marine mammals	Rms SPL: 160 db re 1 μPa SEL: 150 dB re 1 μPa²s	3.9
Comparison of modelling results with Tougaard (2016) threshold for disturbance to marine mammals	SEL: 150 dB re 1 μPa²s	8.9
JNCC (2020) 12 km EDR	EDR of 12 km	12.0
[1] The NOAA 'Level B Harassment' rms SPL threshold of 160 dB re 1 μPa has been converted to an SEL threshold of 150 dB re 1 μPa²s assuming a conservative integration time of 100 ms.		

Measurements made during a seismic survey in the Moray Firth (Thompson *et al.*, 2013) showed displacement of harbour porpoise (HF cetaceans) out to 5 – 10 km from a 470 cu. in array. The modelling estimates that behavioural disturbance to harbour porpoise from the surveys associated with the NEP CCS Project (using a 480 cu. in array) could occur at distances of 3.9 - 8.9 km, which is aligned with the measurements made by Thompson *et al.* (2013).

It is important to note that Figure 4-6 shows the unweighted SEL for a single source array pulse only. As the survey vessel traverses the seismic lines, the source arrays will emit pulses at regular intervals. Therefore, the area where sound levels are above a given threshold value (i.e. the adopted behavioural disturbance threshold value) will vary at any given time as the survey vessel moves. To estimate potential disturbance to marine mammals over a 24 hour period, the survey vessel has been modelled completing two seismic lines spaced approximately 8 km apart. The two lines were selected to be two of the longest lines in the survey area and will be indicative of the maximum disturbance area that could occur over a 24 hour period. The single-pulse SELs for all source points over the seismic lines were aggregated to predict areas where potential disturbance to marine mammals could occur and are shown in Figure 4-7. The single-pulse SELs have also been aggregated over all source points over the entire survey area to demonstrate the cumulative disturbance areas over the entire survey duration and are shown in Figure 4-8.

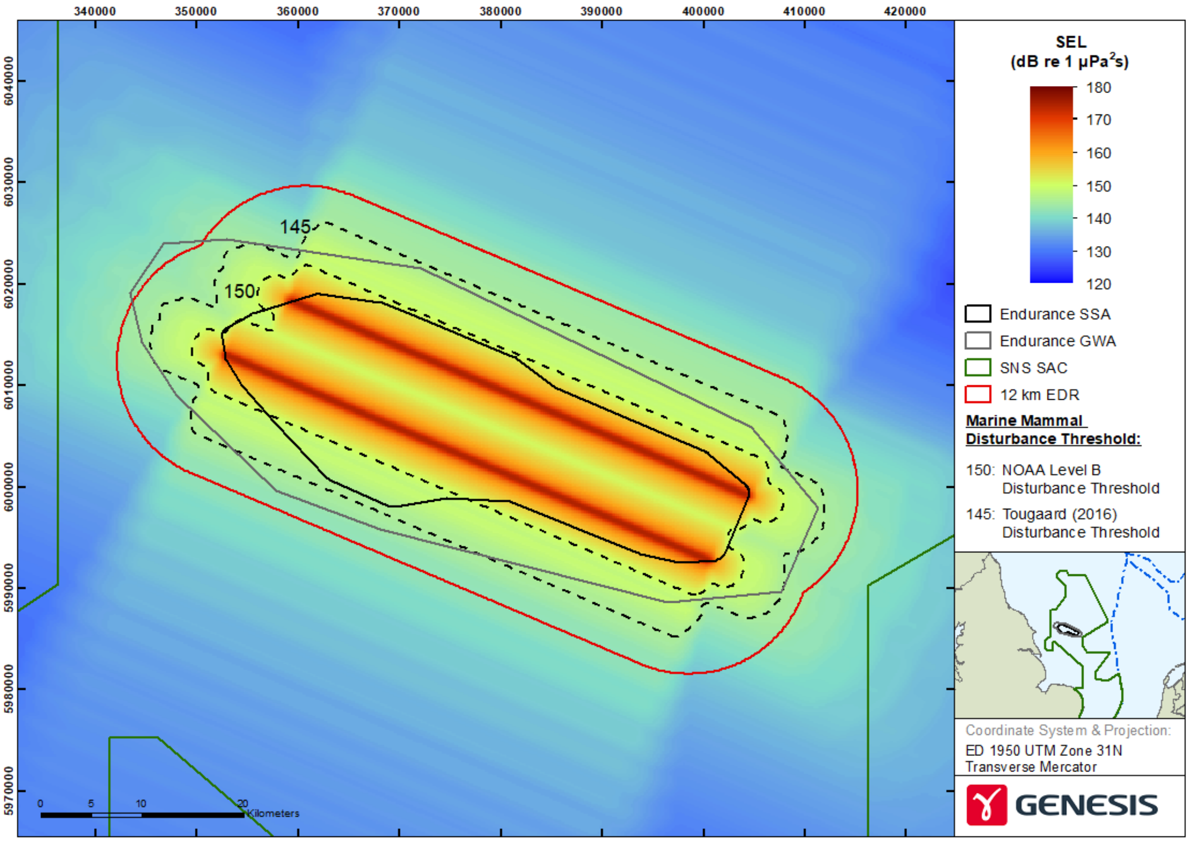


Figure 4-7: Predicted unweighted single pulse SEL received by marine mammals aggregated over all source points over a 24 hour period of the seismic survey.

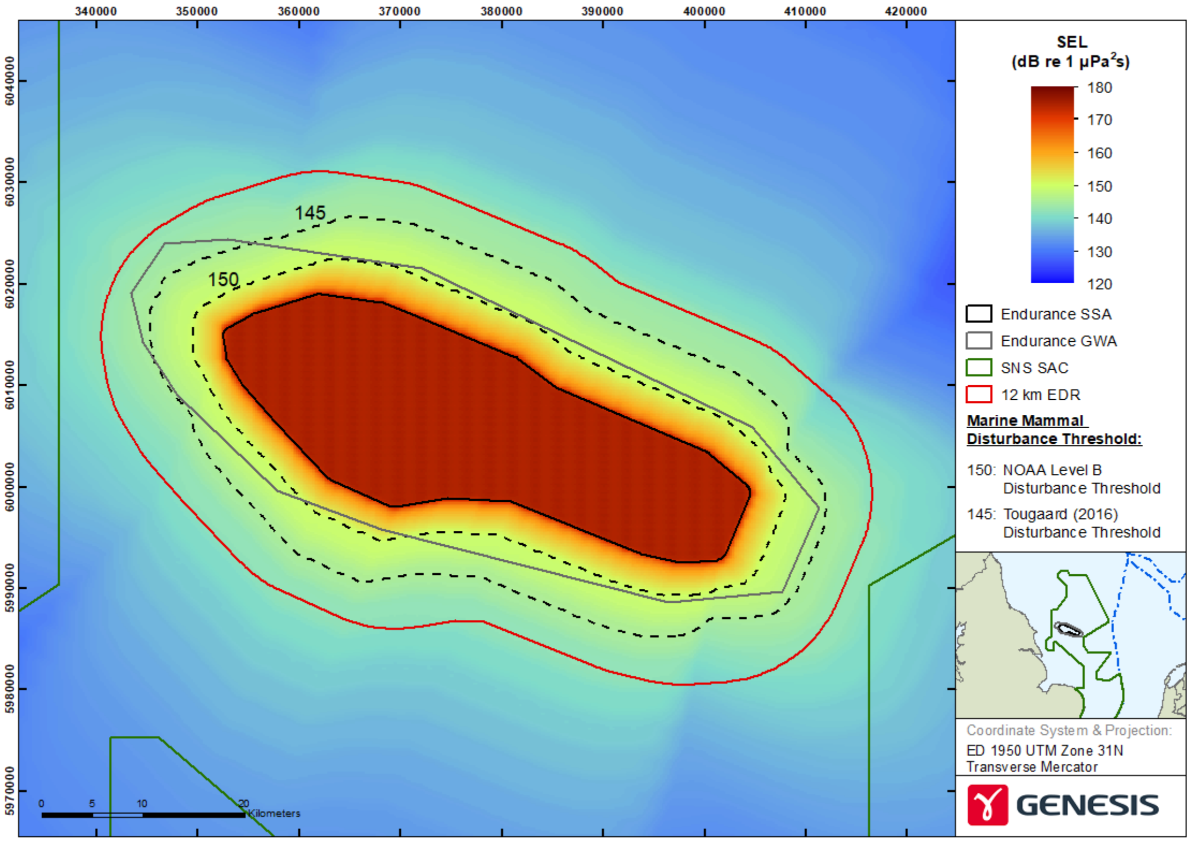


Figure 4-8: Predicted unweighted single pulse SEL received by marine mammals aggregated over all source points over the complete duration of the seismic survey.

The disturbance areas shown in Figure 4-7 and Figure 4-8 have been calculated based on three different threshold values: the NOAA 'Level B harassment' threshold for disturbance to marine mammals, the Tougaard (2016) threshold for disturbance to marine mammals, and the 12 km EDR suggested by JNCC (2020) for assessing possible disturbance to harbour porpoise from seismic surveys. Based on the disturbance areas predicted using these thresholds, the number of marine mammals that may potentially be disturbed during the survey have been calculated using estimated densities of marine mammals in the region of the survey area. Estimated densities for marine mammals are taken from SCANS-III (Hammond *et al.,* 2017). For harbour porpoise, densities from both SCANS III (Hammond *et al.*, 2017) and Heinänen and Skov (2015) have been used to provide a range for the number of harbour porpoise potentially disturbed. This range reflects the variable likelihood and/or uncertainty of harbour porpoise presence in the area. The estimated number of marine mammals disturbed have been compared to the management unit (MU) populations proposed by the Inter-Agency Marine Mammal Working Group (IAMMWG, 2021). The estimated numbers of marine mammals that could potentially be disturbed or exhibit behavioural responses due to the proposed survey are shown in Table 4-5, Table 4-6, and Table 4-7 for the three set of thresholds adopted.

Any marine mammals disturbed from the area by the proposed surveys will likely return after cessation of activities (Sarnocinska *et al.,* 2020; Thompson *et al.,* 2013). It was observed by Thompson *et al.* (2013) that harbour porpoise displaced during a seismic survey returned to the survey area within one day after the survey finished. Similar studies based on impacts associated with sound from piling have indicated that marine mammals return to the area within relatively short periods of time, usually within three days once the activity causing the displacement has ceased (Brandt *et al.,* 2016, 2017, 2018; Carstensen *et al.,* 2006). It has been demonstrated that even long-term disturbance from a limited area over several months is unlikely to have a significant long-term impact on marine mammal populations levels (Nabe-Nielsen *et al.,* 2018; Nabe-Nielsen, 2020). The NEP CCS Project seismic surveys are expected to be completed within a maximum of 75 days (including downtime). It is expected that any marine mammals that may temporarily move away from the area will return after the survey has finished. The NEP CCS Project seismic surveys are therefore not expected to have any adverse effect on any marine mammal populations.

Table 4-5: Estimated number of marine mammals disturbed based on the NOAA 'Level B harassment' threshold for disturbance to marine mammals.

Species	Disturbance Area (km^2)	Animal Density ($animals/km^2$) [1]	Number of Animals Disturbed	MU Population [2]	Percentage of MU Population Disturbed (%)
Disturbance over 24 hours					
Harbour porpoise (HF cetacean)	825	0.888 – 3	733 – 2,475	346,601	0.211 – 0.714
White-beaked dolphin (MF cetacean)	825	0.002	2	43,951	0.005
Minke whale (LF cetacean)	825	0.010	9	20,118	0.045
Disturbance over entire survey duration					
Harbour porpoise (HF cetacean)	1,170	0.888 – 3	1,039 – 3,510	346,601	0.300 – 1.013
White-beaked dolphin (MF cetacean)	1,170	0.002	3	43,951	0.007
Minke whale (LF cetacean)	1,170	0.010	12	20,118	0.060

[1] Marine mammal densities for white-beaked dolphin and minke whale are from SCANS-III data (Hammond *et al*., 2017). For harbour porpoise, the lower density of 0.888 is from SCANS-III whilst the upper density of 3 is based on Heinänen and Skov (2015).
[2] MU populations are from IAMMWG (2021).

Table 4-6: Estimated number of marine mammals disturbed based on the Tougaard (2016) threshold for disturbance to marine mammals.

Species	Disturbance Area (km^2)	Animal Density (animals/km^2) [1]	Number of Animals Disturbed	MU Population [2]	Percentage of MU Population Disturbed (%)
Disturbance over 24 hours					
Harbour porpoise (HF cetacean)	1,458	0.888 – 3	1,295 – 4,374	346,601	0.374 – 1.262
White-beaked dolphin (MF cetacean)	1,458	0.002	3	43,951	0.007
Minke whale (LF cetacean)	1,458	0.010	15	20,118	0.075
Disturbance over entire survey duration					
Harbour porpoise (HF cetacean)	1,810	0.888 – 3	1,608 – 5,430	346,601	0.464 – 1.567
White-beaked dolphin (MF cetacean)	1,810	0.002	4	43,951	0.009
Minke whale (LF cetacean)	1,810	0.010	19	20,118	0.094

[1] Marine mammal densities for white-beaked dolphin and minke whale are from SCANS-III data (Hammond *et al*., 2017). For harbour porpoise, the lower density of 0.888 is from SCANS-III whilst the upper density of 3 is based on Heinänen and Skov (2015).
[2] MU populations are from IAMMWG (2021).

Table 4-7: Estimated number of marine mammals disturbed based on a 12 km EDR for disturbance to marine mammals.

Species	Disturbance Area (km^2)	Animal Density (animals/km^2) [1]	Number of Animals Disturbed	MU Population [2]	Percentage of MU Population Disturbed (%)
Disturbance over 24 hours					
Harbour porpoise (HF cetacean)	2,125	0.888 – 3	1,887 – 6,375	346,601	0.544 – 1,839
White-beaked dolphin (MF cetacean)	2,125	0.002	5	43,951	0.011
Minke whale (LF cetacean)	2,125	0.010	22	20,118	0.109
Disturbance over entire survey duration					
Harbour porpoise (HF cetacean)	2,655	0.888 – 3	2,358 – 7,965	346,601	0.680 – 2.298
White-beaked dolphin (MF cetacean)	2,655	0.002	6	43,951	0.014
Minke whale (LF cetacean)	2,655	0.010	27	20,118	0.134

[1] Marine mammal densities for white-beaked dolphin and minke whale are from SCANS-III data (Hammond *et al*., 2017). For harbour porpoise, the lower density of 0.888 is from SCANS-III whilst the upper density of 3 is based on Heinänen and Skov (2015).
[2] MU populations are from IAMMWG (2021).

4.1.2 Fish

4.1.2.1 Injury

To quantitatively assess any potential injury to fish from the NEP CCS seismic surveys, received sound levels in terms of unweighted zero-to-peak SPL and unweighted cumulative SEL have been predicted and compared to the Popper *et al*. (2014) thresholds for injury (see Table 3-4).

Figure 4-9 shows the maximum predicted zero-to-peak SPL from the NEP CCS Project seismic surveys when the source arrays are operating at full power. The contours in this figure highlights the Popper *et al*. (2014) zero-to-peak SPL thresholds for potential injury to fish species. The maximum predicted distances where the zero-to-peak SPL sound levels decrease to below the Popper *et al*. (2014) thresholds for fish injury are shown in Table 4-8. Table 4-9 summarises the predicted minimum initial distances that fish must be from the source arrays at the start of the sound source in order not to be exposed to cumulative SEL sound levels above the Popper *et al*. (2014) thresholds for potential injury.

The modelling predicts that sound levels will be below threshold values associated with injury to the most sensitive fish beyond a maximum distance of 80 m from the source arrays. Predicted distances are lower for less sensitive fish species. It is expected that the soft-start of the source arrays will likely disperse any mobile fish away from the sound source to further distances where injury impacts are unlikely to occur. However, fish eggs and larvae that cannot move away from the source array are more susceptible to injury. The modelling predicts that fish eggs and larvae that cannot move away from the seismic source may by injured at distances of 400 m from the source.

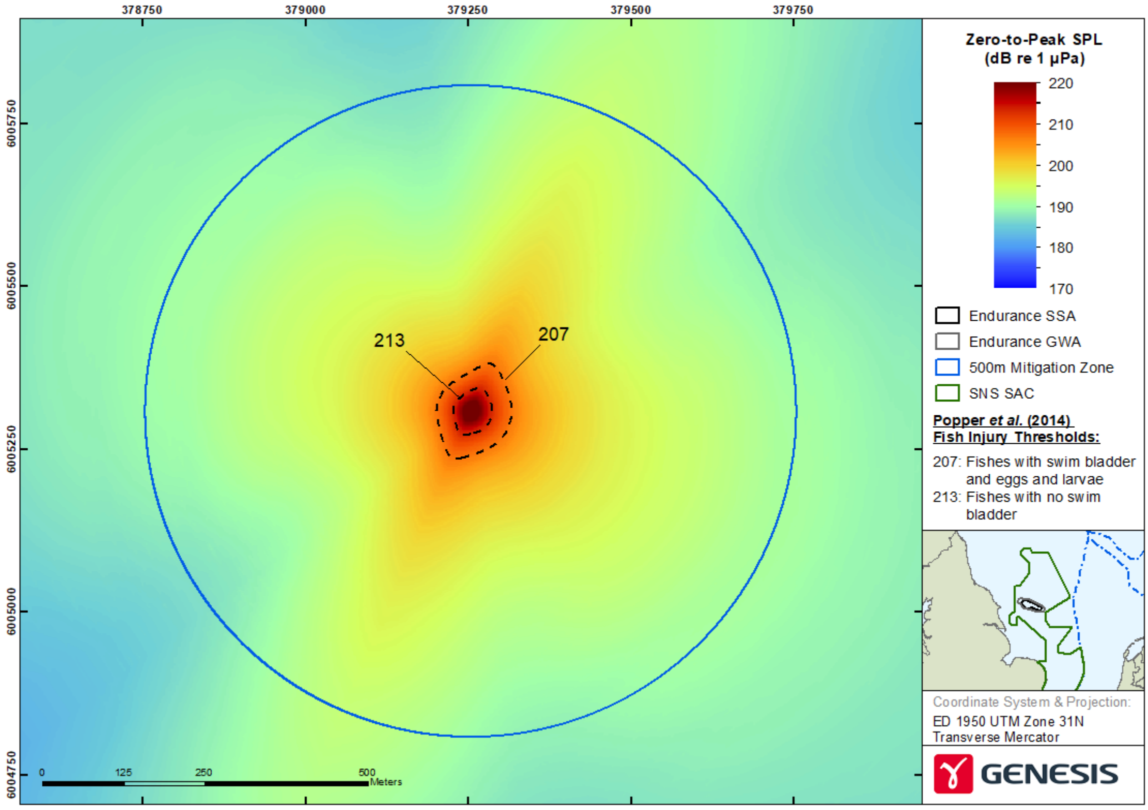


Figure 4-9: Predicted zero-to-peak SPL received by fish during the NEP CCS Project seismic surveys when the source arrays are operating at maximum power.

Table 4-8: Predicted maximum distances from the source arrays where the zero-to-peak SPL sound levels decrease to below the thresholds for fish injury.

Fish Group	Zero-to-peak SPL Injury Threshold (dB re 1 µPa)	Maximum Distance to Threshold (m) [1]
Fishes with no swim bladder	213	40
Fishes with swim bladder involved in hearing	207	80
Fishes with swim bladder not involved in hearing	207	80
Eggs and larvae	207	80
[1] Predicted distances have been rounded up to the nearest 10 m.		

Table 4-9: Predicted initial starting distances from the source arrays where sound levels will be below the cumulative SEL thresholds for fish injury.

Fish Group	Cumulative SEL Injury Threshold (dB re 1 µPa²s)	Swim Speed (m/s)	Maximum Distance to Threshold (m) [1]
Fishes with no swim bladder	219	0.5	Threshold not exceeded
Fishes with swim bladder involved in hearing	207	0.5	Threshold not exceeded
Fishes with swim bladder not involved in hearing	210	0.5	Threshold not exceeded
Eggs and larvae	210	0	400
[1] Predicted distances have been rounded up to the nearest 10 m.			

4.1.2.2 Behavioural Disturbance

Behavioural disturbance to fish cannot be quantitively predicted from the propagation modelling since there are no well-established disturbance thresholds for fish. The qualitative criteria established by Popper *et al.* (2014) suggest that any disturbance to fish species will likely be localised with higher levels of disturbance only occurring in regions near to the source (e.g. within a few hundred metres). At further distances from the source (e.g. beyond one kilometre), the risk of behavioural disturbance to fish is likely to be low (see Table 3-5).

Fish are mobile and would be expected to move away from a sound source that had the potential to cause them harm. If fish are disturbed by sound, evidence suggests they will return to an area once the activity generating the sound has ceased (Slabbekoorn *et al.*, 2010).

4.1.3 SNS SAC

The NEP CCS Project seismic survey area is located within the SNS SAC, which is designated for the protection of harbour porpoise. The JNCC "Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs" (JNCC, 2020), has been used to assess the potential impacts that surveys may have on the SNS SAC and the population of harbour porpoise within the SAC. The JNCC guidelines (JNCC, 2020) suggest that disturbance within an SAC from an activity (individually or in combination) is significant if it excludes harbour porpoises from more than

- 20% of the relevant area of the site in any given day; or
- An average of 10% of the relevant area of the site over a season.

The NEP CCS Project survey area is located within the 'Summer Area' of the SNS SAC and it is most likely that the surveys will be conducted during the 'Summer Season' months of April to September. Following the JNCC (2020) guidance methodology, potential disturbance areas within this area of the SNS SAC have been assessed using two methods to determine distances/areas at which potential disturbance may occur:

- sound modelling results using the NOAA 'Level B harassment' and Tougaard (2016) thresholds (see Table 3-3) for estimating displacement of harbour porpoise; and
- Effective Deterrent Range (EDR) of 12 km suggested by the JNCC guidance (JNCC 2020) for estimating displacement of harbour porpoise.

Uncertainties remain as to whether exposure to sound levels above given thresholds result in individual receptors being 'excluded' from an area. However, the thresholds adopted for the sound modelling results and the EDR's suggested by JNCC (2020) provide temporal/spatial boundary conditions to assess potential disturbance.

The predicted daily percentages of the SNS SAC and the average percentages of the SNS SAC impacted over the season are shown in Table 4-10 based on the three different disturbance thresholds considered in this assessment. It is predicted that the NEP CCS Project seismic surveys will not exceed the daily and seasonal thresholds suggested by JNCC (2020).

The estimated area of the SNS SAC that could be impacted is highest when the JNCC (2020) EDR for seismic surveys is adopted. This is because the JNCC (2020) EDR of 12 km is larger than the 3.9 km to 8.9 km estimated from the modelling. The EDR of 12 km was based on observations made by Sarnocinska *et al.* (2020) of displacement of harbour porpoise from a seismic survey using a 3,570 cu. in array, which is substantially larger than the 480 cu. in source modelled for the NEP CCS Project surveys. Thompson *et al.* (2013) observed displacement of harbour porpoise from a 470 cu. in array to be between 5 – 10 km. The modelling results predicted displacement of harbour porpoise between 3.9 – 8.9 km and are therefore well aligned with the results of Thompson *et al.* (2013).

Both the modelling results and the JNCC (2020) EDR methodology suggest that the NEP CCS Project seismic surveys by themselves will not result in impact areas being above the thresholds suggested by the JNCC (2020) guidelines. However, the thresholds could potentially be exceeded if other activities occur in the area at the same time as NEP CCS seismic survey.

Table 4-10: Predicted areas of the SNS SAC that may be impacted by the NEP CCS Project seismic surveys.

Method	Predicted Daily Disturbance Area (km^2) [1]	Daily % of SNS SAC Impacted [2]	Average % of SNS SAC Impacted Over the Season [3]
Comparison of modelling results with NOAA 'Level B harassment' threshold for disturbance to marine mammals	825	3.05%	0.93%
Comparison of modelling results with Tougaard (2016) threshold for disturbance to marine mammals	1,458	5.39%	1.65%
JNCC (2020) 12 km EDR	2,125	7.86%	2.41%

[1] The predicted daily disturbance areas refer to the areas of the SNS SAC impacted over 24 hours (see Figure 4-7 and Table 4-5 to Table 4-7 for predicted daily disturbance areas from the sound modelling).
[2] The percentage of the SNS SAC 'Summer Area' impacted has been calculated based on the predicted disturbance areas for each disturbance threshold and an area of 27,028 km^2 for the SNS SAC 'Summer Area' as per the JNCC (2020) guidance.
[3] The average percentage of the SNS SAC impacted over the season (183 days) has been calculated assuming that the airgun array will be operational for 56 days and the percentage of the SAC impacted will be the same for each day of seismic operation. For example, for the 12 km EDR disturbance threshold, the average percentage of SNS SAC impacted over the season is calculated as 7.86*56/183 = 2.41%.

4.2 Piling

Potential impacts from piling associated with the NEP CCS Project have been assessed assessed for the following scenarios:

- Piling for manifold installations at Endurance;
- Piling for SSIV installation on the Teesside pipeline; and
- Piling for HDD trestle installations at Teesside and Humberside.

4.2.1 Marine Mammals

4.2.1.1 PTS

Zero-to-Peak SPL

The maximum predicted zero-to-peak SPLs from the manifold piling, SSIV piling, HDD trestle piling at Teesside, and HDD trestle piling at Humberside are shown in Figure 4-10, Figure 4-11, Figure 4-12, and Figure 4-13, respectively, when the hammer is operating at maximum energy. These figures show the maximum unweighted zero-to-peak SPLs over all depths and do not represent sound levels at any specific depth layer. The contours highlighted in these figures represent the zero-to-peak SPL threshold values for potential PTS onset for different marine mammal hearing groups.

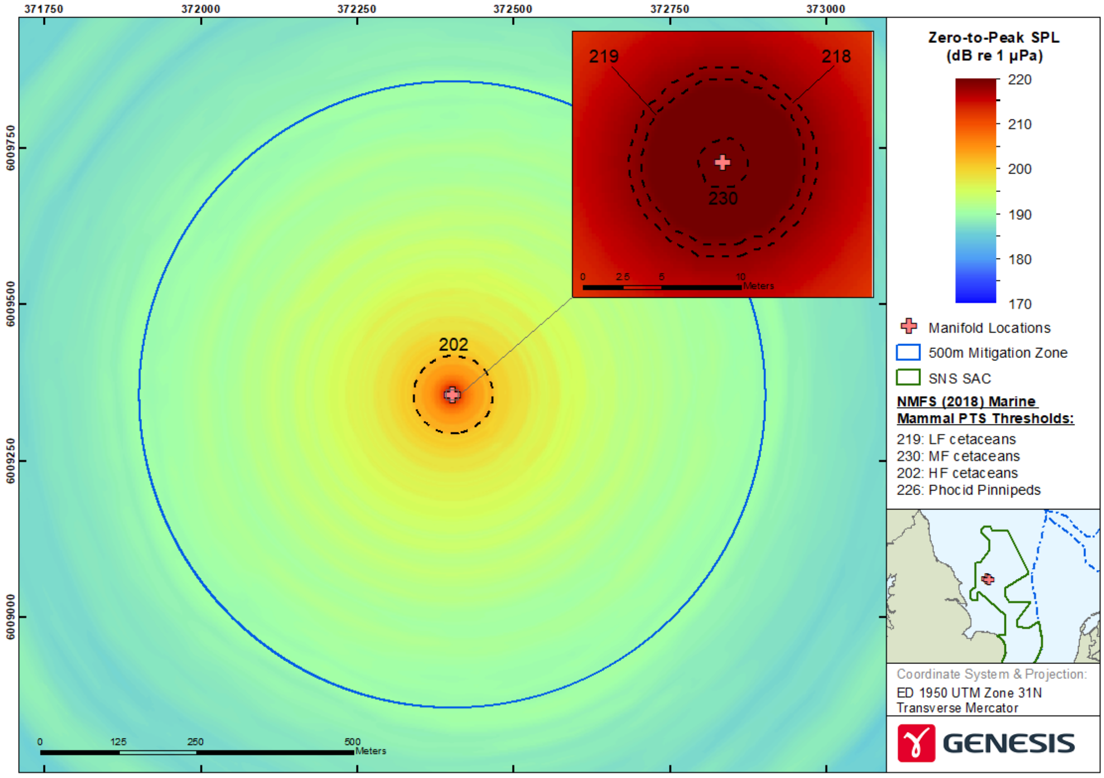


Figure 4-10: Predicted zero-to-peak SPL received by marine mammals during manifold piling at Endurance with the hammer operating at maximum energy of 120 kJ.

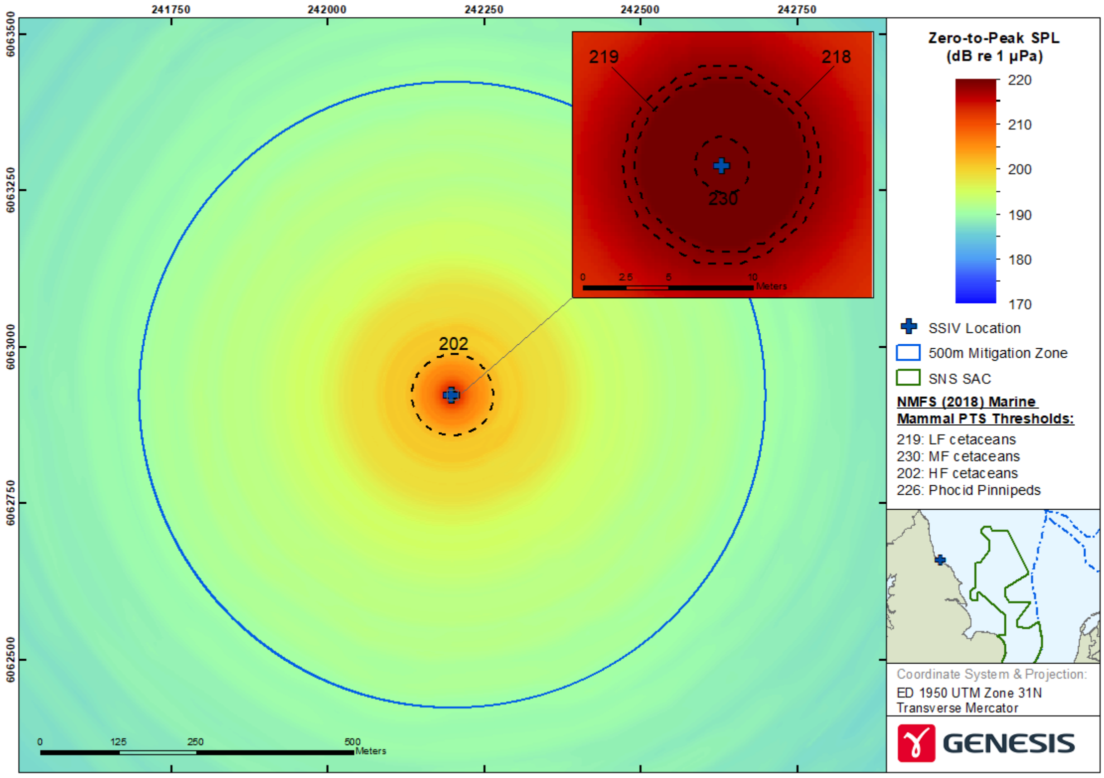


Figure 4-11: Predicted zero-to-peak SPL received by marine mammals during SSIV piling at Teesside with the hammer operating at maximum energy of 120 kJ.

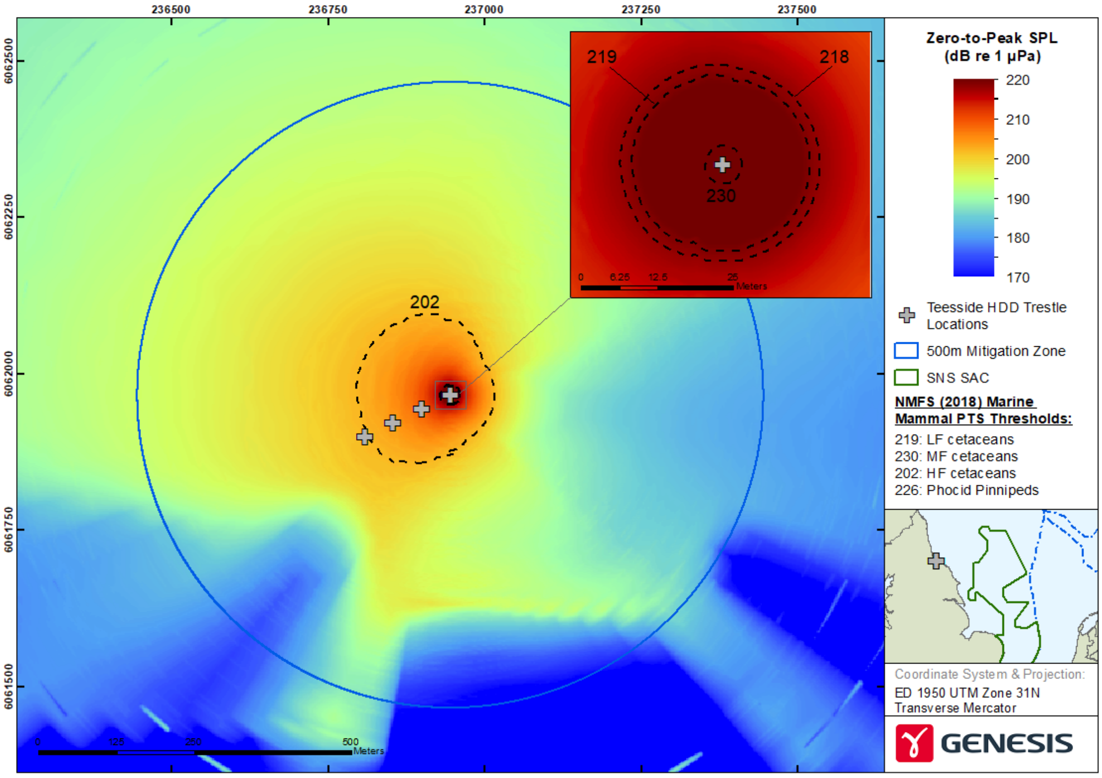


Figure 4-12: Predicted zero-to-peak SPL received by marine mammals during HDD trestle piling at Teesside with the hammer operating at maximum energy of 235 kJ.

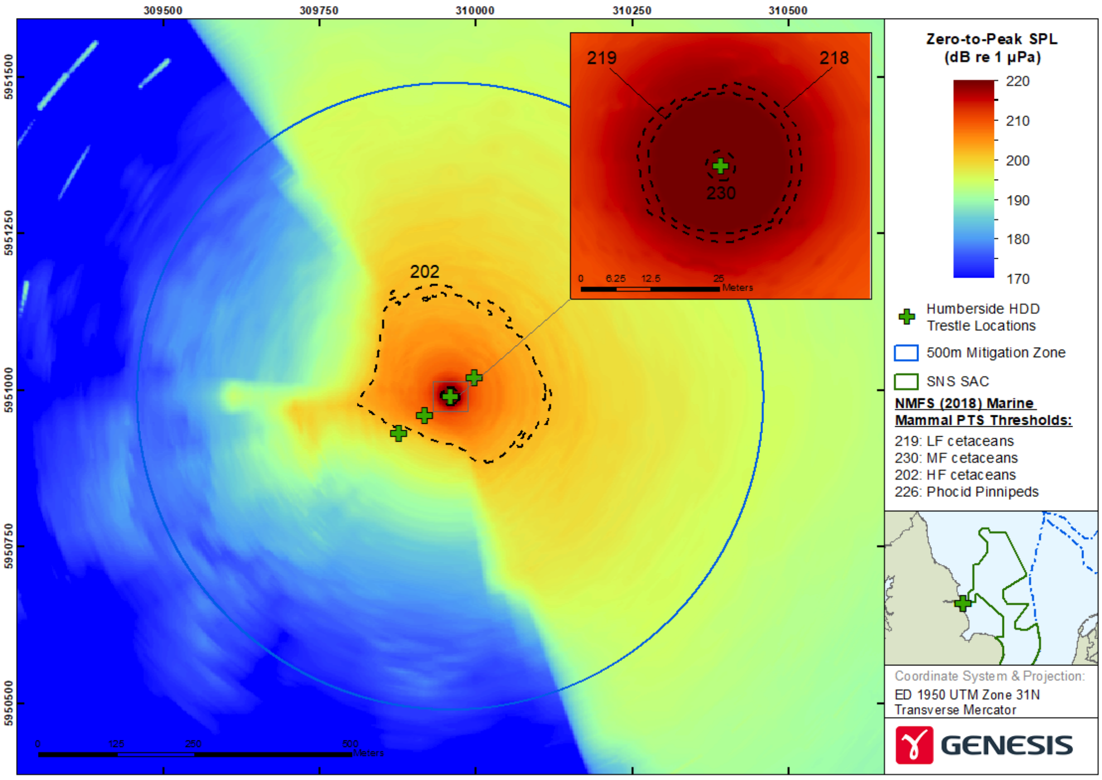


Figure 4-13: Predicted zero-to-peak SPL received by marine mammals during HDD trestle piling at Humberside with the hammer operating at maximum energy of 235 kJ.

The maximum distances where the predicted zero-to-peak SPL sound levels decrease to below the thresholds for PTS onset are summarised in Table 4-11. The modelling predicts that the zero-to-peak SPL will decrease to below the PTS thresholds for all marine mammal hearing groups within the nominal 500 m mitigation zone distance employed during piling operations (JNCC, 2010). Therefore, if a nominal 500 m mitigation zone and associated measures are implemented during the piling operations, the probability of zero-to-peak SPL sound levels generated causing PTS onset to marine mammals is low.

Table 4-11: Predicted maximum distances from the piling locations where the zero-to-peak SPL sound levels decrease to below the thresholds for PTS to marine mammals.

Marine Mammal Hearing Group	Zero-to-peak SPL PTS Threshold (dB re 1 µPa)	Maximum Distance to Threshold (m) [1]			
		Manifold Piling	SSIV Piling	HDD Trestle Piling (Teesside)	HDD Trestle Piling (Humberside)
LF cetaceans	219	10	10	20	20
MF cetaceans	230	10	10	10	10
HF cetaceans	202	70	70	160	190
Phocid pinnipeds	218	10	10	20	20

[1] Predicted distances have been rounded up to the nearest 10 m.

Single-pulse SEL

Received sound levels in terms of single-pulse auditory-weighted SEL have also been predicted for the NEP CCS Project piling operations. Unlike the zero-to-peak SPL results presented in the previous section, the single-pulse SELs have been weighted using the auditory weighting functions shown in Figure 3-1. The auditory-weighted SEL for sound pulses generated by single pile strikes when the hammer is operating at maximum hammer energy are provided in Appendix A.

Distances where the auditory-weighted single-pulse SELs decrease to below the thresholds for PTS for different marine mammal hearing groups have been predicted from the modelling and are summarised in Table 4-12. Results are shown for the hammer operating at maximum energy for each piling scenario when sound levels will be highest.

The modelling predicts that the auditory weighted single-pulse SELs will decrease to below the PTS thresholds for all marine mammal hearing groups well within the nominal 500 m mitigation zone employed during piling operations (JNCC, 2010). Therefore, if a 500 m mitigation zone and associated mitigation measures are implemented during the piling operations, the probability of sound pulses from single pile strikes causing PTS onset to marine mammals is low.

Table 4-12: Predicted maximum distances from the piling locations where the single-pulse SEL sound levels decrease to below the thresholds for PTS to marine mammals.

Marine Mammal Hearing Group	SEL PTS Threshold (dB re 1 µPa)	Maximum Distance to Threshold (m) [1]			
		Manifold Piling	SSIV Piling	HDD Trestle Piling (Teesside)	HDD Trestle Piling (Humberside)
LF cetaceans	183	10	10	40	30
MF cetaceans	185	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
HF cetaceans	155	10	10	20	20
Phocid pinnipeds	185	10	10	10	10

[1] Predicted distances have been rounded up to the nearest 10 m.

Cumulative SEL

The cumulative SEL received by marine mammals from multiple sound pulses generated over a 24 hour period has been estimated for each piling scenario. For the manifold and SSIV piling scenarios, it is assumed that four piles are installed in a single day with each pile taking two hours to install. For the HDD trestle piling scenarios, it is assumed that two piles are installed in a single day with each pile taking four hours to install. The hammer energies and durations taken to install single piles for each piling scenario are shown in Table 2-4. In the modelling it is assumed that there is no downtime between the installation of successive piles, which is a conservative assumption.

The cumulative SEL modelling has been conducted for two cases:

- When no soft-start of the hammer is employed. In these scenarios it is assumed that the hammer operates at maximum hammer energy over the full duration of piling; and
- When a soft-start of the hammer is employed. In these scenarios it is assumed that the hammer commences piling of each pile at 20% of the maximum hammer energy for a period of 20 minutes. After the soft-start period, it is assumed that the hammer operates at maximum hammer energy for the remaining duration of the pile installation.

The predicted minimum initial distances that marine mammals must be from the piling locations at the start of the operations such that the cumulative SEL remains below relevant thresholds when marine mammals swim away are summarised in Table 4-13 (for piling with no soft-start) and Table 4-14 (for piling with soft-start).

The modelling results show that the cumulative SEL sound levels will not be above the thresholds for PTS for any marine mammal hearing group when a soft-start of the hammer is employed. The modelling results demonstrate that the hammer soft-start will enable time for marine mammals to move away from the piling locations to distances where they will not be exposed to sound levels that may cause PTS. It is therefore concluded that the risk of PTS to marine mammals is low when a soft-start of the hammer is employed along with other standard mitigation measures such as a 500 m mitigation zone.

Table 4-13: Predicted initial starting distances from the piling locations where sound levels will be below the cumulative SEL thresholds for PTS to marine mammals when no soft-start of the hammer is employed.

Marine Mammal Hearing Group	Cumulative SEL PTS Threshold (dB re 1 µPa^{2}s)	Swim Speed (m/s)	Maximum Distance to Threshold (m) [1]			
			Manifold Piling	SSIV Piling	HDD Trestle Piling (Teesside)	HDD Trestle Piling (Humberside)
LF cetaceans	183	1.5	640	320	1,400	1,200
		2	350	210	880	790
		3	170	110	410	430
MF cetaceans	185	1.5	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
		2				
		3				
HF cetaceans	155	1.5	70	150	1,200	1,200
		2	50	90	840	900
		3	30	40	530	600
Phocid pinnipeds	185	1.5	Threshold not exceeded	Threshold not exceeded	20	20
		2			10	10
		3			10	10

[1] Predicted distances have been rounded up to the nearest 10 m.

Table 4-14: Predicted initial starting distances from the piling locations where sound levels will be below the cumulative SEL thresholds for PTS to marine mammals when a soft-start of the hammer is employed.

Marine Mammal Hearing Group	Cumulative SEL PTS Threshold (dB re 1 µPa²s)	Swim Speed (m/s)	Maximum Distance to Threshold (m) [1]			
			Manifold Piling	SSIV Piling	HDD Trestle Piling (Teesside)	HDD Trestle Piling (Humberside)
LF cetaceans	183	1.5	60	40	350	280
		2	30	20	100	100
		3	10	10	30	30
MF cetaceans	185	1.5	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
		2				
		3				
HF cetaceans	155	1.5	Threshold not exceeded	Threshold not exceeded	310	360
		2			150	190
		3			60	70
Phocid pinnipeds	185	1.5	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
		2				
		3				

[1] Predicted distances have been rounded up to the nearest 10 m.

4.2.1.2 Behavioural Disturbance

To predict distances at which potential behavioural disturbance to marine mammals may occur form the NEP CCS Project piling operations, received sound levels in terms of unweighted SEL for sound pulses generated by single pile strikes have been estimated and compared to the adopted behavioural disturbance threshold values shown in Table 3-3 (note that the rms SPL threshold values suggested by NMFS in Table 3-3 have been converted to SEL thresholds for comparison with the model results).

The estimated unweighted SEL for a single pile strikes with the hammer operating at maximum energy during the manifold piling at Endurance, SSIV piling at Teesside, HDD trestle piling at Teesside, and HDD trestle piling at Humberside are shown in Figure 4-14, Figure 4-15, Figure 4-16, and Figure 4-17, respectively. The contours highlighted in these figures correspond to the adopted behavioural disturbance thresholds. A 15 km EDR is also shown in Figure 4-14 to Figure 4-17, which is the disturbance radius suggested by JNCC for assessing potential displacement of harbour porpoise from pin pile installations (JNCC, 2020). The maximum predicted distances where sound levels decrease to below the behavioural disturbance thresholds for the piling scenarios are summarised in Table 4-15.

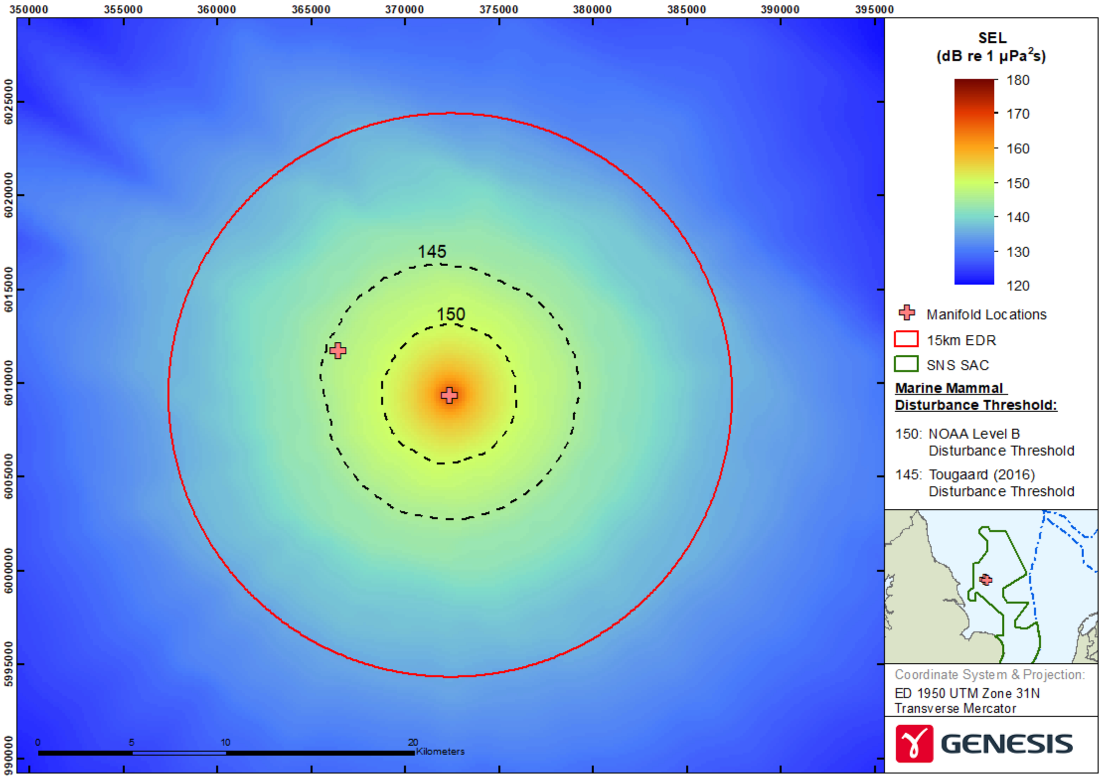


Figure 4-14: Predicted unweighted single-pulse SEL received by marine mammals during manifold piling at Endurance with the hammer operating at maximum energy of 120 kJ.

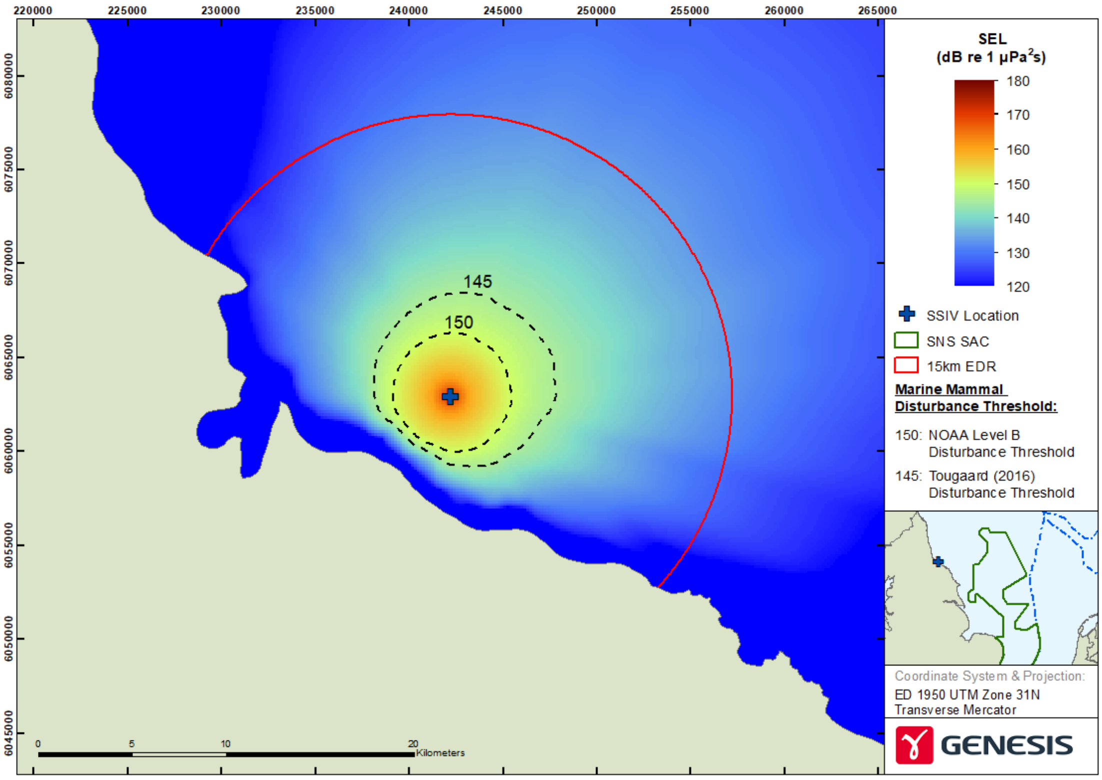


Figure 4-15: Predicted unweighted single-pulse SEL received by marine mammals during SSIV piling at Teesside with the hammer operating at maximum energy of 120 kJ.

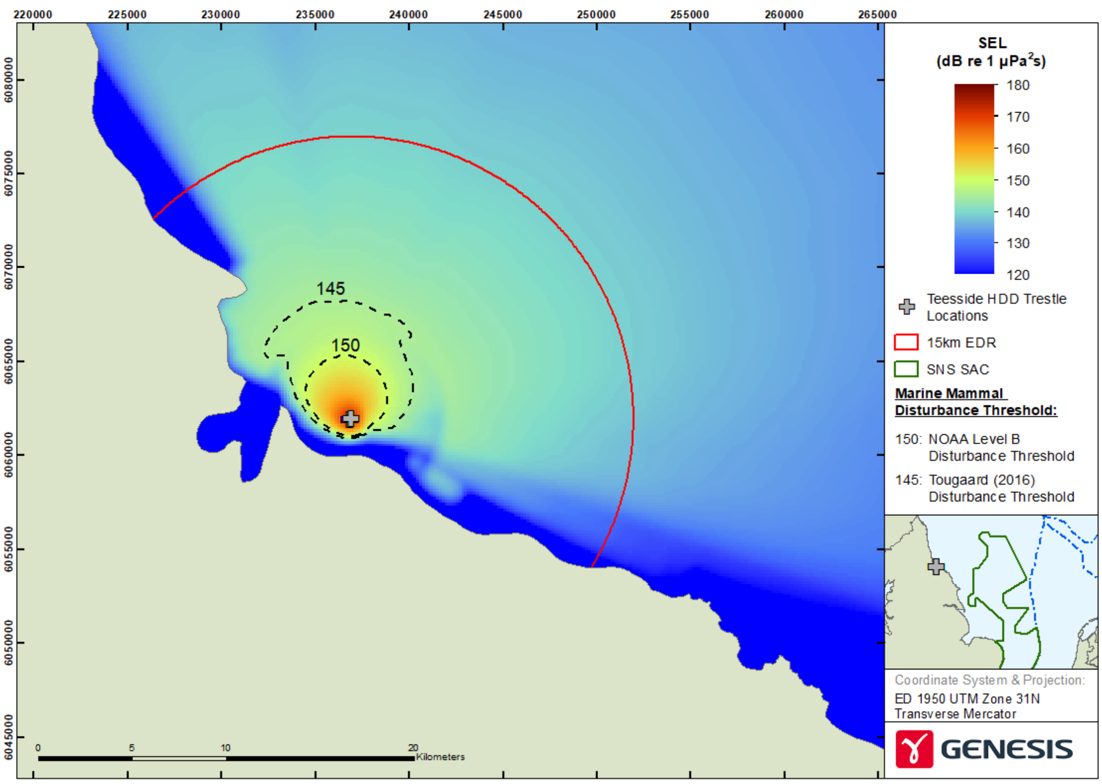


Figure 4-16: Predicted unweighted single-pulse SEL received by marine mammals during HDD trestle piling at Teesside with the hammer operating at maximum energy of 235 kJ.

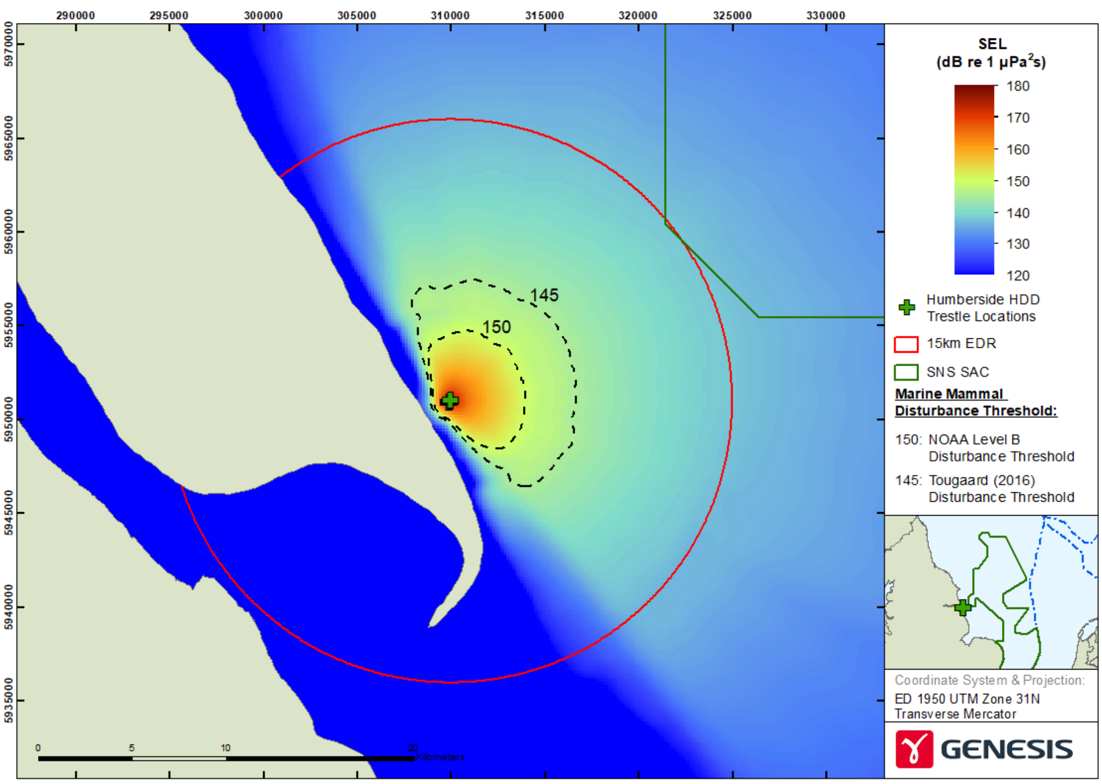


Figure 4-17: Predicted unweighted single-pulse SEL received by marine mammals during HDD trestle piling at Humberside with the hammer operating at maximum energy of 235 kJ.

Table 4-15: Predicted maximum distances from the piling locations where sound levels decrease to below the thresholds for behavioural disturbance to marine mammals.

Method	Behavioural Disturbance Thresholds	Maximum Distance to Threshold (km)			
		Manifold Piling	SSIV Piling	HDD Trestle Piling (Teesside)	HDD Trestle Piling (Humberside)
Comparison of modelling results with NOAA 'Level B harassment' threshold for disturbance to marine mammals	Rms SPL: 160 db re 1 µPa SEL: 150 dB re 1 µPa²s	3.8	3.5	3.6	4.3
Comparison of modelling results with Tougaard (2016) threshold for disturbance to marine mammals	SEL: 150 dB re 1 µPa²s	7.2	5.8	6.8	7.1
JNCC (2020) 15 km EDR	EDR of 15 km	15.0	15.0	15.0	15.0

[1] The NOAA 'Level B Harassment' rms SPL threshold of 160 dB re 1 µPa has been converted to an SEL threshold of 150 dB re 1 µPa²s assuming a conservative integration time of 100 ms.

The estimated number of marine mammals that may be disturbed from piling operations associated with the NEP CCS Project are shown in Table 4-16, Table 4-17, and Table 4-18 based on disturbance areas predicted using the NOAA 'Level B' harassment threshold, Tougaard (2016) threshold for disturbance to marine mammals, and a 15 km EDR (JNCC, 2020), respectively.

Studies based on impacts associated with sound from piling have indicated that marine mammals return to the area within relatively short periods of time, usually within three days once the activity causing the displacement has ceased (Brandt *et al.,* 2016, 2017, 2018; Carstensen *et al.,* 2006). The manifold piling at Endurance is expected to be completed in two to three days (including downtime) days. The SSIV piling is expected to be completed in two to three days (including downtime). The HDD trestle piling at Teesside and Humberside are each expected to be completed in two to four days depending on ground conditions. The piling is therefore of very short duration and disturbance will be short term. It is expected that any marine mammals that may temporarily move away from the piling areas will return after the piling has finished.

Table 4-16: Estimated number of marine mammals disturbed based on the NOAA 'Level B harassment' threshold for disturbance to marine mammals.

Species	Disturbance Area (km^2)	Animal Density ($animals/km^2$) [1]	Number of Animals Disturbed	MU Population [2]	Percentage of MU Population Disturbed (%)
Manifold piling					
Harbour porpoise (HF cetacean)	45	0.888 – 3	41 – 137	346,601	0.012 – 0.040
White-beaked dolphin (MF cetacean)	45	0.002	1	43,951	0.002
Minke whale (LF cetacean)	45	0.010	1	20,118	0.005
SSIV piling					
Harbour porpoise (HF cetacean)	31	0.888 – 3	28 – 93	346,601	0.008 – 0.027
White-beaked dolphin (MF cetacean)	31	0.002	1	43,951	0.002
Minke whale (LF cetacean)	31	0.010	1	20,118	0.005
HDD trestle piling at Teesside					
Harbour porpoise (HF cetacean)	14	0.888 – 3	13 – 42	346,601	0.004 – 0.012
White-beaked dolphin (MF cetacean)	14	0.002	1	43,951	0.002
Minke whale (LF cetacean)	14	0.010	1	20,118	0.005
HDD trestle piling at Humberside					
Harbour porpoise (HF cetacean)	24	0.888 – 3	22 – 72	346,601	0.006 – 0.021
White-beaked dolphin (MF cetacean)	24	0.002	1	43,951	0.002
Minke whale (LF cetacean)	24	0.010	1	20,118	0.005

[1] Marine mammal densities for white-beaked dolphin and minke whale are from SCANS-III data (Hammond *et al*., 2017). For harbour porpoise, the lower density of 0.888 is from SCANS-III whilst the upper density of 3 is based on Heinänen and Skov (2015).
[2] MU populations are from IAMMWG (2021).

Table 4-17: Estimated number of marine mammals disturbed based on the Tougaard (2016) threshold for disturbance to marine mammals.

Species	Disturbance Area (km^2)	Animal Density (animals/km^2) [1]	Number of Animals Disturbed	MU Population [2]	Percentage of MU Population Disturbed (%)
Manifold piling					
Harbour porpoise (HF cetacean)	163	0.888 – 3	41 – 137	346,601	0.012 – 0.040
White-beaked dolphin (MF cetacean)	163	0.002	1	43,951	0.002
Minke whale (LF cetacean)	163	0.010	1	20,118	0.005
SSIV piling					
Harbour porpoise (HF cetacean)	69	0.888 – 3	62 – 207	346,601	0.018 – 0.060
White-beaked dolphin (MF cetacean)	69	0.002	1	43,951	0.002
Minke whale (LF cetacean)	69	0.010	1	20,118	0.005
HDD trestle piling at Teesside					
Harbour porpoise (HF cetacean)	43	0.888 – 3	39 – 129	346,601	0.011 – 0.037
White-beaked dolphin (MF cetacean)	43	0.002	1	43,951	0.002
Minke whale (LF cetacean)	43	0.010	1	20,118	0.005
HDD trestle piling at Humberside					
Harbour porpoise (HF cetacean)	67	0.888 – 3	60 – 201	346,601	0.017 – 0.058
White-beaked dolphin (MF cetacean)	67	0.002	1	43,951	0.002
Minke whale (LF cetacean)	67	0.010	1	20,118	0.005

[1] Marine mammal densities for white-beaked dolphin and minke whale are from SCANS-III data (Hammond *et al*., 2017). For harbour porpoise, the lower density of 0.888 is from SCANS-III whilst the upper density of 3 is based on Heinänen and Skov (2015).

[2] MU populations are from IAMMWG (2021).

Table 4-18: Estimated number of marine mammals disturbed based on a 15 km EDR for disturbance to marine mammals.

Species	Disturbance Area (km^2)	Animal Density ($animals/km^2$) [1]	Number of Animals Disturbed	MU Population [2]	Percentage of MU Population Disturbed (%)
Manifold piling					
Harbour porpoise (HF cetacean)	707	0.888 – 3	628 – 2,121	346,601	0.181 – 0.612
White-beaked dolphin (MF cetacean)	707	0.002	2	43,951	0.005
Minke whale (LF cetacean)	707	0.010	8	20,118	0.040
SSIV piling					
Harbour porpoise (HF cetacean)	491	0.888 – 3	437 – 1,473	346,601	0.126 – 0.425
White-beaked dolphin (MF cetacean)	491	0.002	1	43,951	0.002
Minke whale (LF cetacean)	491	0.010	5	20,118	0.025
HDD trestle piling at Teesside					
Harbour porpoise (HF cetacean)	375	0.888 – 3	333 – 1,135	346,601	0.096 – 0.325
White-beaked dolphin (MF cetacean)	375	0.002	1	43,951	0.002
Minke whale (LF cetacean)	375	0.010	4	20,118	0.020
HDD trestle piling at Humberside					
Harbour porpoise (HF cetacean)	538	0.888 – 3	478 – 1,614	346,601	0.138 – 0.466
White-beaked dolphin (MF cetacean)	538	0.002	2	43,951	0.005
Minke whale (LF cetacean)	538	0.010	6	20,118	0.030

[1] Marine mammal densities for white-beaked dolphin and minke whale are from SCANS-III data (Hammond *et al*., 2017). For harbour porpoise, the lower density of 0.888 is from SCANS-III whilst the upper density of 3 is based on Heinänen and Skov (2015).

[2] MU populations are from IAMMWG (2021).

4.2.2 Fish

4.2.2.1 Injury

To quantitatively assess any potential injury to fish from the NEP CCS Project piling operations, received sound levels in terms of unweighted zero-to-peak SPL and unweighted cumulative SEL have been predicted and compared to the Popper *et al*. (2014) thresholds for injury (see Table 3-4).

The maximum predicted zero-to-peak SPLs from the from the manifold piling, SSIV piling, HDD trestle piling at Teesside, and HDD trestle piling at Humberside with the hammer operating at maximum energy are shown in Figure 4-18, Figure 4-19, Figure 4-20, and Figure 4-21, respectively. The contours in these figures highlight the Popper *et al*. (2014) zero-to-peak SPL thresholds for potential injury to fish species. The maximum predicted distances where the zero-to-peak SPL sound levels decrease to below the Popper *et al*. (2014) thresholds for fish injury are shown in Table 4-19. Table 4-20 summarises the predicted minimum initial distances that fish must be from the source arrays at the start of the sound source in order not to be exposed to cumulative SEL sound levels above the Popper *et al*. (2014) thresholds for potential injury.

The modelling predicts that sound levels will be below threshold values associated with injury to the most sensitive fish beyond a maximum distance of 70 m from the piling locations. It is expected that the soft-start of hammer during piling will likely disperse any mobile fish away from the piling locations to further distances where injury impacts are unlikely to occur. However, fish eggs and larvae that cannot move away from the source array are more susceptible to injury. The modelling predicts that fish eggs and larvae that cannot move away from the piling locations may by injured at distances of 170 m from the manifold piling locations, 130 m from the SSIV location, and 210 m and 240 m from the HDD trestle locations at Teesside and Humberside, respectively.

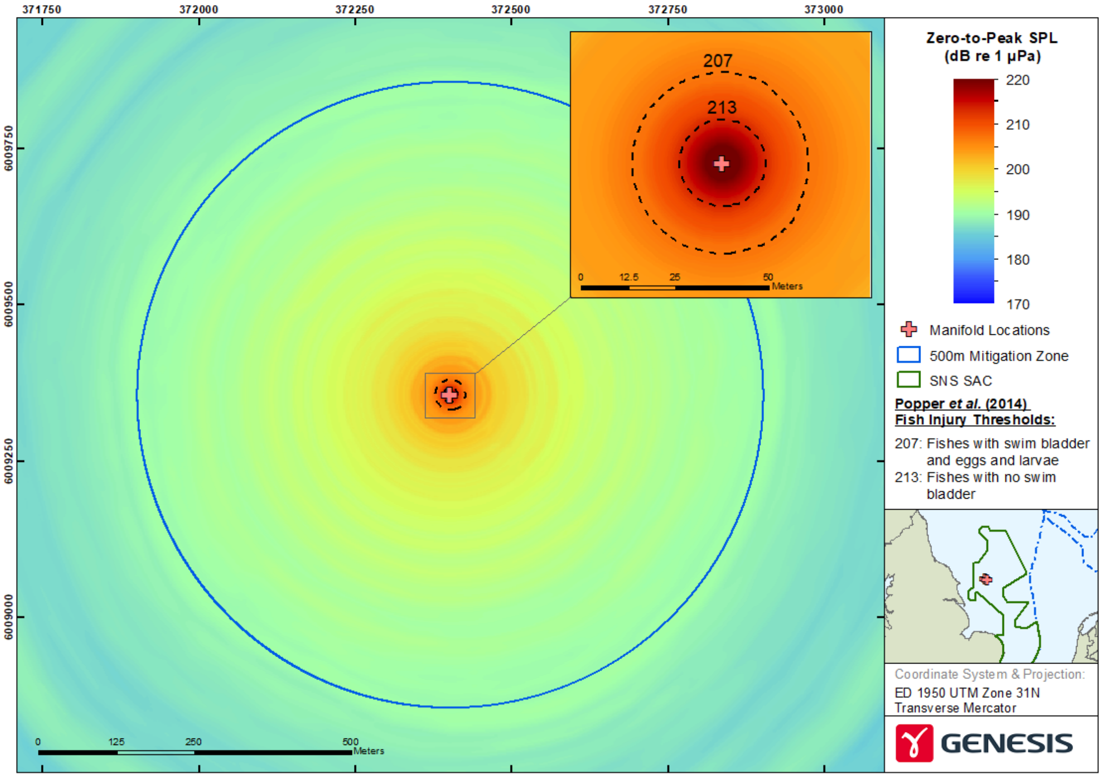


Figure 4-18: Predicted zero-to-peak SPL received by fish during manifold piling at Endurance with the hammer operating at maximum energy of 120 kJ.

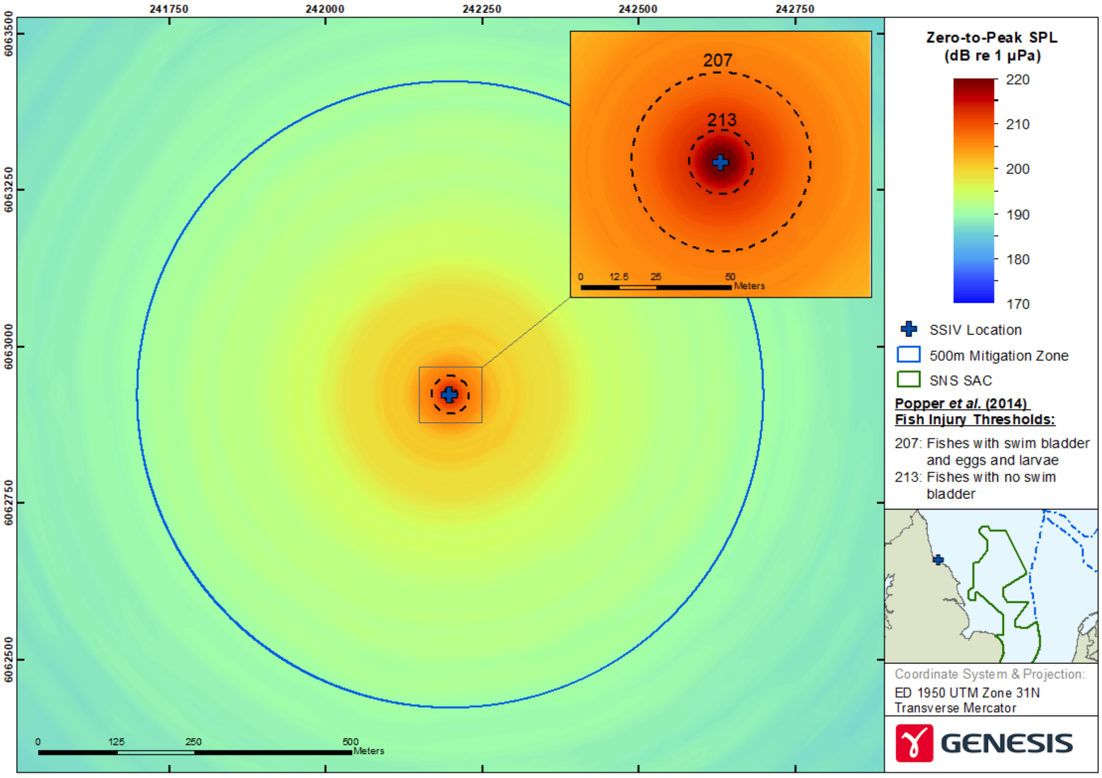


Figure 4-19: Predicted zero-to-peak SPL received by fish during SSIV piling at Teesside with the hammer operating at maximum energy of 120 kJ.

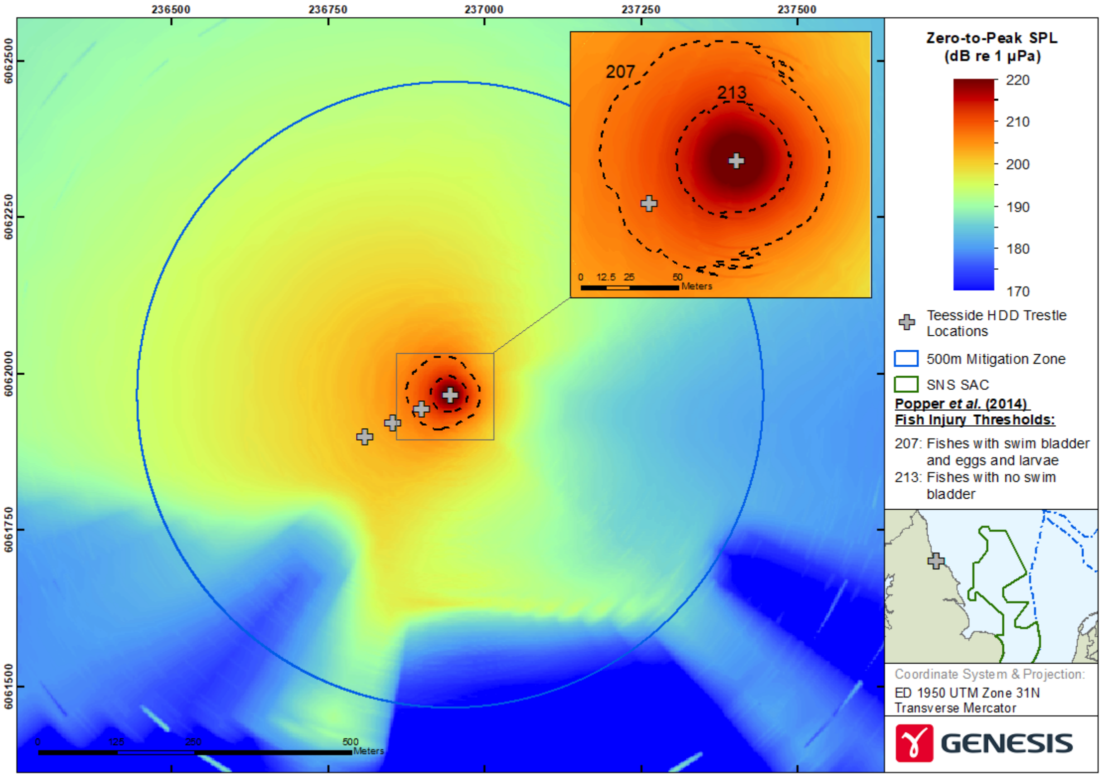


Figure 4-20: Predicted zero-to-peak SPL received by fish during HDD trestle piling at Teesside with the hammer operating at maximum energy of 235 kJ.

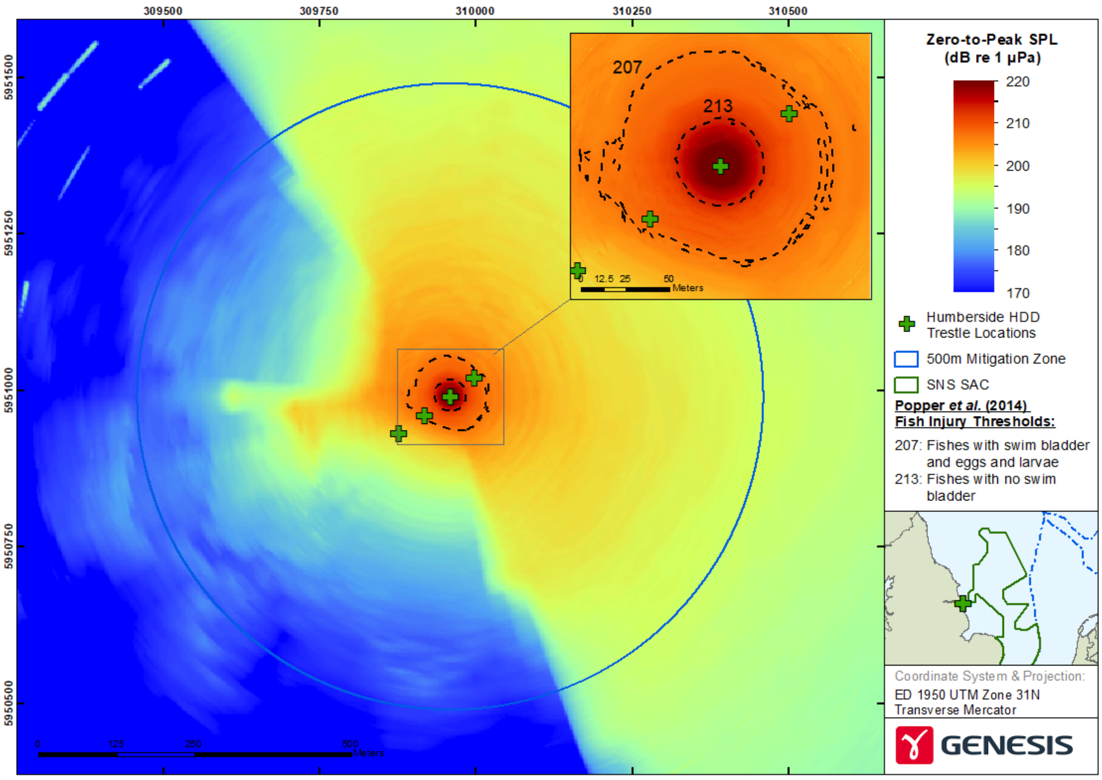


Figure 4-21: Predicted zero-to-peak SPL received by fish during HDD trestle piling at Humberside with the hammer operating at maximum energy of 235 kJ.

Table 4-19: Predicted maximum distances from the piling locations where the zero-to-peak SPL sound levels decrease to below the thresholds for fish injury.

Fish Group	Zero-to-peak SPL Injury Threshold (dB re 1 µPa)	Maximum Distance to Threshold (m) [1]			
		Manifold Piling	SSIV Piling	HDD Trestle Piling (Teesside)	HDD Trestle Piling (Humberside)
Fishes with no swim bladder	213	10	10	40	30
Fishes with swim bladder involved in hearing	207	30	30	80	70
Fishes with swim bladder not involved in hearing	207	30	30	80	70
Eggs and larvae	207	30	30	80	70

[1] Predicted distances have been rounded up to the nearest 10 m.

Table 4-20: Predicted initial starting distances from the source arrays where sound levels will be below the cumulative SEL thresholds for fish injury.

Fish Group	Cumulative SEL Injury Threshold (dB re 1 µPa²s)	Swim Speed (m/s)	Maximum Distance to Threshold (m) [1]			
			Manifold Piling	SSIV Piling	HDD Trestle Piling (Teesside)	HDD Trestle Piling (Humberside)
Fishes with no swim bladder	219	0.5	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
Fishes with swim bladder involved in hearing	207	0.5				
Fishes with swim bladder not involved in hearing	210	0.5				
Eggs and larvae	210	0	170	130	210	240

[1] Predicted distances have been rounded up to the nearest 10 m.

4.2.2.2 Behavioural Disturbance

The qualitative criteria established by Popper *et al.* (2014) suggest that any disturbance to fish species from piling will likely be localised with higher levels of disturbance only occurring in regions near to the piling location (e.g. within a few hundred metres). At further distances from the piling locations (e.g. beyond one kilometre), the risk of behavioural disturbance to fish is likely to be low (see Table 3-5).

4.2.3 SNS SAC

The SSIV piling location and Teesside HDD trestle piling locations are located approximately 94 km and 100 km from the SNS SAC boundary, respectively. As such they will not impact the SNS SAC. However, the manifold piling locations are located within the 'Summer Area' of the SNS SAC and the Humberside HDD trestle piling locations are located within 15 km of the 'Winter Area' of the SNS SAC.

The predicted daily percentages of the SNS SAC and the average percentages of the SNS SAC impacted over the season are shown in Table 4-10 for the manifold piling and HDD trestle piling at Humberside. The daily and seasonal disturbances have been calculated by comparing the modelling result with the NOAA 'Level B harassment' and Tougaard (2016) threshold for disturbance to marine mammals, as well as using the 15 km EDR suggested by JNCC (2020). It is predicted that the NEP CCS Project piling operations will not exceed the daily and seasonal thresholds for the SAC suggested by JNCC (2020).

Table 4-21: Predicted areas of the SNS SAC that may be impacted by the NEP CCS Project piling operations.

Method	Predicted Daily Disturbance Area (km^2) [1]	Daily % of SNS SAC Impacted [2]	Average % of SNS SAC Impacted Over the Season [3]
Manifold piling at Endurance			
Comparison of modelling results with NOAA 'Level B harassment' threshold for disturbance to marine mammals	45	0.17%	0.002%
Comparison of modelling results with Tougaard (2016) threshold for disturbance to marine mammals	163	0.60%	0.007%
JNCC (2020) 15 km EDR	707	2.62%	0.029%
HDD trestle piling at Humberside			
Comparison of modelling results with NOAA 'Level B harassment' threshold for disturbance to marine mammals	0	0%	0%
Comparison of modelling results with Tougaard (2016) threshold for disturbance to marine mammals	0	0%	0%
JNCC (2020) 15 km EDR	0.2	0.002%	0.00002%

[1] The predicted daily disturbance areas refer to the areas of the SNS SAC impacted over 24 hours (see Figure 4-14 to Figure 4-17 for predicted daily disturbance areas from the sound modelling).

[2] The percentage of the SNS SAC 'Summer Area' impacted (which is applicable to the manifold piling) has been calculated based on the predicted disturbance areas for each disturbance threshold and an area of 27,028 km^2 for the SNS SAC 'Summer Area' as per the JNCC (2020) guidance. The percentage of the SNS SAC 'Winter Area' impacted (which is applicable to the HDD trestle piling) has been calculated based on the predicted disturbance areas for each disturbance threshold and an area of 12,696 km^2 for the SNS SAC 'Winter Area' as per the JNCC (2020) guidance.

[3] The average percentage of the SNS SAC impacted over the season (183 days) has been calculated assuming that the manifold piling will be completed within two days and the HDD trestle piling at Humberside will be completed within two days. For example, for the manifold piling assessment using the 15 km EDR disturbance threshold, the average percentage of SNS SAC impacted over the season is calculated as 2.62*2/183 = 0.029%.

5.0 CONCLUSIONS

This report has presented underwater noise propagation modelling results for assessing the potential impacts that seismic surveys and piling activities associated with the NEP CCS Project may have on marine mammals, fish species and fish eggs and larvae. The modelling results were used to assess any potential impacts to marine mammals based on a comparison of estimated received sound levels with the Southall *et al.* (2019) and NMFS (2018) thresholds for potential PTS onset and relevant thresholds for behavioural disturbance. Potential injury to fish species and fish eggs and larvae was also assessed by comparing predicted sound levels to the injury thresholds established by Popper *et al*. (2014).

The modelling results indicate that the likelihood of marine mammals being exposed to sound levels that may cause PTS during the piling and seismic survey is low provided that the standard JNCC (2010) 'Guidelines for minimising the risk of injury to marine mammals from pile-driving noise' and JNCC (2017) 'Guidelines for minimising the risk of injury to marine mammals from geophysical surveys' are followed. The modelling predicts that behavioural disturbance to marine mammals could potentially occur at 3.9 – 8.9 km from the seismic survey, 3.8 – 7.2 km from the manifold piling locations, 3.5 – 5.8 km from the SSIV piling location, 3.6 – 6.8 km from the HDD trestle piling locations at Teesside, and 4.3 – 7.1 km from the HDD trestle piling locations at Humberside. However, any behavioural disturbance that may occur will only be temporary. The seismic survey is expected to be completed within 75 working days of which the airgun source will be active for up to 56 days whilst each piling activity is expected to be completed within two to three days. If any marine mammals are disturbed, they will return to the area once the piling and the seismic survey have finished. Therefore, it is not expected that the piling or seismic survey will have any long-term significant effects on any marine mammal populations.

The seismic survey area is located within the SNS SAC. However, the assessment indicates that the JNCC (2020) daily and seasonal thresholds will not be exceeded by the survey. Similarly, the manifold locations are located within the SNS SAC but it is predicted that the manifold piling will not result in the JNCC (2020) daily or seasonal thresholds being breached. The SSIV piling location and HDD trestle piling locations at Teesside are located approximately 94 km and 100 km from the SNS SAC boundary and therefore will have no impact on the SAC. The HDD trestle piling locations at Humberside are located approximately 15 km from the boundary of the SNS SAC. The JNCC (2020) EDR of 15 km therefore suggests that the HDD trestle piling at Humberside will have negligible impact on the SAC. It is currently unknown if there will be other activities being conducted in the SNS SAC during the seismic survey or piling activities. If there are any activities conducted at the same time as the seismic survey and piling aactivities then this may result in cumulative disturbance to the SAC which will require to be assessed to ensure that the JNCC (2020) daily and seasonal thresholds are not exceeded.

The modelling results indicate that injury to fish species and fish eggs and larvae during the seismic surveys and piling activities will be localised to small areas around the airgun source and piling locations. The soft-start of the airgun array and ramp-up of hammer energy during piling should allow mobile fish species to move away from the sound sources to distances where they are unlikely to suffer injury. However, fish eggs and larvae will not be able to move away from the piling location or the airgun array and will therefore be more susceptible to injury. However, given the small predicted areas where fish eggs and larvae may suffer injury relative the large spawning areas across the North Sea it is not expected that the piling or seismic survey will have a significant effect on spawning fish.

It is concluded that the seismic surveys and piling activities associated with the NEP CCS Project will not have a significant impact on marine mammals, fish, and fish eggs and larvae.

REFERENCES

Ainslie, M. A., de Jong, C. A. F., Robinson, S. P. and Lepper, P. A. (2012) What is the source level of pile driving noise in water? The Effects of Noise on Aquatic Life: Advances in Experimental Medicine and Biology, 730, pp. 445-448.

Brandt, M., Diederichs, A., V., Betke, K. and Nehls, G. (2017). Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Mar Ecol Prog Ser 421:205-216. https://doi.org/10.3354/meps08888.

Brandt, M., Dragon, A., Diederichs, A., Schubert, A., Kosarev, V., Nehls, G., Wahl, V., Michalik, A., Braasch, A., Hinz, C., Ketzer, C., Todeskino, D., Gauger, M., Laczny, M. and Piper, W. (2016). Effects of Offshore Pile Driving on Harbour Porpoise Abundance in the German Bight: Assessment of Noise Effects. Report by BioConsult SH, IBL Umweltplanung GmbH, and Institute of Applied Ecology (IfAO). pp. 262.

Brandt, M.; Dragon, A.; Diederichs, A.; Bellmann, M.; Wahl, V.; Piper, W.; Nabe-Nielsen, J.; Nehls, G. (2018). Disturbance of harbour porpoises during construction of the first seven offshore wind farms in Germany. *Marine Ecology Progress Series,* 596, 213-232. DOI: 10.3354/meps12560

Breitzke, Monika, Olaf Boebel, Saad El Naggar, Wilfried Jokat, and Berthold Werner. 2008. "Broad-Band Calibration of Marine Seismic Sources Used by R/V Polarstern for Academic Research in Polar Regions." Geophysical Journal International 174 (2): 505–24.

Caldwell, J. and Dragoset, W. (2000). A brief overview of seismic air-gun arrays. The Leading Edge 19(8):898-902 · August 2000.

Carstensen, J.; Henriksen, O.; Teilmann, J. (2006). Impacts of Offshore Wind Farm Construction on Harbour Porpoises: Acoustic Monitoring of Echolocation Activity using Porpoise Detectors (T-PODs). *Marine Ecology Progress Series,* 321, 295-308. DOI: 10.3354/meps321295

Collins, M .D. (1993). A split-step Padé solution for the parabolic equation method. Journal of the Acoustical Society of America. 93: 1736–1742.

Duren R. E., (1988). Theory for Marine Source Arrays. Geophysics, Volume 53 No. 5, pp 650-658.

EMODnet (2022a). EMODnet Bathymetry Portal Data. Available at: http://portal.emodnet-bathymetry.eu/

EMODnet (2022b). European Seabed Habitat Maps. Available at: http://www.emodnet.eu/seabed-habitats

Fontana, P. and Boukhanfra, F. (2018). Near-field measurements versus far-field of air gun array sound levels. 80th EAGE Conference and Exhibition 2018, Jun 2018, Volume 2018. European Association of Geoscientists & Engineers

Hammond, P. S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M. B., Scheidat, M., Teilmann, J., Vingada, J., Øien, N. (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCAN-III aerial and shipboard surveys. Available at: https://synergy.st-andrews.ac.uk/scans3/category/researchoutput/

Hassel, A., T. Knutsen, J. Dalen, K. Skaar, S. Løkkeborg, O. Misund, Ø. Østensen, M. Fonn, and Haugland, E. K. (2004). Influence of seismic shooting on the lesser sandeel (*Ammodytes marinus*). Journal of Marine Science. 61:1165-1173.

Heinänen, S., and Skov, H. (2015). The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area, JNCC Report No.544 JNCC, Peterborough.

IAMMWG (Inter-Agency Marine Mammal Working Group) (2021). Updated abundance estimates for cetacean Management Units in UK waters (May, 2021). JNCC Report No. 680, JNCC, Peterborough.

Jensen, F. B., Kuperman, W. A., Porter, M. B. and Schmidt, H. (2011). Computational Ocean Acoustics. Second edition. Springer. Modern Acoustics and Signal Processing. 794 pp.

JNCC (2010). Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise.

JNCC (2017). JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys. April 2017.

JNCC (2020). Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs. June 2020.

Lucke, K., Lepper, P. A., Blanchet, M-A. and Siebert, U. (2008). Testing the acoustic tolerance of harbour porpoise hearing for impulsive sounds. Bioacoustics 17: 329-331.

Malme, C.I., Miles, P.R., Clark, C.W., Tyack, P.L. and Bird, J.E. (1983). Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Final Report for the Period of 7 June 1982 - 31 July 1983. Report Number 5366. Report by Bolt Beranek and Newman Inc. for US Department of the Interior, Minerals Management Service, Alaska OCS Office, Cambridge, MA, USA.

Malme, C.I., Miles, P.R., Clark, C.W., Tyack, P.L. and Bird, J.E. (1984). Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Phase II: January 1984 Migration. Report Number 5586. Report by Bolt Beranek and Newman Inc. for the US Department of the Interior, Minerals Management Service, Cambridge, MA, USA.

Nabe-Nielsen, J., (2020). *Impacts of wind farm construction and the importance of piling order for harbour porpoises in the German Exclusive Economic Zone of the North Sea*. Scientific note from DCE – Danish Centre for Environment and Energy Vol. 2020 No. 73. https://dce.au.dk/fileadmin/dce.au.dk/Udgivelser/Notatet_2020/N2020_73.pdf

Nabe-Nielsen, J., van Beest, F.M., Grimm, V., Sibly, R.M., Teilmann, J. and Thompson, P.M. (2018). Predicting the impacts of anthropogenic disturbances on marine populations. Conservation Letters. 2018; https://doi.org/10.1111/conl.12563

NMFS (National Marine Fisheries Service) (2018). 2018 Revision to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing: underwater acoustic thresholds for onset of permanent and temporary threshold shifts (Version 2.0). U.S. Dept. of Commer. NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 pp.

Oakwood Computing (2022). Gundalf: Marine Seismic Airgun Modelling Software Package. https://www.gundalf.com/theproduct/

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W. T., Gentry, R., Halvorsen, M. B., Lokkeborg, S., Rogers, P., Southall, B. L., Zeddies, D. G., Tavolga, W. N. (2014). Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report by ANSI-Accredited Standards Committee S3/SCI and registered with ANSI. Springer Briefs in Oceanography.

Porter, M. B. and Liu, Y-C. (1994). Finite-element ray tracing. Theoretical and Computational Acoustics, Vol. 2, World Scientific Publishing Co.

Reid, J.B., Evans, P.G.H. and Northbridge, S.P. (2003). Atlas of cetacean distribution in North West European waters. Joint Nature Conservation committee. Available Online: http://jncc.defra.gov.uk/page-271

Richardson, J., Greene, C.R., Malme, C.I. and Thomson, D.H. (1995). Marine Mammals and Noise. San Diego California: Academic Press.

Robinson, S. P., Lepper, P. A., and Ablitt, J., (2007). The measurement of the underwater radiated noise from marine piling including characterisation of a “soft-start” period, IEEE Oceans – Europe 2006.

Russell, D. J. F., Jones, E. L. and Morris, C. D. (2017) Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science Vol 8 No 25, 25pp. DOI: 10.7489/2027-1.

Sarnocinska, J., Teilmann, J., Balle, J.D., van Beest, F.M., Delefosse, M., and Tougaard, J. (2020). Harbor Porpoise (*Phocoena phocoena*) reaction to a 3D seismic airgun survey in the North Sea. Front. Mar. Sci. 6:824.doi: 10.3389/fmars.2019.00824.

Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., ten Cate, C. and Popper, A. N. (2010). A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in Ecology and Evolution. 25(7): 419-427.

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene, C. R. Jr., Kastak, D., Ketten, D. R., Miller, J. H., Nachtigall, P. E., Richardson, W. J., Thomas, J. A. and Tyack, P. L. (2007). Marine mammals noise exposure criteria: initial scientific recommendations. Marine Mammals 33(4).

Southall, B. L., Bowles, Finneran, J. J., Reichmuth, C., Nactigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L. (2019). Marine mammal noise exposure criteria : Updated scientific recommendations for residual hearing effects. Aquatic Mammals 45(2) : 125-232.

Southall, B. L., Nowacek, D.P., Bowles, A.E., Senigaglia, V., Bejder, L. and Tyack, P.L. (2021). Marine mammal noise exposure criteria : Assessing the severity of marine mammal behavioural responses to human noise. Aquatic Mammals 47(5).

Thompson, P.M., Brookes, K.L., Graham, I.M., Barton, T.R., Needham, K., Bradbury, G., Merchant, N.D. (2013). Short term disturbance by a comeerical two-dimensional seismic survey does not lead to long-term displacement. Proceeding of the Royal Society B, Biological Sciences. http://rspb.royalsocietypublishing.org/content/280/1771/20132001

Tougaard J, Wright AJ & Madsen PT (2015). Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. -Marine Pollution Bulletin 90:196-208.

Waggitt, J.J., Evans, P.G.H., Andrade, J., Banks, A.N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C.J., Durinck, J., Felce, T., Fijn, R.C., Garcia-Baron, I., Garthe, S., Geelhoed, S.C.V., Gilles, A., Goodall, M., Haelters, J., Hamilton, S., Hartny-Mills, L., Hodgins, N., James, K., Jessopp, M., A.S. Kavanagh, Leopold, M., Lohrengel, K., Louzao, M., Markones, N., Martínez-Cedeira, J., Cadhla, O.O., Perry, S.L., Pierce, G.J., Ridoux, V., Robinson, K.P., Begoña Santos, M., Saavedra, C., Skov, H., Stienen, E.W.M., Sveegaard, S., Thompson, P., Vanermen, N., Wall, D., Webb, A., Wilson, J., Wanless, S., and GeertHiddink, J. (2019). Distribution maps of cetacean and seabird populations in the North-East Atlantic. WebbJournal of Applied Ecology. (57) pp. 253-269.

Wardle, C. S., Carter, T. J., Urquhart, G. G., Johnstone, A. D. F., Ziolkowski, A. M., Hampson, G. and Mackie, D. (2001). Effects of seismic air guns on marine fish. Continental Shelf Research 21:1005-1027.

WOA, (2013). World ocean database and world ocean atlas series. Data available at: https://www.nodc.noaa.gov/OC5/indprod.html

APPENDIX A: AUDITORY WEIGHTED SEL FOR PILING

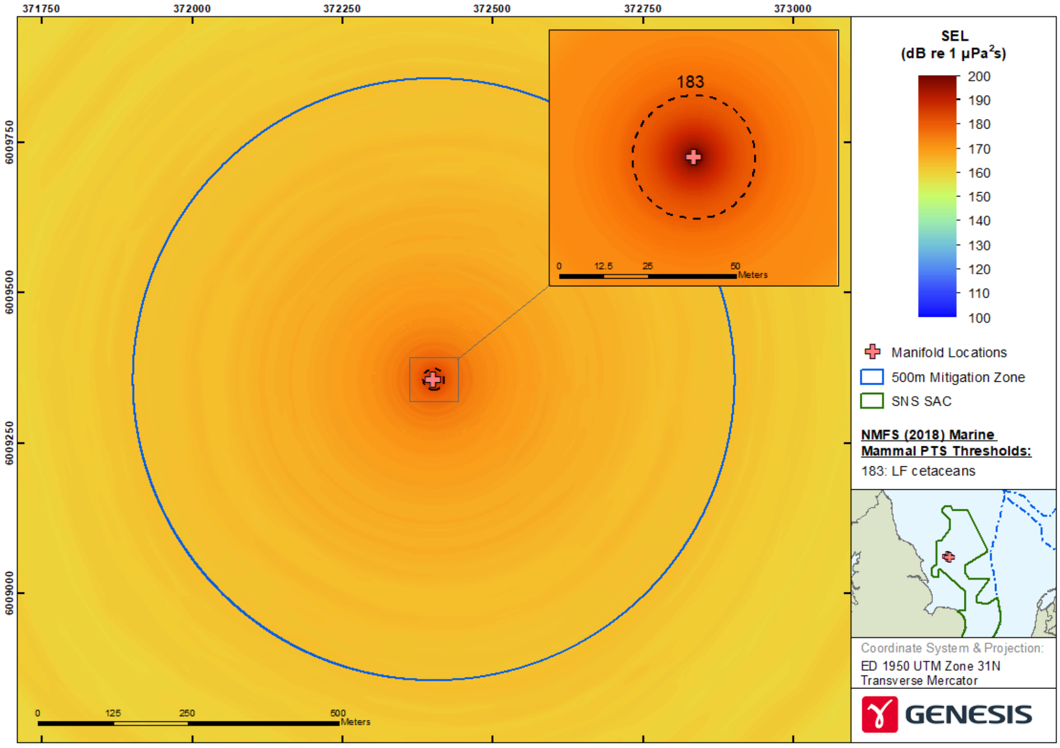


Figure A-1: Predicted LF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during manifold piling at Endurance.

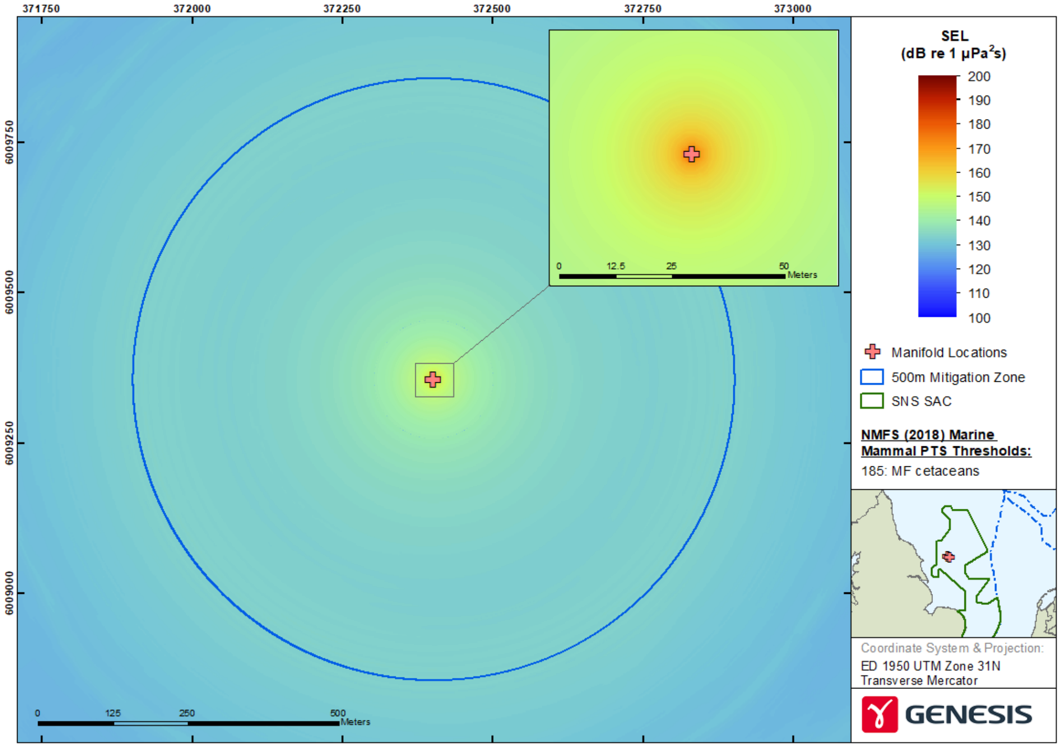


Figure A-2: Predicted MF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during manifold piling at Endurance.

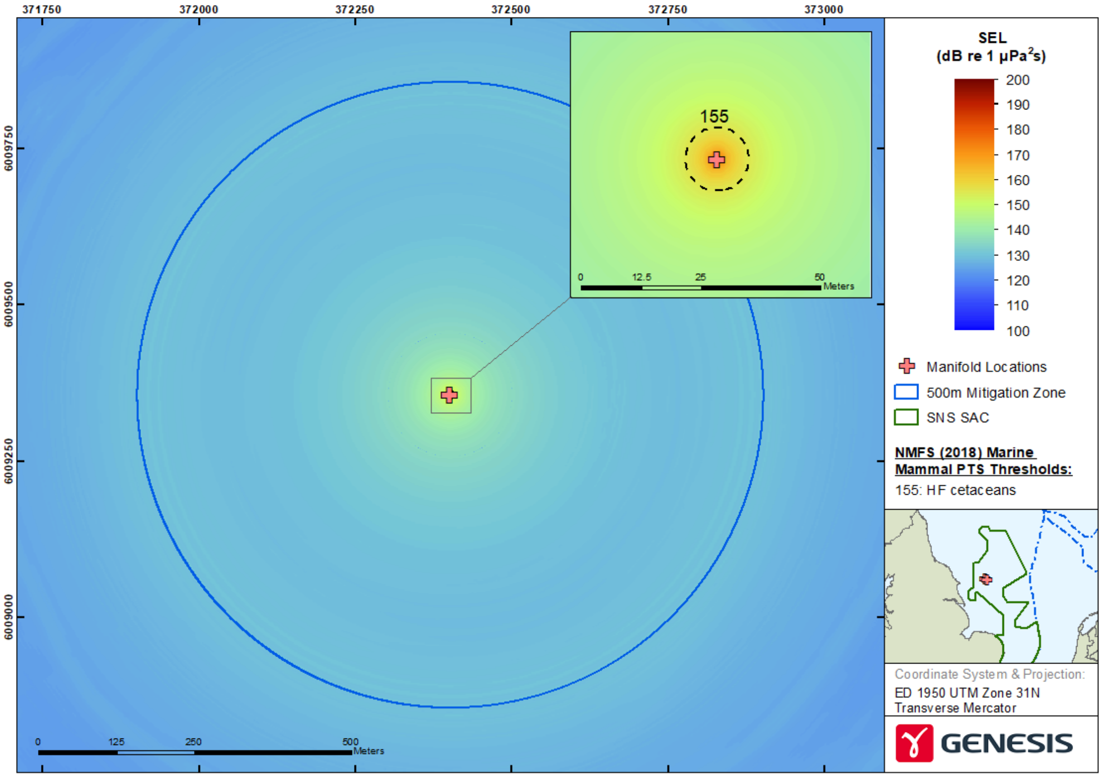


Figure A-3: Predicted HF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during manifold piling at Endurance.

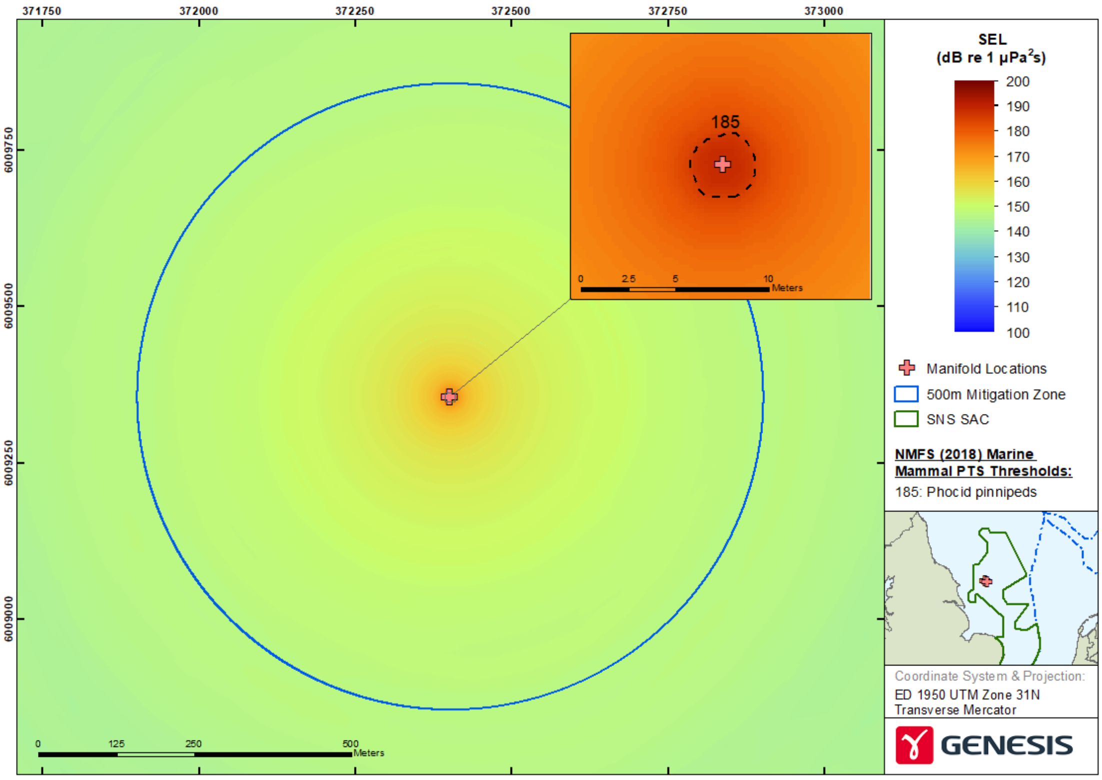


Figure A-4: Predicted phocid pinniped weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during manifold piling at Endurance.

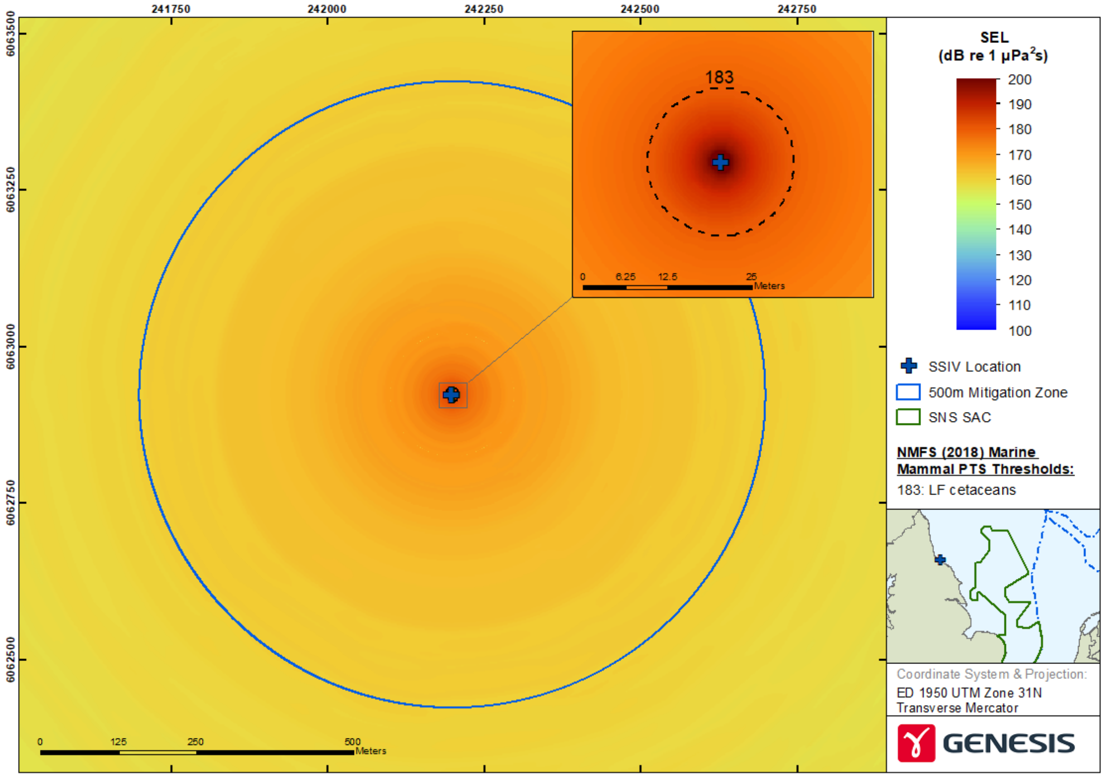


Figure A-5: Predicted LF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during SSIV piling at Teesside.

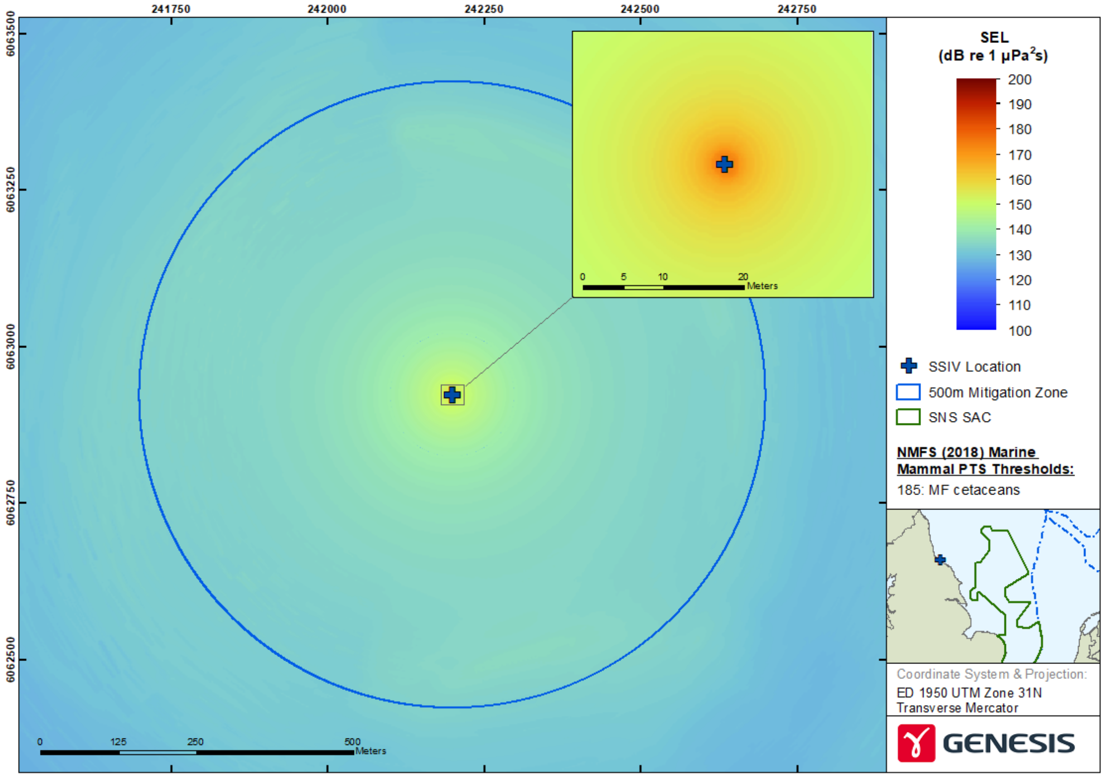


Figure A-6: Predicted MF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during SSIV piling at Teesside.

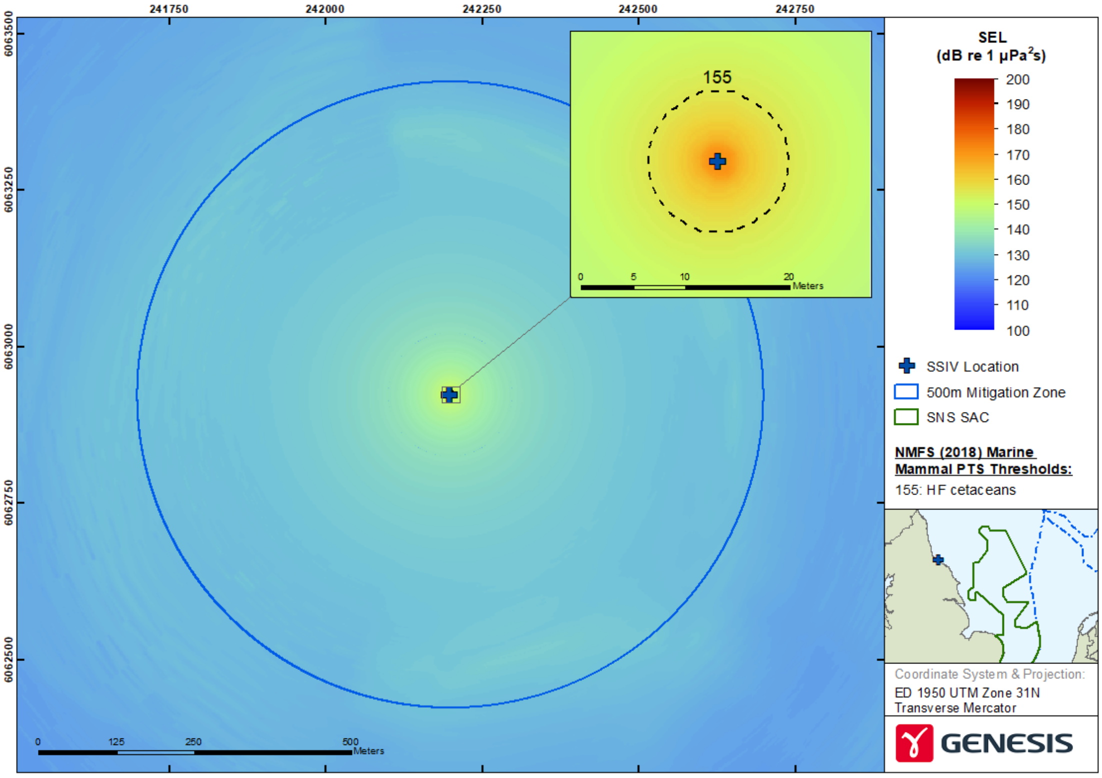


Figure A-7: Predicted HF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during SSIV piling at Teesside.

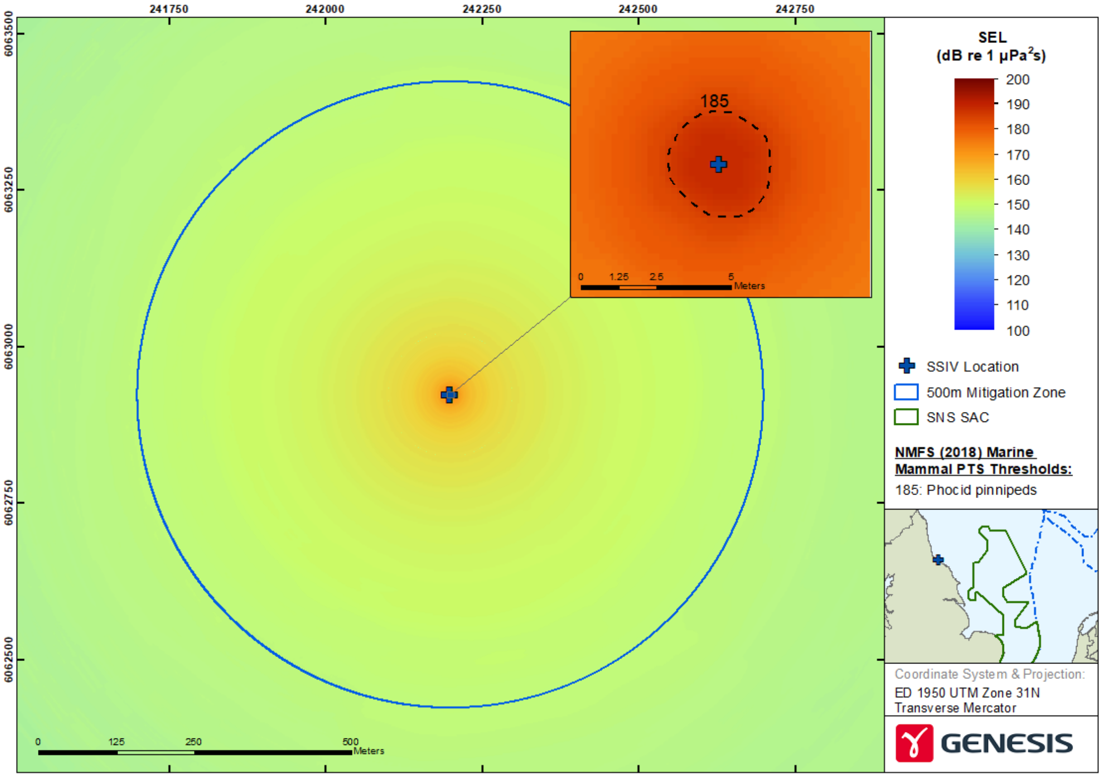


Figure A-8: Predicted phocid pinniped weighted SEL from a single pile strike when the hammer is operating at maximum energy of 120 kJ during SSIV piling at Teesside.

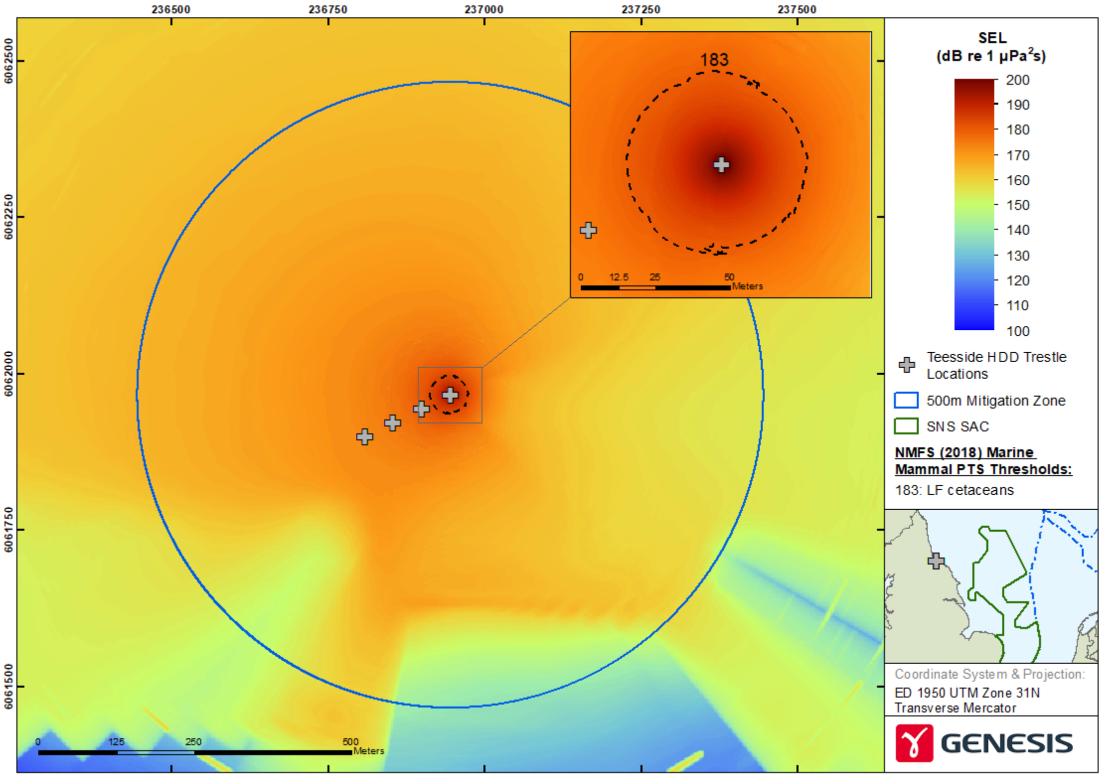


Figure A-9: Predicted LF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Teesside.

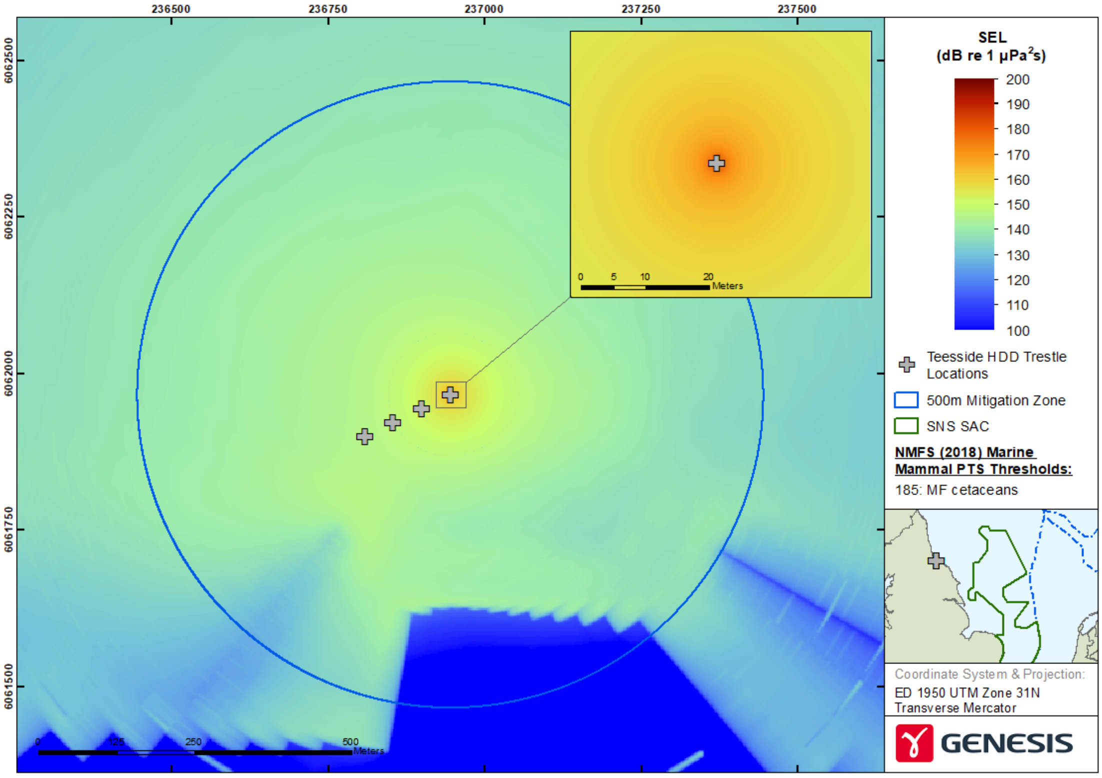


Figure A-10: Predicted MF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Teesside.

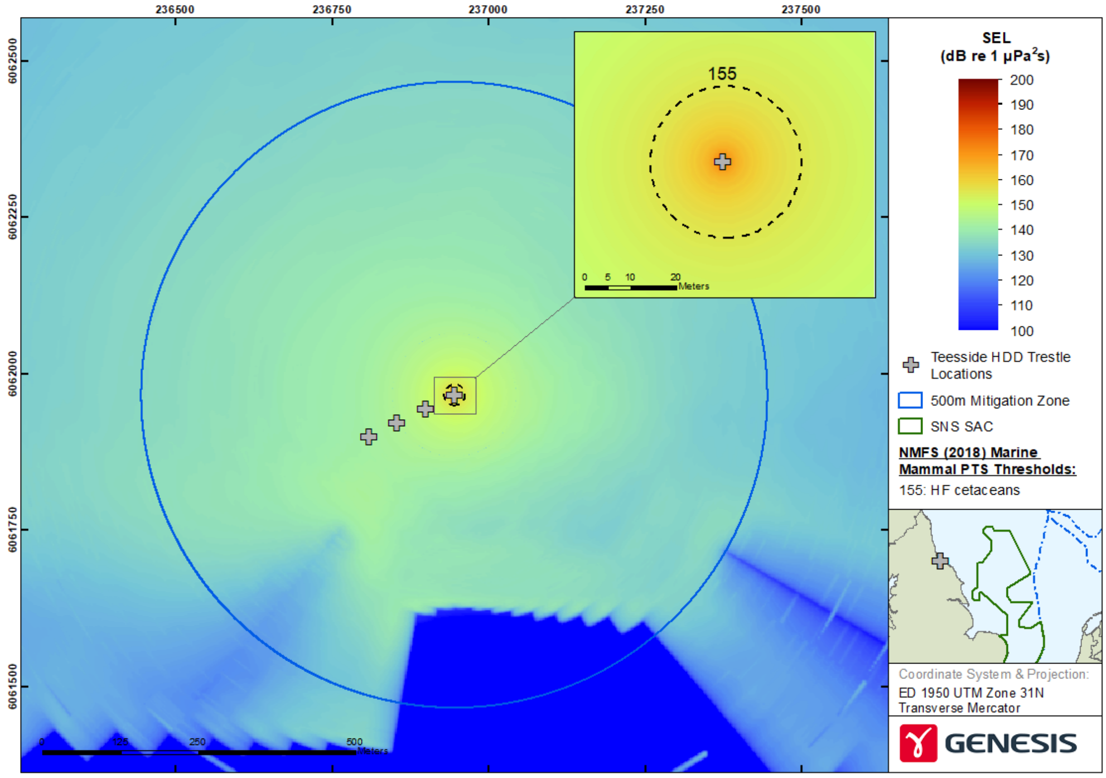


Figure A-11: Predicted HF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Teesside.

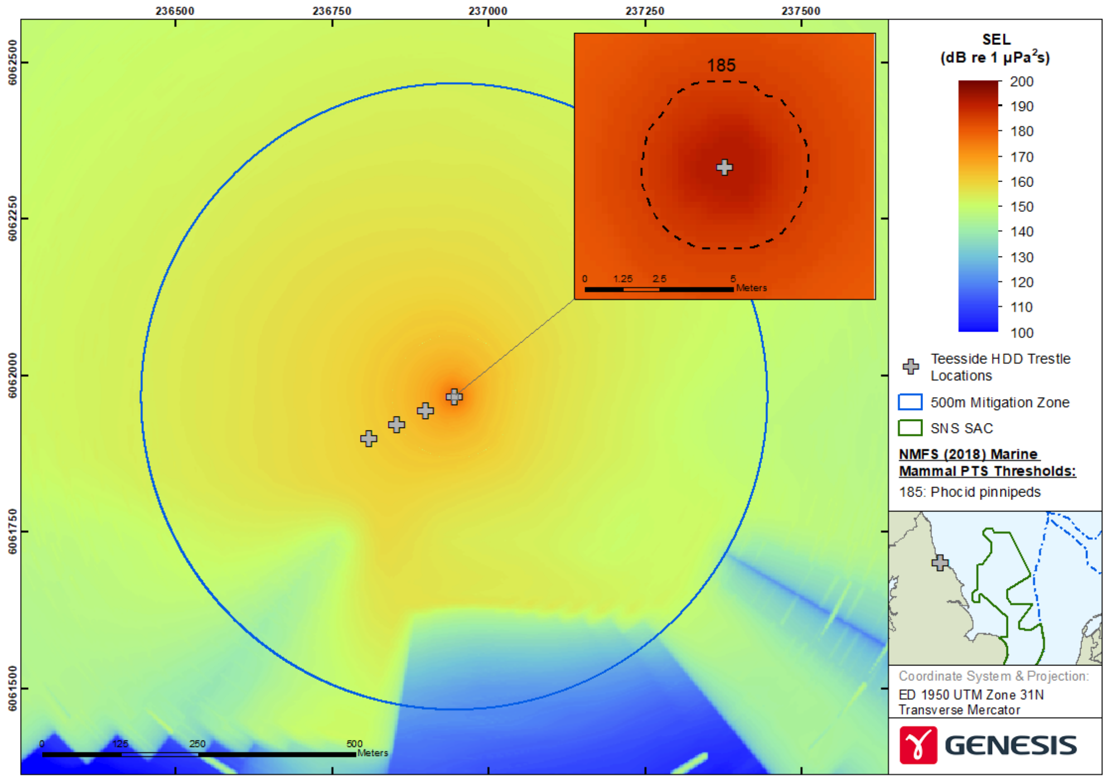


Figure A-12: Predicted phocid pinniped weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Teesside.

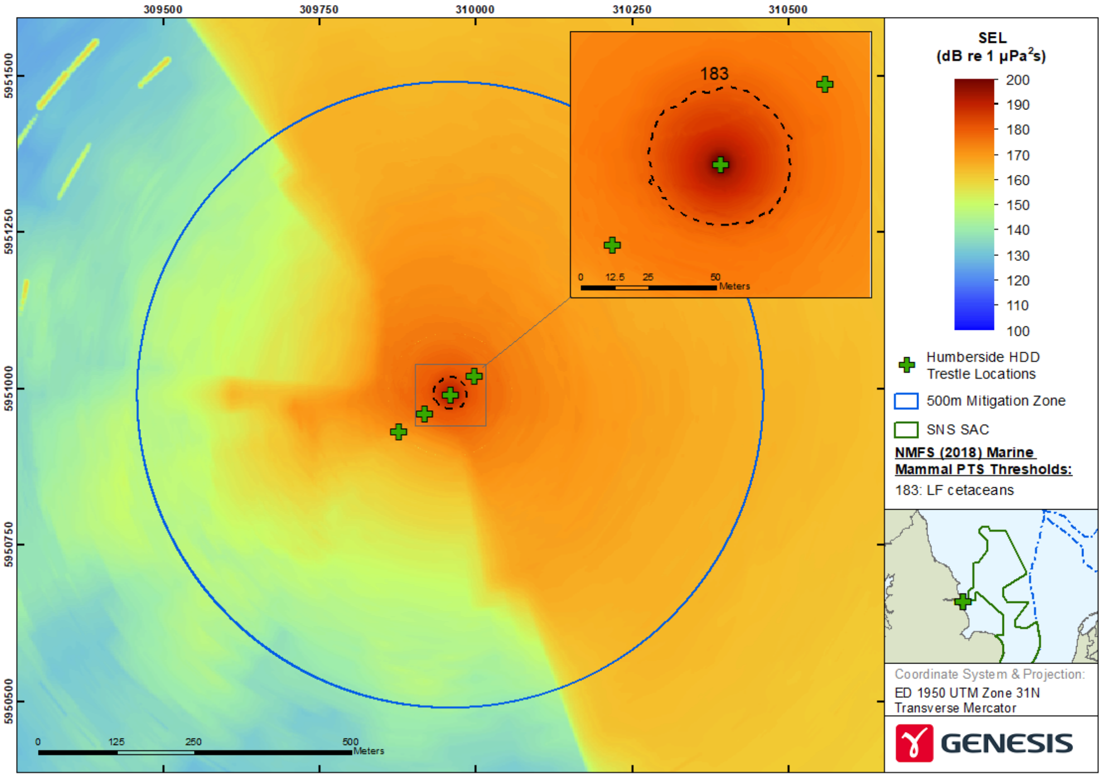


Figure A-13: Predicted LF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Humberside.

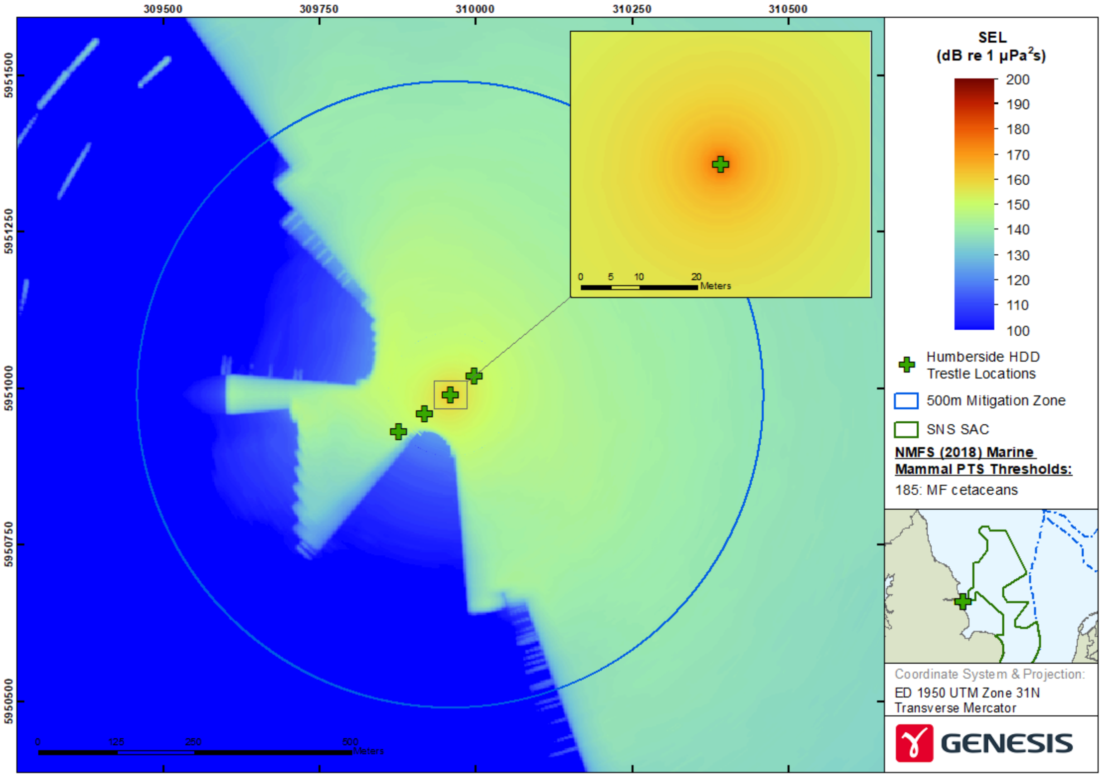


Figure A-14: Predicted MF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Humberside.

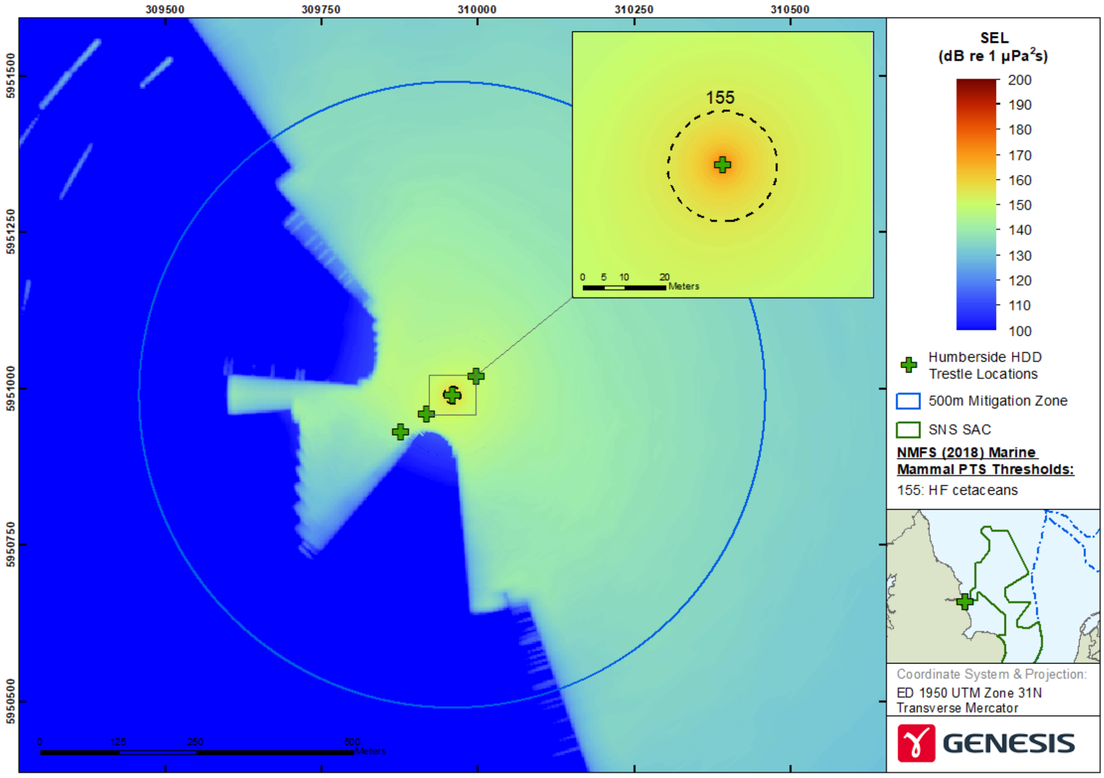


Figure A-15: Predicted HF cetacean weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Humberside.

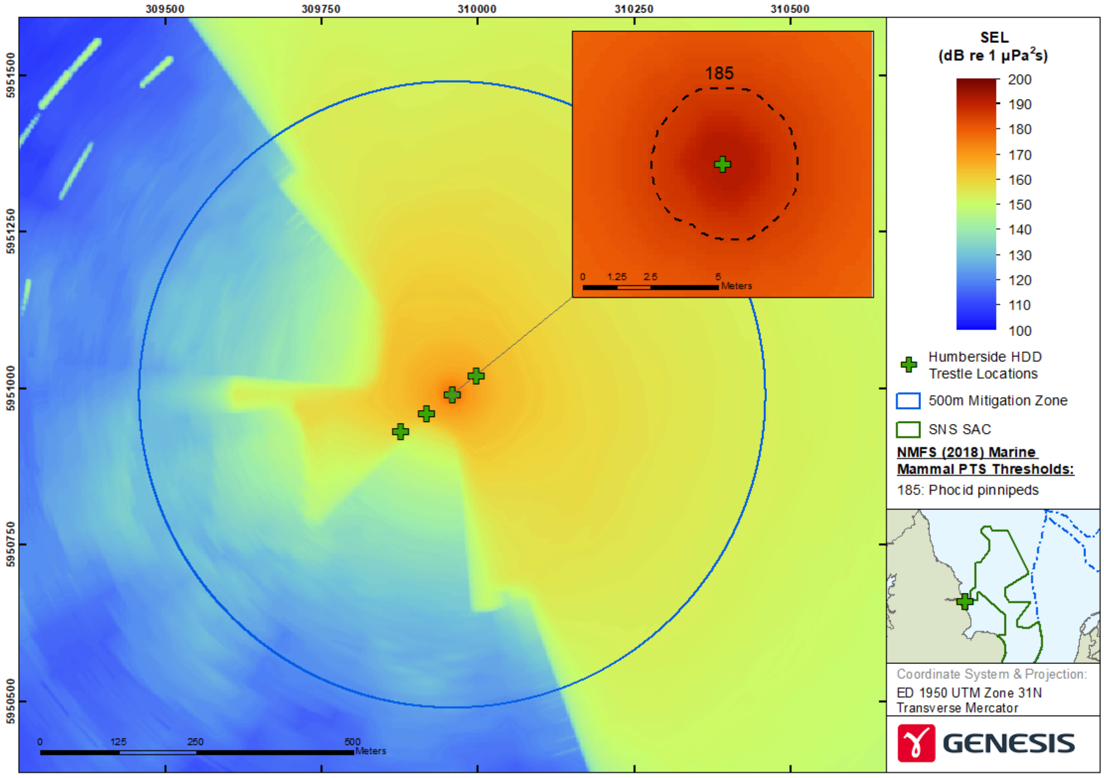


Figure A-16: Predicted phocid pinniped weighted SEL from a single pile strike when the hammer is operating at maximum energy of 235 kJ during HDD trestle piling at Humberside.

Appendix K: Drill Cuttings Dispersion Modelling Report

BP Exploration Operating Company Ltd

Offshore Environmental Statement for the Northern Endurance Partnership

Drill Cuttings Dispersion Modelling Report

ASSIGNMENT A200540-S00
DOCUMENT A-200540-S00-REPT-005

XODUS

London

Cheapside House
138 Cheapside . London
EC2V 6BJ . UK

T +44 (0)207 246 2990

www.xodusgroup.com

REVISIONS & APPROVALS

This report has been prepared by Xodus Group Ltd exclusively for the benefit and use of BP Exploration Operating Company Ltd. Xodus Group Ltd expressly disclaims any and all liability to third parties (parties or persons other than BP Exploration Operating Company Ltd) which may be based on this report.

The information contained in this report is legally privileged and strictly confidential and intended only for the use of BP Exploration Operating Company Ltd. This report shall not be reproduced, distributed, quoted, or made available – in whole or in part – to any company, person, regulatory body, or organization other than for the purpose for which the report was produced without the prior written consent of Xodus Group Ltd.

The authenticity, completeness and accuracy of any information provided to Xodus Group Ltd in relation to this report has not been independently verified. No representation or warranty express or implied, is or will be made in relation to, and no responsibility or liability will be accepted by Xodus Group Ltd (or any of its respective directors, officers, employees, advisers, agents, representatives, and consultants) as to or in relation to, the accuracy or completeness of this report. Xodus Group Ltd expressly disclaims any and all liability which may be based on such information, errors therein or omissions there from.

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A02	02/08/23	Issued for Use	MD	AM	AM	
A01	13/01/22	Issued for Use	SW	BO	AM	
R01	10/12/21	Issued for Review	SW	SF	AM	

CONTENTS

LIST OF TABLES		4
LIST OF FIGURES		5
EXECUTIVE SUMMARY		6
1	INTRODUCTION	7
1.1	Drilling Programme	7
1.2	About the Model	8
2	MODEL PARAMETERS	10
2.1	Scenarios	10
2.2	Environmental Conditions	12
3	RESULTS AND DISCUSSION	13
3.1	Modelling of a Single Well	13
3.1.1	Water Column Risk	13
3.1.2	Seabed Risk	16
3.2	Modelling of Six Wells	18
3.2.1	Water Column Risk	18
3.2.2	Seabed Risk	21
4	CONCLUSION	23
5	ABBREVIATIONS	24
6	REFERENCES	25
APPENDIX 1		26

LIST OF TABLES

Table 1.1 - Well location data 7
Table 2.1 - Drilling programme data for the Development wells 10
Table 2.2 - Mass of drilling mud components and cuttings 10
Table 2.3 - Concentration of metals attached to barite 11
Table 2.4 – Environmental parameters 12

LIST OF FIGURES

Figure 1.1 - Well design schematic 8
Figure 3.1- Development of water column risk (%) due to particulate material discharged during drilling over time 14
Figure 3.2 - Development of the water column impact in terms of EIF during drilling 15
Figure 3.3 - Weighted contribution to water column risk in terms of EIF 15
Figure 3.4 - Modelled cuttings accumulation on the seabed from single well; EC01 17
Figure 3.5 - Sediment thickness on the seabed along transect A-B 17
Figure 3.6 - Development of water column risk (%) due to particulate material discharged during drilling over time 19
Figure 3.7 - Development of the water column impact in terms of EIF during drilling 20
Figure 3.8 - Weighted contribution to water column risk in terms of EIF 20
Figure 3.9 - Modelled cuttings accumulation on the seabed from six wells 22
Figure 3.10 - Sediment thickness on the seabed along transect A-B 22

EXECUTIVE SUMMARY

This report covers the drill cuttings requirements for the offshore Northern Endurance Partnership (NEP) wells which lie in the Southern North Sea (SNS), off the coast of Teesside and Humber in northeast England. The Development will route CO_2 from industrial clusters in the Teesside and Humber regions to the offshore geological storage site, the Endurance Store which is located approximately 63 km from the nearest coastline. The Endurance carbon storage licence CS001, awarded by the Oil and Gas Authority (OGA, now the North Sea Transition Authority (NSTA)), is held by BP Exploration and Operating Company Limited (BPEOC, 50%), and Equinor New Energy Limited (50%). The discharge of particulate materials from the drilling of the wells were modelled with the SINTEF's Dose-Related Exposure Assessment Model (DREAM) using the ParTrack module.

Single well and 6 well discharge scenarios were modelled whereby the wells consisted of four vertical sections of which 2 were discharged at the seabed and two skipped and shipped to shore. It was assumed all wells were of the same design. For the single well the lateral extent of the section of the water column was predicted to have an impact risk on more than 5% of species present extends to a maximum of 5.25 km to the north of the release site, near the seabed. As generally expected with drilling programmes the water column impact is very transitory, with much of the risk in the water column occurring between days 2 and 5 after drilling begins with rapid dissipation after this until the risk falls below 5% at day 6, there is no risk occurring by day 12.

The modelled cuttings pile for a single well is predicted to have a maximum thickness of 1215 mm, rapidly decreasing as the distance from the well increases such that, within 10 m of a wellbore the sediment thickness has decreased to approximately 20 mm and within 50 m it has decreased to less than 1 mm. The thickest area of the mud and cuttings was predicted to be formed to the immediate west of the drilling location.

The modelling of six wells shows the lateral extent of the section of the water column predicted to have an impact risk on more than 5% of species present extends to a maximum of 5.7 km to the north of the release sites and 3.1 km east, near the seabed. The majority of the risk in the water column occurs between days 2 and 7 after drilling begins. The risk is shown to dissipate rapidly after this where the risk falls below 5% at day 9, and after day 19 the risk returns to zero.

For the six well scenario, the modelled cuttings pile is predicted to have a maximum thickness of 122 mm for a single well of the six wells. This rapidly decreases as the distance from the well increases such that, within 50 m the thickness decreases to less than 1 mm. Maximum depths for the six wells are as follows: EC01: 114 mm; EC02: 122 mm; EC03: 119 mm; EC04 :117 mm; EC05: 200 mm; EM01: 122 mm. The thickest area of the mud and cuttings pile was predicted to be predominantly formed to the immediate west of the drilling location. The direction of the wider-scale deposition of sediment is dominated by prevailing currents to the south-west and west at levels that are not easily detectable in the environment. Therefore, any potential seabed impacts are likely to remain localised.

The thickness of cuttings accumulation after 30 years is shown to remain at a maximum thickness of 122 mm for a single well of the six wells. Maximum depths for the six wells are unchanged over this period.

1 INTRODUCTION

This report describes the modelling of drilling discharges for the offshore Northern Endurance Partnership (NEP) wells which lie in the Southern North Sea (SNS), off the coast of Teesside and Humber in northeast England. The Development will route CO_2 from industrial clusters in the Teesside and Humber regions to the offshore geological storage site, the Endurance Store which is located approximately 63 km from the nearest coastline. The Endurance carbon storage licence CS001, awarded by the Oil and Gas Authority (OGA, now the North Sea Transition Authority (NSTA)), is held by BP Exploration and Operating Company Limited (BPEOC, 50%), and Equinor New Energy Limited (50%).

At the time the drill cuttings modelling was conducted, the locations of the proposed wells were assumed to be those shown in Table 1.1. While minor modifications to well locations may be made during engineering design, these modifications do not alter the conclusions of the assessment. The wells include five CO_2 injection wells (EC01-EC05) and one spare/Observation Well (EM01). Drilling of the wells into the Endurance Store is expected to commence in 2026.

Table 1.1 - Well location data

WELL NAME	SURFACE COORDINATES (ED50 UTM ZONE 31N)	
	LATITUDE	LONGITUDE
EC01	54º 12’ 0.739”N	0º 59’ 29.989”E
EC02	54º 14’ 35.360”N	0º 56’ 57.643”E
EC03	54º 14’ 17.462”N	1º 1’ 23.637”E
EC04	54º 11’ 44.101”N	1º 3’ 37.083”E
EC05	54º 13’ 3.841”N	1º 4’ 53.694”E
EM01	54º 11’ 53.025”N	1º 6’ 58.641”E

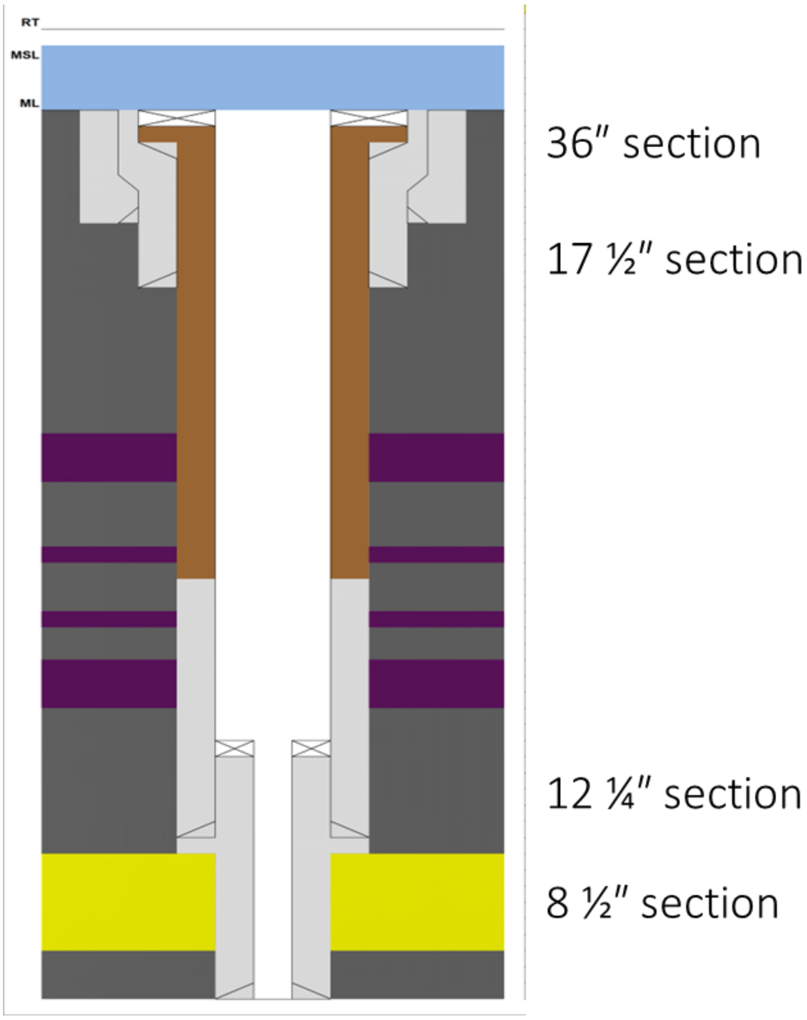
1.1 Drilling Programme

The Development wells will be drilled in several sections, each becoming successively reduced in diameter with depth (Table 2.1). Each well section will be lined with a steel casing to provide stability, prevent wellbore collapse, and prevent loss of drilling fluid from the well into the surrounding formations. The first section (or tophole) will be drilled with a 36” bit to 72 m measured depth below the mudline. A 30” x 20” conductor will be run and cemented in place.

Subsequent sections will then be drilled in the same way as the tophole section, using a drill string. This is a long section of pipe, or many pipes connected, that terminates in a drill bit, which grinds through the seabed and formations beneath. The drill string also passes a mixture of chemicals, called drilling mud, down into the well to keep the drill bit cool and lubricated during drilling and to aid in the suspension and removal of drill cuttings. Each subsequent section that is drilled, and reinforced with steel casing, will be of successively reduced diameter.

Following installation of the 36'' conductor, a 17.5'' diameter by 418 m long section will be drilled and mud and cuttings will be discharged at the seabed. The subsequent, 12.25'' diameter by 607 m and 8.5″ diameter by 407 m long well sections will then be drilled, and the mud and cuttings will be skipped and shipped to shore.

Figure 1.1 - Well design schematic



1.2 About the Model

The discharges from this potential drilling scenario were modelled using the ParTrack module within SINTEF's Dose-Related Risk and Effect Assessment Model (DREAM) (included in Marine Environmental Modelling Workbench (MEMW) version 12.1.0). Dispersion of particulates and dissolved material in the water column and settling behaviour were assessed primarily in the immediate vicinity of the development well. Environmental impact factors (EIFs) for the water column and sediment were calculated for the drilling discharges to inform the assessment of the potential impacts of the drilling programme on the marine environment. More details are given in Appendix 1.

EIFs are a relative measure of risk to the biota in the marine environment. They are calculated using the PEC/PNEC approach, in which the predicted environmental concentration (PEC) of a contaminant is divided by the predicted no effect concentration (PNEC; the highest concentration at which no environmental effect is predicted). A ratio of PEC/PNEC > 1 indicates there is likely to be an environmental effect.

The PNEC values within the ParTrack model are estimated highest concentrations at which toxic effects are not expected. The PNEC value for each substance is determined by laboratory ecotoxicity tests on a number of species divided by an assessment factor determined by the regulator. The PNEC may be considered to be a value that is protective of all but the most sensitive 5% of species. This approach is internationally accepted in the regulatory assessment of chemicals. SINTEF have adapted this methodology by using experimental data to calculate pseudo-PNECs for non-toxic stressors such as burial, sediment grain size change and oxygen depletion.

The PEC for each contaminant is modelled by simulating the behaviour of contaminants in the water column. Processes including dilution, partitioning, degradation and deposition into the sediment are simulated in order to generate a PEC for each contaminant over time. EIFs for the sediment compartment are more complex, incorporating toxicity of contaminants, but also processes such as oxygen depletion, change in median grain size and burial effects.

The basis for the calculation of the EIF within the model is that the entire water volume in the modelled area is split into compartments measuring 100 m x 100 m x 10 m (0.0001 km^3). Each compartment where the PEC/PNEC ratio is >1 contributes a value of 1 to the water EIF [1].

Sediment EIFs are calculated based on area rather than volume. The sediment is divided into compartments measuring 100 m x 100 m (1 ha or 0.01 km^2). Each compartment where the PEC/PNEC ratio is > 1 contributes a value of 1 to the sediment EIF.

It should be noted that SINTEF, the developers of DREAM (ParTrack), clearly state that the EIF is not a measure of absolute impact, but a comparative tool to support environmental management decision making. As such, the absolute value of the EIF is not meaningful; however, comparison of EIF values for different discharge scenarios based on equivalent assumptions provides a powerful tool for understanding and comparing potential impacts of these scenarios. The modelling described in this report is intended to inform the assessment of the environmental impacts of drill cuttings from the site and was based upon the information available at the time the work was conducted.

[1] *As this method converts ratios to probabilities, probability theory may be used to sum the impact of multiple stressors into a final result.*

2 MODEL PARAMETERS

2.1 Scenarios

Table 2.1 presents the drilling programme for the Development wells, and Table 2.2 presents quantities of drilling mud components and drill cuttings.

Table 2.1 - Drilling programme data for the Development wells

WELL SECTION	1	2	3	4
Diameter (inches)	36	17.5	12.25	8.5
Length (m)	72	418	607	407
Discharge Type	Continuous	Continuous	N/A	N/A
Drilling rate (m/hr)	10	30	30	30
Discharge Location	Riserless	Riserless	N/A (skip and ship)	N/A (skip and ship)
Discharge orientation	Vertically upwards from seabed	Vertically upwards from seabed	N/A	N/A

Table 2.2 - Mass of drilling mud components and cuttings

COMPONENT	MODELLED DISCHARGES PER SECTION	
	1	2
Cuttings (te)	293	203
MUD/Fluid name or description	Seawater with bentonite sweeps	KCl or Polyglycol WBM
Barite (te)	20	60
Bentonite (te)	25	N/A
Non PLONOR chemicals (STARCIDE) (te)	N/A	5
Total mud (te)	350	680

Particulates in the discharge (cuttings, barite and bentonite) were set up using the model default values. Most of the added chemicals in the drilling fluids will be OSPAR PLONOR substances. Non-PLONOR added chemicals including a biocide was included in the modelling. The water-based mud biocide; STARCIDE was selected for modelling, however the specific biocide will not be confirmed until 2023/2024. Modelling was conducted for well sections 1 and 2 (Table 2.2) and it was assumed that all wells are of the same design as shown (Table 2.1).

A conservative approach was used in setting up the model that assumed the toxicity value on the template represented the whole product. In reality it is likely that the actual toxicity of the product is less than that used in this modelling due to many components having negligible toxicity to marine organisms. Metals attached to barite were set up according to the data in Table 2.3 which contains values taken from previous work carried out by Xodus Group.

Table 2.3 - Concentration of metals attached to barite

METAL	CONCENTRATION (PPM)
Arsenic (As)	4.19
Cadmium (Cd)	0.26
Chromium (Cr)	5.59
Copper (Cu)	27.6
Lead (Pb)	76.6
Mercury (Hg)	1.63
Zinc (Zn)	260

2.2 Environmental Conditions

Table 2.4 presents a summary of the environmental parameters used in this modelling study.

Table 2.4 – Environmental parameters

PARAMETER	VALUE	SOURCE
Location	Table 1.1	Data request
Median initial seabed sediment grain size (mm)	0.383	Data request
Sea surface temperature (°C)	12.8	MyOcean[2]
Seabed temperature (°C)	12.7	
Salinity (ppt)	35	DREAM default value
Winds	European Centre for Medium-Range Weather Forecasts (ECMWF)[3]	
Currents	Hybrid Coordinate Ocean Model (HYCOM)[4]	

Four definitive model runs were conducted as follows:

- Near-field model run of a single well (EC01):
  - Low resolution far-field model run to assess water column impacts and to identify the area for higher resolution modelling (50 m grid cell size, 20 km x 20 km extent); and
  - High resolution near-field model to assess mud and cuttings accumulation and sediment impacts close to the discharge location (10 m grid cell size, 2 km x 2 km extent).
- Far-field model run of the six wells (EC01-EC05; EM01):
  - Low resolution far-field model run to assess water column impacts and to identify the area for higher resolution modelling (200 m grid cell size, 130 km x 130 km extent); and
  - High resolution near-field model to assess mud and cuttings accumulation and sediment impacts close to the discharge location (50 m grid cell size, 15 km x 15 km extent).

The selection of the model grid size will have an impact on the resolution of the result generated from the model; model grids are therefore selected to provide the output required for the different elements of the study being conducted.

The modelled discharge occurred over 1.1 days. However, the model was run for 30 days to monitor the dispersion of chemicals and suspended particles and resultant risk.

[2] *www.myocean.eu*

[3] *https://www.ecmwf.int/*

[4] *https://www.hycom.org/*

3 RESULTS AND DISCUSSION

3.1 Modelling of a Single Well

3.1.1 Water Column Risk

A time series showing the developing risk to the water column during drilling is shown in Figure 3.1. The model considered both particulate and chemical material likely to be discharged during the drilling programme. The quantity of particulate and chemical material included in the model was a worst case estimation of discharge.

The lateral extent of the section of the water column precited to have an impact risk on more than 5% of species present extends to a maximum of 5.25 km to the north of the release site, near the seabed. As it is to be expected with drilling programmes the water column impact is very transitory, with much of the risk in the water column occurring between days 2 and 5 after drilling begins with rapid dissipation after this until there the risk falls below 5% at day 6. Figure 3.1 also displays the water column risk along transect A-B. This shows water column risk is predicted to occur close to the seabed.

The development of the water column risk as described by the EIF values is presented in Figure 3.2. This shows one peak in EIF occurring on day 3 which corresponds with the discharge of the cuttings from well sections 1 and 2. The maximum EIF was 5,607 and returns to 0 by day 6. Well section 2 contains biocide which results in the largest contribution to the EIF (Figure 3.3).

Figure 3.1- Development of water column risk (%) due to particulate material discharged during drilling over time

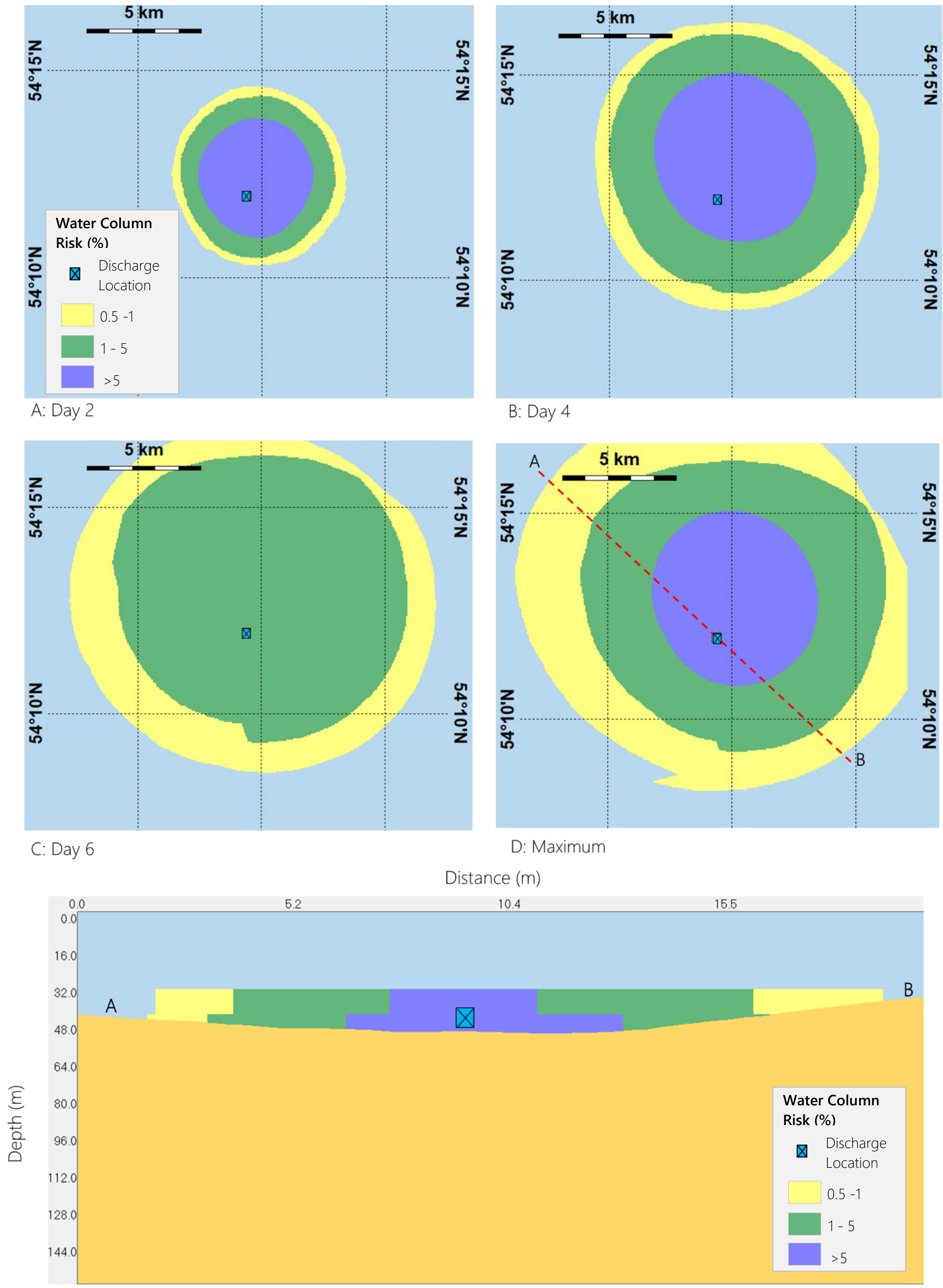
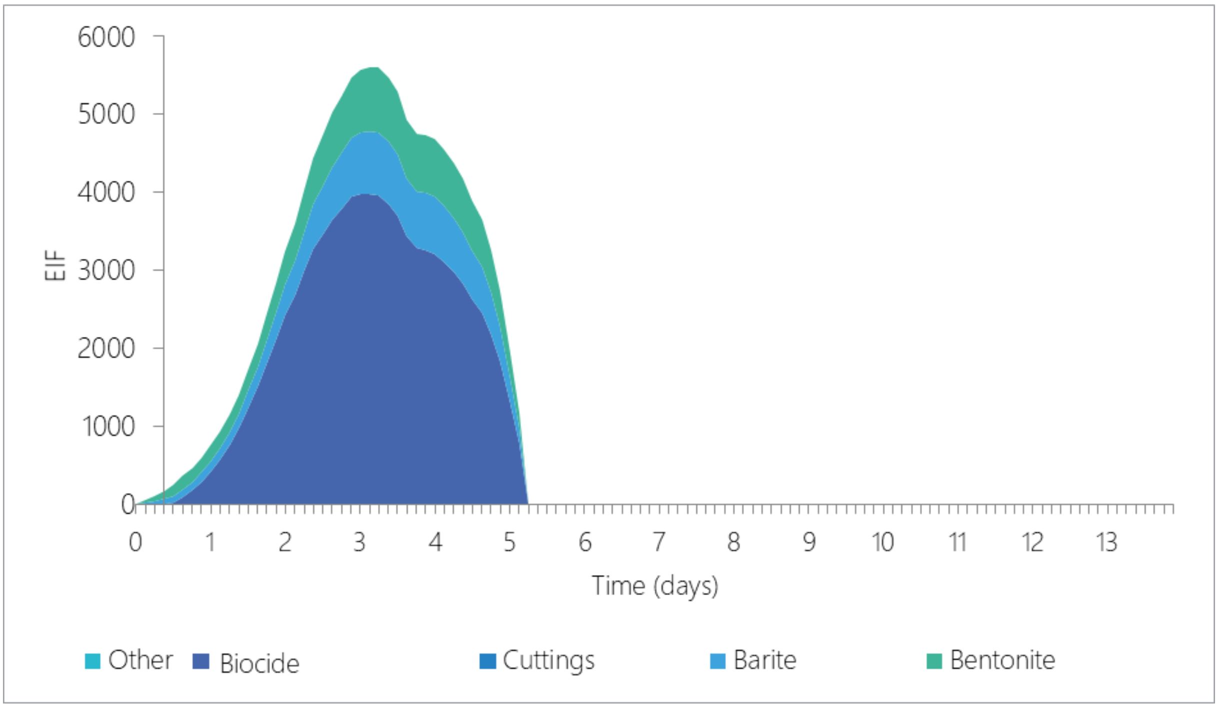
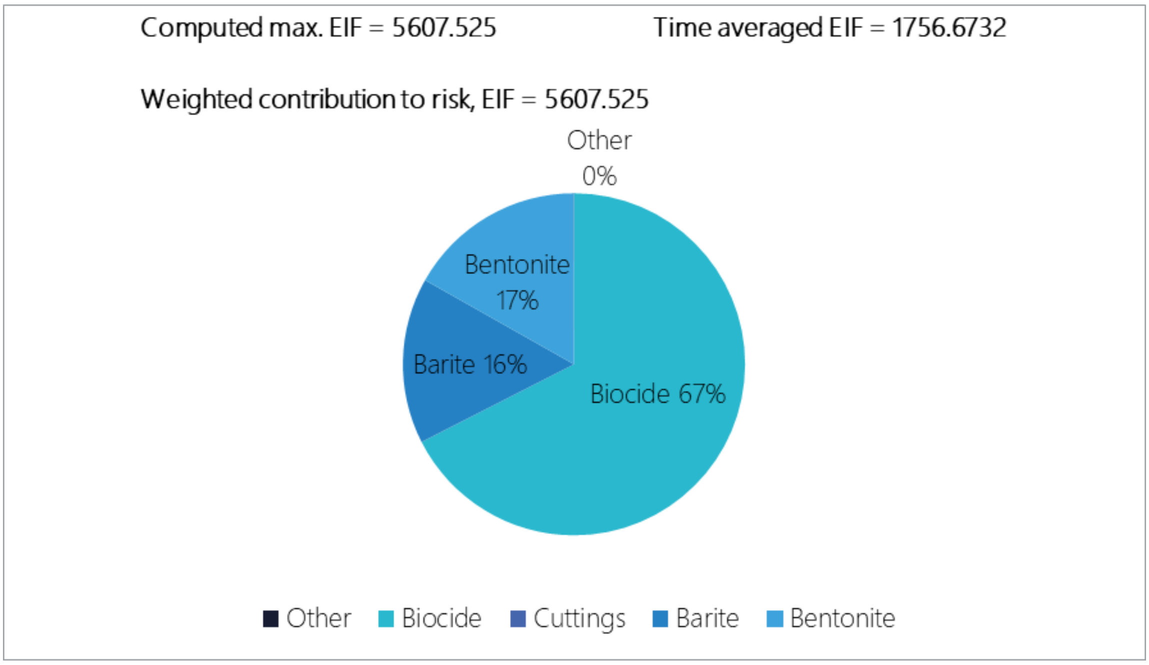


Figure 3.2 - Development of the water column impact in terms of EIF during drilling



N.B Timeframe of 14 days was selected for this figure due to EIF remaining at 0 for the rest of the model simulation.

Figure 3.3 - Weighted contribution to water column risk in terms of EIF



3.1.2 Seabed Risk

The modelled thickness of the deposited drilling mud is presented in Figure 3.4 and Figure 3.5, in both plan and section view, respectively. The modelled cuttings pile at the well is predicted to have a maximum thickness of 1,215 mm rapidly decreasing as the distance from the well increases such that, within 10 m of a wellbore the sediment thickness has decreased to approximately 20 mm and within 50 m it has decreased to less than 1 mm. The thickest area of the mud and cuttings was predicted to be formed to the immediate west of the drilling location. The predicted EIF for the cuttings pile was predicted to be zero.

Figure 3.4 - Modelled cuttings accumulation on the seabed from single well; EC01

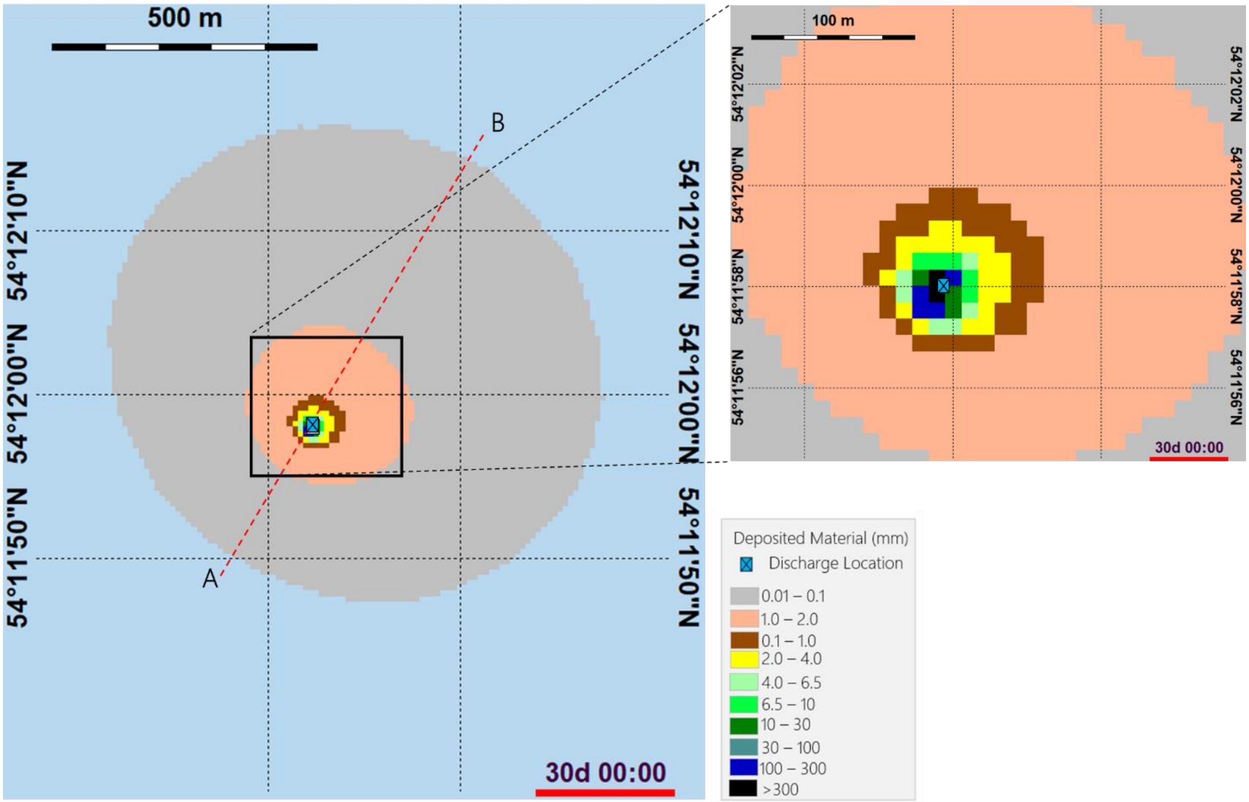
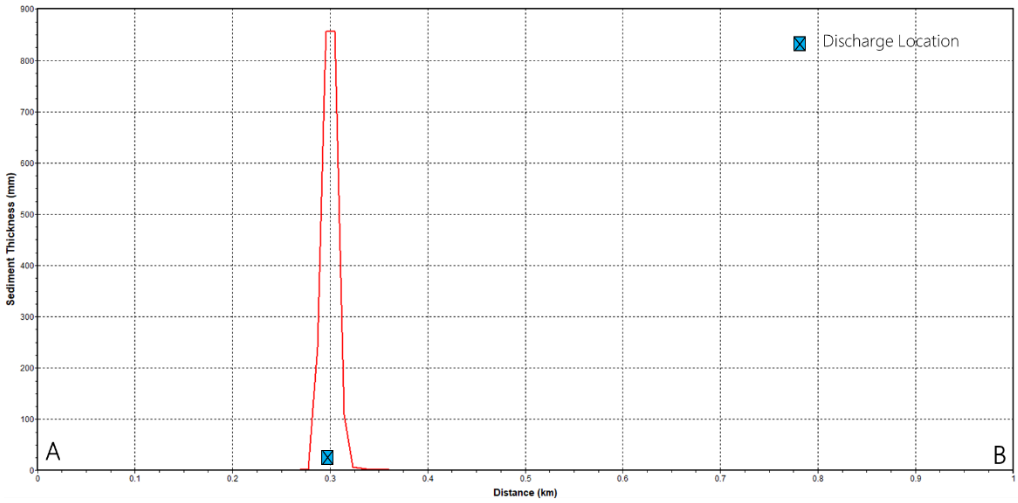


Figure 3.5 - Sediment thickness on the seabed along transect A-B



3.2 Modelling of Six Wells

3.2.1 Water Column Risk

A time series showing the developing risk to the water column from six wells during drilling is shown in Figure 3.6. The model only considered particulate and chemical material likely to be discharged during the drilling programme. The quantity of particulate and chemical material included in the model was a worst case estimation of discharge.

The lateral extent of the section of the water column predicted to have an impact risk on more than 5% of species present extends to a maximum of 5.7 km to the north of the release sites and 3.1 km east, near the seabed. As is predicted with drilling programmes the water column impact is very transitory, with most of the risk in the water column occurring between days 2 and 7 after drilling begins. The risk is shown to dissipate rapidly after this falling below 5% by day 9 and zero by day 19. Figure 3.6 also displays the water column risk along transect A-B. This shows water column risk is predicted to occur close to the seabed.

The development of the water column risk as described by the EIF values is presented in Figure 3.7. This shows that a peak in EIF, which links with the discharge of the cuttings from well sections 1 and 2. The maximum EIF was 30,999 and returns to zero by day 9. Well section 2 contains biocide which results in the largest contribution to the water column chemical stress. However, potential water column impacts are predicted to be short-term and localised.

Figure 3.6 - Development of water column risk (%) due to particulate material discharged during drilling over time

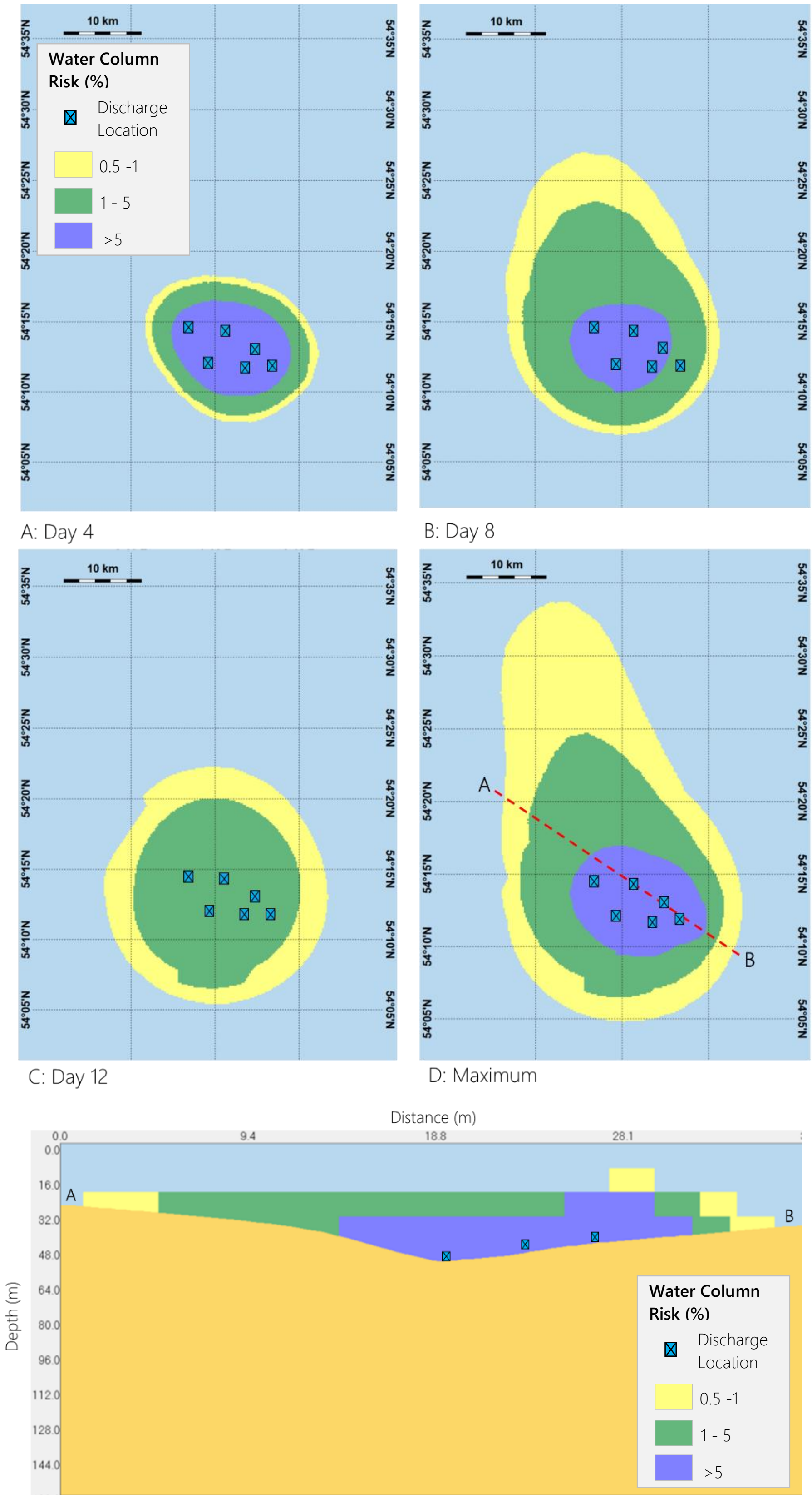
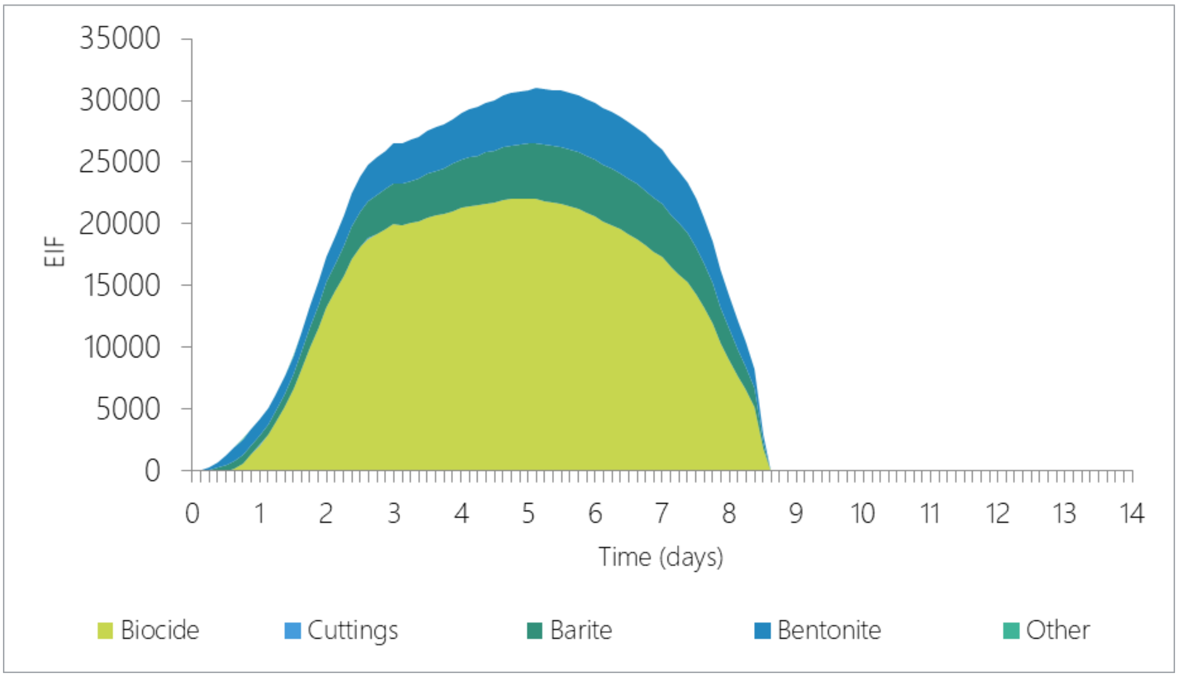
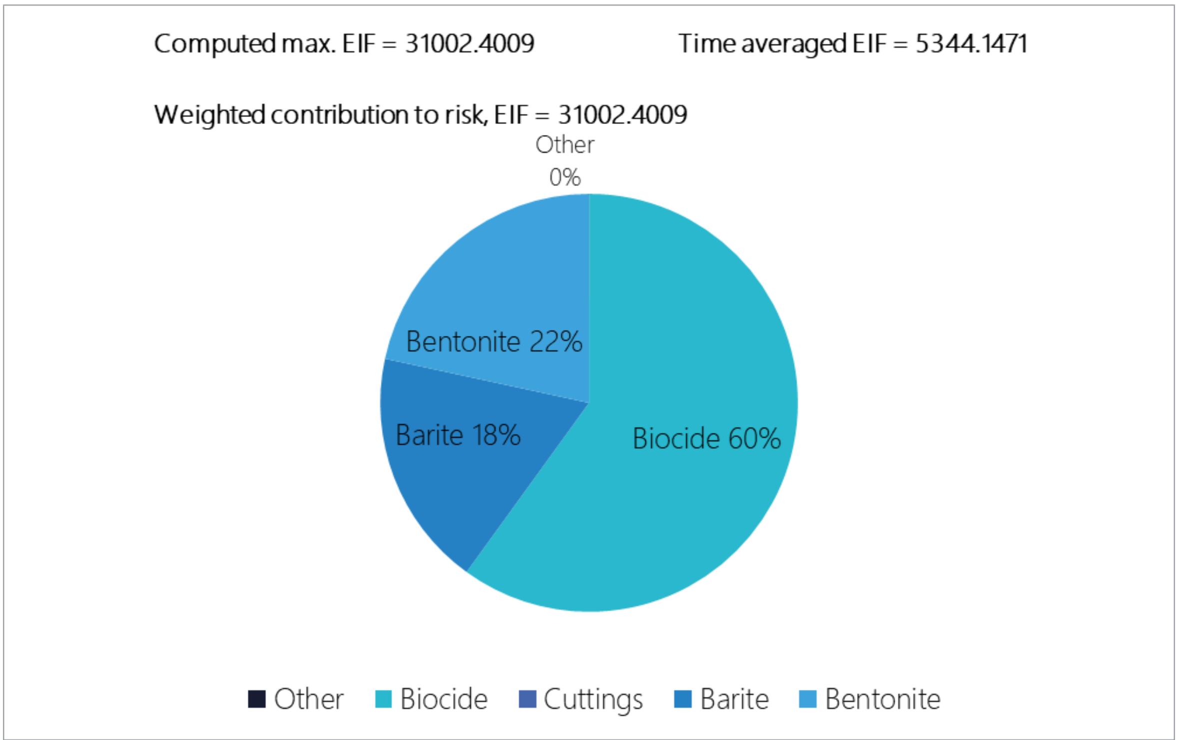


Figure 3.7 - Development of the water column impact in terms of EIF during drilling



N.B Timeframe of 14 days was selected for this figure due to EIF remaining at 0 for the rest of the model simulation.

Figure 3.8 - Weighted contribution to water column risk in terms of EIF



3.2.2 Seabed Risk

The modelled thickness of the deposited drilling mud is presented in Figure 3.9 and Figure 3.10, in both plan and section view. The modelled cuttings pile at the six wells is predicted to have a maximum thickness of 200 mm for any single well of the six wells modelled. This rapidly decreasing as the distance from the well increases such that, within 50 m the thickness decreases to less than 0.6 mm. Maximum depths of the drill mud and cuttings piles for the six wells are as follows: EC01 (CI1 in Figure 3.9): 114 mm; EC02 (CI2): 122 mm; EC03 (CI3): 119mm; EC04 (CI4): 117 mm; EC05 (CI5): 200 mm; EM01 (OE1): 122 mm. The thickest area of the mud and cuttings pile was predicted to be predominantly formed to the immediate west of each drilling location. There was no overlap predicted for the individual cuttings piles as the drill centre locations are well separated from one another. The direction of the wider-scale deposition of sediment is dominated by prevailing currents to the south-west and west at levels that are not easily detectable in the environment. Therefore, any potential seabed impacts are likely to remain localised.

There was no predicted interaction between the 6 cuttings piles modelled due to the relative positions and distance. Therefore, the model predicts the EIF to be zero immediately after drilling has ceased as the individual wells have an EIF of zero.

Figure 3.9 - Modelled cuttings accumulation on the seabed from six wells

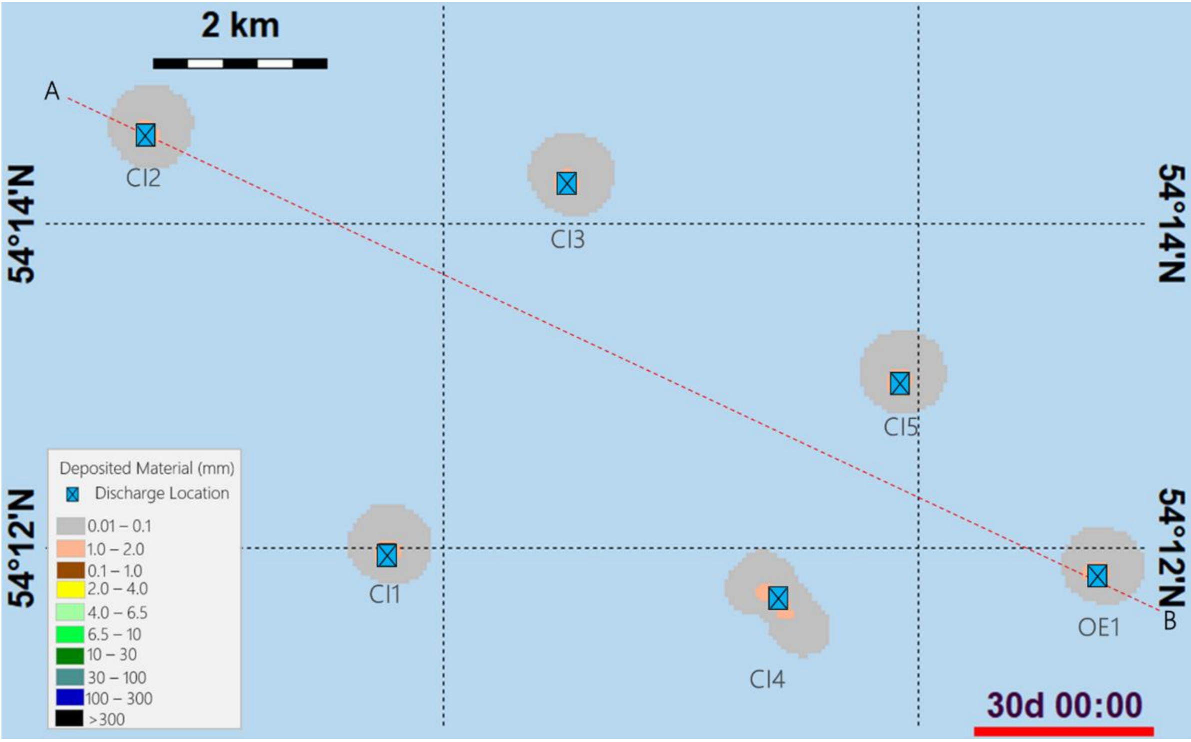
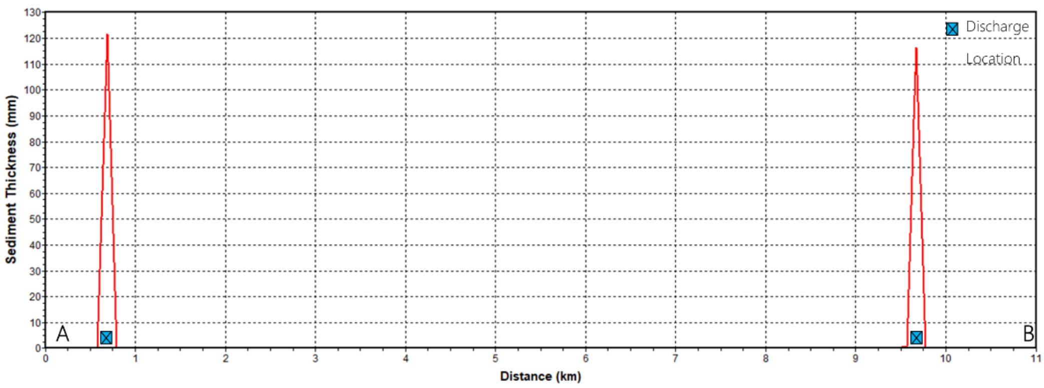


Figure 3.10 - Sediment thickness on the seabed along transect A-B



N.B. Transect does not go through maximum thickness of drill cuttings.

4 CONCLUSION

The modelling predicts that the discharge of the top-hole sections at the six proposed drill centres will results in small distinct cuttings piles with a thickness of less than 200 mm. These cuttings piles are not predicted to result in a sediment EIF and therefore no impact is predicted to the seabed by the model.

In the water column the model predicts the usual transitory high EIF that results from chemical and particle stress in the water column from the mud and cuttings components that remain suspended or dissolve in the water column for longer periods. Well section 2 contains biocide which results in the largest contribution to the EIF. The maximum EIF of 30,999 for the six well scenario predicts the worst case risk for the combined effect of all wells being drilled at the same time. In reality the wells will be drilled sequentially with the maximum EIF equating to that in the single well scenario of 5,607, of which section 2 predominantly contributes to the water column risk in terms of EIF. Thus, there are likely to be 6 discrete spatial separated transient impacts through the drilling programme.

5 ABBREVIATIONS

Abbreviation	Definition
CO_2	Carbon dioxide
DREAM	Dose-Related Risk and Effects Assessment Model
ECMWF	European Centre for Medium-Range Weather Forecasts
EIF	Environmental Impact Factors
HOCNF	Harmonised Offshore Chemical Notification Format
HYCOM	Hybrid Coordinate Ocean Model
km	Kilometre
m	metre
MEMW	Marine Environmental Modelling Workbench
NEP	Northern Endurance Partnership
NOEC	No Observed Effect Concentration
NSTA	North Sea Transition Authority
OSCAR	Oil Spill Contingency and Response
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PEC	Predicted Environmental Concentration
PLONOR	Pose Little or No Risk to the Environment
PNEC	Predicted No-Effect Concentration
s	Second
SNS	Southern North Sea

6 REFERENCES

Neff, J. M. (2005). Composition, environmental fates, and biological effects of water-based drilling muds and cuttings discharged to the marine environment: a synthesis and annotated biography. Washington, DC: Petroleum Environmental Research Forum (PERF) and the American Petroleum Institute.

Xodus. (2019). AGC Profond Deepwater Drilling. Environmental and Social Impact Assessment Report. Environmental Baseline.

APPENDIX 1

The DREAM Model

The DREAM/EIF approach was developed by SINTEF, based upon research by SINTEF, TNO and other bodies using well established techniques given in the EU Technical Guidance Document on Risk Assessment (European Commission, 2003). The model incorporates a sophisticated dispersion model together with metocean data.

The numerical model DREAM (Dose-Related Risk and Effects Assessment Model) was developed at SINTEF as a decision support tool for management of operational discharges to the marine environment. The system is in continuous development.

DREAM is integrated with the oil spill model OSCAR within a graphical user interface called the Marine Environmental Modelling Workbench (MEMW). DREAM is a 3-dimensional, time-dependent, multiple-chemical transport, exposure, dose, and effects assessment model. DREAM can account simultaneously for up to 200 chemical components, with different release profiles for 50 or more different sources (Reed *et al*., 2001). Each chemical component in the effluent mixture is described by a set of physical, chemical, and toxicological parameters. Governing physical-chemical processes are accounted for separately for each chemical in the mixture, including:

- vertical and horizontal dilution and transport;
- dissolution from droplet form;
- volatilization from the dissolved or surface phase;
- particulate adsorption/desorption and settling;
- bio-degradation; and
- sedimentation to the sea floor.

The algorithms used in the computations, and verification tests of the resulting code, are presented in Reed *et al.* (2002). The model has also been verified against field measurements (Neff *et al*., 2006; Durell *et al*., 2006).

The predicted environmental concentration (PEC) is one output from the model. It is the three-dimensional and time variable concentration in the recipient caused by the discharge of the produced water. The PEC is calculated for all compounds that are assumed to represent a potential for harmful impact on the biota.

The PEC is used in conjunction with the predicted no effect concentration (PNEC) to understand the environmental risk. The PNEC is the estimated lower limit for effects on the biota in the recipient for a single chemical component or component group. The PNEC value is derived from EC50, LC50 or NOEC values from laboratory testing of toxicity for each component (or chemical product) in question, where the EC50, LC50 or the NOEC value determined is divided by some assessment factor in order to arrive at the expected chronic PNEC.

The environmental impact factor (EIF) is a measurement of the number of unit water volumes, or areas of seabed, that have been impacted to a level of 5% risk to biota and is similar to a PEC/PNEC ratio of 1 or greater in each unit volume or area. The unit volume is 100 x 100 x 10 m of water (10^5 cubic meters) and 100 x 100 m of seabed (10^4 square metres). The technique allows the contributions to the EIF to be compared e.g., how much risk is contributed from chemical toxicity versus uptake of fine sediments by zooplankton. The stressors are not limited to chemical toxicity but include other stressors such as physical changes in sediment particle size that are correlated with environmental impacts, again using a 5% risk threshold for an EIF of 1.

For drilling discharges, the following stressors are modelled in the EIF approach:

- Water column (Singsaas *et al*., 2008);
  - Chemical stress (modelled using the EIF based on the PEC/PNEC approach from HOCNF testing taking into account biodegradation and partitioning);
  - Particle stress in the water column;
- Sediment (Rye *et al*., 2006);
  - Chemical stress (PEC/PNEC approach);
  - Oxygen depletion (20% reduction in pore water free oxygen);
  - Burial effects (taken to start at 6.5 mm for a 5% risk level); and
  - Median grain size change (0.0527 mm is identified as 5% risk level to sediment biota).

This is considered a much more holistic assessment than methods relying on, for example, simply the extent of the cuttings pile. A substantial amount of information giving further detail on this topic is available on the Environmental Risk Management System website (https://www.sintef.no/Projectweb/ERMS/Reports/). The DREAM model also incorporates some sophistication on modelling recovery of the cuttings pile through re-oxygenation and bioturbation processes, acknowledging that the area affected by cuttings deposition will ultimately return to the prevailing habitat over time (Schaaning and Bakke, 2006).

It should be noted that the EIF is not a measure of environmental impact. It is a reflection of potential environmental risk, and is conservative in that it assumes the most sensitive species always to be present. It is therefore a relative measure of potential risk, not an absolute measure in that no actual impact is necessarily implied. The EIF provides an objective quantitative measure of risk that has proven to be a very useful decision support tool for environmental management.

Appendix References:

Durell, G., T. R. Utvik , S. Johnsen, T. Frost, J. Neff. (2006). Oil well produced water discharges to the North Sea. Part I: Comparison of deployed mussels (Mytilus edulis), semi-permeable membrane devices, and the DREAM model predictions to estimate the dispersion of polycyclic aromatic hydrocarbons. Marine Environmental Research 62 (2006) 194–223.

EC (2003): Technical Guidance Document on risk assessment in support of Commission Directive 93/67/EEC on risk assessment for new notified substances and Commission Regulation (EC) No 1488/94 on risk assessment for existing substances and Directive 98/8/EC of the European parliament and of the council concerning the placing of biocidal products on the market.

Neff, J., S. Johnsen, T. K. Frost, T., G. S. Durell. (2006). Oil well produced water discharges to the North Sea. Part II: Comparison of deployed mussels (Mytilus edulis) and the DREAM model to predict ecological risk. Marine Environmental Research 62 (2006) 224–246.

Reed, M. et. al. (2001). DREAM: A Dose-Related Exposure Assessment Model. Technical Description of Physical-Chemical Fates Components. Proceedings 5th Int. Marine Environmental Modelling Seminar, New Orleans, USA, Oct. 9-11, 2001.

Reed, M., B. Hetland. (2002). DREAM: A Dose-Related Exposure Assessment Model. Technical Description of Physical-Chemical Fates Components. SPE 73856

Rye, H., M. Reed, I. Durgut and M.K. Ditlevsen. (2006). The use of the diagenetic equations to predict impact on sediment due to discharges of drill cuttings and mud. International Marine Environmental Modelling Seminar, Rio, 9 – 11 October 2006

Schaaning, M., T.Bakke. (2006). Remediation of sediments contaminated with drill cuttings. NIVA Report no. 5188-2006, ERMS Report no. 22.

Singsaas, I., E.Garpestad, I.Skare, K.Bakke, L.Falcao Veiga, M. Buffagni, O.A. Follum, S. Johnsen, U.E. Moltu. (2007). "Environmental Risk Management System (ERMS) – development of a risk-based environmental management tool for drilling discharges. A Summary paper".

Appendix L: Pipeline Dispersion Modelling Report

BP Exploration Operating Company Ltd

Offshore Environmental Statement for the Northern Endurance Partnership

Appendix L: Pipeline Dispersion Modelling Report

ASSIGNMENT A200540-S00
DOCUMENT A-200540-S00-REPT-0012

XODUS

London

Cheapside House
138 Cheapside . London
EC2V 6BJ . UK

T +44 (0)207 246 2990

www.xodusgroup.com

REVISIONS & APPROVALS

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A01	21/07/22	Issued for Use	MB	AM	AM	
R01	21/04/22	Issued for Review	PB	AM	MD	

CONTENTS

ABBREVIATIONS 4

EXECUTIVE SUMMARY 5

1 INTRODUCTION 7

2 METHODOLOGY 8
2.1 Model Inputs 8
2.2 Current Data 9
2.3 Chemical Data 10
2.4 Scenario Summary 11

3 RESULTS AND DISCUSSION 12
3.1 Hydrotest Chemical (HD5000, RX-5255, RX-5227, RX-9022) Discharges 12
3.2 MEG Discharge Scenarios 14

REFERENCES 15

APPENDIX A 16

APPENDIX B 18

APPENDIX C 19

ABBREVIATIONS

bp	bp Exploration Operating Company Ltd
CAD	Computer-Aided-Design
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CHARM	Chemical Hazard and Risk Management
CO_2	Carbon dioxide
E	East
ES	Environmental Statement
kg	Kilogram
km	Kilometre
m	Metre
m/s	Metres per second
MEG	Mono-ethylene glycol
MLWS	Mean Low Water Springs
N	North
NEP	Northern Endurance Partnership
OSPAR	Oslo Paris Agreement
PEC	Predicted Environmental Concentration
PLONOR	Poses Little Or NO Risk
PNEC	Predicted No Effect Concentration
REACH	Registration, evaluation, authorisation and restriction of chemicals
s	Second
SNS	Southern North Sea
ThOD	Theoretical oxygen demand
UK	United Kingdom
W	West

EXECUTIVE SUMMARY

This report describes the modelling of pipeline discharges for the offshore Northern Endurance Partnership (NEP) Development. The Development will route CO_2 from industrial clusters in the Teesside and Humber regions to the offshore geological storage site, the Endurance Store which is located approximately 63 km from the nearest coastline. The Endurance carbon storage licence CS001, awarded by the Oil and Gas Authority (OGA, now the North Sea Transition Authority (NSTA)), is held by bp Exploration and Operating Company Limited (BPEOC, 50%), and Equinor New Energy Limited (50%).

To prevent corrosion once installed, the two pipelines will be flooded with filtered, chemically treated seawater and subsequently hydrotested to verify system integrity. Once fully installed and tested, the remaining volumes of inhibited seawater will be flushed out of each pipeline in a process known as dewatering. Typical chemical requirements include oxygen scavenger and biocide which are generally used up in protecting the pipeline whilst *in situ* and dye which is used for leak identification.

This report describes an assessment with the dispersion model CORMIX v8.0 GTS (CORMIX) to investigate the dilution of these discharges. The CORMIX model uses the density and flow rate of the effluent and ambient environment together with the geometry of the discharge port to estimate the movement and dilution of the discharge in the receiving environment. Assessment of chemical concentrations in the plume was based on the Chemical Hazard Assessment and Risk Management (CHARM) method of calculating Predicted No Effect Concentrations (PNEC), this being the accepted methodology in the UK, as required under the Offshore Chemicals Regulations 2002 (as amended).

The modelling study indicated that the dilution required to achieve the Predicted No-Effect Concentrations (PNEC) of the pipeline chemicals is predicted to occur within 334 m (for all chemicals and currents except RX-5255 with a current of 0.1 m/s where the distance was 568 m). The assessment conservatively assumed that the concentration of chemicals discharged equalled the concentration of chemicals added. As these chemicals react within the pipeline and break down into inert components in a process which protects the pipeline, the discharge concentration of these chemicals is much lower than the concentrations initially added. Consequently, the degree of dilution required to achieve concentrations of any excess chemical in the discharge which pose no risk to the environment is likely to be significantly lower. In addition, the discharge will occur as a small volume during hydrotesting (i.e., the volume of water released equals the volume required to reduce pressure in the pipeline following completion of the test). The dewatering of a pipeline is the longest and worst case discharge during pipeline commissioning. However, the dewatering may not occur as single discharge, due to operational constraints, thus limiting the size of any plume in the far field.

Sedentary organisms on the seabed may be exposed to the plume for some hours, mobile benthic and pelagic organisms would be able to move away from the plume. This limited spatial and temporal extent predicted for the plume in the far field will limit any toxicity effects of residual chemicals as exposure time for any organisms is likely to be much less than the exposure of organisms in regulatory toxicity used to define acute ecotoxicity.

Mono-ethylene glycol (MEG) is used in dewatering of the pipelines which will also aid in drying the pipelines. Under OSPAR regulations, MEG is considered to Pose Little Or No Risk (PLONOR) to the environment. Therefore, unlike the

other chemicals considered in this study, assessing pelagic ecotoxicity based on the PEC/PNEC ratio is not a relevant concern. The potential impact from discharges of MEG is through the potential for deoxygenation of the water column due to the ready biodegradation of MEG.

In each of the MEG discharge scenarios the centreline concentration at the furthest extent of the chemical plume reduced to below the water degradative capacity within 2,500 m. However, in the offshore environment metabolically active micro-organisms would be expected to be present at very low concentrations and therefore whilst the MEG discharge provides a source of carbon and energy for any organisms present, it is unlikely under North Sea environmental conditions that these organisms could increase their numbers sufficiently to cause degradation that would deplete the oxygen in the water column. In addition, the MEG is unlikely to reside in a particular location for a prolonged period and therefore there is no potential for a stable community of organisms to develop on this intermittent, short-term point discharge.

1 INTRODUCTION

Xodus Group (hereafter Xodus) was commissioned to undertake pipeline discharge modelling for bp Exploration Operating Company Ltd (hereafter bp) to support the Environmental Statement (ES) which covers the offshore aspects of the Northern Endurance Partnership (NEP) Development ('the Development') which fall under the remit of the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020, including all infrastructure seawards of Mean Low Water Springs (MLWS).

The Development is located within the UK Southern North Sea (SNS) and consists of offshore carbon dioxide (CO_2) transport and storage infrastructure. The Development consists of three main elements, including an offshore geological storage site, the Endurance Store, approximately 63 km from the nearest coastline, and two 28", concrete coated, CO_2 export pipelines running from Humber ('the Humber Pipeline') and Teesside ('the Teesside Pipeline') to a subsea manifold and well injection site at the Endurance Store. The Humber Pipeline landfalls at Easington and is approximately 100 km in length and the Teesside Pipeline, which landfalls at Coatham Sands, is approximately 142 km in length.

Once installed, each export pipeline will be flooded with filtered, chemically treated seawater and subsequently hydrotested to verify system integrity. Inhibited water is typically pumped into the pipeline (approximately 120 % of line volume). The pressure of the system is then increased until the pressure has been established and a successful hold time and stabilisation period achieved. The test pressure will be held for 24 hours before the lines are depressurised, by discharging the extra volume of water to sea, at predetermined rates.

After hydrotesting, spools will be installed to tie each pipeline into the crossover manifold. Once tied-in, the pipelines will be leak-tested following a similar procedure as hydrotesting, using filtered chemically treated seawater. Additional quantities of inhibited seawater will be pumped into each pipeline to establish leak test pressures will be discharged to sea. Once fully installed and tested, the remaining volumes of inhibited seawater will be flushed out of each pipeline upstream of the first co-mingling manifold, in a process known as dewatering.

Alternatively, pipelines could be hydrotested after the spool pieces have been installed in a combined hydro/leak test however the total volume of water and chemicals discharged to the environment remains unchanged in either scenario.

Mono-ethylene glycol (MEG) is used in dewatering of the pipelines which will also aid in drying the pipelines. The MEG will be driven through the pipeline in multiple slugs to maximise the amount of water removed. The MEG, an OSPAR PLONOR[1] substance will be discharged out of each pipeline upstream of the first co-mingling manifold once it has travelled along the length of a pipeline.

This report describes the modelling work undertaken as part of the environmental assessment of the worst case pipeline discharges.

[1] *Poses Little Or No Risk to the environment*

2 METHODOLOGY

The dispersion model CORMIX v8.0 GTS (CORMIX) was used to investigate the dilution of hydrotest and dewatering discharges. The CORMIX model uses the density and flow rate of the discharge and ambient environment together with the geometry of the discharge port to estimate the movement and dilution of the discharge in the receiving environment. This model has been widely used in the estimation of discharges from the offshore oil and gas industry. Further details of this model are given in Appendix A.

Assessment of chemical concentrations in the plume was based on the Chemical Hazard Assessment and Risk Management (CHARM) method of calculating Predicted No Effect Concentrations (PNEC), since this is the accepted methodology in the UK. This assessment considers the use of the following products:

- Hydrosure HD5000 – Function: Biocide;
- Roemex RX-5255 – Function: Pipeline hydrotest chemical;
- Roemex RX-5227 – Function: Surface and well clean;
- Roemex RX-9022 – Function: Pipeline hydrotest chemical; and
- Mono-ethylene glycol (MEG) – Function: Pipeline pigging chemical.

2.1 Model Inputs

CORMIX runs steady state currents (i.e., currents which do not vary over time) for each model run. Representative currents and other supporting environmental data were taken from the Net Zero Teesside MetOcean criteria document (bp, 2020).

The modelling study used several assumptions with regards to the Metocean and discharge conditions. These assumptions are summarised in Table 2-1.

Table 2-1: Summary of assumptions

PARAMETER	ASSUMPTION
Metocean data	• Density of seawater – 1035 kg/m • Water depth – 45 m • Water currents derived from values presented in bp (2020) – 0.1 to 1.4 m/s in 0.1 m/s increments • Wind speed – 10 m/s

Discharge data	• Discharge depth – 44.3 m
	• Port diameter – 0.1524 m
	• Flow rate – 0.32917 m^3/s (329.17 l/s)
	• Discharge density:
	  ◦ HD5000, RX-5255, RX-5227, RX-9022 – 1035 kg/m^3
	  ◦ MEG – 1120 kg/m^3

2.2 Current Data

The Net Zero Teeside MetOcean Criteria (bp, 2020) provides surface and near-bed currents for the Endurance Store location at 1°E 54.15°N,. Table 2-2 provides the omnidirectional near-bed current speeds and occurrences for this location.

Table 2-2: Omnidirectional near-bed currents for Endurance Store location, in fraction of occurrence. The current speeds in the leftmost columns provide the lower (left) and upper (right) bounds of the bins. The rightmost column shows fraction of occurrence from all directions in each bin (Source: bp, 2020)

Current speed (m/s)		Fraction of occurrence
0	0.1	1.612204
0.1	0.2	10.36873
0.2	0.3	19.6771
0.3	0.4	23.85242
0.4	0.5	19.22787
0.5	0.6	12.56927
0.6	0.7	6.850158
0.7	0.8	3.247212
0.8	0.9	1.678334
0.9	1.0	0.72743
1.0	1.1	0.168746
1.1	1.2	0.013682
1.2	1.3	0.004561
1.3	1.4	0.00228
1.4	1.5	0

The modelling was conducted for current speeds in the range of 0.1 m/s to 1.4 m/s in 0.1 m/s increments. This was done to provide a comprehensive understanding of how the release would disperse in all possible current speeds at the site.

As the modelled release was perpendicular to the seabed, current directionality was not considered in the modelling study.

2.3 Chemical Data

The chemical impact assessment was based on data from the CEFAS template and safety data sheet for the products (Table 2-3).

Table 2-3 CEFAS chemical template data

	Hydrosure HD5000	RX-5255	RX-5227	RX-9022	MEG
Manufacturer	Nalco Champion	Roemex	Roemex	Roemex	Roemex
Function	Biocide	Pipeline Hydrotest	Surface & Well Clean	Pipeline Hydrotest	Pipeline hydrotest/ Pipeline Pigging
Registration number	24858	27896	22982	4579	23517
Template dose rate (ppm)	350	550	1000	100	1,000,000
Worst case toxicity (mg/l)	0.13	0.13	3.41	55.8	N/A
Number of aquatic toxicity tests	3	3	3	3	-
OCNS Group	-	-	-	-	E
100% PLONOR	No	No	No	No	Yes
PNEC	0.013	0.013	0.341	5.58	-
Percentage in product	0.35	0.055	0.1	0.01	100
Log P_{ow}	Not available				
Comments	No sediment re-worker data				

PNEC values were calculated from the data utilising the methodology used in the preparation of UK offshore chemical permits (i.e., CHARM assessment factor of 10 (CIN, 2017)) and are shown in Table 2-3. These values were used to consider the potential impact of the chemicals in the plume on marine water column receptors by the calculation of risk quotients (i.e., by dividing the predicted environmental concentration by the PNEC value for the chemical (a risk quotient of 1 or greater indicates that there is potential for a toxic impact to occur)). No sediment re-worker toxicity data were available for the assessment of sediment dwelling species. This type of assessment is important where sediment exposure to the plume occurs and the Log P_{ow} for the chemical is greater than 3[2].

2.4 Scenario Summary

The modelled scenarios are presented in Appendix B. The port vertical angle, and therefore discharge angle, was set to 90° to indicate that the port centreline was upwards perpendicular to the seabed. The hydrotest chemicals (HD5000, RX-5255, RX-5227 and RX-9022) were modelled as single discharge and assessed individually during the post processing of the results. Actual discharges are expected to contain RX-9022 and only one of the other 3 chemicals.

[2] N.B. log (P_{ow}) is used in environmental chemistry as a surrogate for screening the potential for a chemical to partition into sediment from the water column. In the north-east Atlantic OSPAR region a Log P_{ow} value of 3 or greater is considered to be indicative of a high potential for sediment partitioning to occur

3 RESULTS AND DISCUSSION

Interpretation of CORMIX modelling results requires evaluation of the output in terms of both duration and extent of the discharge and its predicted behaviour against the natural variation in the environment seen over the same time scale (e.g., tides). CORMIX provides detailed output of plume behaviour. However, it is important to interpret these results in terms of near-field and far-field behaviour and, in doing so, assess at what point uncertainties in the model are too large to produce a meaningful result. It is therefore important to be cautious in interpreting far-field results so as not to neglect the effect of tide and varying currents on the dispersion of the plume. The near-field region is the section of the discharge behaviour whereby the port through which discharge occurs, has an influence on the degree of mixing. In the far-field region mixing is caused by natural processes such as passive dispersion and ambient mixing. These natural processes are slow and therefore after initial dilution in the nearfield, further dilution of the plume will only occur over great distances.

3.1 Hydrotest Chemical (HD5000, RX-5255, RX-5227, RX-9022) Discharges

Table 3-1 provides details of the distances at which each hydrotest chemical concentration is predicted to dilute sufficiently to produce centreline PEC/PNECs of less than 1, and therefore be considered to present no environment risk. The concentration of RX-9022 were not sufficient to exceed the PNEC value and therefore no distance reported in Table 3-1. Table 3-2 presents the results of the flow-weighted average dilution calculation for the hydrotest chemicals released.

Table 3-1 Predicted distances at which hydrotest chemical concentrations produce PEC/PNECs < 1

Run	Current velocity (m/s)	Predicted distances from source (m) at which centre line PEC/PNECS are less than 1			
		HD5000	RX-5255	RX-5227	RX-9022
1	0.1	253	568	3	-
2	0.2	44	226	4	-
3	0.3	65	89	5	-
4	0.4	79	133	5	-
5	0.5	91	156	6	-
6	0.6	104	178	6	-
7	0.7	116	199	6	-
8	0.8	128	220	6	-
9	0.9	139	240	7	-
10	1.0	150	259	7	-
11	1.1	162	279	7	-
12	1.2	172	297	8	-
13	1.3	183	315	8	-
14	1.4	194	334	9	-

Table 3-2 - Flow weighted average dilution calculations for hydrotest chemical release

Flow weighted average dilution at defined distances from the release point		
Nearfield region	100 m	500 m
887	338	1080

When assessing an offshore release, the dilution factor at 500 m is the value that is commonly analysed when considering whether a release will cause harm to the environment. As shown in Table 3-1, PEC/PNEC values of less than 1 are achieved before 500 m for all chemicals released at all current speeds, apart from RX-5255 at 0.1 m/s. A current speed of 0.1 ms/s has a frequency of only 1.6% (Table 2-2), so the environmental effects of this anomaly will be minor.

When considering the flow weighted average dilution calculations, the dilution factor at 500 m was 1080 (Table 3-2). Therefore, the hydrotest chemical concentration at 500 m would be 0.09% of the concentration discharged.

Pipeline chemicals undergo reactions and break down to inert components in the pipeline during storage in order to bring about their primary function of protecting the pipeline. The discharge concentration of these chemicals will therefore be very much lower than the concentrations initially added, thus the degree of dilution likely to be required to achieve PEC/PNEC < 1 for the chemicals in the discharge is likely to be significantly lower than that for the amounts of chemicals initially dosed into the pipelines. In addition, the discharge will occur as a small volume during hydrotesting (i.e., only that amount of water will be released that is necessary to reduce pressure in the pipeline once the test is complete) and then a full emptying of the line during dewatering. The dewatering discharge of a pipeline is the longest and worst case discharge during pipeline commissioning. Potentially the dewatering will not occur as single discharge, but as several smaller releases due to operational constraints, thus limiting the size of any plume in the far field.

3.2 MEG Discharge Scenarios

MEG is considered to Pose Little Or No Risk (PLONOR) to the environment under OSPAR regulations and is fully registered under the EU REACH regulation as having very low toxicity. Therefore, unlike the other chemicals discharged in this study, assessing pelagic ecotoxicity based on the PEC/PNEC ratio is not a relevant concern. The potential impact from discharges of MEG is through the potential for deoxygenation of the water column due to the ready biodegradation of the MEG. The theoretical oxygen demand (ThOD) of an organic chemical is the amount of oxygen required to completely mineralise (convert it to CO_2 and H_2O) the amount of the chemical present. The ThOD represents a worst case scenario for the oxygen removal capacity of an amount of a chemical. The actual oxygen demand of any compound depends on its biodegradability and the presence of specific organisms to metabolize the compound.

REFERENCES

bp (2020). Net Zero Teeside MetOcean Criteria. Document No.: UE-2020-0147. 7th July 2020.

CHARM Implementation Network (2017) CHARM Chemical Hazard Assessment and Risk Management Manual Vers 1.5.

Marine Scotland (2020). Scotland Marine Assessment 2020 – Dissolved Oxygen. https://marine.gov.scot/sma/assessment/dissolved-oxygen-0 Accessed January 2022.

APPENDIX A

Table B1) the MEG remained close to the seabed as it spread from the discharge location. It should also be noted that while the model assumes a continuous discharge, in reality the discharge is likely to be discontinuous.

The ThOD for MEG was calculated as 1.289 milligrams (mg) of oxygen per mg of MEG. In the North Sea the dissolved oxygen content is typically between 6 mg/l and 10 mg/l (Marine Scotland, 2020), therefore based on the lower level within this range, the oxygen content at the Endurance Store location is conservatively assumed to be 6 mg/l. Thus, it is assumed that 1 litre of water has a degradative capacity for MEG of 4.50 mg (defined as oxygen content divided by ThOD).

In each of the MEG discharge scenarios the centreline concentration at the furthest extent of the chemical plume failed to reduce to below the water degradative capacity. Table 0-1 provides details of the predicted centreline concentrations for the MEG plume at 500 m and 2500 m, the model extent. Table 0-2 presents the results of the flow-weighted average dilution calculation for the MEG discharge.

Table 0-1 Predicted MEG discharge extent and concentration

Run	Current velocity (m/s)	Predicted centreline concentration at 500 m (mg/L)	Predicted centreline concentration at model extent / 2500 m (mg/L)
1	0.1	8650	957
2	0.2	5610	947
3	0.3	3710	641
4	0.4	3020	426
5	0.5	2620	289
6	0.6	2330	195
7	0.7	2130	145
8	0.8	1950	133
9	0.9	1780	183
10	1.0	1630	258
11	1.1	1490	394
12	1.2	1360	482
13	1.3	1240	644
14	1.4	1390	775

Table 0-2 - Flow weighted average dilution calculations for MEG discharge

Flow weighted average dilution at defined distances from the release point		
Nearfield region	100 m	500 m
165	206	344

In the offshore environment, metabolically active micro-organisms would be expected to be present at very low numbers and therefore whilst the MEG discharge provides a readily utilised carbon and energy source for any organisms present, it is unlikely under North Sea environmental conditions that these organisms could increase their numbers sufficiently to cause degradation that would deplete the oxygen in the water column. In addition, the MEG is unlikely to reside in a particular location for a prolonged period and therefore there is no potential for a stable community of organisms to develop on this intermittent and short-term point discharge.

APPENDIX B

CORMIX 8.0 GTS (CORMIX) is a comprehensive software system for the analysis, prediction, and design of outfall mixing zones resulting from the discharge of aqueous effluents, which can be applied to a variety of water bodies. The system contains mathematical models of point source discharge mixing within an intelligent computer-aided-design (CAD) interface. CORMIX is a useful tool to support environmental impact assessments as well as regulatory management. CORMIX uses flow dynamics and boundary interactions to model the dispersions and dilution of the discharges.

CORMIX contains various simulation systems to model hydrodynamic inputs and outputs and is designed to analyse water quality criteria within mixing zones. It is used to assess whether water quality criteria will be met at set distances from the discharge point. Effluents considered may be conservative, non-conservative, heated, or they may contain suspended sediments. The system tools support water quality modelling, regulatory decision support, mixing zone visualisation, and tools for outfall specification and design optimisation.

Further information on CORMIX can be seen in the CORMIX manual (http://www.mixzon.com).

APPENDIX C

Table B1: Modelled CORMIX Scenarios

Run	Effluent			Ambient				Discharge			
	Chemical	Flow (m^3/s)	Density	Depth (m)	Wind speed (m/s)	Current Velocity (m/s)	Density	Discharge depth (m)	Vertical angle (°)	Horizontal angle (°)	Port Diameter (m)
1	Hydrotest chemicals	0.32917	1025	45	10	0.1	1035	44.3	90	0	0.1524
2	Hydrotest chemicals	0.32917	1025	45	10	0.2	1035	44.3	90	0	0.1524
3	Hydrotest chemicals	0.32917	1025	45	10	0.3	1035	44.3	90	0	0.1524
4	Hydrotest chemicals	0.32917	1025	45	10	0.4	1035	44.3	90	0	0.1524
5	Hydrotest chemicals	0.32917	1025	45	10	0.5	1035	44.3	90	0	0.1524
6	Hydrotest chemicals	0.32917	1025	45	10	0.6	1035	44.3	90	0	0.1524
7	Hydrotest chemicals	0.32917	1025	45	10	0.7	1035	44.3	90	0	0.1524
8	Hydrotest chemicals	0.32917	1025	45	10	0.8	1035	44.3	90	0	0.1524
9	Hydrotest chemicals	0.32917	1025	45	10	0.9	1035	44.3	90	0	0.1524
10	Hydrotest chemicals	0.32917	1025	45	10	1.0	1035	44.3	90	0	0.1524
11	Hydrotest chemicals	0.32917	1025	45	10	1.1	1035	44.3	90	0	0.1524
12	Hydrotest chemicals	0.32917	1025	45	10	1.2	1035	44.3	90	0	0.1524
13	Hydrotest chemicals	0.32917	1025	45	10	1.3	1035	44.3	90	0	0.1524
14	Hydrotest chemicals	0.32917	1025	45	10	1.4	1035	44.3	90	0	0.1524

Run	Effluent			Ambient				Discharge			
	Chemical	Flow (m^3/s)	Density	Depth (m)	Wind speed (m/s)	Current Velocity (m/s)	Density	Discharge depth (m)	Vertical angle (°)	Horizontal angle (°)	Port Diameter (m)
1	MEG	0.32917	1120	45	10	0.1	1035	44.3	90	0	0.1524
2	MEG	0.32917	1120	45	10	0.2	1035	44.3	90	0	0.1524
3	MEG	0.32917	1120	45	10	0.3	1035	44.3	90	0	0.1524
4	MEG	0.32917	1120	45	10	0.4	1035	44.3	90	0	0.1524
5	MEG	0.32917	1120	45	10	0.5	1035	44.3	90	0	0.1524
6	MEG	0.32917	1120	45	10	0.6	1035	44.3	90	0	0.1524
7	MEG	0.32917	1120	45	10	0.7	1035	44.3	90	0	0.1524
8	MEG	0.32917	1120	45	10	0.8	1035	44.3	90	0	0.1524
9	MEG	0.32917	1120	45	10	0.9	1035	44.3	90	0	0.1524
10	MEG	0.32917	1120	45	10	1.0	1035	44.3	90	0	0.1524
11	MEG	0.32917	1120	45	10	1.1	1035	44.3	90	0	0.1524
12	MEG	0.32917	1120	45	10	1.2	1035	44.3	90	0	0.1524
13	MEG	0.32917	1120	45	10	1.3	1035	44.3	90	0	0.1524
14	MEG	0.32917	1120	45	10	1.4	1035	44.3	90	0	0.1524

Appendix M: Navigational Risk Asssessment

BP Exploration Operating Company Ltd

Offshore Environmental Statement for the Northern Endurance Partnership

Navigational Risk Assessment

ASSIGNMENT	**A200540-S00**
DOCUMENT	**A-200540-S00-REPT-011**
CLIENT DOCUMENT	**NS051-HS-REP-219-00007**

XODUS

London

Cheapside House
138 Cheapside . London
EC2V 6BJ . UK

T +44 (0)207 246 2990

www.xodusgroup.com

REVISIONS & APPROVALS

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A01	23/06/2023	Issued for Use	PM	LM/JDM	MD	
R02	03/11/2022	Issued for Review	PM	LM	MD	
R01	14/06/2022	Issued for Review	LM/PM	JDM/JA	MD	

CONTENTS

EXECUTIVE SUMMARY		6
ABBREVIATIONS		7
1	INTRODUCTION	9
1.1	**Background**	**9**
1.2	**Project Design Scenario**	**9**
1.2.1	Endurance Store	9
1.2.2	Pipelines and cable	10
1.2.3	SSIV	10
1.3	**NRA purpose and scope**	**13**
1.4	**Guidance and legislation**	**13**
1.4.1	Legislation	13
1.4.2	Policy	13
1.4.3	Guidance	16
2	METHODOLOGY	17
2.1	**NRA Methodology**	**17**
2.1.1	Baseline Methodology	17
2.2	**Formal Safety Assessment Methodology**	**18**
2.2.1	Hazard and Effects Identification	18
2.2.2	Risk Assessment	19
2.2.3	Identification of Additional Mitigation Measures and Residual Risk	21
2.2.4	Cost-Benefit Analysis	21
2.2.5	Risk Assessment Table	21
2.2.6	Cumulative Effects and Future Case	21
2.3	**Data sources**	**22**
2.3.1	AIS Data	23
2.3.2	VMS and sightings data	24
2.3.3	Additional Data Sources	24
2.4	**Consultation**	**25**
2.4.1	Consultation sessions	25
2.4.2	Consultation summary	25
2.5	**Data limitations and assumptions**	**29**
3	NAVIGATIONAL BASELINE	30
3.1	**Introduction and overview**	**30**
3.2	**Key navigational features**	**30**
3.2.1	Ports and harbours	30
3.2.2	Aids to navigation	31
3.2.3	IMO routing measures	32

3.2.4 Military Practice and Exercise Areas 35
3.2.5 Other infrastructure and navigational features 35
3.3 Recreation 37
3.4 Emergency Response Overview 41
3.4.1 RNLI 41
3.4.2 SARH 41
3.5 Maritime incidents 42
3.5.1 RNLI 42
3.5.2 SARH 42
3.5.3 MAIB Incident Data 42

4 MARINE TRAFFIC STUDY 46
4.1 Vessel track counts and seasonality 46
4.2 Vessel type 51
4.2.1 Cargo vessels and tankers 51
4.2.2 Passenger vessels 51
4.2.3 Recreational vessels 52
4.2.4 Offshore industry vessels 52
4.2.5 Other vessels 52
4.3 Vessel size and status 54
4.3.1 Vessel length 54
4.3.2 Vessel DWT 55
4.3.3 Vessel draught 59
4.3.4 Anchored vessels 60
4.4 Fishing analysis 64
4.4.1 Introduction 64
4.4.2 Fishing vessels in AIS data 64
4.4.3 VMS and sightings data points 68
4.4.4 VMS by ICES sub-rectangles 70
4.4.5 Regional fishing activity information from North Sea (West) Pilot 70
4.5 Future case vessel traffic 72

5 FORMAL SAFETY ASSESSMENT 73
5.1 Introduction 73
5.2 Assessment Basis 73
5.2.1 Development Phases 73
5.2.2 Embedded Mitigation 73
5.2.3 Scenario Outcomes 75
5.3 Assessment 75
5.3.1 Vessel collision (Installation / Commissioning) 76
5.3.2 Disruption to established vessel routes and areas (Installation / Commissioning) 77
5.3.3 Interactions with vessel anchors (Installation / Commissioning) 78
5.3.4 Interactions with fishing gear (Installation / Commissioning) 79
5.3.5 Vessel collision (Normal Operations and Maintenance) 80

5.3.6 Vessel allision resulting from reduction in under-keel clearance (Normal Operations and Maintenance) 82
5.3.7 Disruption to established vessel routes and areas (Normal Operations and Maintenance) 84
5.3.8 Interactions with vessel anchors (Normal Operations and Maintenance) 85
5.3.9 Interactions with fishing gear (Normal Operations and Maintenance) 87
5.4 Cost Benefit Analysis 88
5.5 Cumulative and In Combination effects 90
5.5.1 In-combination Effects 90
5.5.2 Cumulative Effects 90
5.6 Residual Impact 94
5.7 Recommendations 94

6 SUMMARY AND CONCLUSION 96

REFERENCES 98

APPENDIX 1: HAZARD LOG 100

APPENDIX 2: UNDER KEEL CLEARANCE (UKC) ASSESSMENT 104
6.1 Introduction 104
6.2 Method 104
6.2.1 MCA UKC Assessment Approach 104
6.2.2 UKC assesment model 105
6.2.3 Scope of assessment 106
6.3 Results 107
6.3.1 SSIV 108
6.3.2 Wellhead trees 108
6.3.3 Manifolds at Endurance Store (location tbc) 108
6.3.4 Other subsea infrastructure at Endurance Store (location tbc) 108

EXECUTIVE SUMMARY

This Appendix to the Environmental Statement (ES) contains an appraisal of the potential interaction of the Development and shipping and navigation. The appraisal comprises a Navigational Risk Assessment (NRA) which addresses the impact to shipping and navigation via Formal Safety Assessment (FSA). The assessment identifies impacts to shipping and navigation through desktop study, stakeholder consultations, and workshop exercise. The impacts are appraised via a risk matrix framework to determine requirements for impact or risk reduction and to ultimately establish additional risk reduction measures to ensure that risks are as low as is reasonably practicable (ALARP).

As a basis for the appraisal, extensive navigational baseline data has been compiled via a study of historical shipping and navigation data using a range of sources and is presented via a series of images and analysis. The study area comprises an indicative corridor of 10 nautical miles (NM) width encompassing the Development, which includes CO_2 pipelines running from Humber and Teesside compression/pumping systems (the 'Humber Pipeline' and the 'Teesside Pipeline') to subsea infrastructure including a common subsea manifold and injection wells at the Endurance Store. A large Subsea Safety Isolation Valve (SSIV), located on the Teesside Pipeline in the near shore area between KP6 and KP8 is also included.

Using the baseline data and applying the FSA methodology, the appraisal identified impacts which are 'tolerable if ALARP' and 'Broadly Acceptable' as according to the framework. The 'tolerable if 'ALARP' and 'Broadly Acceptable' assessments are based principally upon the combination of existing legislation which establishes safe practices regarding navigation in general, and fishing and anchoring in the vicinity of subsea infrastructure, and the reduction of the seabed hazard through pipeline burial and protections where required. Additionally, the study includes an Under-Keel Clearance assessment which specifically addresses the risk of subsurface allision, given the substantial profile of elements of the proposed infrastructure and the impact that could have on shipping in the area. The risk assessment output is captured in a Hazard Log appended to this document which serves to provide hazard management traceability.

The study makes a number of recommendations to address the identified risks and in particular has recommended that the location of the Endurance Store manifolds be optimised (within the foreseen location ranges or areas) to minimise reduction in under-keel clearance and subsequently marked appropriately, as according to Trinity House. Additionally, the assessment recommends that ongoing pipeline protection considerations include the possibility of interactions with fishing gear at particular locations as identified in the baseline data. The report concludes that where the recommendations made in this assessment are implemented the risks to shipping and navigation would be considered ALARP.

ABBREVIATIONS

Abbreviation	Definition
ABP	Associated British Ports
AAIA	Areas of Intense Aerial Activity
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
AtoN	Aids to Navigation
CATS	Central Area Transmission System
CCS	Carbon Capture and Storage
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CLV	Cable laying vessel
COLREGS	International Regulations for Preventing Collisions at Sea
CoS	Chamber of Shipping
CtL	Consent to Locate
CRA	Collision Risk Assessment
CRMP	Collision Risk Management Plan
DWT	Deadweight Tonnage
EIA	Environmental Impact Assessment
ES	Environmental Statement
EU	European Union
FLO	Fisheries Liaison Officer
FOAK	First-of-a-Kind
FSA	Formal Safety Assessment
HES	Humber Estuary Services
HVDC	High-Voltage Direct Current
IALA	International Association of Lighthouse Authorities
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
IRPCS	International Regulations for Prevention of Collision at Sea
KIS-ORCA	Kingfisher Information Service – Offshore Renewable and Cable Awareness
LAT	Lowest Astronomical Tide
MAIB	Marine Accident Investigation Branch
MCA	Maritime and Coastguard Agency

Abbreviation	Definition
MEG	Mono Ethylene Glycol
MEHRA	Marine Environment High Risk Areas
MHWS	Mean High Water Springs
MGN	Marine Guidance Notice
MLWS	Mean Low Water Spring
MMO	Marine Management Organisation
MMSI	Maritime Mobile Service Identity
MPS	Marine Policy Statement
MSN	Marine Shipping Notice
MTS	Marine Traffic Survey
NEP	Northern Endurance Partnership
NM	Nautical Miles
NPS	National Planning Statement
NRA	Navigational Risk Assessment
OREI	Offshore Renewable Energy Installation
OWF	Offshore Wind Farm
PEXA	Military Practice and Exercise Areas
RCZ	Recommended Clearance Zone
RNLI	Royal National Lifeboat Institution
ROV	Remotely Operated Vehicle
RRM	Risk Reduction Measures
RYA	Royal Yachting Association
SAR	Search and Rescue
SARH	Search and Rescue by Helicopter
SNS	Southern North Sea
SOLAS	Safety of Life at Sea
SSIV	Subsea Isolation Valve
TCE	The Crown Estate
TH	Trinity House
UKCS	United Kingdom Continental Shelf
UKHO	United Kingdom Hydrographic Office
VMS	Vessel Monitoring System
VTS	Vessel Traffic Service

1 INTRODUCTION

1.1 Background

Xodus Group was commissioned by bp to undertake a Navigational Risk Assessment (NRA) for the proposed Northern Endurance Partnership (NEP) carbon capture and storage (CCS) Development ('the Development'), located off the east coast of England in the UK Southern North Sea (SNS). This NRA contains an appraisal of the potential interaction of the Development, with shipping and navigation, and forms an Appendix to the Environmental Statement (ES).

1.2 Project Design Scenario

The Development is one component of the proposed East Coast Cluster strategic initiative that aims to deliver the UK's first zero carbon industrial cluster. The East Coast Cluster consists of a diverse mix of low-carbon projects including industrial carbon capture, low-carbon hydrogen production, negative emissions power, and power with carbon capture. All these technologies are considered to be essential for the UK to meet its net zero targets, consistent with the Overarching National Policy Statement (NPS) for Energy (EN-1).

The Development consists of offshore CO_2 transport and storage infrastructure in the UK SNS and will route CO_2 from industrial clusters in the Teesside and Humber regions to the offshore geological storage site, the Endurance Store ('the Store') located approximately 63 km from the nearest coastline in the SNS. The overall objective of the Development is to deliver technical and commercial solutions required to implement innovative First-of-a-Kind offshore low-carbon CCS infrastructure in the UK. This includes CO_2 pipelines running from Humber and Teesside compression/pumping systems (the 'Humber Pipeline' and the 'Teesside Pipeline') to subsea infrastructure including two subsea manifolds and five well injection sites at the Store (see Figure 1-1). The Development is summarised here, however further detail can be found in the Environmental Statement (ES) Chapter 3: Project Description.

1.2.1 Endurance Store

The Endurance Store is a four-way dip closure, which means the structure dips away in all four possible directions. The crest of the dome is located at a depth of approximately 1,020 m below the seabed surface. The structure is formed above a salt pillow, and is approximately 25 km long by 8 km wide, oriented northwest to southeast, as well as 150 m thick. The Endurance Store contains highly saline water (approximately 250,000 mg/kg) (bp, 2021). The CO_2 will be injected into the Triassic-age (approximately 250 to 200 million years ago) Bunter Sandstone Formation. The Endurance Store infrastructure will include the following:

- One crossover co-mingling manifold to combine flows from Teesside and Humber Pipelines and distribute it for injection into two wells at the Endurance Store;
- One four-slot injection subsea manifold at the Endurance Store which distributes CO_2 for injection into three wells;
- A subsea pig receiver per manifold at the Endurance Store;
- One infield pipeline, up to 28" in diameter which runs between the two manifolds of maximum 6 km in length;

- Five infield flowlines up to 8" in diameter which run from the manifolds to the injection wells (each max 3 km in length);
- Cables from the manifolds to the wells, to supply power and communications;
- Five CO_2 injection wells and one monitoring well, with six associated subsea trees (i.e. structures above a well that are used in well monitoring and control); and
- Monitoring features including four benthic landers, dimensions 3 x 2.4 x 4 m, and up to 50 concrete plinths for gravimetric analysis.

There will be no permanent structures above sea level associated with the Development at the Endurance Store area, and for the purposes of this report the Endurance Store is treated as a single unit. Further details are contained within the ES Chapter 3: Project Description.

1.2.2 Pipelines and cable

Two 28" CO_2 pipelines are planned; the Teesside Pipeline will be approximately 143 km in length and the Humber Pipeline approximately 101 km in length[1]. Both will be coated with either Fusion Bonded Epoxy or 3-layer polyethylene/polypropylene and from 40 mm up to 150 mm of concrete along their entire lengths. KP0 for each pipeline is located at the landfall tunnel entry point (i.e. above Mean High Water Springs (MHWS)).

It is anticipated that the Teesside Pipeline will be laid into a pre-cut trench from 8 m LAT up to KP7.1 and subsequently backfilled. The Teesside Pipeline will then be surface laid (with sections of rock placement) up to KP90 and thereafter shallow trenched for scour mitigation up to the co-mingling manifold at the Endurance Store. Similarly, the Humber Pipeline will be laid in a pre-cut trench from 8 m LAT up to KP16.3. Thereafter the pipeline will be surface laid up to KP60, then shallow trenching for scour mitigation may be required from KP60 to the co-mingling manifold at the Endurance Store. Both pipelines will require rock placement along sections of their lengths. 100% rock placement is assumed from KP7.5 to KP37.1 and KP73.0 to KP79.0 on the Teesside Pipeline, with a further 5% for the remaining length (106.5 km), consisting of the following sections: KP0.9 – KP7.5, KP37.1 - KP73 and KP79 – KP143. The worst-case rock placement scenario assessed for the Humber Pipeline is rock placement on 7.5% of its length between KP1 to KP6.0 and 5% for the remaining length.

An electric power and fibre-optic communications control cable will be installed from Teesside to the subsea infrastructure at the Store ('Teesside – Store cable'). It is anticipated that this will be installed using a standard cable laying vessel (CLV). Following installation of the Teesside Pipeline, the power and communications cable will be laid and then trenched simultaneously within the Teesside Pipeline working corridor. While the cable may be laid within the pipeline trench, installation via a separate trench has been assumed for the purposes of the ES. It is assumed that the length of rock placement required will be the same as that foreseen for the Teesside pipeline.

Further details are contained within the ES Chapter 3: Project Description.

1.2.3 SSIV

A Subsea Safety Isolation Valve (SSIV) is planned for the Teesside Pipeline between KP6 and KP8. The SSIV will require a protective structure and will be fishing friendly. The design and location of the SSIV and associated protective

[1] *From KP0*

structure are yet to be finalised, however the dimensions of the SSIV and structure will be up to 16 m L x 8 m H x 9 m W. A power, control and hydraulics umbilical will be installed from Teesside to the Teesside SSIV ('Teesside – SSIV cable'). Further details are contained within the ES Chapter 3: Project Description.

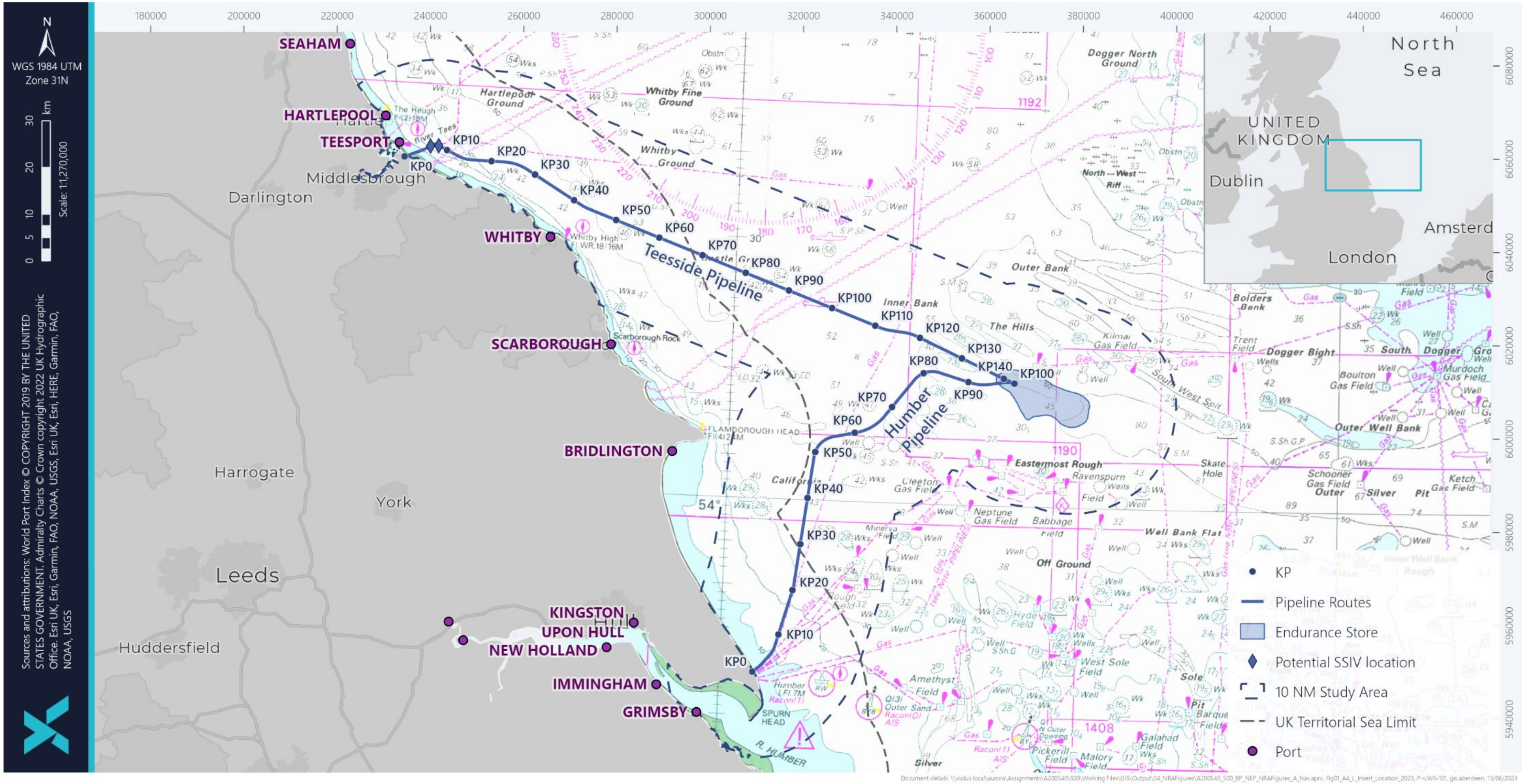


Figure 1-1 - Location of the Development

1.3 NRA purpose and scope

This NRA aims to characterise the shipping and navigation surrounding the Store, pipeline routes and Teesside SSIV and to provide detail on possible impacts to commercial and recreational navigation.

This NRA encompasses offshore activity associated with the Development that is seaward of the Mean Low Water Spring (MLWS). The NRA study area comprises a 10 NM wide area encompassing the Development, as illustrated in Figure 1-1. It therefore encompasses the Store, the Teesside Pipeline and Teesside – Store cable from landfall at Redcar to the Store, Humber Pipeline from landfall at Easington to the Store, and the nearshore SSIV on the Teesside Pipeline.

1.4 Guidance and legislation

This section outlines legislation, policy and guidance relevant to the appraisal of the potential effects on shipping and navigation associated with the installation, operation and maintenance, and decommissioning of the Development.

1.4.1 Legislation

The following legislation informs the approach of the appraisal in this NRA:

- International Regulations for Preventing Collisions at Sea (COLREGS) 1972/78, as implemented in the UK through the Merchant Shipping (Distress and Prevention of Collisions) Regulations 1996. Merchant Shipping Notice MSN 1781 (M+F);
- United Nations Convention on the Law of the Sea (UNCLOS) (1982); and
- Submarine Telegraph Act (1885).

1.4.2 Policy

A number of policies and regulations aim to ensure that shipping and navigation are taken into account during planning and execution of developments within UK waters. These include the UK Marine Policy Statement (MPS) and the UK Marine Plans, specifically the plans detailed below:

- East Inshore and Offshore Marine Plans, MMO (2014); and
- North East Inshore and Offshore Marine Plans, MMO (2021).

The ES Appendices can be referred to for the full detail on how the Development meets the requirements of the policies in these Marine Plans (in Appendix E). The particular policies most relevant to this NRA are summarised in Table 1-1.

Table 1-1 Summary of relevant Marine Plan policies

Plan	Policy	Objective / Policy	How and where it is considered
East Inshore and Offshore Marine Plans	PS2	Proposals that require static sea surface infrastructure that encroaches upon important navigation routes should not be authorised unless there are exceptional circumstances. Proposals should: 1. Be compatible with the need to maintain space for safe navigation, avoiding adverse economic impact; 2. Anticipate and provide for future safe navigational requirements where evidence and/or stakeholder input allows; and 3. Account for impacts upon navigation in-combination with other existing and proposed activities.	No permanent static sea surface infrastructure will be in place for the Development. However, the jackup rig will be present at the Store for 370 days during the drilling operations. There will also be slow moving vessels on site for the duration of the pipeline installation. The area of the Development is known to be within a relatively busy shipping area. A collision risk assessment and consideration of potential impacts to navigation have been carried out (see Section 5) and it is considered that through employment of the proposed mitigation and management there will be no significant impact to navigation in the area. The ES also considers the potential for cumulative impacts to arise with other existing and proposed activities. No significant cumulative impacts were identified.
East Inshore and Offshore Marine Plans	PS3	Proposals should demonstrate, in order of preference: 1. That they will not interfere with current activity and future opportunity for expansion of ports and harbours 2. How, if the proposal may interfere with current activity and future opportunities for expansion, they will minimise this 3. How, if the interference cannot be minimised, it will be mitigated 4. The case for proceeding if it is not possible to minimise or mitigate the interference	During the life of the Development, port/harbour facilities will be required, and therefore, would support opportunities for port and harbour expansion.
East Inshore and Offshore Marine Plans	TR2	Proposals that require static objects in the East Marine Plan areas, should demonstrate, in order of preference:	Recreational boating activities in the area are presented as part of the NRA Baseline (see Section 3.3). The only potential impact to recreational boating

Plan	Policy	Objective / Policy	How and where it is considered
		1. That they will not adversely impact on recreational boating routes; 2. How, if there are adverse impacts on recreational boating routes, they will minimise them; 3. How, if the adverse impacts cannot be minimised, they will be mitigated; or 4. The case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts.	is predicted to be temporary exclusion from the nearshore Development area during pipeline installation, since many of the activities will be occurring offshore, away from areas known for use for recreational sailing. Any exclusion during pipeline installation is anticipated to be temporary in nature and not significant.
North East Inshore and Offshore Marine Plans	NE-PS-1	In line with the National Policy Statement for Ports, sustainable port and harbour development should be supported. Only proposals demonstrating compatibility with current port and harbour activities will be supported. Proposals within statutory harbour authority areas or their approaches that detrimentally and materially affect safety of navigation, or the compliance by statutory harbour authorities with the Open Port Duty or the Port Marine Safety Code, will not be authorised unless there are exceptional circumstances. Proposals that may have a significant adverse impact upon future opportunity for sustainable expansion of port and harbour activities, must demonstrate that they will, in order of preference: 1. Avoid; 2. Minimise; or 3. Mitigate – adverse impacts so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding.	During the life of the Development, port/harbour facilities will be required, and therefore, would support opportunities for port and harbour expansion.
North East Inshore and Offshore Marine Plans	NE-PS-3	Proposals that require static sea surface infrastructure or that significantly reduce under-keel clearance which encroaches upon high density navigation routes, strategically important navigation routes, or that pose a risk to the viability of passenger services, must not be	There will be slow moving vessels on site for the duration of the pipeline installation. The area of the Development is known to be within a relatively busy shipping area. A collision risk assessment and consideration of potential impacts to navigation have been carried out (see

Plan	Policy	Objective / Policy	How and where it is considered
		authorised unless there are exceptional circumstances.	NRA Section 5) and it is considered that through employment of the proposed mitigation and management there will be no significant impact to navigation in the area.

1.4.3 Guidance

The appraisal methodology has been aligned to the following best practice guidance documents in so far as relevant for the Development:

- IMO Revised Guidelines For Formal Safety Assessment (FSA) For Use In The IMO Rule-Making Process- MSC-MEPC.2/Circ.12/Rev.2 (9 April 2018) (IMO, 2018);
- Maritime and Coastguard Agency (MCA) MGN 661 (M+F) Navigation - safe and responsible anchoring and fishing practices (1 December 2021) (MCA, 2021a);
- MCA MGN 654 (M+F) Offshore Renewable Energy Installations (OREI) safety response (MCA, 2021b); and
- International Association of Marine Aids to Navigation (AtoN) and Lighthouse Authorities (IALA) Guideline G1162: The Marking of Offshore Man-Made Structures, Edition 1.0 (IALA, 2021).

2 METHODOLOGY

2.1 NRA Methodology

A Scoping Report identified that an NRA would be conducted to determine changes in navigational risk resulting from the Development. In line with NRA methodology, this appraisal comprised three principal elements:

- Baseline Conditions – summarising navigational baseline characterisation work to establish densities and types of traffic in the marine environment;
- Stakeholder Consultation – range of stakeholder consultation activities including an hazards workshop; and
- Appraisal of Potential Impacts – presenting the outcomes of a Formal Safety Assessment (FSA).

Navigational features and patterns of vessel activity within the study area were assessed to establish baseline conditions (Section 3) and inform the subsequent FSA. Key features located outside of the study area were also considered as required. Stakeholder consultation informed both the baseline understanding of shipping in the area and, through hazard workshops, the population and refinement of hazard logs (see Section 2.4 for further consultation details). The appraisal of potential impacts (Section 5) has identified and logged hazardous outcomes such as collision, snagging and disruption to shipping against risk categorisation, mitigation measures, and ultimately, acceptability, adhering to the FSA methodology. These are explained in further detail in the following sections. The outcome of these steps is the formulation of recommendations to inform decision-making for all relevant parties.

2.1.1 Baseline Methodology

The navigational baseline characterisation comprises the following four elements:

- Identification of key navigational features;
- Emergency response overview;
- Maritime incident analysis; and
- Marine Traffic Survey (MTS).

Navigational features

The navigational baseline identifies key navigational features within the NRA study area including ports, anchorage areas, military practice areas and recreational features, as well as planned and existing offshore infrastructure.

Emergency response overview and maritime incidents

An overview of the emergency response in the region is described, considering Royal National Lifeboat Institution (RNLI) and Search and Rescue by Helicopter (SARH) resources in proximity to the Development. Historical marine incidents were studied and have been included to give an indication of the general level of marine incident risk in this region.

Marine Traffic Study

The MTS uses vessel traffic data including Automatic Identification System (AIS) and Vessel Monitoring System (VMS) data to establish baseline vessel traffic conditions in the study area, analysing such aspects as vessel type, size and status, as well as a section focussing on fishing traffic. A year of AIS data from March 2021 to February 2022 was utilised, covering four full seasons Spring to Winter. The data used in this MTS will be discussed in detail in Section 2.3.

2.2 Formal Safety Assessment Methodology

The FSA process provides a systematic method for evaluating and controlling risk, within a structured framework. Baseline shipping patterns and navigational features along with stakeholder consultation provide the basis for establishing potential hazards (or impacts) and their relevant details. These hazards are then characterised in terms of their severity (or magnitude) of consequence and likelihood, which ultimately provides for risk categorisation against a risk matrix, to determine an outcome of either 'Unacceptable', 'Tolerable if ALARP' or 'Broadly Acceptable'.

In the case of 'Unacceptable' assessment comprehensive changes to the design are required, as additional risk reduction, control or mitigation measures are considered likely to be insufficient to reduce the risk appropriately. Where a 'Broadly Acceptable' initial assessment is determined no further measures are required as these are considered unlikely to provide substantial risk benefit. Additional measures are however identified to provide a reduction in risk where a 'Tolerable if ALARP' assessment is made.

The residual risk, with additional mitigation measures considered, is subsequently assessed to determine risk acceptability in accordance with the principles of ALARP (As Low As Reasonably Practicable). Where necessary or appropriate, qualitative cost-benefit analysis of mitigation measures is undertaken to determine/justify a basic ALARP position.

Cumulative effects from neighbouring developments are also considered to ensure any interactions and future situations with potential hazardous outcomes are captured and suitable recommendations can be made. The FSA therefore comprises the following elements:

- Hazard and Effects identification;
- Initial risk assessment, considering existing or embedded mitigation measures;
- Identification of additional risk mitigation measures and resulting residual risk;
- Cost-benefit analysis; and
- Cumulative effects and future case considerations.

These elements are each described in the following sections.

2.2.1 Hazard and Effects Identification

Considering the activities of the Development, baseline information provided in the MTS, other consultation responses, professional judgement and industry experience, a list of hazards or impacts and their outcomes or effects, relevant to marine navigation was compiled and assessed through stakeholder preliminary hazards identification sessions (see Section 2.4). The list was compiled considering all principal phases and elements of the Development, Including consideration of the Store respective Teesside and Humber Pipelines and SSIV elements. Note that the worst credible and most likely outcomes were established to provide a comprehensive understanding of the hazards / impacts. The list was captured in a table, to be retained as an auditable hazard log (see Appendix 1: Hazard Log).

In addition to the hazards / impacts the workshop identified mitigation measures considered as 'embedded' i.e. assumed to be existing, effective and therefore taken into consideration when determining risk. These were categorised are being specific to the project or otherwise statutory or good industry practise. Any further risk reduction considerations, based on stakeholder expertise and local knowledge were also identified and captured in the sessions.

The potential consequences or effects of the hazards and the likelihood of the outcomes were then assessed using a risk assessment matrix as part of a desktop exercise.

2.2.2 Risk Assessment

The risk assessment process is based on a classic risk matrix approach. The assessment categorisations directly reflect the UK Health and Safety Executive principles of ALARP and align with NRA terminology. Additionally, the approach is broadly consistent with relevant marine guidance from the International Maritime Organisation (IMO, 2018) and the UK Maritime Coastguard Agency (MCA, 2021b).

Each hazard/impact is individually evaluated against specific criteria and assigned categories for consequence severity as presented in Table 2-1 and likelihood as presented in Table 2-2. The Risk Matrix used to combines the two categorisation to determine an initial risk is included in Table 2-3.

The assessment of initial risk has been conducted in consideration of the embedded mitigation as detailed in Section 2.2.1 These measures are assumed to be in place and effective and therefore minimise the likelihood, severity, or general impact of the hazards to shipping.

Table 2-1 - Severity of consequence of hazard / impact criteria

Severity / Magnitude	Criteria description
High	Loss of a crew member, or multiple serious injuries / Major/Severe damage to infrastructure or vessel / Operations / activities halted indefinitely
Medium	Serious injury to person / Notable damage to infrastructure or vessel / Protracted operational delays
Low	Minor injury(s) to person / Minor/Local damage to equipment or vessel / Minor operational delays
Negligible	No significant operational impacts

Table 2-2 - Likelihood criteria

Likelihood	Criteria description
Remote	Never occurred during Company's activities but has been known to occur in the wider industry.
Unlikely	Has occurred in Company's activities in the past but as an isolated incident under exceptional circumstance.
Occasional	Has occurred on more than one occasion during Company's activities in the past.
Likely	Occurs regularly during Company's activities.

The likelihood and consequence categories are combined for each hazard/impact using the risk matrix shown in Table 2-3, which is used to derive a risk tolerability level of either Unacceptable, Tolerable or Broadly Acceptable. Definitions of each risk tolerability level are provided in Table 2-4.

Table 2-3 - Risk Matrix

Likelihood					
	Likely	Broadly Acceptable	Tolerable	Unacceptable	Unacceptable
	Occasional	Broadly Acceptable	Tolerable	Tolerable	Unacceptable
	Unlikely	Broadly Acceptable	Broadly Acceptable	Tolerable	Tolerable
	Remote	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Tolerable
	-	Negligible	Low	Medium	High
		Severity of consequence / magnitude			

Table 2-4 - Tolerability Definitions

Tolerability	Definition
Broadly Acceptable (Low Risk - not significant)	Generally regarded as acceptable and adequately controlled. At these risk levels the opportunity for further reduction is limited.
Tolerable if ALARP (Moderate Risk - significant)	Typical of the risks from activities which people are prepared to tolerate to secure benefits. There is however an expectation that such risks are properly assessed, appropriate mitigation measures are in place, residual risks ALARP and that risks are periodically reviewed to monitor if further controls are appropriate.
Unacceptable (High Risk - significant)	Generally regarded as unacceptable whatever the level of benefit associated with the activity. Significant risk mitigation or design modification required to reduce to tolerable (ALARP).

2.2.3 Identification of Additional Mitigation Measures and Residual Risk

Where risks are assessed as being unacceptable or tolerable (significant) after factoring in the embedded mitigation measures already identified, further additional mitigation / risk reduction measures are considered. Additional risk reduction considerations or measures identified in the hazards workshop are considered where relevant or appropriate. The risk is then assessed again considering the additional measures to determine a residual risk outcome.

2.2.4 Cost-Benefit Analysis

To formulate recommendations for decision-making, any additional risk mitigation measures identified are subjected to a qualitative cost-benefit comparison in order to justify the measure and establish the residual risk categorisation and basic ALARP position.

2.2.5 Risk Assessment Table

The risk assessment outputs are presented in a table, such that the hazards or impacts relevant for each of the development phases and their associated mitigation measures (embedded and additional) are captured to provide a single auditable hazards and effects register (See Appendix 1: Hazard Log). The table also includes both the initial and residual risk assessment outcomes and supporting cost benefit analysis such that a complete record of the assessment is captured.

2.2.6 Cumulative Effects and Future Case

The term cumulative effects refer to effects upon receptors arising from the Development when considered alongside other plans and projects that result in an additive impact with any element of the Development and can be described as the net effect of both direct and indirect cumulative pressures, from different activities. An individual effect alone may be considered insignificant, but the additive effects of more than one effect, from any number of sources, could result in a significant cumulative effect, either beneficial or adverse.

The approach to Cumulative and In-Combination effects assessment is informed by the MMO Strategic Framework for Scoping Cumulative Effects (MMO, 2014) and has considered the guidance set out in Consenting and Licensing Guidance: For Offshore Wind, Wave and Tidal Energy Applications, Marine Scotland (2018). The approach to the assessment of Cumulative and In-Combination Effects provided within Planning Inspectorate Advice Note Seventeen (PINS, 2019) provides a contemporaneous and well-tested process to help guide this assessment

The assessment is based on the best available data from other plans, projects and marine activities and associated information which is currently in the public domain or has been provided to the project team. The assessment assumes that publicly available information is accurate; the assessment is also reliant on collaboration with a range of statutory consultees to the Marine Licensing process, neighbouring authorities and other developers to identify changes in information which may be pertinent to the assessment. Where there are specific limitations associated with data, they will be highlighted as the assessment progresses

A list of potential cumulative projects and activities has been compiled and includes windfarm extensions and offshore industry activities in the North Sea. Each hazard/impact has been qualitatively reviewed against the potential direct and indirect cumulative effects from any of the projects listed as well as general increases in traffic density. Any issues have been captured, and further risk mitigation measures considered where deemed appropriate.

Cumulative and in-combination effects are discussed more widely throughout the ES.

2.3 Data sources

Baseline conditions have been established by undertaking a desktop review of published information and through consultation with relevant organisations (see Section 2.4). An MTS has been undertaken and involved the acquisition of detailed AIS data for a 10 NM wide corridor around the Development.

The data sources used to inform the baseline description and appraisal are detailed in Table 2-5.

Table 2-5 - Data sources

Title	Source	Year(s) analysed
Navigational features		
Royal Yachting Association (RYA) UK Coastal Atlas of Recreational Boating	RYA	v2.1 (2019)
Military practice areas (PEXA)	OceanWise	2022
Marine Themes Administrative and Transport Themes	OceanWise	Current / 2022
Admiralty charts	OceanWise	
Admiralty Sailing Directions – North Sea (West) Pilot (NP54), 11th Edition	UKHO	2018
RNYC Sailing Directions – Humber to Rattray Head, 6th Edition	Royal Northumberland Yacht Club	2021
Disposal sites	CEFAS	2021
Emergency response & marine incidents		
RNLI lifeboat station locations and SARH base locations	RNLI, Dept for Transport	2020
RNLI Return to Service and SARH taskings data	RNLI, Dept for Transport	2008 – 2020, 2015 – 2022
Marine Accident Investigation Branch (MAIB) incidents	MAIB	1992 - 2021
Marine Traffic Study (MTS)		
Automatic Identification System (AIS) data from 2021 - 2022	Marine Traffic	Mar 2021 – Feb 2022
Vessel Monitoring System data (VMS)	MMO	
Sightings/surveillance data	MMO	2015 - 2019
Port and harbour authority websites and documentation	Various	2023

2.3.1 AIS Data

AIS data has been used to assess the patterns and intensity of shipping activity in the vicinity of the Development. The IMO requires that all ships of ≥ 300 gross tonnage engaged on international voyages, cargo vessels of ≥ 500 gross tonnage not engaged on international voyages, and all passenger ships regardless of size built on or after 1st July 2002, are fitted with an AIS. All European Union (EU) registered fishing vessels of length 15 m and above are required to carry AIS equipment by EU directive. Smaller fishing vessels (below 15 m) as well as recreational craft are not required to carry AIS although a proportion does so voluntarily smaller fishing vessels are likely to be underrepresented in the AIS data.

A full year of data with the following timespan was obtained:

- 01/03/2021 to 31/02/2022.

The AIS records were supplied by Marine Traffic (industry standard commercial AIS data supplier) with all standard parameters (longitude, latitude, vessel Maritime Mobile Service Identity (MMSI) number, status, speed, course, heading and timestamp) and the following additional parameters:

- Deadweight tonnage (DWT);
- Vessel length;
- Vessel draught; and
- Vessel type.

The AIS data was provided in a raw, point-based format, as well as in a format converted into vessel tracks. The tracks were subsequently clipped to the 10 NM study area shown in Figure 1-1. Vessel density grids for the wider area were produced by overlaying a 2 square kilometres (km^2) hexagonal grid and determining the density of tracks within each cell. Vessel tracks were assumed to be wholly in the season or month in which the track started. Vessel speeds were calculated from the length of the track and the start and end times of that track.

2.3.2 VMS and sightings data

As mentioned above, AIS is only a requirement of larger vessels, or those carrying passengers, whereas fishing vessels <15 m length are exempt (although many carry AIS voluntarily for safety). As such, AIS data can underrepresent fishing activity. However, the EU requires that all EU, Faroese and Norwegian fishing vessels of 12 m and above are fitted with a VMS. Vessel positions are transmitted every two hours rather than every few minutes as for AIS data, so tracks cannot be readily reconstructed. Nevertheless, the data provides an informative overview of the distribution and density of fishing vessels over 12 m.

Two sets of VMS data were obtained:

- Anonymised VMS point data for the area of interest for 2019 (no information on gear type or status, but vessel speeds can be used as a proxy for vessel fishing status, albeit with an inherent level of uncertainty); and
- MMO Fishing activity for UK vessels 15 m and over by International Council for the Exploration of the Sea (ICES) statistical rectangle (this includes data about time spent fishing and gear type; 2016 - 2019).

Additionally, MMO sightings data 2011 to 2019 representing vessels sighted on surveillance flights was sourced.

2.3.3 Additional Data Sources

Due to the likely under representation of small recreational vessels in the AIS data, additional data sources including the RYA Coastal Atlas have been used to validate the findings of the AIS analysis. Additional analysis considers key navigational features which were extracted from a variety of data sources including Admiralty charts and Admiralty Pilot (Sailing Directions) books. Maritime incident data from the Marine Accident Investigation Branch (MAIB) and Royal National Lifeboat Institution (RNLI), as well as Search and Rescue Helicopters (SARH) taskings data from the Department of Transport and MCA have been utilised to assess the emergency response in the region.

2.4 Consultation

In order to inform the shipping and navigation appraisal, consultation with key relevant maritime stakeholders was undertaken to obtain supplementary information which may not be available through the data sources outlined in Section 2.3. Two dedicated consultation sessions were held via Microsoft Teams, each comprising the following elements:

- Introduction to team and summary of NRA process;
- Development overview;
- Navigational baseline summary; and
- Facilitated preliminary hazards assessment workshop.

2.4.1 Consultation sessions

The NRA consultation meetings and consultees are summarised in Table 2-6. In addition, the Royal Yachting Association (RYA), RYA Scotland and Cruising Association (CA) were provided with project information and invited to a consultation session. The Cruising Association have been informed of this decision and invited to provide further comment. Whitby Harbour was also contacted and invited to join the ports consultation session but did not respond.

Consultee input has been incorporated where appropriate into the NRA such that concerns and impacts are recorded and associated risks are addressed.

Table 2-6 - Consultation meetings

Date	Meeting	Location	Attendees
26/04/2022	Ports	Microsoft Teams	Tees and Hartlepool Port Authority/Teesport (TP) ABP Humber Estuary Services (ABP)
27/04/2022	Statutory	Microsoft Teams	Maritime and Coastguard Agency (MCA) Trinity House (TH) Chamber of Shipping (CoS)

2.4.2 Consultation summary

The issues raised during consultation with marine stakeholders and where these issues are considered is detailed in Table 2-7.

Table 2-7 - Consultation summary

Consultee and type of response	Issue raised	Response to issue raised / where considered in NRA
CoS – consultation meeting	Complimented the temporal range of the MAIB marine incident data that has been utilised for this NRA, which runs back to 1992, rather than the usual arbitrary 10 year selection of data.	The NRA made sure to consider the full range of MAIB incidents data, as seen in Section 3.5.
CoS – consultation meeting	Requested that we look more closely at the AIS tracks seasonal density with relation to the SSIV.	An additional figure was prepared to look in detail at the AIS tracks seasonal density in the immediate vicinity of the Teesside SSIV, shown in Section 4.1.
MCA – consultation meeting	Queried the fishing vessel traffic in this region.	Fishing activity is studied in Section 4.4.
MCA – consultation meeting	HC listed the key deliverables the MCA is expecting to see addressed within the NRA including: – seasonal variations; – poor weather routing; – cable crossings; – proximity to Hornsea Four; – reduction in navigable depth; – RYA data; and – to cover commercial and fishing traffic. HC confirmed that these will all have been addressed and therefore that the baseline covers the requirements agreed for the NEP NRA.	The Baseline in Section 3 and 4, and Impact Assessment is in Section 5 cover these aspects in detail.
MCA – consultation meeting	Questioned if a Fishing Liaison Officer will be included on this Development.	An FLO has been supporting on survey activity and will support on early engagement through to installation. A Fishing Intensity Study has also been produced and has been consulted on with relevant national and local fisheries organisations.
TH – consultation meeting	Queried if there has been any modelling of possible changes to traffic patterns based on e.g. Hornsea Four being built.	This is considered in the cumulative and in combination effect section of the FSA (Section 5.5), which considered such effects, made recommendations and highlighted any issues that might need to be carried forward.

Consultee and type of response	Issue raised	Response to issue raised / where considered in NRA
		Modelling would not need to be carried out in this instance, as the Store would not have any long-term surface structures which could cause deviations from normal shipping routes, so no operational effects, only installation.
Cos/MCA – consultation meeting	Noted MCA guidance on under keel clearance where water depth is reduced by more than 5% as standard.	An under-keel clearance study will be conducted, covering the SSIV and all other subsea structures that may cause >5% reduction in water depth, and will accompany the NRA.
TH – consultation meeting	Commented that due to the nature of vessel types which are present in the Humber and Teesside, namely many chemical tankers, one of the worst credible outcomes could be severe environmental damage.	Captured in Hazard Log (Appendix 1: Hazard Log).
MCA – consultation meeting	Commented on the potential need for relevant permits, e.g. obtaining port permits.	Captured in Hazard Log (Appendix 1: Hazard Log).
MCA – consultation meeting	Noted that as jack up barges are being used, would expect to see the standard marking schedule for offshore installations there as well.	Captured in Hazard Log (Appendix 1: Hazard Log).
TH – consultation meeting	Noted that UKHO could put out temporary and preliminary notices beforehand, in this installation and commissioning phase.	This was captured as an additional mitigation in Section 5.3.4
TH – consultation meeting	Noted that the markings required for the SSIV would depend on what is decided regarding its exact location.	Noted that there is a trade-off where bringing the SSIV closer to shore brings it out of a region of higher traffic density, but poses possible greater under keel clearance and engineering constraints. Noted that there is also a trade-off between the benefit of the SSIV from a process safety perspective, against the risk of the structure itself from a navigational perspective. This is addressed within Section 5.3.6 of the FSA.
General discussion – statutory	Noted that locating the SSIV in closer proximity to the Teesside windfarm may also mean there needs to be	This is discussed in Section 5.3.1 of the FSA.

Consultee and type of response	Issue raised	Response to issue raised / where considered in NRA
consultation meeting	consideration of larger vessels attending to the windfarm e.g jackups/heavy lift vessels, turbine removal or replacement etc.	
TP – consultation meeting	Highlighted that there is designated jackup area at Teesside to the east of the port approach.	Noted in Section 3.2.1.
ABP/TP – consultation meeting	ABP explained that Humber has adverse weather guidelines, but only inside jurisdiction, so not necessarily relevant to this assessment. TP explained that it is very similar at Tees. Adverse weather policies within compulsory pilotage areas in Tees channel, but well away from pipeline route.	Adverse weather guidelines captured as embedded mitigation Section 5.2.2
TP – consultation meeting	Teesport stated that there is ample searoom, so assuming the standard mitigation is in place (Notice to Mariners, guard vessels, security broadcasts) it will be a fairly simple diversion, provided multiple vessels do not span broad regions of the route simultaneously.	There will likely be minimum of two vessel per route (likely larger e.g. jackup or pipelay barge, support by a dive-support vessel). There would then be a deep water pipelay barge that starts work afterwards. Mitigations are described in Section 5.2.2 and throughout.
ABP/TP – consultation meeting	Confirmed that so long as the Port Authorities are copied into notices, they will distribute the information to their users.	Captured in Hazard Log (Appendix 1: Hazard Log).
TP – consultation meeting	Teesside have managed pipelines within port authority area and have moved anchorages in the past. Also explained that they monitor beyond the VTS area to ensure vessels don't anchor immediately. Procedures could be extended to incorporate Development infrastructure in direct vicinity of Teesside VTS area. This would not be a dedicated service, but it is something that happens as a matter of course.	Anchorage areas and anchoring vessels are investigated in Section 3.2.2 and Section 4.3.4. Risk reduction measures are discussed in Section 5.3.8
TP – consultation meeting	PB explained the details of a historic incident in which a vessel called the "Young Lady" dragged its anchor across the Central Area Transmission	This incident is noted in Section 3.2.2.

Consultee and type of response	Issue raised	Response to issue raised / where considered in NRA
	System (CATS) pipeline, moving 6 m across the seabed.	
TP – consultation meeting	Explained that team is anticipating marks and lights at SSIV, with diversions around. Teesport agreed (beacon and light) and highlighted careful siting will also be important to minimise disruption. Placement inside the line of the nearshore Teesbay wind farm should be considered e.g. KP2 directly adjacent to OWF. Maintenance vessels for wind farm will need to be considered.	Mitigation measures are discussed in Section 5.3.7.
TP – consultation meeting	Explained that SSIV issues similar to above, though placemen at wind farm might present issue for fishing vessels and recreational craft operating out of Redcar.	Cumulative effects considered in FSA in Section 5.5.
TP – consultation meeting	Highlighted that route follows CATS and Breagh pipelines, so assuming it is trenched and buried it shouldn't present an issue. Discussed that there is significant precedent at Humber location with numerous pipelines coming ashore.	Other pipelines in the study area are discussed in Section 3.2.5.

2.5 Data limitations and assumptions

As noted in Section 2.3, small fishing and recreation vessels are likely to be underestimated in AIS data. In order to mitigate this, analysis of VMS data has also been included in this NRA to capture a fuller picture of small fishing and recreation vessels. It should however be noted that VMS data does not cover vessels of < 12 m in length, and in the case of the MMO fishing activity by ICES rectangle data, does not include vessels of < 15 m in length. RYA Coastal Atlas data supports the study of recreational activity in the region. It should also be noted that as the AIS data encompasses a time period of March 2021 to February 2022, it may be affected by the COVID-19 pandemic.

3 NAVIGATIONAL BASELINE

3.1 Introduction and overview

This section covers the shipping and navigation baseline for the Development. It is necessary to identify and assess the potential interactions, to understand the impacts, identify possible mitigation measures and ultimately demonstrate that the Development will not adversely affect vessel traffic.

The Development is located offshore from the English east coast, in a region which has a number of major industrial hubs as well as numerous offshore infrastructure present including windfarms and oil and gas installations. This region also hosts recreational vessel activity.

3.2 Key navigational features

3.2.1 Ports and harbours

A chart of the main ports and harbours in the vicinity of the study area is presented in Figure 3-1.

As Figure 3-1 shows, Tees and Hartlepool, Whitby and Grimsby ports and harbours fall within the NRA study area. Grimsby is part of the Humber ports, while the ports of Tees and Hartlepool are known collectively as Teesport and form the UK's fifth largest maritime complex (Teesport, 2021). The Teesside Pipeline route overlaps with the Teesport Harbour Authority Area up to KP6. The planned Teesside SSIV location being considered between KP6 - KP8 would fall just outside of the Teesport Harbour Authority Area, as shown in detail in Figure 3-2. Whitby Harbour is located 9.3 km from KP40 along the Teesside Pipeline route. The Humber Pipeline route and the Store do not directly interact with any ports or harbours.

Details of the ports and harbours within the study area are given below:

- Hartlepool lies on the north side of Hartlepool Bay and is a mid-sized commercial port handling a range of cargoes and has facilities for platform and pipeline construction (UKHO, 2018), operated by PD Ports. Hartlepool port considers itself a renewables and oil and gas hub, and currently is used to service the Teesside Offshore Wind Farm (PD Ports, 2022). Hartlepool has a large marina development (Royal Northumberland Yacht Club, 2021);
- Teesport is also operated by PD Ports, and is a busy deep-water port and hub for several major petro-chemical complexes in the Tees Valley region, as well as handling a range of cargos (UKHO, 2018). Tees VTS is a Vessel Traffic Management and Information Service with full radar surveillance and covers the ports of both Hartlepool and Tees as well as the Tees and Hartlepool Bays and seaward to about three to four miles from South Gare Light (UKHO, 2018). The Royal Northumberland Yacht Club pilot notes that Teesport has minimal facilities for recreational vessels (Royal Northumberland Yacht Club, 2021). Consultation with Teesport highlighted that there is designated jackup area at Teesside to the east of the port approach.
- Whitby Harbour is a small commercial ad fishing port, and also a centre for recreational vessels (UKHO, 2018), operated by Scarborough Borough Council;

- Grimsby is operated by Associated British Ports (ABP) and lies on the south bank of the River Humber. It is a medium-sized commercial and fishing port specialising in cargo trade to mainland Europe and the Baltic (UKHO, 2018), is one of the UK's leading automotive ports, (Associated British Ports, 2022) and also services the windfarm industry (UKHO, 2018). The Humber VTS Operations Centre is based in Grimsby and is run by ABP Humber Estuary Services (HES), the Competent Harbour Authority. Grimsby's Meridian Quay Marina is suitable for recreational vessels up to 50 ft in length (Royal Northumberland Yacht Club, 2021).

3.2.2 Aids to navigation

An overview of key aids to navigation is presented in Figure 3-1. The following navigational features have been considered:

- Anchorage areas;
- Pilot boarding;
- Navigational aids including buoys, beacons and navigation lines; and
- IMO routeing.

In terms of anchorage, the Development does not overlap with any charted anchorage areas. Within the study area near the Teesside Pipeline and SSIV, the Charlie, Echo and Whiskey designated anchorage areas associated with Teesport are present. At their closest points, the Charlie anchorage is 4.8 km from KP7, Echo is approximately 6.9 km from KP11 and Whiskey is 11.7 km from KP3 of the Teesside Pipeline route respectively. Masters of vessels anchoring in Tees Bay are advised against anchoring in weather conditions where windspeed is above Force 8 from any direction and Force 6 from north-northwest through north to southeast and if swell exceeds 4 m, as anchors are likely to drag (UKHO, 2018). Consultation with Teesport noted a previous marine incident which occurred within the Tees and Hartlepool harbour Authority Area in 2007, in which the "Young Lady" vessel anchored in adverse weather conditions and as a result of weather and a mechanical failure dragged its anchor across the Central Area Transmission System (CATS) pipeline causing material damage (Marine Accident Investigation Branch, 2008). Vessels are prohibited from anchoring within the PD Teesport limits except with prior approval from Tees VTS, and prohibited from anchoring within 2.5 cables of the Ekofisk oil and CATS gas pipelines and from anchoring within 1 mile of the Teesside Wind Farm (UKHO, 2018), displayed in Figure 3-2.

Regarding the Humber Pipeline, the Hawke, Haile, Bull, Humber Deep Water anchorage areas are within the study area in proximity to the Humber Pipeline landfall. The Hawke, Haile and Bull anchorage areas are 8.7 km, 12.9 km and 11.4 km respectively from KP0, and the Humber Deep Water anchorage 15.4 km from KP6. There is also one unnamed anchorage area for small craft located to the south-west of the Haile and Bull anchorages close to Fitties Beach. The Store is not close to any charted anchorage areas.

In terms of navigation lines and routes, the Teesside Pipeline crosses a transit line from Redcar KP4 – KP5 (Figure 3-2). The Humber Pipeline route, Teesside SSIV and Store do not interact with any navigational lines and routes.

3.2.3 IMO routing measures

The Development does not directly overlap with any IMO routing measures. There are no routing measure areas within the study area in the vicinity of the Teesside Pipeline route, Teesside SSIV or the Store; however, to the south of the Humber Pipeline route Traffic Separation Schemes are present outside the entrance to the River Humber (see Figure 3-2). The northeast approaches to the River Humber routing area are approximately 13.9 km southeast of the Humber Pipeline route at the closest point at KP6.

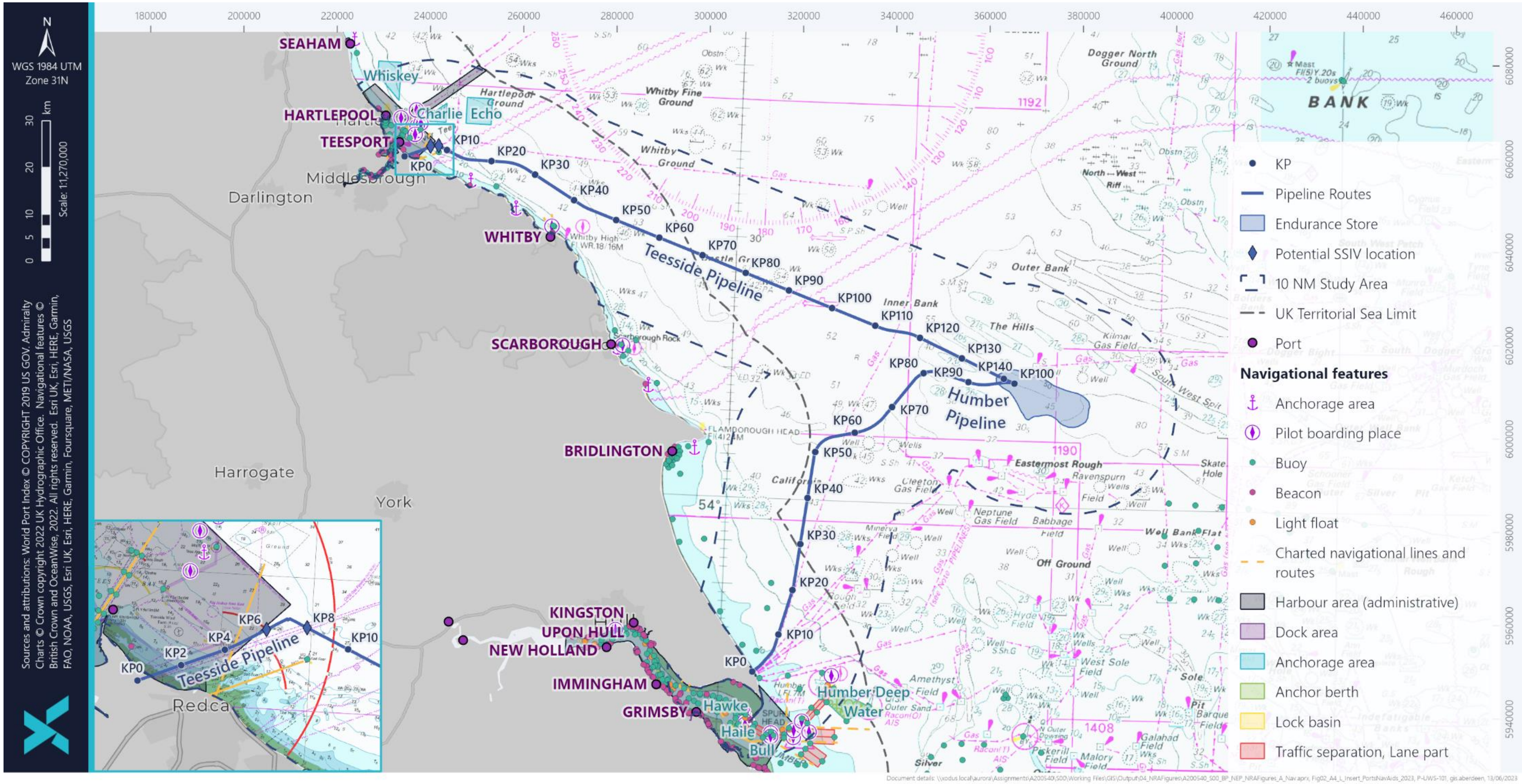


Figure 3-1 - Ports, harbours and navigational aids

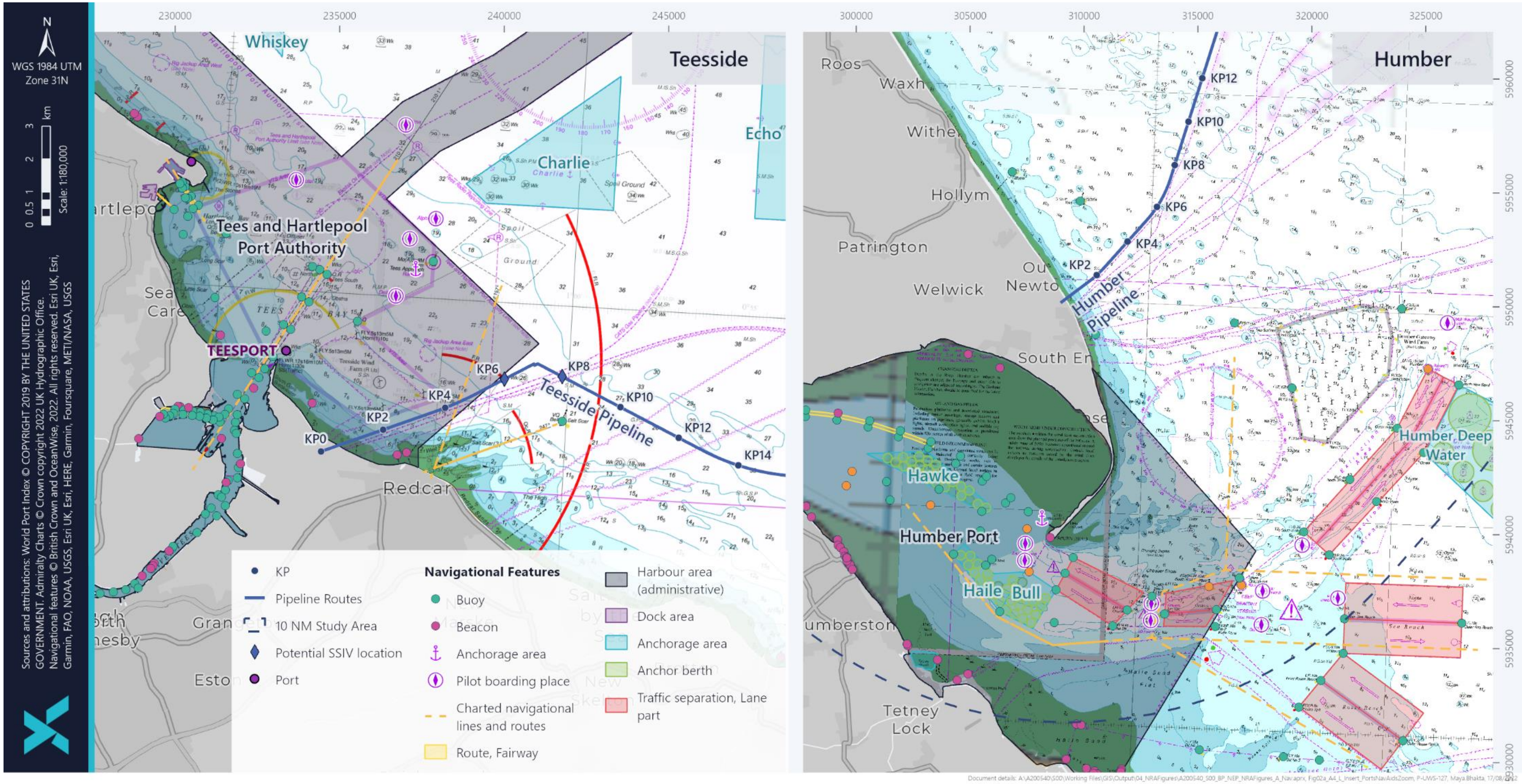


Figure 3-2 - Ports, harbours and navigational aids with focus on landfalls

3.2.4 Military Practice and Exercise Areas

Figure 3-3 shows the military practice areas, also known as PEXA, within the region of the Development. The Teesside Pipeline route overlaps with PEXA from approximately KP19 to the Store. The stretch of the Teesside Pipeline which is being considered for the siting of the SSIV does not overlap with any PEXA. The Humber Pipeline route overlaps with PEXA from approximately KP14 to the Store. The Store sits within PEXA D323C. The full details of specific PEXA which overlap the Development are shown in Table 3-1.

Table 3-1 - Details of overlapping PEXA

PEXA	Type of PEXA	Development infrastructure	Where it overlaps
D323G	AIAA - Areas of Intense Aerial Activity	Teesside Pipeline	KP19 – KP30.7
D323E	AIAA - Areas of Intense Aerial Activity	Teesside Pipeline	KP30.7 – KP56.6
D323A	AIAA - Areas of Intense Aerial Activity	Teesside Pipeline	KP56.6 – KP63.3
D323B	AIAA - Areas of Intense Aerial Activity	Teesside Pipeline	KP63.3 – KP121
D323C	AIAA - Areas of Intense Aerial Activity	Teesside Pipeline	KP121 – KP143 (end)
D323C	AIAA - Areas of Intense Aerial Activity	Endurance Store	-
D323F	AIAA - Areas of Intense Aerial Activity	Humber Pipeline	KP13.9 – KP24.5
D323C	AIAA – Areas of Intense Aerial Activity	Humber Pipeline	KP24.5 – KP51, KP53.8 – KP100.6 (end)
D323B	AIAA - Areas of Intense Aerial Activity	Humber Pipeline	KP51 – KP53.8

3.2.5 Other infrastructure and navigational features

The Development is situated in a busy region of the North Sea in terms of other infrastructure, as shown in Figure 3-4. The following additional features have been considered in this Baseline from a navigational perspective:

- Offshore wind farms and other renewable sites;
- Subsea cables;
- Aggregate areas;
- Dredge spoil disposal areas;
- Oil and gas infrastructure and licences; and
- Charted wrecks.

Figure 3-4 shows that there are a number of offshore windfarms in the vicinity of the Development. The Teesside Windfarm and its designated cable area are less than 500 m from the Teesside Pipeline up to KP4. No windfarms directly interact with the Teesside SSIV. The potential Teesside SSIV would be over 2 km from the Teesside Pipeline at the closest potential location of KP6. The southern portion of the Store overlaps with the Hornsea Four lease area (see Figure 3-4). The Humber Pipeline route does not overlap with any windfarms however the Westermost Rough offshore windfarm is located approximately 280 m from the Humber Pipeline route at the closest point to the west of KP17, and the cable area for the Humber Gateway offshore windfarm is at the closest point 2.2 km to the south of the planned Humber Pipeline landfall.

In terms of cables, the Teesside Pipeline route crosses two active telecoms cables, the Pangea North cable at KP12 and the Tata North cable at KP90, as well as one disused cable, the UK-Denmark 4 at approximately KP87. The Teesside Pipeline route also crosses the Breagh fibre optics cable associated with the Breagh pipeline at approximately KP7. The Teesside Pipeline route would also cross the planned EGL2 HVDC link at approximately KP87.

The Teesside Pipeline route also crosses three wind farm cable areas, one associated with the Sofia Offshore Wind Farm between KP20 – KP22, and three associated with the Dogger Bank C (between KP22 - 26) and Dogger Bank A/B (between KP115 - 117) windfarms. The potential Teesside SSIV would be approximately 2.2 km from the Teesside offshore windfarm if placed at the closest point at KP6. The Humber Pipeline route crosses the Hornsea 4 windfarm cable area between KP46 – KP48. The Store does not overlap with any known cables.

Oil and gas infrastructure is present within the study area, mainly concentrated towards the southeast. The Teesside Pipeline landfall is in close proximity to the onshore Teesside Terminal, and the pipeline crosses three active pipelines between KP7 and KP8 (Everest to Teesside CATS Trunkline, Breagh chemical and Breagh gas pipelines), as well as crossing the Langeled pipeline at approximately KP115 (Figure 3-4). Oil and gas licence areas overlap with the Teesside Pipeline route between approximately KP91 to KP119. The three pipelines between KP7 and KP8 are also relevant to the placement of the Teesside SSIV. The Humber Pipeline landfall is close to the onshore Easington Gas Terminal and the pipeline crosses the Langeled pipeline at approximately KP58, as well as overlapping with licence areas between KP39 – 60 and KP67 – 77. The Store does not overlap with any oil and gas licences.

Charted wrecks are located throughout the study area but show an increased concentration close to shore and within the UK Territorial Sea Limit (Figure 3-4). The Teesside Pipeline route up to KP50 sees a higher concentration of charted wrecks in comparison to the rest of the route, likewise the Humber Pipeline sees a greater concentration of charted wrecks closer to shore up to KP32. The concentration of charted wrecks is lower at the Endurance Store. For further detail on charted wrecks, see the Chapter 9: Physical Presence of the ES.

Regarding aggregate lease areas, the Teesside Pipeline route crosses over offshore minerals evaporites sites from KP6 to KP54 (Boulby and Hundale Potash Mines), which is also relevant to the possible placement of the Teesside SSIV between KP6 and KP8. The Humber Pipeline route and Store do not overlap with known aggregates sites. In terms of dredging and spoil grounds, the Teesside Pipeline route overlaps with a closed disposal site associated with the CATS pipeline trench from KP1 to just after KP4. The Teesside SSIV would be 1.9 km from this site if located at the closest point at KP6. The Humber Pipeline route passes just over 150 m from a closed disposal site associated with the Westermost Rough windfarm at KP17 (Figure 3-4).

Approximate locations of Marine Environment High Risk Areas (MEHRAs) have been displayed in Figure 3-4. These are areas highlighted as having high environmental sensitivity and at risk from shipping pollution (Dept for Transport and Dept for Environment, Food and Rural Affairs, 2006). The Teesside Pipeline and planned SSIV sit within the Tees MEHRA which overlaps up to approximately KP12. The Humber Pipeline sits within the Spurn Bight MEHRA up to KP12. The Store does not overlap with any MEHRA.

3.3 Recreation

As stated previously, AIS is not compulsory for recreational vessels and they tend to be under-represented in AIS data; however, there are alternative approaches to understand recreational usage patterns. The RYA Coastal Atlas was used to identify recreational features relevant to the study area. This includes general boating areas, clubs and other facilities, as displayed in Figure 3-5.

The Teesside Pipeline route crosses a General Boating Area up to just after KP9, as well as a region of higher AIS intensity close to shore from KP4 – KP30. The South Gare Marine Club is located approximately 3 km to the northwest of the pipeline landfall. There are also three other sailing clubs, two training clubs and Hartlepool Marina associated with Tees and Hartlepool ports within this General Boating Area. The Teesside Pipeline route runs within 9 km of a number of recreational facilities between KP30 – 40 at Runswick Bay and Whitby (one marina, three training centres and three sailing clubs). The Teesside SSIV would be sited within the General Boating Area at the mouth of the River Tees, and would overlap with the region of high AIS intensity close to shore from KP6 to KP8.

The Humber Pipeline route crosses a General Boating Area up to KP10, and a region of moderate AIS intensity close to shore which occurs from KP1 to KP7, otherwise there is low recreational AIS intensity across the remainder of the pipeline route. A number of recreational facilities fall within the study area to the south of the Humber Pipeline route, including two marinas, three sailing clubs and a training centre associated with Grimsby and the Humber, however these facilities are separated from the Humber Pipeline route by Spurn Head (see Figure 3-5).

The Store sees little recreational activity, due to its location further offshore.

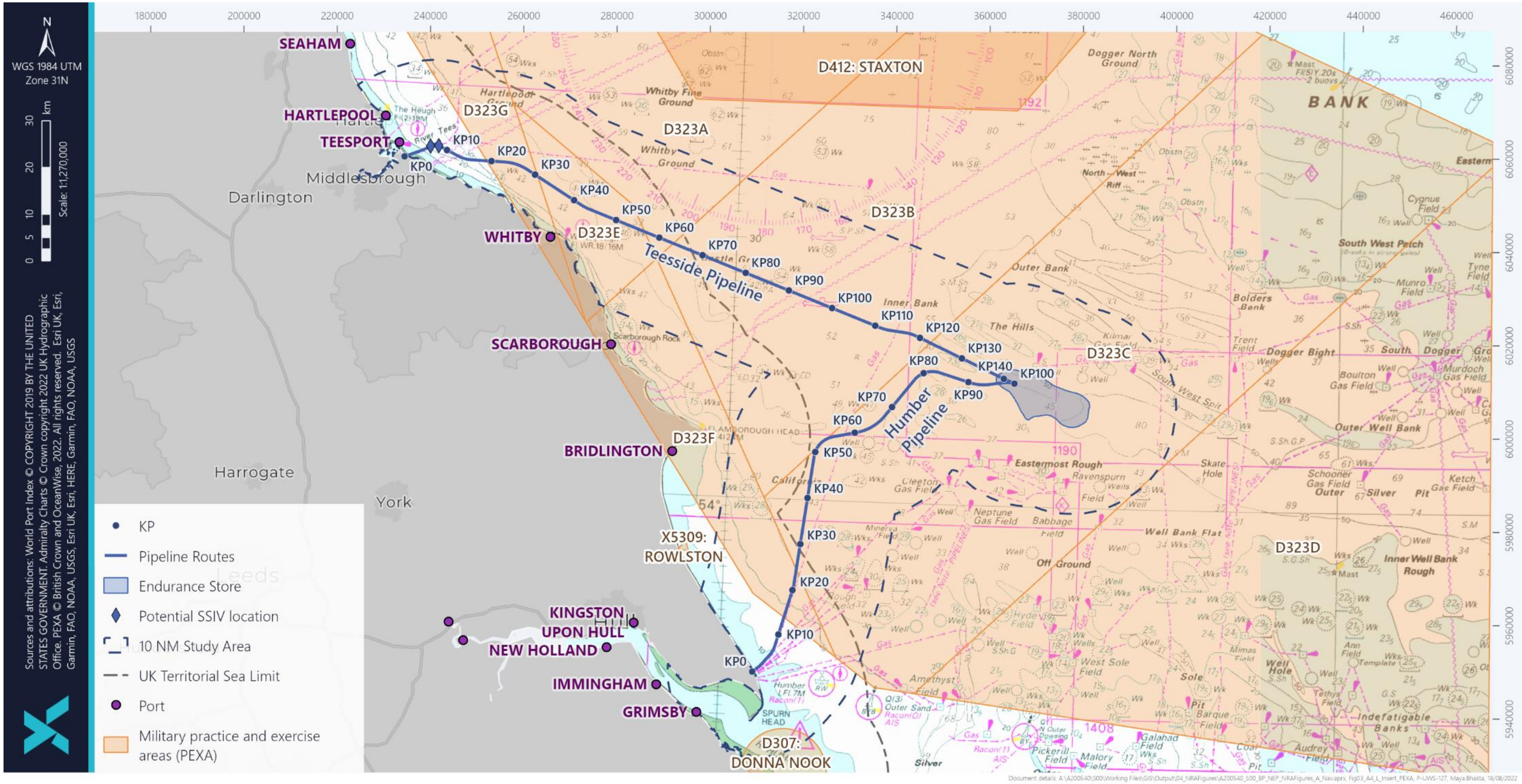


Figure 3-3 - Military practice areas

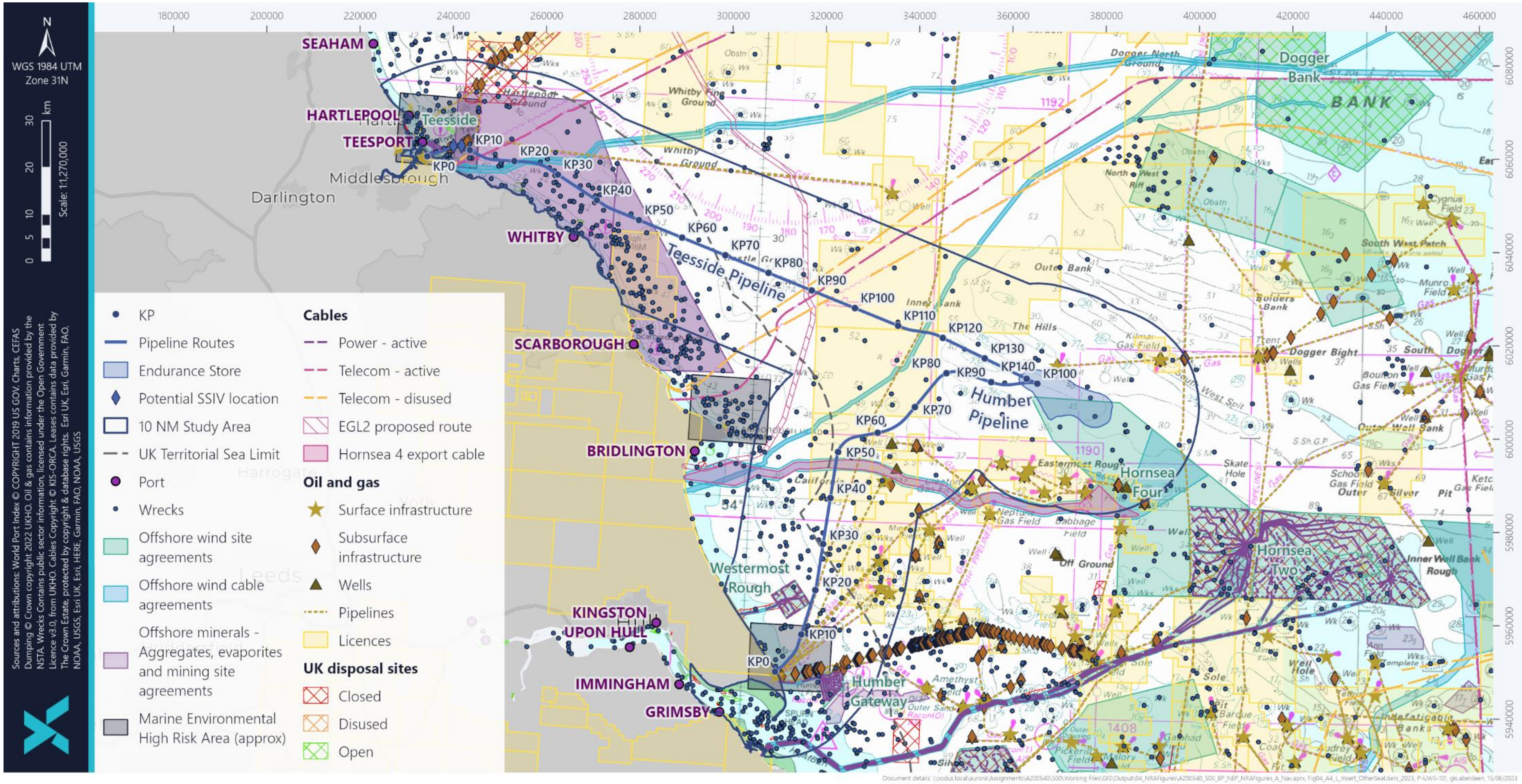


Figure 3-4 - Other navigational features

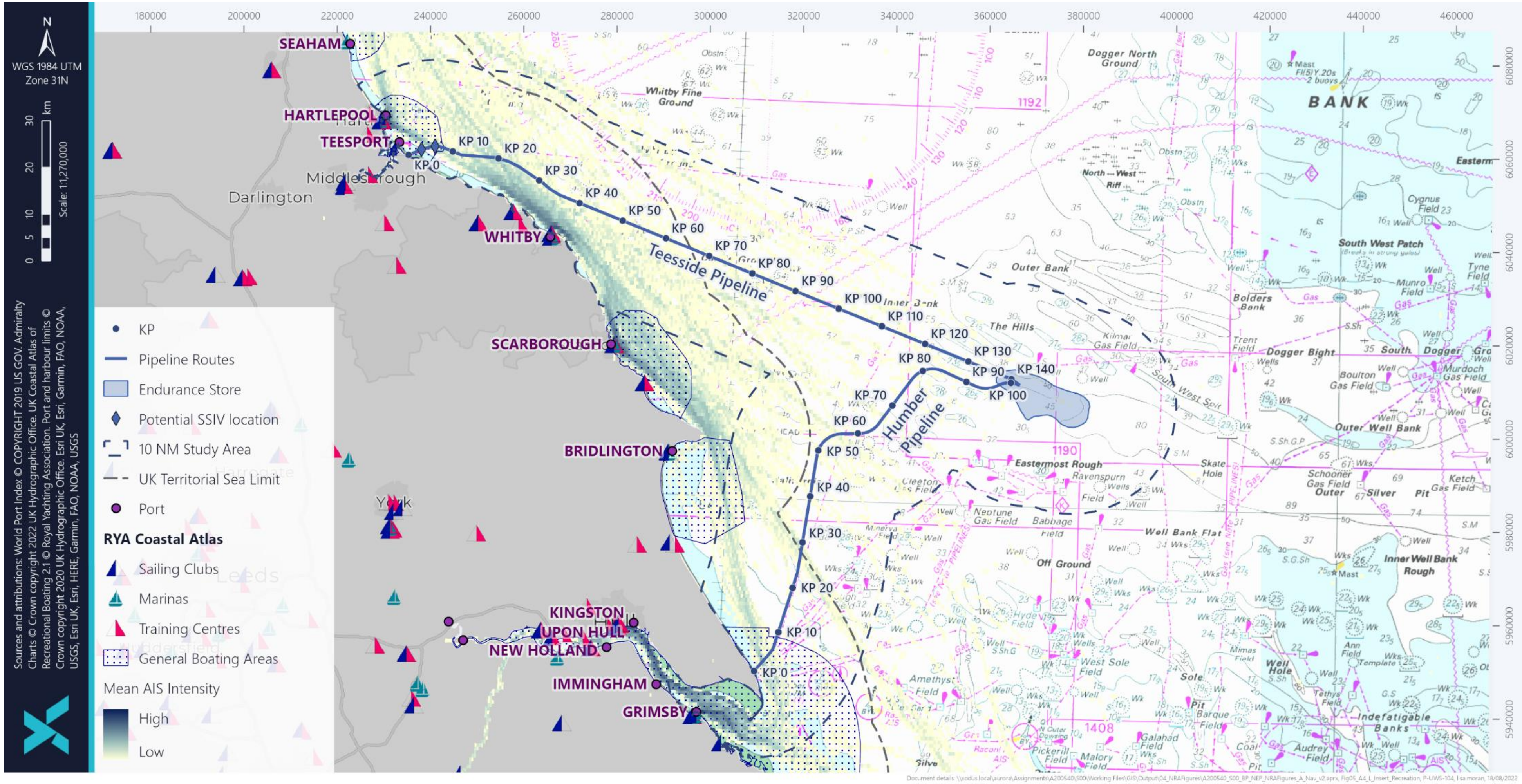


Figure 3-5 - Recreational features

3.4 Emergency Response Overview

This section considers the emergency response in the study area by the RNLI and by SARH including such data as:

- RNLI Stations (RNLI); and
- SARH bases and radii of action (Department for Transport and MCA).

3.4.1 RNLI

The RNLI has six regions; the study area falls within the 'North and East' region (see Figure 3-6). The RNLI has 238 stations and more than 400 lifeboats (RNLI, 2022a). There are a number of RNLI lifeboat stations within close proximity to the study area, shown in Figure 3-6.

There are seven lifeboat stations within the study area, as presented in Table 3-2. Redcar station is the closest to the Teesside Pipeline route (1.8 km from KP2) as well as the planned SSIV location, and has Atlantic 85 and IB1 class lifeboats (RNLI, 2022b). Withernsea is the closest lifeboat station to the Humber Pipeline route, at 1.9 km from KP2. Withernsea operates Henley Eight, a D class inshore lifeboat (RNLI, 2022c). The closest RNLI lifeboat station to the Store is Flamborough Head, which is located 66.5 km to the west, falling outside of the NRA study area.

Table 3-2 - RNLI lifeboats in the study area

Station	Lifeboats	County	Division	Proximity to
Hartlepool	ALB/ILB	County Durham	North & Scot South	Teesside Pipeline; Teesside SSIV
Redcar	ILB	North Yorkshire	North & Scot South	Teesside Pipeline; Teesside SSIV
Staithes and Runswick	ILB	North Yorkshire	North & Scot South	Teesside Pipeline; Teesside SSIV
Whitby	ALB/ILB	North Yorkshire	North & Scot South	Teesside Pipeline; Teesside SSIV
Withernsea	ILB	East Riding of Yorkshire	East	Humber Pipeline
Humber	ALB	East Riding of Yorkshire	East	Humber Pipeline
Cleethorpes	ILB	North Yorkshire	East	Humber Pipeline

3.4.2 SARH

As part of the MCA, HM Coastguard initiates and coordinates Search and Rescue (SAR) response around the UK. Since April 2015, Bristow Search and Rescue has provided the helicopter SAR service on behalf of HM Coastguard, operating 10 helicopter bases around the UK (Bristow Group, 2022).

The study area lies between the SARH bases of Humberside to the south (approximately 27 km away from the Humber Pipeline route), Prestwick to the north (approximately 245 km away at the closest point of the Teesside

Pipeline route), and Caernarfon to the southwest (approximately 298 km away from the Humber Pipeline route) (see Figure 3-7). The study area sits fully within the radii of action of two SARH bases (Humberside and Caernarfon).

3.5 Maritime incidents

A review of previous marine incidents within the study area can give an indication of the general level of marine incident risk in this region, which may be relevant during the installation phase of the Development.

This section considers such data as:

- RNLI Return to Service (launches in response to incidents);
- SARH taskings (Department for Transport); and
- MAIB marine incidents.

3.5.1 RNLI

The RNLI keeps a record of callouts to marine incidents. Those in the study area between 2008 and 2020, which were deemed not to be false alarms or hoaxes, are shown in Figure 3-6. A total of 2,765 unique incidents were recorded in the study area between 2008 and 2020. Of those incidents, 29.7% were due to machinery failure, followed by 15.9% of incidents whose reason was stated as 'unknown'. 84.1% of incidents were within 5 km of shore, and 98.3% of incidents occurred within the UK Territorial Sea Limit.

3.5.2 SARH

There were 173 SARH taskings in the study area between April 2015 and September 2022 (Figure 3-7). Of those taskings, 68.8% were 'rescue/recovery', and 69.9% (121) were within the UK Territorial Sea Limit.

3.5.3 MAIB Incident Data

The Marine Accident Investigation Branch works with the Department of Transport and investigates marine accidents involving all vessels within UK waters. The full dataset from 1992 – 2021 was utilised in this Baseline. There were 1,422 MAIB incidents within the study area during this timeframe, as displayed in Figure 3-8. Of the incidents studied, 39% were due to some form of loss of control (including loss of propulsion power, electrical power, containment or directional control), and 93.4% of incidents were within the UK Territorial Sea.

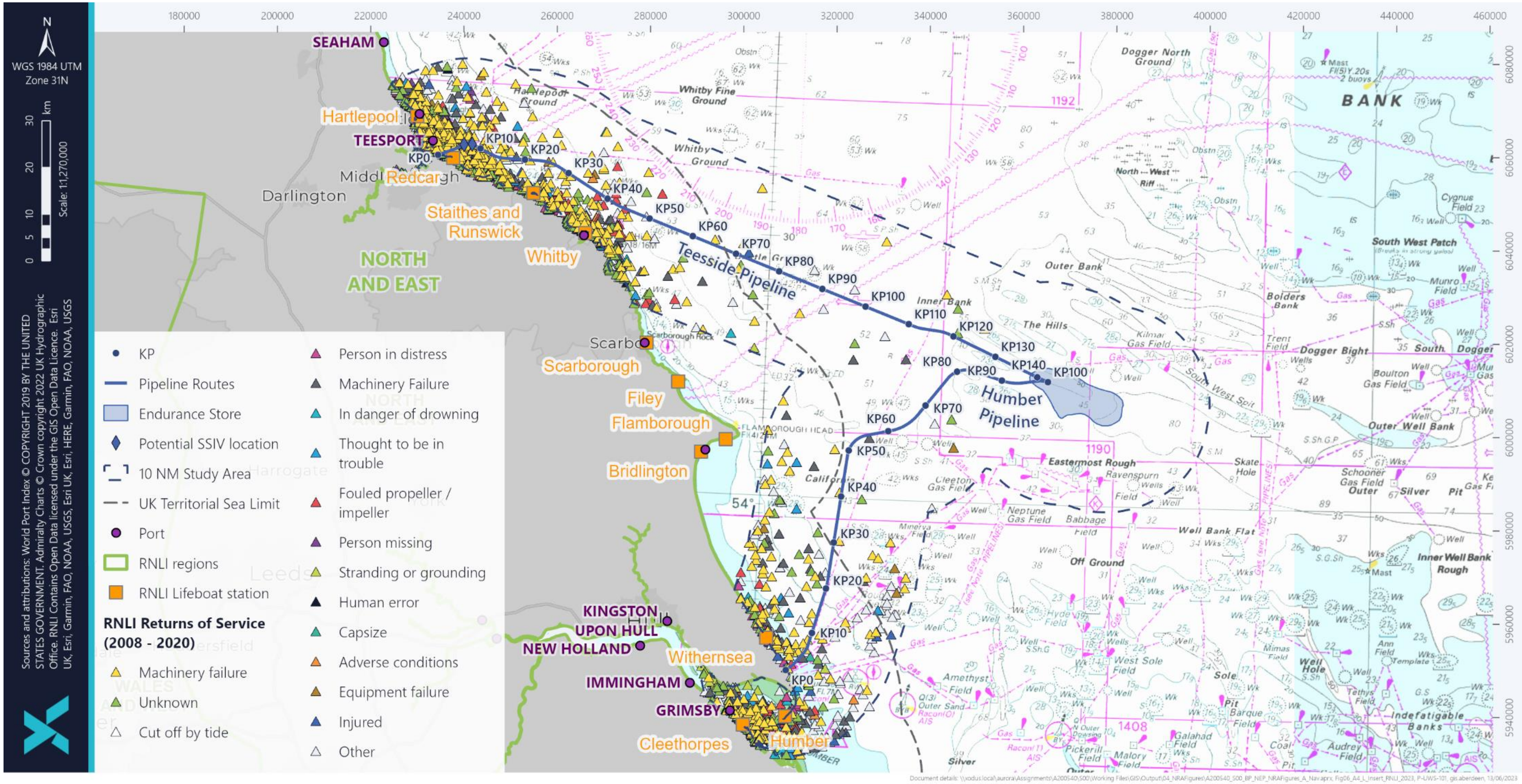


Figure 3-6 - RNLI lifeboat stations and returns to service (launches in response to incidents) in the study area

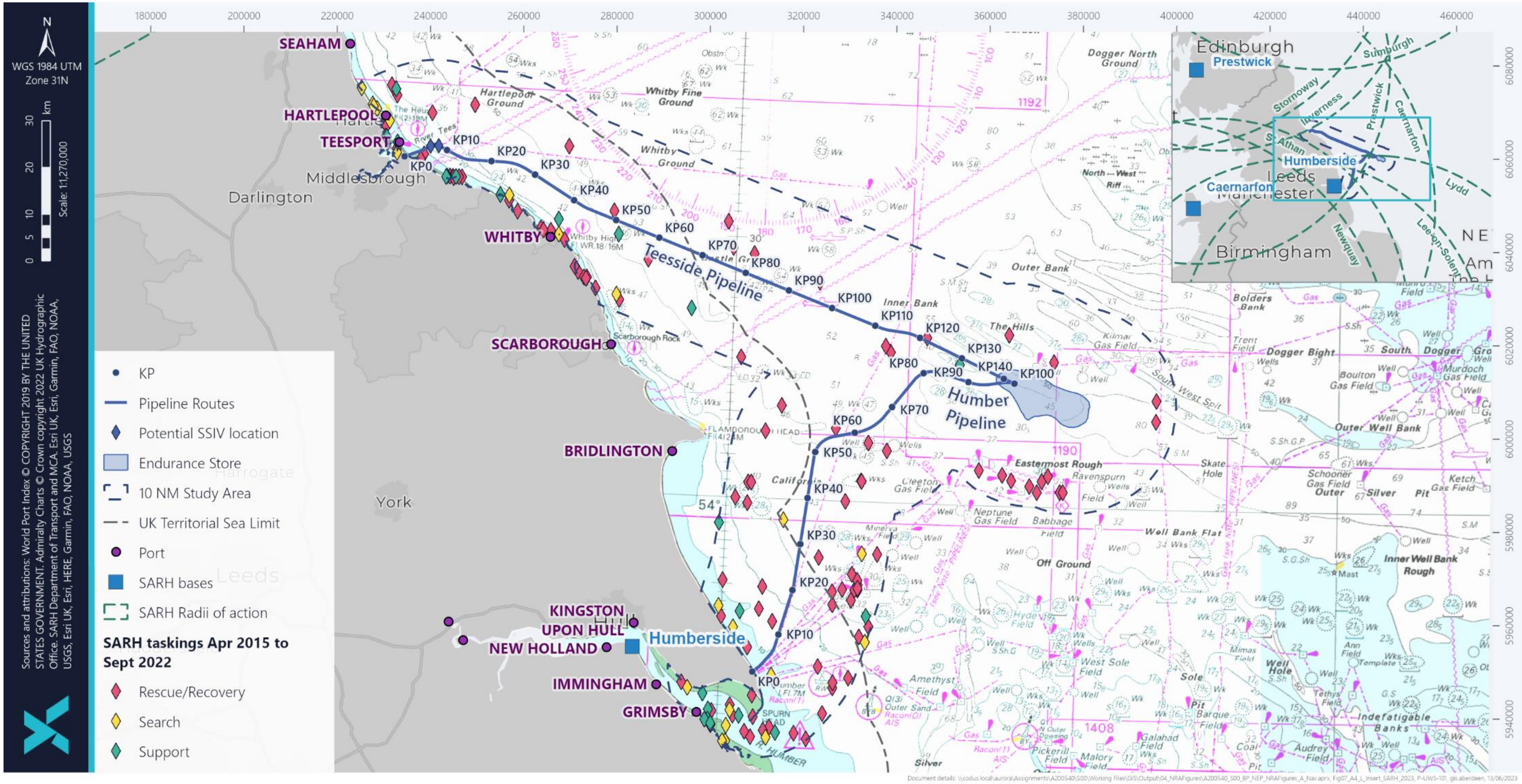


Figure 3-7 - SARH stations and taskings in the study area

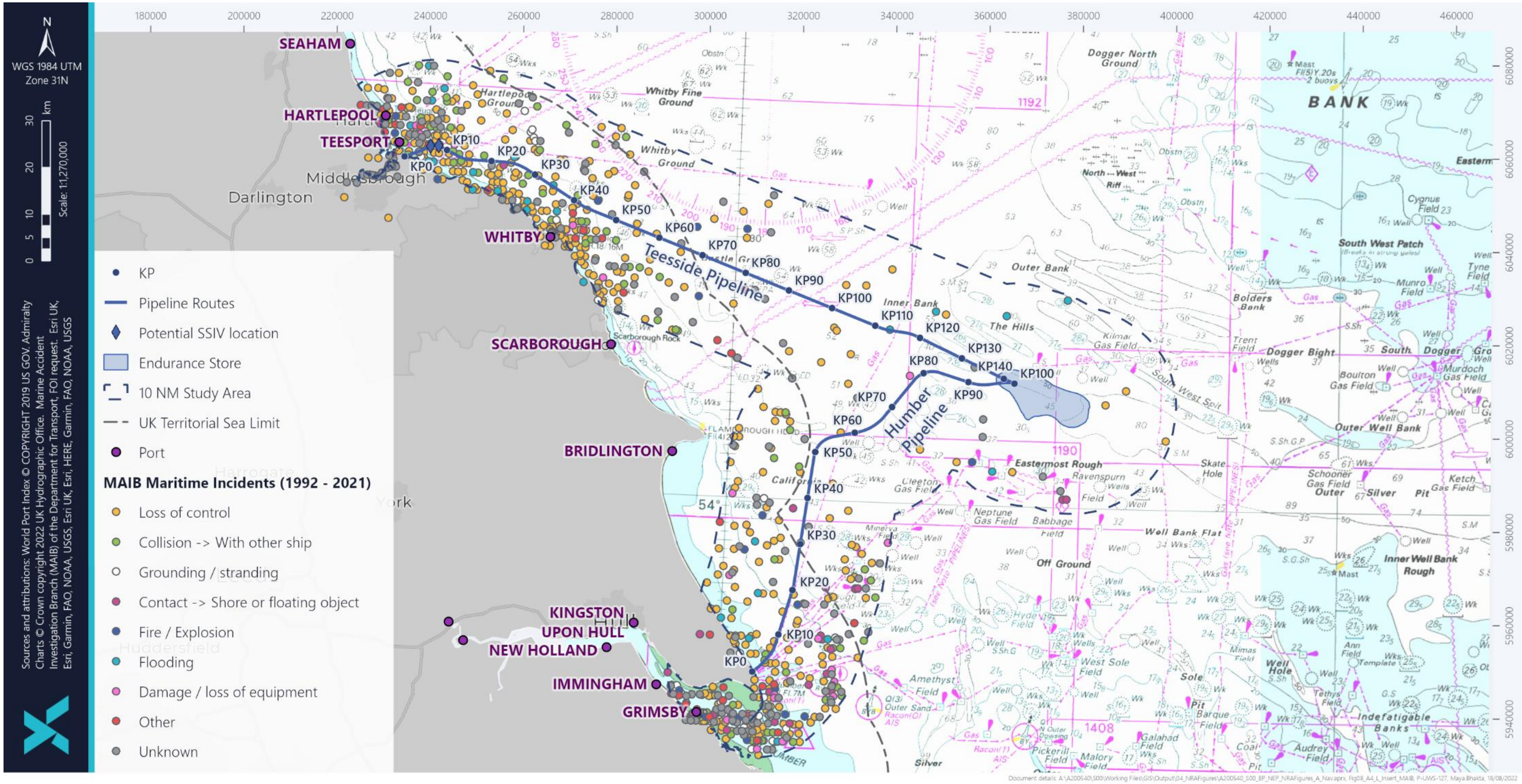


Figure 3-8 - MAIB maritime incidents in the study area

4 MARINE TRAFFIC STUDY

4.1 Vessel track counts and seasonality

A total of 49,320 AIS vessel tracks were recorded across the study year of 2021 to 2022. Tracks per month are displayed in Figure 4-1, and show that July was the month with the most tracks at 5,005 and February 2022 was the month with the least tracks at 2,923. One of the main differences across the year is greater numbers of recreational and passenger tracks within the late spring, summer and early autumn months (May to September). Offshore industry vessel tracks were greater from March to August 2021, and lower October 2021 to Feb 2022. Time of year is therefore a significant consideration for the installation phase of the Development.

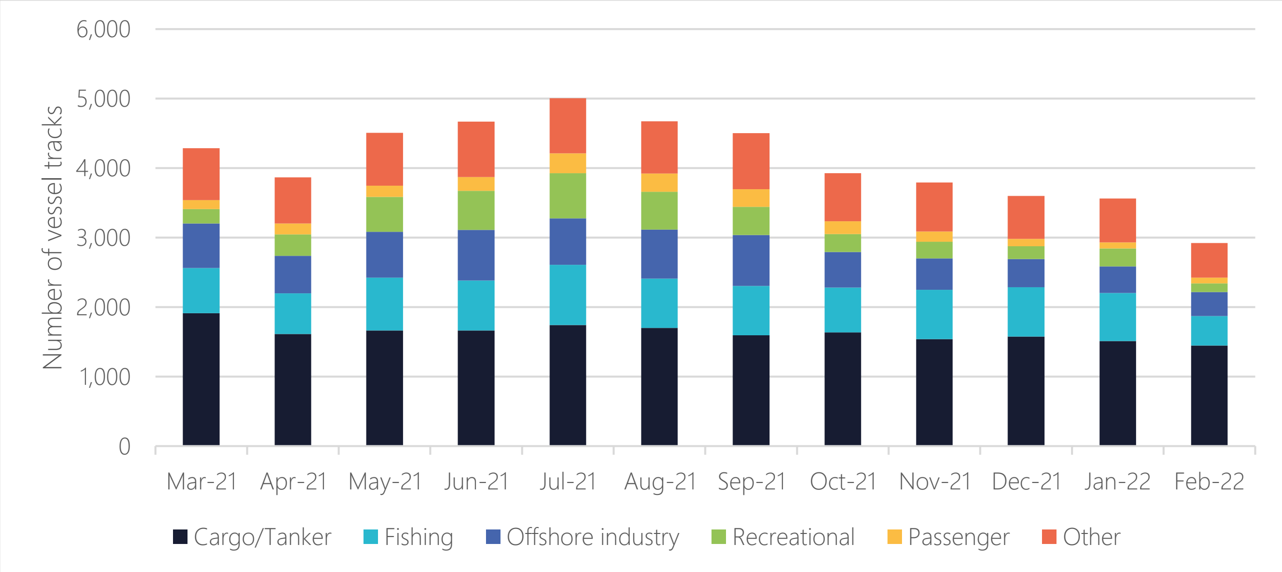


Figure 4-1 - AIS vessel tracks per month and vessel type

The seasonal AIS vessel track densities are displayed in Figure 4-2. There are similar patterns of density across all four seasons. The Teesside Pipeline route is in proximity to high track density to the north, routing to and from the River Tees, and crosses a region of moderate density from KP6 to KP50. The study area around the Teesside Pipeline route shows lower density in summer (see Figure 4-2). With the Teesside SSIV, Figure 4-3 shows more detail on the density across seasons at this location, and shows that density is moderate between KP6 – KP8 throughout spring, summer and autumn, with slightly higher density seen in winter in particular between KP7 to KP8.

The Humber Pipeline route crosses a region of moderate vessel traffic density between KP19 – KP54 and KP60 – KP74. There is very high density of vessel traffic to the south of the Humber Pipeline landfall, routing to and from the Humber Mouth however the pipeline does not directly cross this. The Store sees low density of vessel traffic across all seasons.

The day on which most vessels began a journey or crossed into the study area was 1st March 2021, as shown in Figure 4-4, when 318 tracks were recorded within the study area. Conversely, the quietest day was 5th December 2021, when only 39 tracks were recorded within the study area.

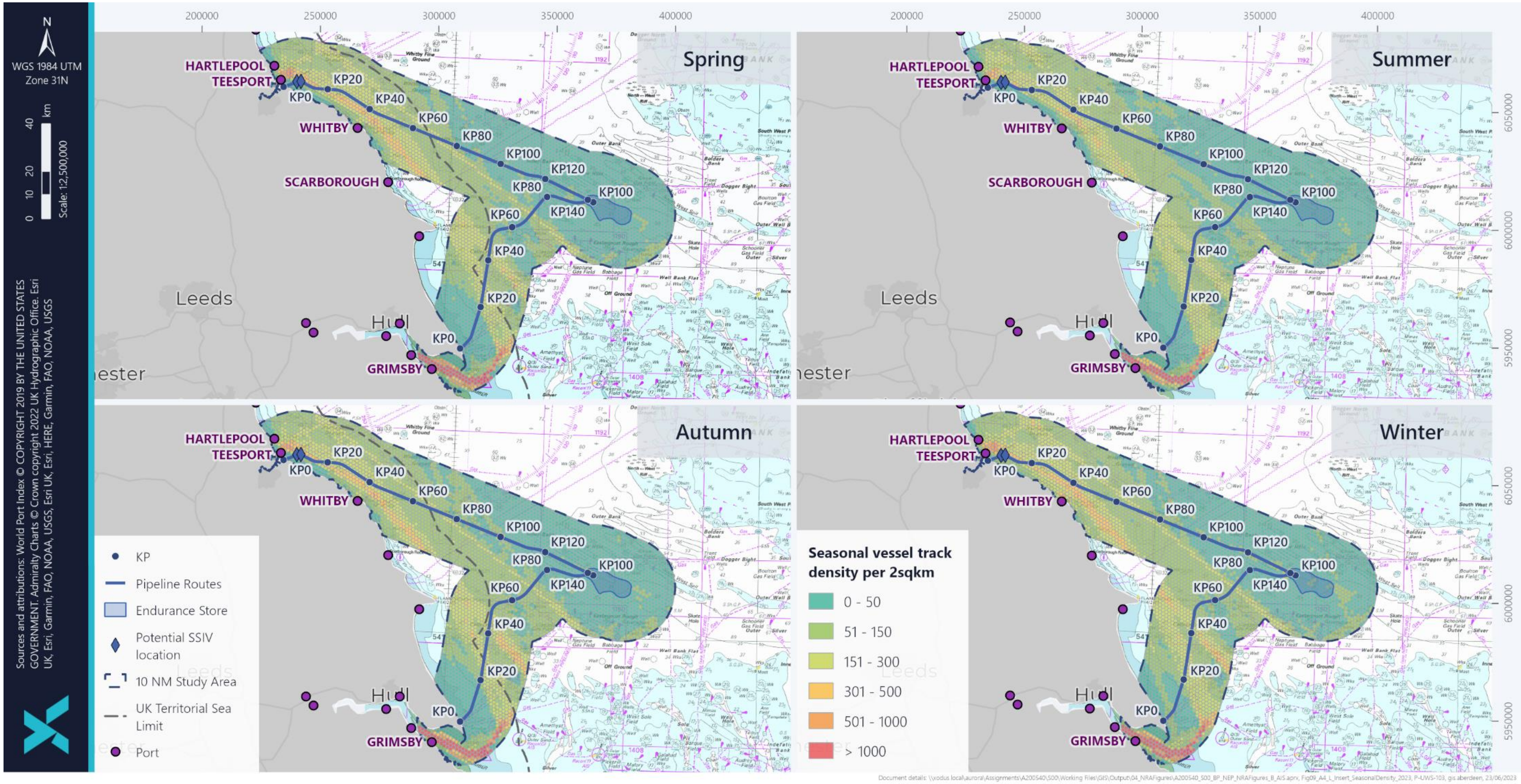


Figure 4-2 - AIS vessel track density by season

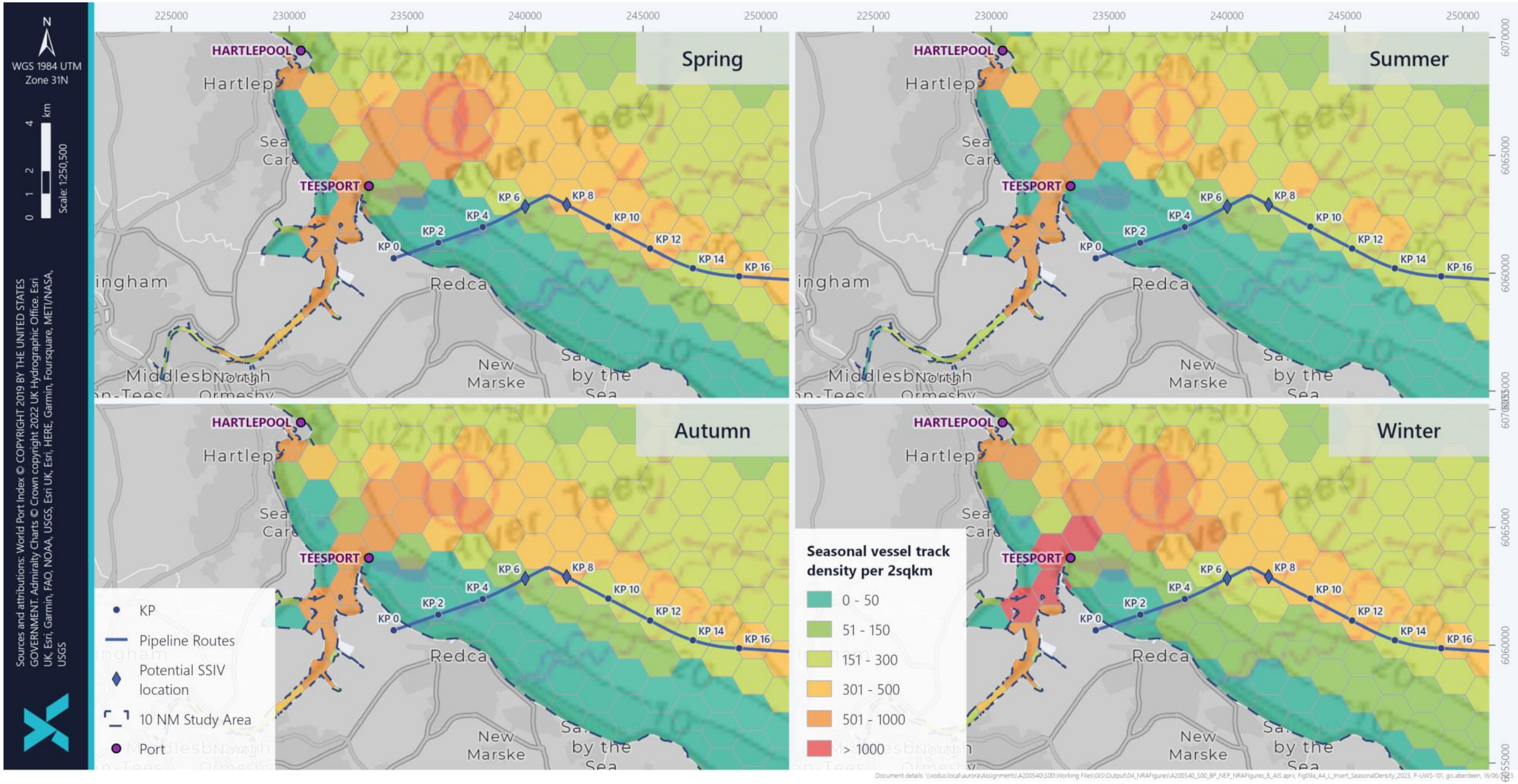


Figure 4-3 - AIS vessel track density by season for the SSIV location

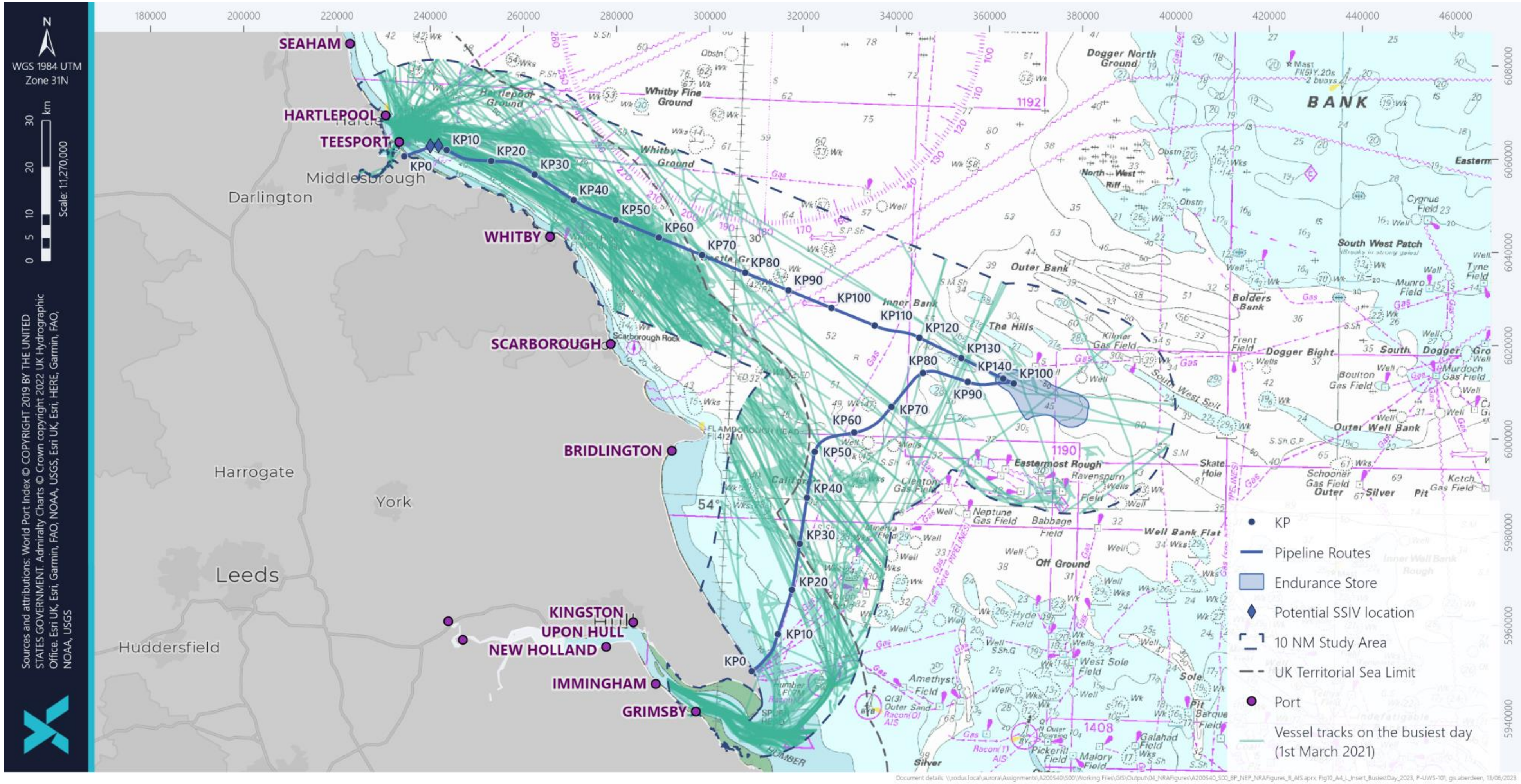


Figure 4-4 - Busiest day in the AIS data

4.2 Vessel type

The most frequently recorded AIS vessel tracks in the study area were from cargo/tanker vessels with 39.8% of all tracks across the studied year, with "other", "fishing" and "offshore industry" vessels following at 17.2%, 16.6% and 13.7% of tracks respectively (Table 4-1 and Figure 4-5). "Recreational" and "passenger" tracks were relatively low, at 8.6% and 4.2% of all tracks, respectively.

Table 4-1 - AIS tracks per vessel type

Type	Number of vessel tracks	Percentage of total
Cargo/Tanker	19,607	39.8
Fishing	8,169	16.6
Offshore industry	6,774	13.7
Passenger	2,059	4.2
Recreational	4,250	8.6
Other	8,461	17.2
Total	*49,320*	100

Figure 4-6 shows the vessel tracks by vessel type across the study area. The following sections describe the vessel activity across the study area per vessel type. Fishing vessel traffic is considered separately in Section 4.4.

4.2.1 Cargo vessels and tankers

Cargo/tanker vessel tracks are present throughout the study area, across the Teesside Pipeline route from approximately KP6 onwards, which is also relevant for the possible placement of the Teesside SSIV, across the Humber Pipeline route from KP18 onwards, and overlapping with the Store.

4.2.2 Passenger vessels

With passenger vessel tracks, activity is generally low throughout the study area, but some activity at the coast routing to and from Whitby and Staithes can be seen from approximately KP14 to KP39 along the Teesside Pipeline route. A prominent route crosses the Teesside Pipeline route at KP63 - KP73 (Figure 4-6). This passenger route also crosses the Humber Pipeline route between KP68 to KP71. This relates mainly to Newcastle to Ijmuiden (Netherlands) ferry vessel traffic, which is run by operator DFDS (DFDS, 2022). There is minimal passenger traffic at the Teesside SSIV and Store locations.

4.2.3 Recreational vessels

Regarding recreational AIS vessel tracks, these are concentrated mainly inshore and within the UK Territorial Sea Limit, as Figure 4-6 shows. This region of higher activity is present along the Teesside Pipeline route from approximately KP1 to KP55. The area of search for the Teesside SSIV would also fall within this region between KP6 – KP8. The Humber Pipeline route crosses the higher recreational activity inshore from approximately KP1 to KP45. There is little recreational activity at the Store.

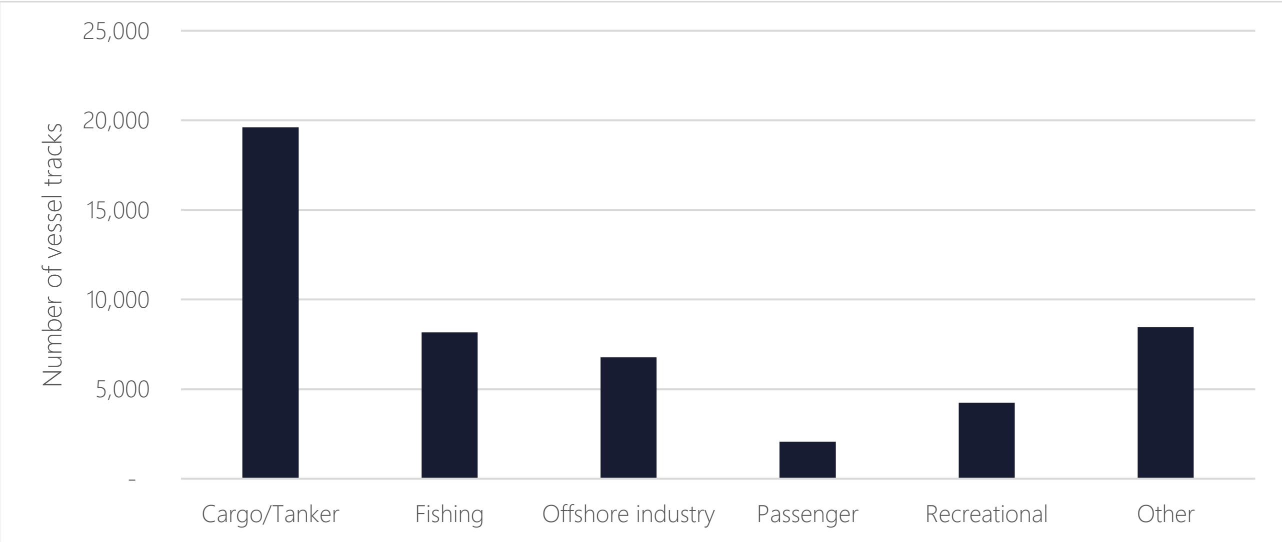


Figure 4-5 - AIS vessel tracks per vessel type chart

4.2.4 Offshore industry vessels

Offshore industry vessel tracks are present across much of the study area (Figure 4-6). The Teesside Pipeline route sees moderate offshore industry activity from KP3 onwards, but with fewer tracks present further offshore to towards the Store. The SSIV would be placed in a region of moderate offshore industry vessel activity between KP6 and KP8. Several regions of high intensity offshore industry vessel activity are identified to the east and south of the Humber Pipeline along its route, as shown on Figure 4-6, relating to oil and gas as well as offshore wind infrastructure (see Figure 3-4). The pipeline crosses offshore industry vessels routing to and from the River Humber to service the Westermost Rough windfarm between KP5 to KP16. The Store experiences low levels of offshore industry vessels across the studied year.

4.2.5 Other vessels

"Other" vessels could include research vessels, search and rescue, and unknown vessel types, and those identified within the study area are displayed on Figure 4-6. Tracks from other vessel types are concentrated mostly inshore along the Teesside Pipeline route, to KP50. This also overlaps with the potential SSIV location. Other vessel tracks are present at a low level across the Humber Pipeline route, with some higher activity crossing the pipeline, in particular between KP19 to KP33 and KP45 to KP48.

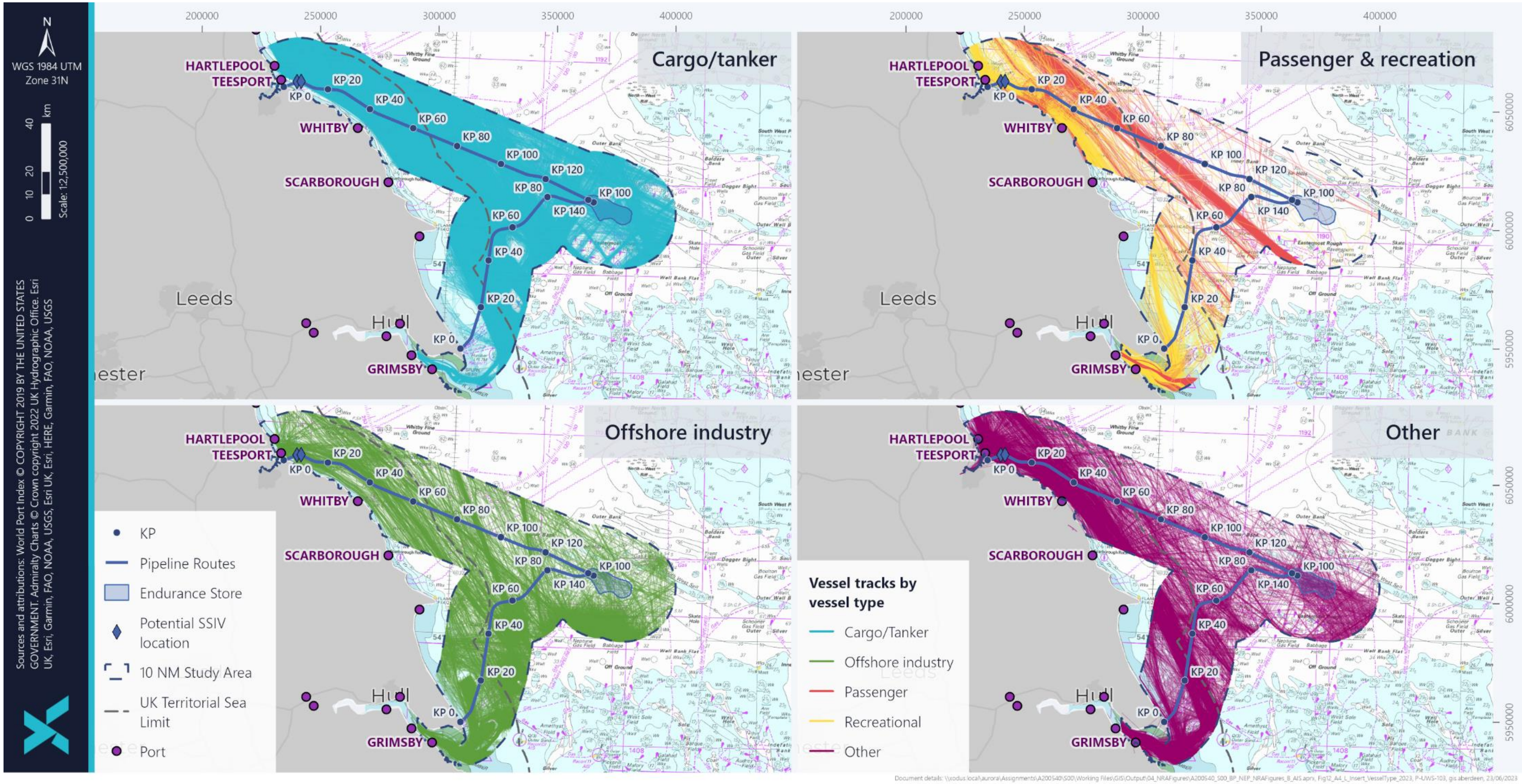


Figure 4-6 - Vessel type

4.3 Vessel size and status

4.3.1 Vessel length

AIS data contains information on vessel length. As shown in Table 4-2, 49.4% of all tracks were associated with small vessels of under 50 m in length. Only 5.2 % of vessels in the study area were from vessels of over 250 m in length, and only 25.3% of vessel tracks were from vessels of over 100 m in length. Figure 4-7 shows that the vessel tracks associated with vessels of under 50 m in length were mainly fishing, offshore industry, recreational and other vessels. Cargo and tanker vessels dominated tracks associated with vessels of over 50 m in length. Offshore industry vessel tracks are higher represented in the 50 – 100 m vessel length class, and passenger vessel tracks comprise a significant portion of traffic from vessels of over 150 m in length.

Table 4-2 - AIS vessel tracks by vessel length

Vessel length	Number of vessel tracks	Percentage of total tracks
0 - 50	24,377	49.4
50 – 100	11,096	22.5
100 - 150	5,971	12.1
150 - 200	3,950	8.0
Over 200	2,577	5.2
Unknown	1,349	2.7
Total	49,320	100

The spatial patterns in vessel length are presented in Figure 4-9. There is a clear trend of larger vessels routing further offshore. Smaller vessels are present close to shore along the Teesside Pipeline route, however from KP5 to the end of the pipeline at the Store, medium to larger vessels (over 100 m in length) are present. For the Teesside SSIV, medium to larger vessels (up to 200 m) are present between KP6 – KP8. For the Humber Pipeline route, smaller vessels (0 – 100 m in length) dominate from landfall to KP19 (Figure 4-9). From KP19 onwards to the Store, larger vessels (over 100 m) are present. Vessels which fall into the largest class of vessel length (over 200 m) are present at the Store location (Figure 4-9).

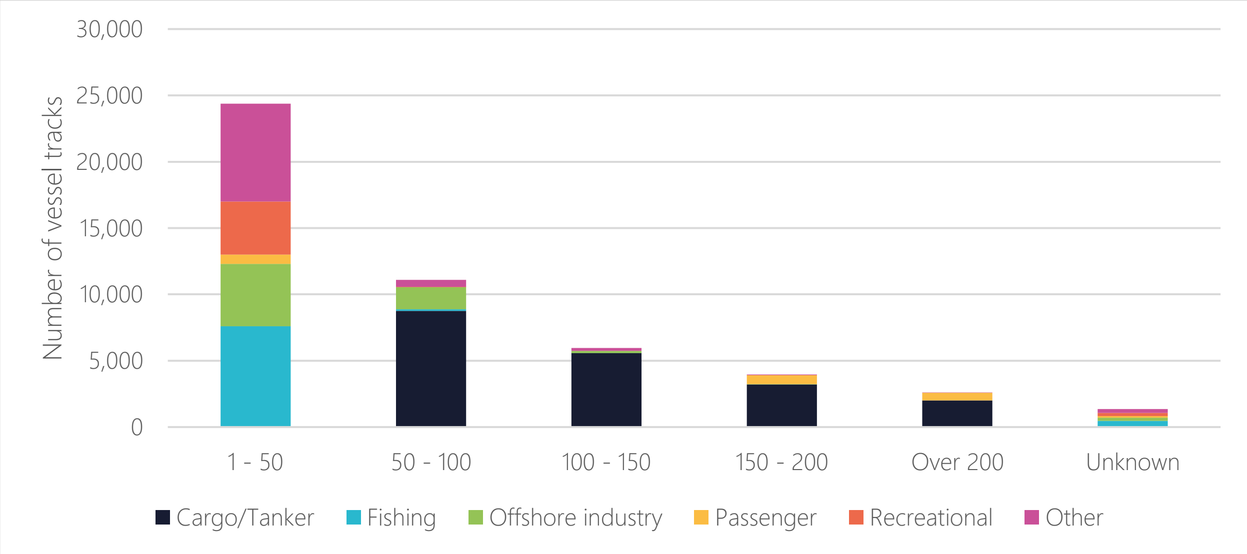


Figure 4-7 - AIS tracks vessel length by vessel type

4.3.2 Vessel DWT

DWT is an indication of vessel size as it refers to the carrying capacity of the vessel. There were 1,213 vessels missing DWT values in the AIS data for the study area, so a regression model was used based on the available data for each vessel type to calculate the missing values. The distribution of AIS vessel DWT is presented in Table 4-3 and shows that 53.8% of vessel tracks in the study area fell into the 1 – 1,500 DWT class. The chart in Figure 4-8 shows that fishing and other vessels comprised the majority of vessel tracks in this class, with offshore industry and recreational vessel tracks also significant. Cargo and tanker vessels dominate the other DWT classes (250 – 2,500, 2,500 – 5,000, 5,000 – 50,000, over 50,000). Offshore industry and other vessels also comprise significant portions of the tracks in the 250 – 2,500 DWT class.

Table 4-3 - AIS vessel tracks by DWT class

DWT	Number of vessel tracks	Percentage of total tracks
0 - 1,500	26,548	53.8
1,500 - 5,000	10,338	21.0
5,000 - 15,000	8,600	17.4
15,000 - 40,000	2,818	5.7
>40,000	1,016	2.1
Total	49,320	100

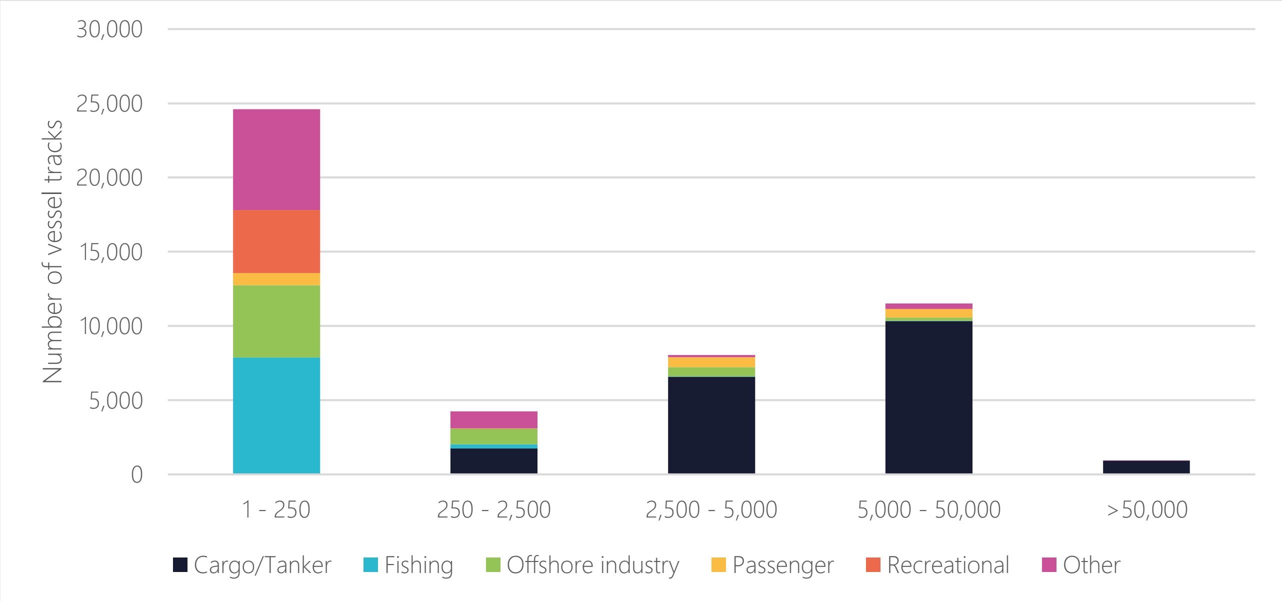


Figure 4-8 - AIS tracks by DWT and vessel type

In terms of the spatial distribution, along the Teesside Pipeline route up to KP5, tracks associated with vessels in the smallest DWT class (0 – 250 DWT) dominate (see Figure 4-10). From KP5 to KP13 vessels of up to 50,000 DWT are present, then from KP13 onwards vessels from the largest vessel DWT class (>50,000 DWT) are also present, until the end of the pipeline at the Store. Regarding the Teesside SSIV, vessels up to 50,000 DWT are present from KP6 – KP8 which is where the SSIV is currently planned to be located.

Up to KP19 along the Humber Pipeline route, the smallest vessel DWT class (0 – 250 DWT) dominates. From KP19 onwards until the end of the pipeline at the Store vessels in the largest DWT class (> 50,000 DWT) are present. Vessels with DWT of over 50,000 are present at the Store.

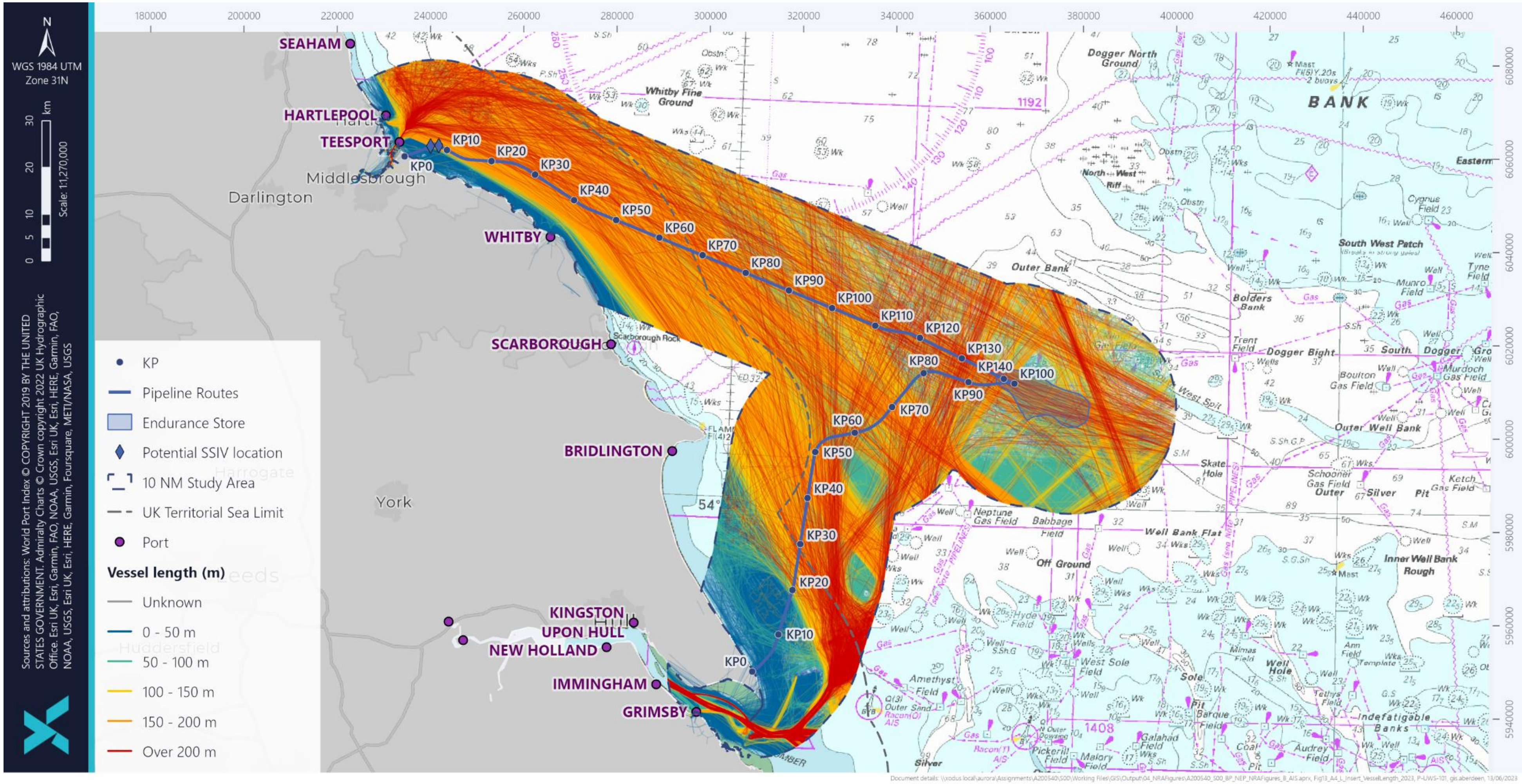


Figure 4-9 - Spatial distribution of AIS vessel tracks by vessel length

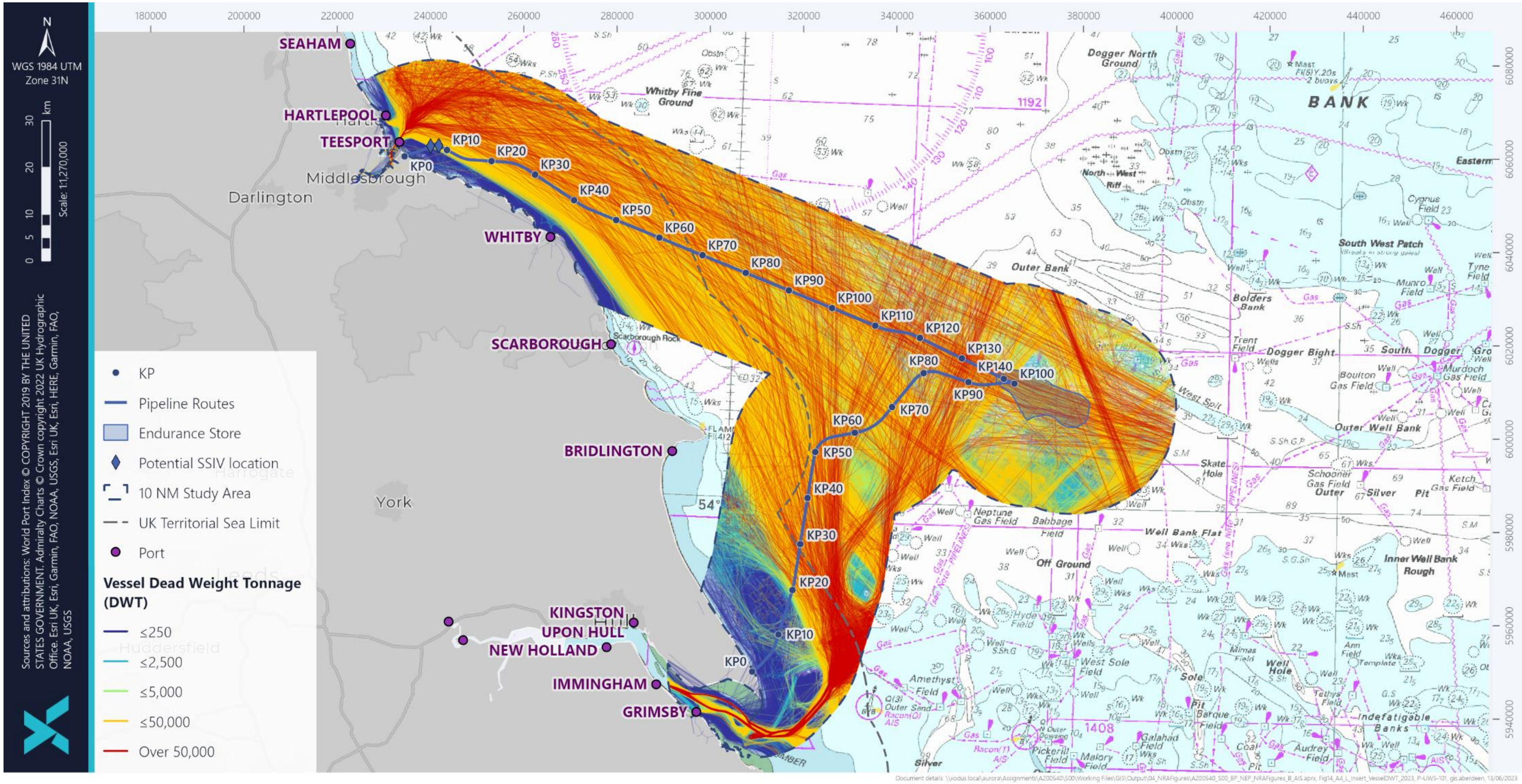


Figure 4-10 - Spatial distribution of AIS vessel tracks by vessel DWT

4.3.3 Vessel draught

Vessel draught distribution within the study area is presented in Table 4-4, and shows that 30.2% of vessel tracks across the studied year had a registered draught between 5 and 7.5 m. It should be noted that 30.9% of vessel tracks in the study area did not provide this draught information.

Figure 4-11 presents the vessel draught classes by vessel type and shows that cargo vessels and tankers were the dominant vessel type across draught classes 2.5 – 5 m, 5 – 7.5, 7.5 – 10 m, and over 10 m. Offshore industry vessels were the responsible for the majority of vessel tracks in the 0 – 2.5 m draught class. The majority of fishing and recreational vessels tracks did not provide this draught information (Figure 4-11).

Table 4-4 - AIS vessel tracks by vessel draught

Draught at timestamp (m)	Number of vessel tracks	Percentage of total tracks
0 - 2.5	7,444	15.1
2.5 - 5	8,285	16.8
5 - 7.5	14,898	30.2
7.5 - 10	2,416	4.9
Over 10	1,049	2.1
Unknown	15,228	30.9
Grand Total	49,320	100

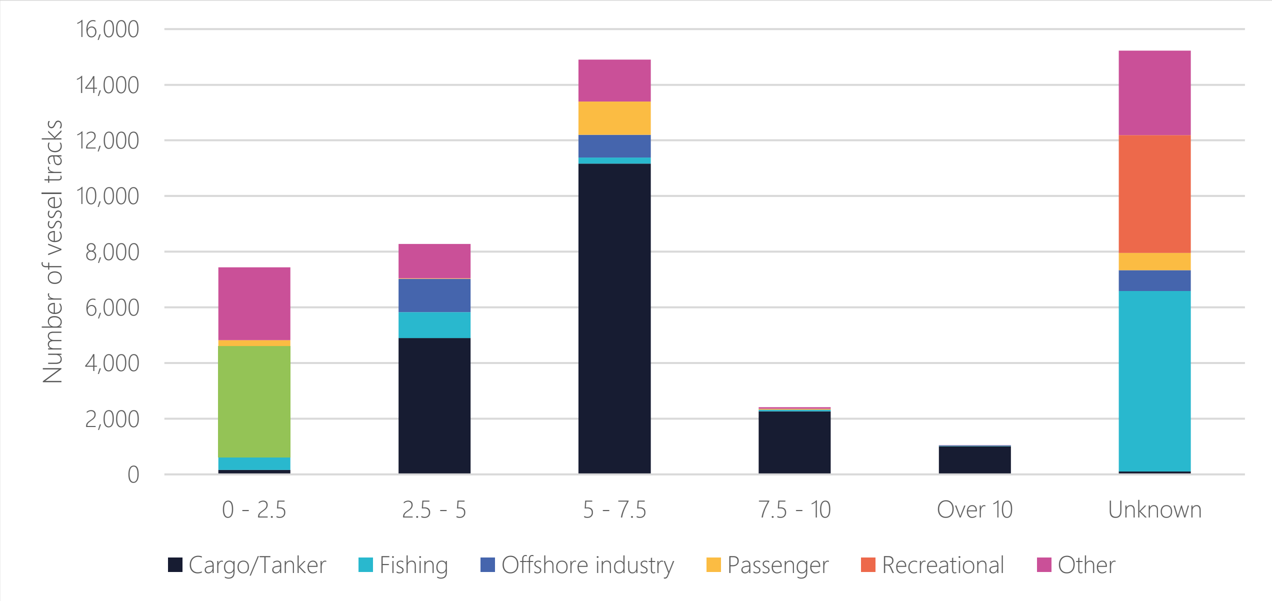


Figure 4-11 - AIS vessel track draught by vessel type

In terms of the spatial distribution, similar to the trend seen with vessel lengths, along the Teesside Pipeline route up to KP5 the majority of tracks are associated with vessels in the smallest draught classes, with under 5 m draught (Figure 4-12). Tracks from vessels with draughts of over 10 m are present from KP5 to the end of the pipeline at the Store. With the Humber Pipeline route, tracks from vessels with draughts of under 5 m dominate from the landfall up to KP4, and vessels with draughts of between 5 – 7.5 m are present from KP4. At approximately KP19, the Humber Pipeline route enters a region of increased vessel traffic where tracks from vessels with draught of over 10 m are present, and vessels in this largest draught class are present until the end of the pipeline at the Store. The Store experiences traffic from vessels with draught of over 10 m, as shown in Figure 4-12.

4.3.4 Anchored vessels

AIS data points contain information on a vessel's status, including if it is 'at anchor'. This status is manually set by the crew and is acknowledged to be subject to human error but nonetheless can give an indication of presence of anchoring vessels in the study area. Points with status set to 'at anchor' were filtered by speed, displaying points which had a speed of <2 knots as these are likely to be anchoring on Figure 4-13. Points with a speed of >2 knots were not displayed as these are more likely to have been erroneously set as 'at anchor'. As mentioned in Section 3.2.2, the Development does not overlap with any charted anchorage areas.

In Figure 4-13 anchoring vessel points can be seen overlapping with the identified anchorage areas of Charlie, Echo and Whiskey, associated with Teesport. Anchoring vessel points can also be seen within the Tees and Hartlepool Harbour Authority Area; from consultation with PD Ports, it was confirmed that anchoring within the harbour area is prohibited without specific permission from the harbour authority, so these points may be instead due to a result of erroneous setting of vessel status by captains. The Charlie anchorage area is 4.8 km from KP7, and Echo is approximately 6.9 km from KP11. Additionally, a region of anchoring vessels is present outside of these anchoring areas, approximately 17 km to the north of KP25. There is little other anchoring vessel activity throughout the rest of the study area surrounding the Teesside Pipeline route. Regarding the Teesside SSIV, no anchoring vessel points are identified between KP6 and KP8, however the location is in proximity to the Charlie anchorage area being 5.6 km from KP6, as well as to the anchoring vessel points within the Harbour Authority Area. Regarding the Humber Pipeline route, anchoring points can be seen within the anchorage areas identified in Section 3.2.2, namely Hawke, Haile, Bull and the Humber Deep Water anchorage, all associated with the Humber Port Authority Area. Some vessels are identified as anchoring outside of these charted anchorage areas. There is a region of anchoring vessels east of the Humber Pipeline route between KP4 to KP21, approximately 4 km at the closest point from KP4 (Figure 4-13), additionally some anchoring activity is present to the northwest of KP3 – KP12 (see Figure 4-13). The Store does not see any anchoring activity.

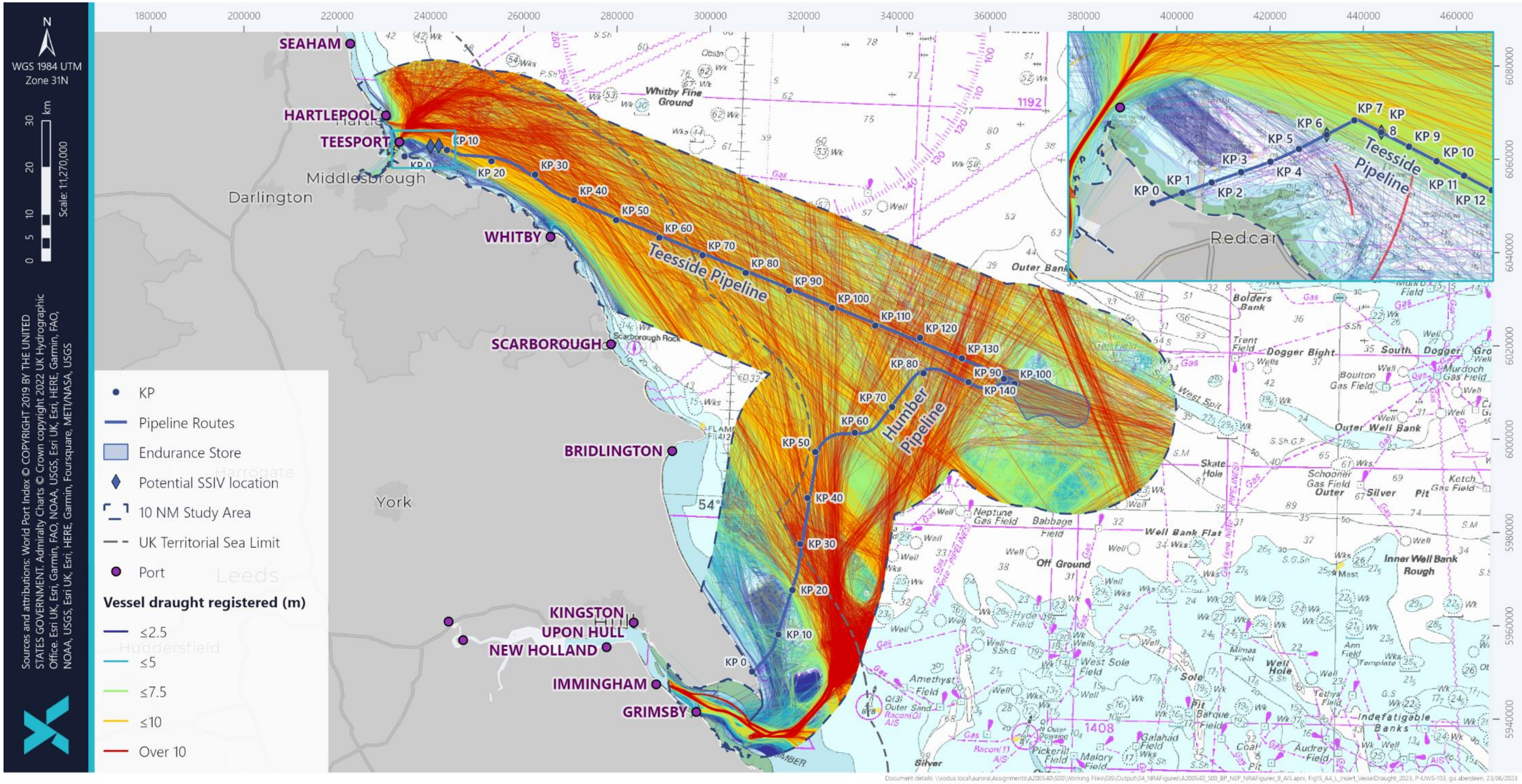


Figure 4-12 - Spatial distribution of AIS vessel tracks by vessel draught

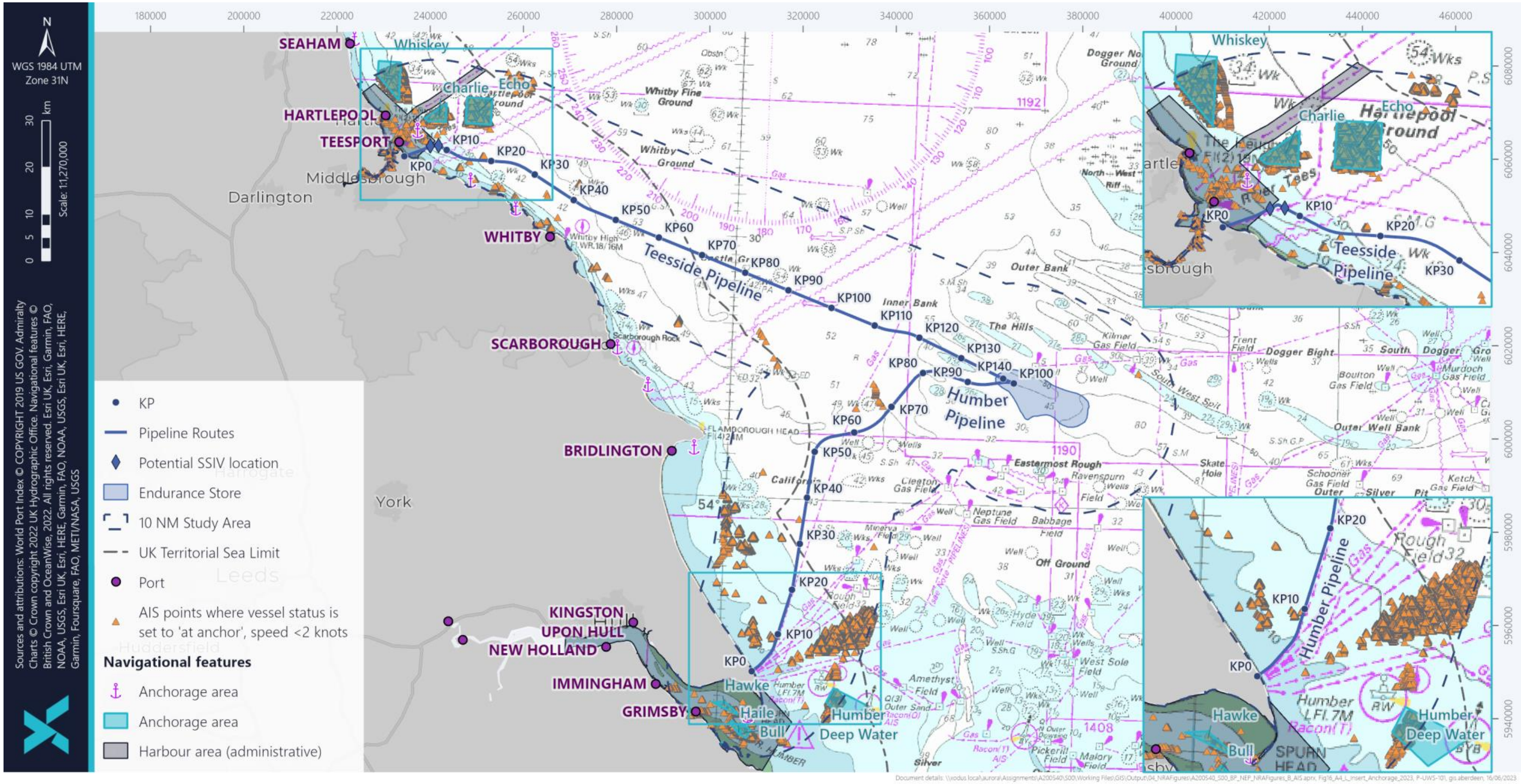


Figure 4-13 - Vessels at anchor in AIS data

4.4 Fishing analysis

4.4.1 Introduction

This section presents an analysis of fishing vessels in the vicinity of the Development, based on both AIS and VMS data. It should be noted that fishing is considered from a broad navigational perspective here. For detailed assessment of commercial fisheries baseline condition please refer to ES Chapter 9: Physical Presence. It should also be noted that the AIS data used in this NRA provides detailed information on the specific trajectories of the vessels, but is likely to under-represent fishing activity, since fishing vessels under 15 m length are not obliged to carry an AIS transponder, (though many do voluntarily for safety). VMS data can provide a more comprehensive picture of fishing activity since vessels greater than 12 m are obliged to carry VMS equipment, however, the data are not publicly available in a format that allows reconstruction of trajectories, and vessels under 12 m will not be represented.

Three types of AIS vessel data have been used to gain insight into fishing activity in the study area:

- AIS fishing vessel tracks categorised by length;
- AIS fishing vessel tracks categorised by vessel subtype; and
- AIS data points with status set to "actively fishing".

As detailed in Section 2.3, three additional data sources have been used to supplement the AIS data:

- Anonymised VMS point data during 2019, which has been processed to provide density information for the study area. This data provides no information on gear type or fishing status, however vessel speed can be used as a proxy for fishing status. Vessels travelling at speeds of < 6 knots (kts) are considered likely to be fishing;
- MMO sightings data 2011 to 2019 representing vessels sighted on surveillance flights; and
- Fishing activity by International Council for the Exploration of the Sea (ICES) statistical rectangle distributed by the MMO. This data includes details about time spent fishing and gear type over the period 2016 - 2019, but is aggregated within each ICES statistical rectangle, so local patterns of activity cannot readily be discerned.

Additionally, information regarding fishing activity within the region from the North Sea (West) Pilot was noted.

4.4.2 Fishing vessels in AIS data

Fishing vessel length and subtype

Fishing vessel tracks classified by length and by fishing vessel subtype are shown in Figure 4-14. As previously noted, vessels under 15 m in length are underrepresented in this data. Fishing vessel traffic is present throughout the study area but sees increased concentration within the UK Territorial Sea Limit. In terms of vessel subtypes, the most common type is "fishing vessel / fishing" with 95% of tracks in the study area. Trawlers represented 4.7% of tracks in the study area.

The Teesside Pipeline route sees little fishing traffic up to KP6, and those that are present are under 15 m in length. From KP6, vessels of up to 50 m in length are present, and trawlers are present from KP6 routing around the coast.

There is increased traffic from vessels over 50 m in length from KP64 to the end of the pipeline at the Store. Fishing vessel traffic intensity lessens along the Teesside Pipeline route after approximately KP80 onwards to the Store.

Regarding the Teesside SSIV, from KP6 to KP8 vessels of over 15 m and up to 50 m in length are present and general fishing traffic is moderate.

The Humber Pipeline route up to KP18 mainly sees presence of fishing traffic from vessels of under 15 m in length, with large vessels of 15 – 30 m and over 50 m in length present after this point until the end of the pipeline at the Store. Up to KP42, increased fishing traffic can be seen routing to and from Bridlington, noted as a busy fishing harbour (Royal Northumberland Yacht Club, 2021); after approximately KP42, lesser intensity of fishing activity is seen, until the end of the pipeline at the Store. Trawlers are present from KP17 until the end of the pipeline at the Store.

A lower intensity of fishing traffic can be seen at the Endurance Store compared to the rest of the study area (Figure 4-14), however larger vessels of between 30 – 50 m and over 50 m in length are higher represented here. Trawlers and fish carriers are also present across the Store.

Actively fishing

AIS points that are likely to represent fishing activity based on speed and/or AIS status are displayed in Figure 4-15. Those points from vessels travelling at > 6 knots are assumed to be transiting rather than actively fishing. Actively fishing vessels show decreased intensity in the summer and winter months, and greater geographic spread in the spring and autumn months (Figure 4-15).

The Teesside Pipeline route sees presence of actively fishing vessels concentrated between approximately KP12 to KP80 in spring, and from the landfall up to KP44 in summer. In autumn, actively fishing vessels are present between KP5 to KP55, with an additional region of lower activity between KP66 to KP99. In winter, actively fishing vessels are concentrated between KP6 to KP67. For the Teesside SSIV, vessels actively fishing are present between KP6 and KP8 but in relatively low density.

The Humber Pipeline route also experiences clear seasonal variation in the spatial patterns of actively fishing vessels. In spring, actively fishing vessel activity is concentrated mainly between KP2 to KP80, with highest intensity KP26 – KP51, and in summer up to KP28 with an additional region of activity between KP45 – KP70. Autumn sees the greatest geographic spread of actively fishing vessels across the studied year, with activity present up to KP93 and highest intensity between KP36 to KP58, and winter sees the least geographic spread with actively fishing vessels concentrated up to KP39.

The Store experiences little actively fishing vessel activity in spring, summer and winter, but with some increased activity seen in autumn (Figure 4-15).

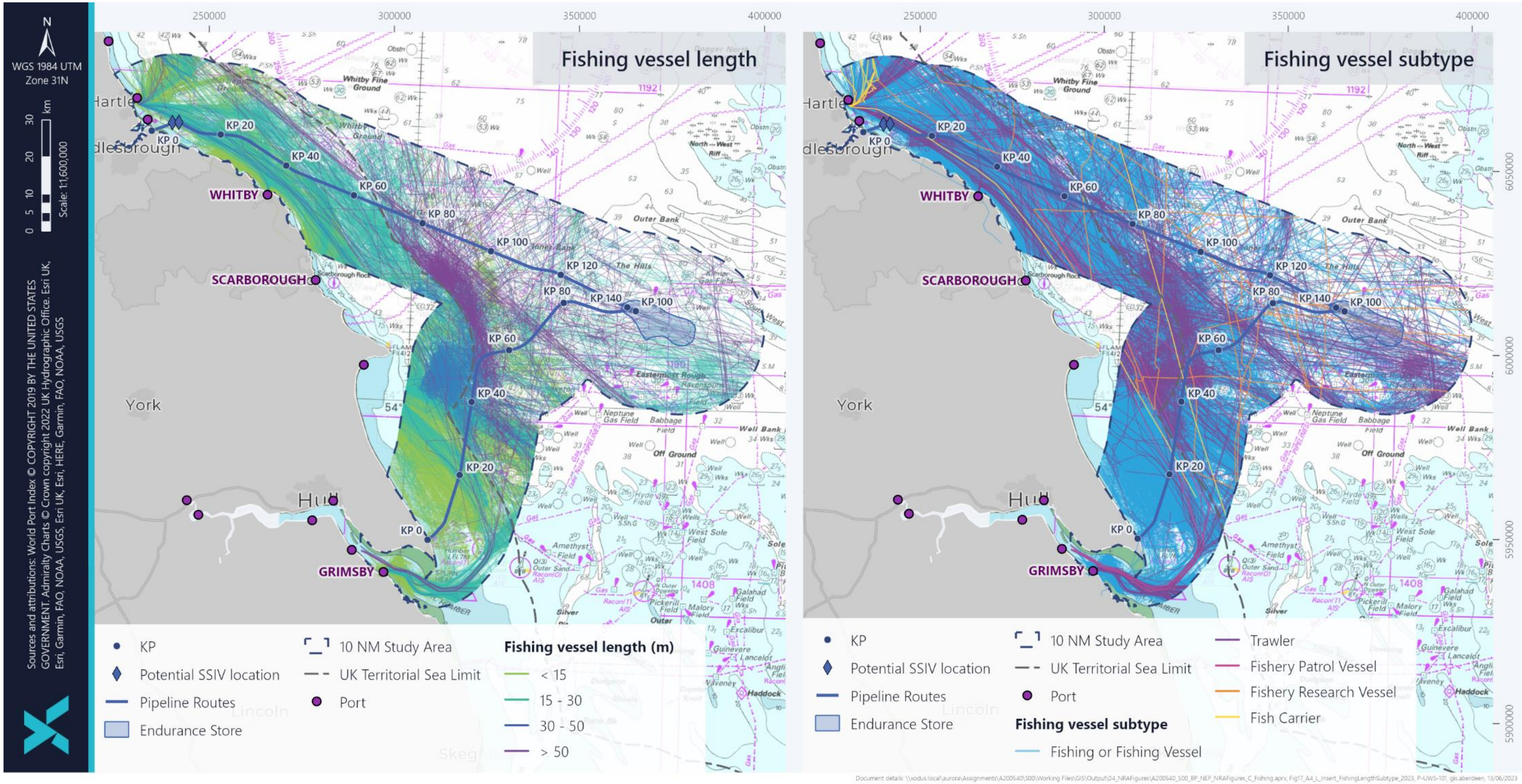


Figure 4-14 - AIS data of fishing vessels by vessel length and subtype

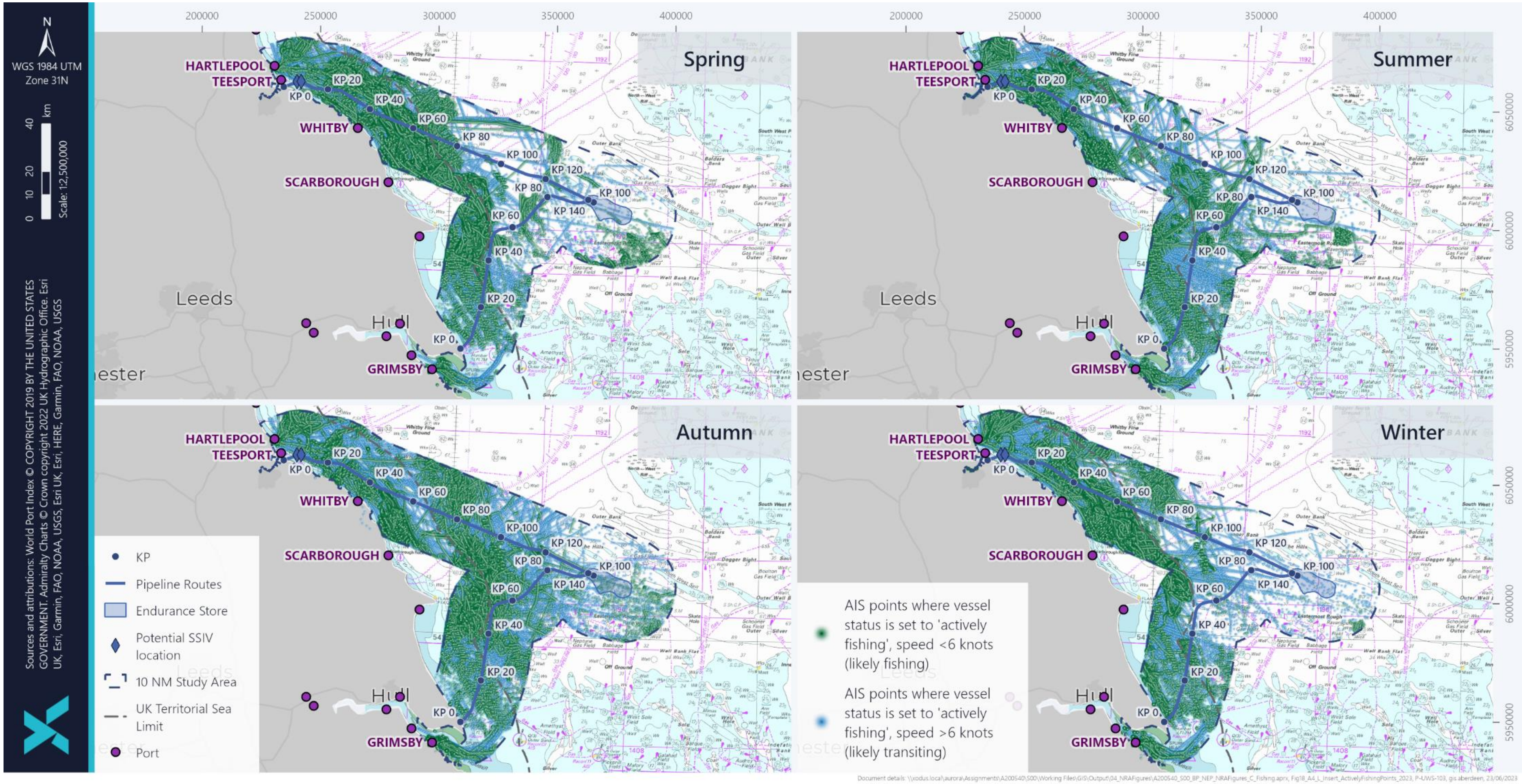


Figure 4-15 - Actively fishing

4.4.3 VMS and sightings data points

This section utilised the point VMS and sightings data to supplement the use of AIS data in studying fishing activity, using anonymised VMS points from the MMO to explore density of slow moving vessels, and 2019 vessel sightings points data from the MMO to study vessel types, as mentioned previously in Section 4.4.1.

VMS vessel density of slow moving vessels

Vessel density of slow moving (< 6 kts) vessels is displayed in the left panel of Figure 4-16, giving an indication of the presence of vessels which are actively fishing. It can be assumed that those vessels travelling at more than 6 kts are not fishing and are likely to be in transit, whilst those travelling at less than 6 kts may be fishing or engaged in other activities (Lee, South, & Jennings, 2010).

Figure 4-16 shows that along the Teesside Pipeline route there is greater density of vessels travelling at < 6 kts between approximately KP43 and KP81, as well as between KP120 – KP138, while along the rest of the route density is low. The Teesside SSIV does not interact with any vessels travelling at < 6 kts in this dataset. Along the Humber Pipeline route there are a number of regions of higher density of vessels travelling at < 6 kts, between KP28 – KP34, KP44 – KP56 and KP73 – KP98, while across the rest of the pipeline density is low. The west of the Store overlaps with some regions of moderate density, as shown in Figure 4-16.

Vessel sightings

The right panel of Figure 4-16 presents MMO sightings data 2011 to 2019 representing vessels sighted on surveillance flights, classified by vessel type. The most common fishing vessel type sighted within the study area were 'scallop dredger (French/Newhaven)' vessels, which accounted for 4.5% of all sightings, and 'potter/whelker' vessels accounted for 2.8% of all sightings. The majority of sightings are within the UK Territorial Sea Limit.

Figure 4-16 shows that within the study area in proximity to the Teesside Pipeline route, 'scallop dredgers (French/Newhaven)' have a wide geographic spread between KP18 to KP80, predominantly to the south of the pipeline and within the UK Territorial Sea Limit. 'Stern trawlers (pelagic/demersal)' are also present, concentrated around KP62 – KP78. The sightings data also indicates the presence of a variety of trawlers including 'potter/whelkers', 'demersal stern trawlers' and 'beam trawlers' up to KP80. There were no sightings in the vicinity of KP6 – KP8 at the potential SSIV location.

The study area surrounding the Humber Pipeline route saw fewer sightings than the Teesside Pipeline route. There were few sightings in the study area up to KP20, where sparse sightings were recorded up to approximately KP50, including 'potter/whelkers' and 'stern trawlers (pelagic/demersal)'. Between KP43 and KP58 along the Humber Pipeline route there were recorded sightings of 'scallop dredgers (French/Newhaven)', 'potter/whelkers', 'bottom seiner (anchor/Danish/fly/Scots)' and 'trawlers (all)' was present, predominantly to the west of the pipeline. There were few vessel sightings in the vicinity of the Store (Figure 4-16).

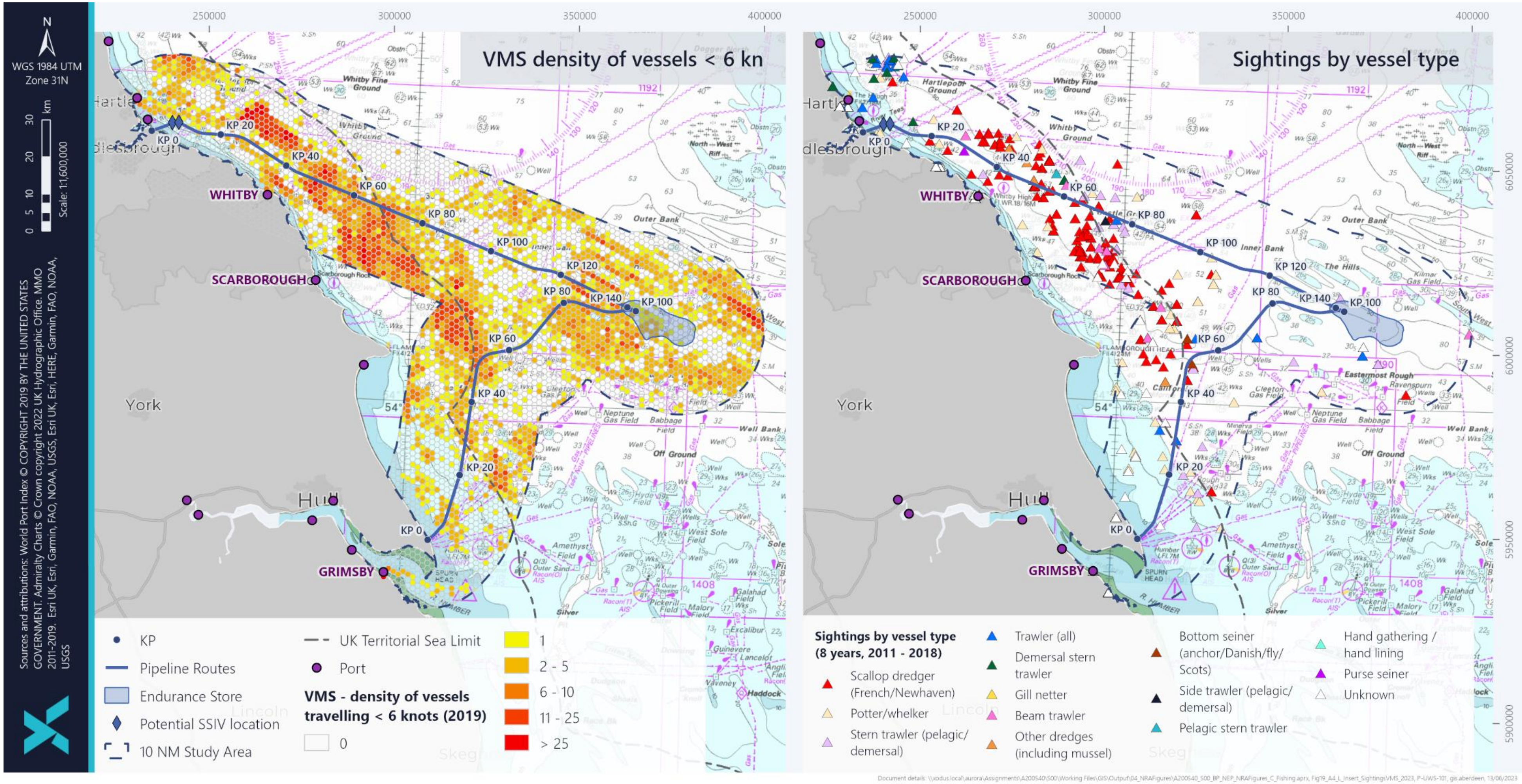


Figure 4-16 - VMS and sightings

4.4.4 VMS by ICES sub-rectangles

This section utilises fishing activity data available by ICES statistical sub-rectangle for four years over the period 2016 – 2019 obtained from the MMO. This data set provides summaries of fishing activity for UK commercial fishing vessels of 15 m and over in length that are deemed to have been fishing within a specified calendar year. This data has been aggregated to show the average annual time spent fishing by gear type from 2016 to 2019.

Figure 4-17 shows mean time spent fishing by demersal trawl or seine, pelagic trawl or seine, dredges and pot or traps gear types. Along the Teesside Pipeline route there is low intensity of demersal trawl or seine, with a region of moderate intensity present at approximately KP31 – KP35. Pelagic trawl or seine is very low intensity along the Teesside Pipeline route. Fishing using dredges shows some high intensity between KP42 and KP70, but remains low across the rest of the pipeline. In terms of fishing using pots or traps, there are areas of moderate to high intensity present along the Teesside Pipeline route from KP64 onwards (Figure 4-17). There is no data available up to KP8 to provide insight for the Teesside SSIV.

Regarding the Humber Pipeline route, demersal trawl or seine and pelagic trawl or seine both show low fishing intensity throughout the study area (Figure 4-17). There is some moderate to high intensity dredge fishing present from KP25 to KP55 along the Humber Pipeline. In terms of ports or traps there is greater fishing intensity across the Humber Pipeline route with this gear type; fishing intensity is high between KP3 and KP11, and moderate to high between KP11 and KP99.

The Store experiences low fishing intensity with demersal trawl or seine, pelagic trawl or seine and dredge gear types, but low-to-moderate intensity of fishing with pots or traps (see Figure 4-17).

4.4.5 Regional fishing activity information from North Sea (West) Pilot

The North Sea (West) Pilot (UKHO, 2018) notes that:

- this region is fished extensively;
- trawling is undertaken over this region throughout the year by vessels of all sizes;
- seine netting is present throughout the region; and
- potting and drifting are present throughout the region.

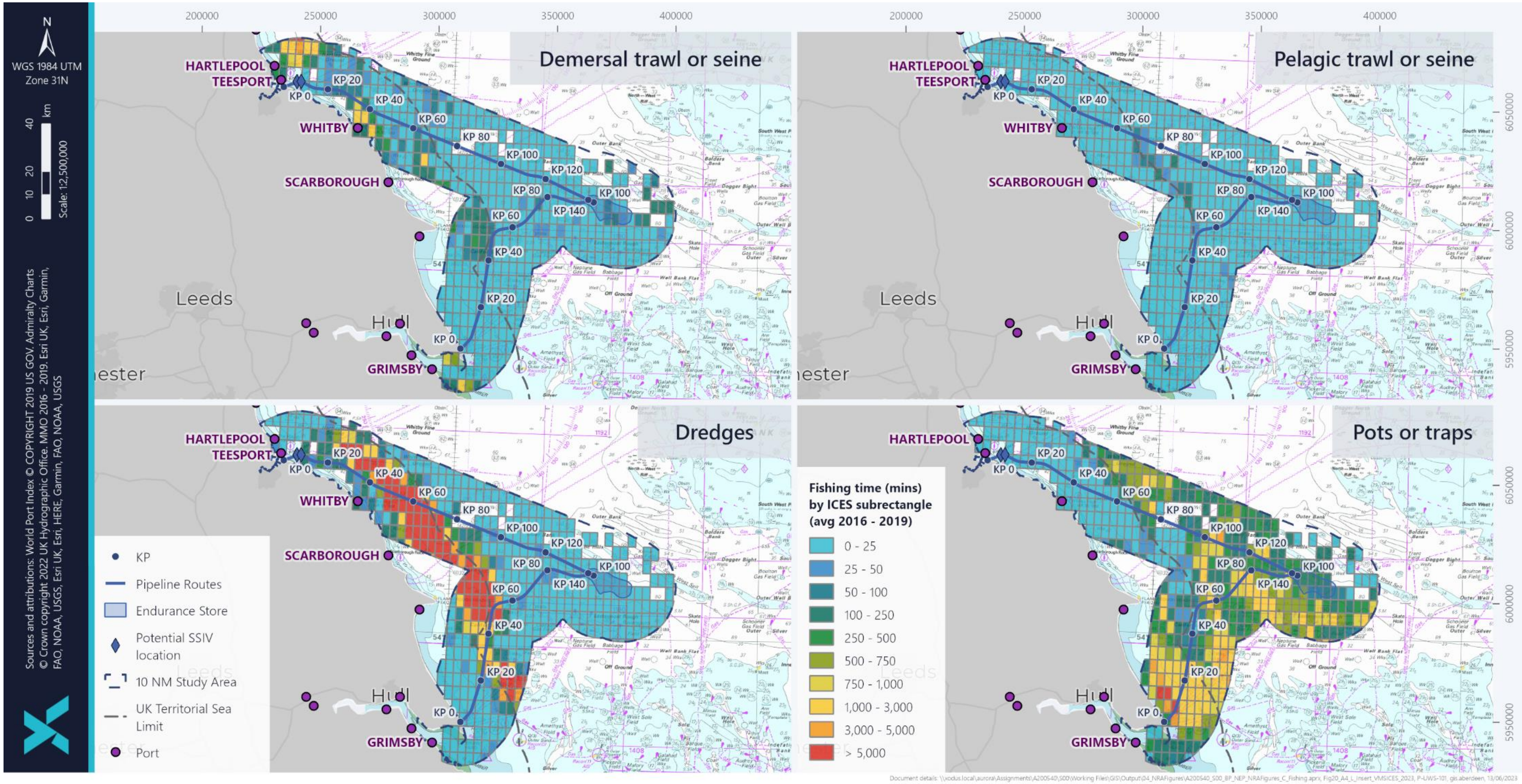


Figure 4-17 - VMS fishing sub-rectangles

4.5 Future case vessel traffic

This NRA baseline has used current and existing information to form this appraisal. Due to uncertainties including the possible future effects of Brexit and the COVID-19 pandemic, it is difficult to predict how this current baseline may change in terms of the magnitude and spatial distribution of shipping activity, and in terms of different types of shipping activity such as fishing or recreation. Additionally, further development of the marine region in terms of future offshore infrastructure including wind farms and oil and gas infrastructure may affect the shipping and navigational baseline presented here. The ES Chapter 9: Physical Presence should be referred to understand any potential future offshore developments which may be awarded and constructed in the region.

5 FORMAL SAFETY ASSESSMENT

5.1 Introduction

The following sections report the assessment of hazards or impacts to shipping and navigation, following the FSA framework as part of the wider NRA methodology. The assessment represents the development of the preliminary hazard identification assessment conducted as part of stakeholder consultations (see section 2.4) providing a complete NRA and hazard log based on highly detailed baseline data, stakeholder expertise and local knowledge. The assessment therefore also includes relevant details or issues raised during the consultation process.

Each potential impact identified in the preliminary assessment is assessed using the definitions of likelihood and consequence severity against the risk matrix in Section 2.2 and assigned a risk ranking of 'Broadly Acceptable', 'Tolerable' or 'Unacceptable', considering existing or embedded mitigations which are either part of the Development design or otherwise accepted industry practise. Where appropriate, additional risk reduction measures (RRMs) are identified, and a residual risk ranking is assigned. The assessments are summarised in a table in the relevant subsections and collated in Appendix 1: Hazard Log.

5.2 Assessment Basis

As detailed in Section 2.2 and mentioned above the assessment follows an FSA approach. The approach is applied where appropriate using the details of the Development found in the ES, Chapter 3: Project Description. However, further details are captured here to provide additional context to the subsequent assessment.

5.2.1 Development Phases

The Project Description details all aspects of the Development, which cover a range of activities or stages relevant to all physical elements of the Development (pipelines, cables, Endurance Store infrastructure, SSIV) including near shore surveys, dredging, trench maintenance, pre-sweeping, seabed and crossing preparations, pipeline and cable lay, rock placement, construction, drilling campaign, post lay activities and surveys among other details.

In line with the preliminary hazard assessment approach each of the impacts or hazards are assessed against all elements of the Development including the Store, pipelines and SSIV, with only two broad phases of the Development activities being addressed separately. Installation phases covering; all preparation, installation and commissioning works are considered to be broadly similar to each other and to all decommissioning activities. Therefore, these are assessed together. The 25-year operational phase of the Development is assessed separately and also includes all foreseen maintenance activities.

5.2.2 Embedded Mitigation

A range of existing risk mitigation measures and considerations have been established during preliminary hazard assessment. The risk associated with each identified hazard or impact is assessed in consideration of their mitigation effects. The embedded mitigation measures are captured the summary table in Appendix 1: Hazard Log. However, they are also identified in Table 5-1 with greater clarity / detail.

Table 5-1 - Embedded mitigation

Measure	Details
Compliance with: International Regulations for the Prevention of Collision at Sea (IRPCS) (IMO, 1972) and Relevant Marine Shipping Notices (MSN) and Guidance Notices (MGN) International Regulations for the Safety of Life at Sea (SOLAS, 1974, as amended).	IRPCS are the international standards designed to ensure safe navigation of vessels at sea. All installation vessels are expected to adhere to these rules, including displaying appropriate lights and shapes. SOLAS is an international maritime treaty which sets minimum safety standards in the construction, equipment and operation of merchant ships. The convention requires signatory flag states to ensure that ships flagged by them comply with at least these standards. In relation to the Development its compliance will ensure navigational safety.
Notice to Mariners (including local), Kingfisher bulletins, Radio Navigational Warnings, and/or broadcast warnings will be promulgated in advance of any proposed works. The notices will include the time and location of any work being carried out, and emergency event procedures.	Promotes navigational safety and minimises the risk of equipment snagging.
Guard Vessels and Recommended Clearance Zone (RCZ) – 500 m	A guard vessel marshalling a 500 m RCZ may be used during the installation campaign where a potential risk to the asset or danger to navigation has been identified.
A Fisheries Liaison Officer (FLO) will be employed to manage interactions between Pipeline installation vessels, personnel, equipment and fishing activity.	The employment of a FLO is intended to ensure all commercial fisheries operators in the vicinity of the Development will be proactively and appropriately communicated with in terms of proposed Development operations.
Compliance with MGN661 Navigation - safe and responsible anchoring and fishing practices.	In line with guidance provided by the UKHO and International Convention for the Safety of Life at Sea (SOLAS) it is recommended that fishing vessels should avoid trawling over installed subsea infrastructure.

Measure	Details
As built survey data will be provided to the UKHO and Kingfisher for inclusion on Admiralty Charts and the Kingfisher Information Service – Offshore Renewable and Cable Awareness (KIS-ORCA) charts.	Ensure navigational safety and minimise the risk and equipment snagging.
Notification of regular runners including ferry operators	Engagement with regular runners and specifically ferry operators ensures awareness of the installation details which minimises disruption.
Vessel Traffic Service (VTS)	Shore-side systems which range from the provision of simple information messages to ships, such as position of other traffic or meteorological hazard warnings, to extensive management of traffic within a port or waterway.
Consent to Locate (CtL) Process	Controls siting of surface hazards through requirement for risk assessment and management measures.
Collison Risk Assessments (CRA) / Collision Risk Management Plan (CRMP)	Identifies collision risk and appropriate risk reduction measures
Adverse Weather Guidelines	Issued by Humberside and Teesport in response to forecast bad weather. Potentially limits collisions, disruption and seabed interactions by deterring vessels from navigating anchoring fishing etc near hazards in bad weather.

5.2.3 Scenario Outcomes

As part of the preliminary hazard assessment the worst case and most likely outcomes were recorded (see Appendix 1: Hazard Log). This provides balanced sense of the impact or hazardous outcome for the purposes of hazard identification. However, it should be noted that the desktop risk assessment is based upon the worst-case scenarios.

5.3 Assessment

The following sections present the assessments of each of the hazards or impacts to shipping and navigation identified in the preliminary hazard assessment and developed as part of this desktop exercise. Each section presents a narrative summarising the assessments and capturing the most relevant aspects and considerations. These correspond to the hazard log in Appendix 1: Hazard Log. However, an accompanying summary table is included in each section for clarity and ease of use.

5.3.1 Vessel collision (Installation / Commissioning)

The installation and commissioning phases of the Development require the use of heavy construction vessels, jackup rigs and otherwise large slow-moving vessels that will be constrained by their operations and hence restricted in their ability to manoeuvre. The Development schedule requires substantial periods of activity in the various areas. The offshore drilling campaign alone is expected to last 370 days. The prolonged presence of both stationary vessels involved in installation of subsea infrastructure, or vessels associated with the progressive pipeline installation will therefore present an obstacle to all passing traffic, and hence may increase the risk of collisions in the area. It is also noted that historic vessel to vessel collision incidents have been recorded between 1992 and 2021 along the installation corridor (See Figure 3-8).

Throughout the year, a large number and range of vessel types cross the installation corridor in multiple locations, including the majority of the pipeline, Store location, potential SSIV locations and landfall areas. AIS data show that 'Cargo/Tanker' Vessels comprise the largest proportion of the traffic at almost 40% of the total. However, the remaining categories also contribute substantially. The collision risk is likely to be greater in higher density sections of the installation corridor and therefore particularly from around KP5 to KP80 along the Teesside Pipeline route and around KP20 to KP75 (See Figure 4-2) on the Humber Pipeline route. The potential locations for the SSIV (KP6 to KP8) and the Store also represent areas of potentially raised surface collision risk due to the possibility for the prolonged presence of installation vessels / surface hazard such as jack up rig, resulting from the installation activities. However, almost the entire length of the Development experiences some vessel activity as illustrated in Figure 4-6 and is generally speaking within a busy shipping area.

Due to embedded mitigations, such as Notice to Mariners, Notification of Regular Runners, guard vessel patrol and stakeholder consultations, awareness of the operations among most of the vessels using the area will be suitably raised through the various promulgations and communications. The presence of stationed jackup rigs or any otherwise stationary hazards will be managed via the 'Consent to locate' (CtL) process and, as such, subject to Collision Risk Assessment (CRA) and collision risk management planning steps. Most of this traffic, is unlikely to experience significantly increased collision in the case where they are required to navigate the installation vessels. This is standard navigational practise for these vessel categories who routinely follow guidelines for avoiding collisions and otherwise exercise good shipping practises, including IRPCS. It is also noted that a traffic separation scheme is in place at Humber Port which provides a raised level of organisation and traffic discipline in this area. Nonetheless, it cannot be presumed that all vessels using the locations will necessarily be aware of the presence of the installation vessels, jackup rigs or their schedule of activities.

Given the raised awareness from embedded mitigations, the likelihood of vessel collision as a result of the activities associated with all elements of the Development, and at any point along the installation corridor, is considered to be 'Remote'. The severity of a collision with any vessel or surface obstacle may however result in a 'High' Severity/Magnitude consequence outcome (loss of crew) among other consequences in the worst case. These combine to present an initial risk ranking of 'Tolerable' if ALARP.

It is therefore necessary to consider potential risk reduction measures in addition to the embedded mitigation. However, given the considerable range of embedded mitigation in place to raise awareness of the installation and decommissioning activities, both prior to and during operations, no further measures related to the pipeline have been identified as part of this exercise, or during stakeholder consultations. Similarly, as the Store and associated installation and decommissioning activities are further offshore within a less densely trafficked area and subject to the CtL process with CRA and Collision Risk Management Plan (CRMP), no additional mitigations are currently identified.

Table 5-2 - Vessel collision risk assessment summary (installation / commissioning / decommissioning)

Hazard	Likelihood	Consequence	Risk	Additional RRM	Residual risk
Vessel Collision	Remote	High	Tolerable	No additional RRMs Identified	ALARP

5.3.2 Disruption to established vessel routes and areas (Installation / Commissioning)

Some disruption to routine vessel routeing and any otherwise scheduled activity is expected during the installation and commissioning phases. The vessels used during these phases include heavy construction vessels and vessels restricted in their ability to manoeuvre. A jackup rig and tow vessels are also required as part of the activities which are scheduled to last over a year. In addition, inshore activities, in particular surrounding the SSIV construction, may present more challenging and therefore disruptive route deviations. As such, the installation will present obstacles, and other vessels routinely operating in the area may be required to deviate from their planned routes in order to avoid them.

Throughout the year, a range of vessel types will cross the installation corridor in multiple locations. However, most of this traffic is unlikely to experience significant disruption in the case where they are required to navigate the installation vessels, as this is standard navigational practise for most of these vessel categories. Passenger vessels, which comprise a smaller but significant proportion of the total vessel count, are also likely to be aware and prepared to navigate clear of the installation vessels due to the embedded mitigations promulgating the operation (Notice to Mariners etc) and practice good passage planning techniques and procedures. Similarly, local boat clubs will also be notified of the installation operations in advance, to permit rescheduling or relocating of any organised events. The UK Ministry of Defence will likewise be informed of the installation details as the area is designated as a military practice ground. Additionally, jackup rigs are regularly stacked at Teesport, therefore vessels regularly using this area are familiar with this kind of obstacle / hazard and permitting measures in place at Teesport further control disruption. Finally, it is also noted that at the Humber Pipeline installation corridor the majority of traffic approaches Humber Port from the southeast and ample sea room permits simple passing procedures when installation vessels present an obstacle.

Nonetheless, Teesport and Humber Port are busy ports and the wider area in general is also generally very busy. The installation of the Store and SSIV infrastructure elements may present additional complexity and scope / footprint of the Development, which extends the obstacle in size and or duration. Throughout most of the corridor, vessels making minor route deviation to avoid the RCZ will not suffer any significant operational impact, however the Humber Pipeline installation corridor passes immediately next to 'Westermost Rough' windfarm at approximately KP17. Although traffic is reduced in this area as would be expected and as seen in Figure 4-6, in the worst-case, delays are considered possible for some vessel types at this and other potential locations in the Development. This impact is assessed therefore as 'Remote' and of 'Medium' consequence severity. This results in a 'Broadly Acceptable' assessment and no requirement to consider further risk reduction measures. However, during consultation with both port authorities, the measure of ensuring Notice to Mariners is passed on to the ports for further distribution was identified. Therefore, it is recommended to ensure that this action is indeed taken at the appropriate time.

Table 5-3 - Disruption risk assessment summary (installation / commissioning / decommissioning)

Hazard	Likelihood	Consequence	Risk	Additional RRM	Residual risk
Disruption to established vessel routes and areas	Remote	Medium	Broadly Acceptable	Ensure Notice to Mariners is transmitted to Port Authorities for further distribution	Broadly Acceptable

5.3.3 Interactions with vessel anchors (Installation / Commissioning)

During the installation phase, there is a risk that a third-party vessel will drop anchor or lose its holding ground in adverse weather and subsequently drag its anchor over a section of exposed pipeline, cable or subsea infrastructure prior to any required protection being installed. In the case of an anchor snagging incident, it is possible that smaller vessels could suffer a risk of foundering should they not be able to free themselves.

Vessel anchoring activities in the area of the installation corridor are captured in Figure 3-2. The figure shows that the installation corridor does not encroach on any designated anchorage areas. However, vessels are recorded at anchor at several locations within the study area including directly on the installation corridor at both Teesport and (at approximately KP15) and at the Humber Pipeline (approximately KP10 and KP35). The presence of a range of vessels involved in both the pipe lay operations and burial operations limits the likelihood of such an event considerably. Guard vessels are in place to patrol the operation and monitor unprotected or unburied sections of the pipeline and cable prior to any protection being installed. Vessel Traffic Service (VTS) is also in place at ports to further inform and deter vessels from anchoring near the pipeline. Notice to Mariners and other communications provide additional awareness of the potential hazard and Industry guidelines are in place to deter vessels from anchoring in the vicinity of pipelines.

Snagging is therefore considered to be 'Unlikely'. However, a consequence severity of outcome of 'High' is selected in the worst-case scenario where foundering leads to loss of crew. These combine to present an initial risk of 'Tolerable' if ALARP and the need to consider further risk reduction measures.

Therefore, it is recommended that UKHO temporary or preliminary notices are issued to relevant parties such that the basic location of the pipelines and subsea infrastructure is captured prior to post lay / as-built survey. Awareness among mariners can therefore be further increased, and industry guidance on anchoring in the vicinity of pipelines can offer maximum effectiveness during the installation phase.

Table 5-4 - Interaction with vessel anchor risk assessment summary (installation / commissioning / decommissioning)

Hazard	Likelihood	Consequence	Risk	Additional RRM	Residual risk
Interaction with vessel anchors	Unlikely	High	Tolerable	UKHO Temporary/Preliminary Notice to be issues prior to installation	ALARP

5.3.4 Interactions with fishing gear (Installation / Commissioning)

Fishing vessels whose gear becomes snagged on the pipeline, cable or subsea infrastructure prior to burial or protection may sustain extensive damage or suffer foundering during the installation, commissioning, and decommissioning phases of the Development. Pre-lay preparation such as ploughing may also result in the creation of berms and rock displacement which presents additional seabed hazards to fishing gear.

A large number and variety of fishing vessels are seen throughout the area, in the baseline data. Significant levels of actively fishing vessels are seen at various locations on the installation corridors (see Figure 4-15). However, it is noted that the Store and SSIV location see very little fishing activity. AIS data shows only a small proportion of this was trawler activity however VMS, vessel sightings and regional fishing information show that the region is extensively fished by dredgers in particular and demersal type fishing vessels, among others, across a range of sizes.

The appointment of a FLO for the duration of the Development installation, combined with Kingfisher notifications and Notices to Mariners, and other marine warnings as appropriate, represents suitable and effective embedded fishing impact and or gear interaction risk mitigation. This ensures that fishermen using the area can be made aware of the potential seabed hazard prior to installation. The presence of a range of vessels involved in both the pipe lay operations and burial operations, particularly including guard vessels monitoring unprotected or unburied pipeline and cable sections, limits the likelihood of such an event considerably. Such interactions are nonetheless more likely where fishing activity is most dense; predominantly dredging activity around Scarborough, Whitby and Bridlington (see Figure 4-17) or more specifically at approximately KP20 to KP80 along the Teesside Pipeline installation corridor and KP20 to KP60 along the Humber Pipeline installation corridor.

Given the prior promulgation of information on the Development to fishermen, via the FLO, and other notices to mariners including the Kingfisher Bulletin, the probability of interactions with fishing gear is already considered to be suitably reduced. The presence of guard vessels limits the likelihood of fishing gear interactions considerably. Industry guidance on fishing in the vicinity of pipelines and subsea infrastructure further deters fishing in close proximity. The likelihood of gear snagging is therefore assessed as 'Unlikely'. The consequences of such an outcome can be severe and are assessed as 'High' due to the potential loss of crew members or vessel. This results in an overall 'Tolerable' if ALARP assessment and the need to consider further risk reduction measures.

Therefore, it is recommended that UKHO temporary or preliminary notices are issued to relevant parties such that the basic location of the pipelines and subsea infrastructure is captured prior to post lay / as-built survey so awareness among mariners is further increased and industry guidance on fishing in the vicinity of pipelines offers maximum effectiveness.

Table 5-5 - Fishing gear interaction risk assessment summary (installation / commissioning / decommissioning)

Hazard	Likelihood	Consequence	Risk	Additional RRM	Residual risk
Interactions with fishing gear	Unlikely	High	Tolerable	UKHO Temporary / Preliminary Notice to be issued to relevant parties prior to installation	ALARP

5.3.5 Vessel collision (Normal Operations and Maintenance)

During their operational lifetime of 25 years, the pipelines a number of 'in-line' inspections to examine integrity as part of the pipeline integrity management strategy are foreseen. External inspection of the infrastructure is intended to take place through a combination of ROV/autonomous operated underwater vehicle and towed sonar. Internal pipeline inspections of 14 days in a seven-year period are also foreseen. Additionally, 5 yearly seismic campaigns in the store area will entail vessel activity that essentially requires a very large exclusion footprint, due to the length of hydrophone streamers. Maintenance requirements for the SSIV are as yet not defined. However, it is expected that the Store will require the presence of a well intervention vessel connected to the subsea infrastructure at least once per year. Such inspections and maintenance activities require slow-moving vessels, constrained by their operations, and hence restricted in their ability to manoeuvre. The presence of these vessels or any other required for maintenance activities associated with the entire Development, may present an obstacle to all passing traffic and hence may increase the risk of collision.

Throughout the year, a large number and a range of vessel types cross the installation corridor in multiple locations, including the majority of the pipeline, Store location, potential SSIV locations and landfall locations. The collision risk is likely to be greater in higher density sections of the installation corridor and therefore particularly from around KP5 to KP80 on the Teesside Pipeline route and around KP20 to KP50 (See Figure 4-2) on the Humber Pipeline route. The locations for the SSIV (KP6 to KP8) and the Store also represent locations of potentially raised collision risk due to added complexity and the possibility of extended periods of vessel activity.

Embedded mitigation measures, such as Notice to Mariners, and Notification of Regular Runners ensure that awareness of the operations among many of the vessels using the area will be suitably raised through the various promulgations and communications. However, guard vessel patrol may not be in place during inspection activities, and it cannot be presumed that all vessels using the locations, will necessarily be aware of the presence of the maintenance vessels, jackup rig or their schedule of activities.

The principal activity associated with pipeline maintenance is inspection via Remotely Operated Vehicle (ROV) or towed sonar. The time associated, and number of vessels involved with inspection activities such as these is likely to be significantly reduced as compared to the installation and decommissioning phases which in turn limits the risk of collision. Integrated acoustic sensing equipment is also in place to permit remote monitoring and thus reduce the need for field inspection.

Maintenance activities specific to the SSIV and Store may require prolonged presence of vessels for inspections or other undefined measures. However, it should be noted that the SSIV will require to be a marked seabed hazard and as such vessels will be aware of and routinely avoiding the particular location once in place. Furthermore, A safety zone may also be in force at the SSIV, should this be considered appropriate by offshore regulator. It is also noted that proximity and crossing agreements, including identification of means of communication, are normal practice where neighbouring Teesside windfarm or other nearby or interacting infrastructure projects' activities are relevant. The Store is further offshore and in less densely trafficked water therefore presenting no generally raised risk of collision for maintenance activities. However, the collision risk associated with maintenance activities is ultimately dependent upon details such as particular locations, durations and complexities of the Development.

The likelihood of vessel collision as a result of the maintenance activities associated with all elements of the Development and at any point along the installation corridor is therefore considered to be 'Remote' (Never occurred during installation contractor's activities but has been known to occur in the wider industry). The severity of a collision with any vessel or surface obstacle may again result in a 'High' Severity/Magnitude consequence outcome (loss of crew) among other consequences in the worst case. These combine to present an initial risk ranking of 'Tolerable' if ALARP.

It is therefore necessary to consider potential risk reduction measures in addition to the embedded mitigation. Suitable measures to raise awareness of the operations among sea users are already in place. The maintenance activities are generally expected to present minimal collision hazard under normal circumstances (i.e. inspection activity). Therefore, given that proximity and crossing agreements are expected to be arranged with interacting infrastructure operators where appropriate, it is proposed that case by case risk assessment is made where maintenance activities, in addition to inspection, are required. This will ensure that details of unforeseen maintenance activities are considered such that any substantial increase in collision risk can be addressed without undue restrictions on normal activities.

Table 5-6 - Vessel collision risk assessment summary (installation / commissioning / decommissioning)

Hazard	Likelihood	Consequence	Risk	Additional RRM	Residual risk
Vessel Collision	Remote	High	Tolerable	Case-by-Case Risk Assessment to address collision risk of maintenance activities excluding inspections	ALARP

5.3.6 Vessel allision resulting from reduction in under-keel clearance (Normal Operations and Maintenance)

Subsea structures associated with the Development, in particular the SSIV, present a large local reduction in the under-keel clearance which potentially results in the increased risk of allision. The Development infrastructure is generally in waters greater than 30 m LAT. Therefore, any slight reduction in effective depth between the keel of a vessel and the seabed topography (under keel clearance) is not considered to present any concern for the vast majority of the Development. The pipelines and cables are to be buried in the near shore areas (Teesside Pipeline landfall to KP7.1 and Humber Pipeline landfall to KP16.3) to a target depth of 1.5 m.

However, the proposed SSIV location; between KP6 and KP8 on the Teesside Pipeline route, which has a depth of between 24 m to 29 m at LAT, and the potential max profile (16 m length, 9 m width, and 8 m height) of the SSIV presents a significant seabed hazard and approximately 30% reduction in water depth. Similarly, wellhead structures, manifolds and other equipment such as pig receiver to be located at the Endurance Store also create the potential for significant reduction in under-keel clearance.

Therefore, an under-keel clearance assessment has been conducted to identify issues and support the NRA. The assessment can be seen in Appendix 2: Under Keel Clearance (UKC) Assessment. The assessment addresses the potential SSIV locations, likely wellhead locations, possible manifold locations, and location of other structures by comparing worst case sea states, AIS vessel draught details and bathymetry data with the heights of the structures.

SSIV

Assuming worst-case sea states, vessel draughts and including conservative safety margins, as demonstrated in Appendix 2: Under Keel Clearance (UKC) Assessment shows sufficient under-keel clearance at any point between KP6 and KP8 for all vessels recorded in the baseline study period. This demonstrates that the allision risk is extremely low in these locations and would not therefore represent an obstacle that would continuously disrupt or displace navigation in the area, particularly once awareness of the location prevails among sea users.

Wellheads

Table 0-4 in the UKC assessment demonstrates that the likely location for each of the six well heads located at the Store effectively present no allision risk. Sufficient depth exists for vessels with the deepest draughts to pass over the 4 m high structures at the worst-case sea states with ample safe clearance.

Manifolds and other structures

The locations of manifolds and other structures associated with the Store, such as monitoring landers, are subject to further engineering. Therefore, the UKC assessment identified a range of locations, including the worst case (or lowest depth) at the Store. The study shows that under the most conservative sea state conditions, biggest draught values and lowest available depth, the potential for allision is not entirely precluded in the worst case. It is therefore recommended that the location of the manifolds is optimised to ensure that risk of allision is eliminated by location/depth.

Given the potential for reduction in under-keel clearance from the seabed equipment associated with the Development, the potential effects on shipping and navigation may be substantial. These obstacles could present a permanent source of allision and potentially permanent displacement or alteration of vessel movement patterns, depending on the final selected locations. However, the UKC assessment demonstrates that sufficient clearance is available between the targeted pipeline section for SSIV location (KP6 to KP8). The assessment also shows sufficient clearance at the majority of potential manifold locations under worst case conditions. Additionally, as-built locations of the pipeline and infrastructure, including the SSIV and manifolds, are to be supplied to UKHO. Awareness of the hazard will be raised via Notice to Mariners and a range of promulgation of information, and general awareness of the hazards will also be raised throughout the progress of the development through ongoing consultation with stakeholders and other interested parties.

The worst-case likelihood for impact to shipping is therefore assessed as 'Remote'. As allision may result in loss of life or severe damage to a vessel, the consequence severity is assessed as 'High'. This gives an 'Tolerable' initial risk. Under the FSA framework a tolerable risk requires further risk mitigation to reduce the risk to ALARP.

The UKC assessment demonstrates that the manifold location can likely be optimised to minimise the risk of allision with a vessel hull. Therefore, it is recommended that:

- The location of Endurance Store manifolds is optimised such that allision risk with vessel hulls is eliminated through provision of sufficient clearance above the structures at worst case sea states and considering worst case vessel parameters; and
- Trinity House should be consulted to determine marking requirements of the infrastructure, following final positioning.

Table 5-7 - Reduction in under-keel clearance risk assessment summary (operation and maintenance)

Hazard	Likelihood	Consequence	Risk	Additional RRM	Residual risk
Reduction in Under-keel Clearance	Remote	High	Tolerable	Optimisation of Endurance Store manifold to minimise reduction in under-keel clearance Trinity House to determine marking requirements	ALARP

5.3.7 Disruption to established vessel routes and areas (Normal Operations and Maintenance)

The placement of the SSIV, which is a large object, in relatively shallow water (between KP6 and KP8), could present a significant seabed hazard with an accompanying 500 m safety zone, should this be considered appropriate, effectively presenting a permanent source of disruption to vessels routinely using the near shore area south of Teesport. Similarly, manifolds at the Store may present a disruptive hazard depending on their precise location within the Store, and the offshore regulator may determine the requirement to enforce 500 m safety zones at any or all of the subsea infrastructure. In addition, the SSIV, Store and the two pipelines have maintenance requirements which involve vessel activity and the potential to disrupt the busy surrounding shipping areas.

During their operational lifetime of 25 years, the pipelines are to be subject to a number of 'in-line' inspections to examine integrity as part of the pipeline integrity management strategy. External inspection of the pipelines is intended to take place through a combination of ROV/autonomous operated underwater vehicle and towed sonar. Internal pipeline inspections of 14 days in a seven-year period are also foreseen. Additionally, 5 yearly seismic campaigns in the store area will entail vessel activity that essentially requires a very large exclusion footprint, due to the length of hydrophone streamers. Maintenance requirements for the SSIV are as yet not defined. However, it is expected that the Store will require the presence of a well intervention vessel connected to the subsea infrastructure at least once per year. Such inspections and associated maintenance activities require slow-moving vessels, constrained by their operations, and hence restricted in their ability to manoeuvre. The presence of these vessels or any other required for maintenance activities associated with the entire Development may present an obstacle to all passing traffic, and hence may increase the risk of disruption.

Throughout the year, a range of vessel types will cross the pipelines in multiple locations. However, most of this traffic is unlikely to experience significant disruption in the unlikely case where they are required to navigate around maintenance vessels, this being standard navigational practise for most of these vessel categories. They are likely to be aware of the SSIV, Store, pipelines and cable due to familiarity with the area and the UKHO charting and marking of the infrastructure elements and locations, particularly if safety zones are required. They are also likely to be prepared to navigate clear of the maintenance vessels due to the embedded mitigations promulgating the operation (Notice to Mariners, Notification of Regular Runners, Port Communications) and are generally expected to apply good passage planning techniques and procedures. Maintenance activities associated with the Store will take place in less dense traffic and with ample sea room, limiting disruption. It is also noted that, with regards to the Humber Pipeline route, the majority of traffic approaches Humber Port from the southeast and ample sea room permits simple passing procedures when installation vessels present an obstacle. Seismic campaigns are likely to cause some disruption to vessels using the area due to the large footprint of hydrophone streamers and the associated exclusion footprint. The appropriate permits and associated notification to mariners combined with the low frequency (approximately every 5 years) is considered to limit disruption.

Assuming that the SSIV and Store manifolds are positioned to minimise reductions in under-keel clearance, they don't present permanent obstacles or hazards to vessels currently using the immediate area (see also Appendix 2: Under Keel Clearance (UKC) Assessment). However, the objects will nonetheless be marked appropriately, and local boat clubs notified of any maintenance operations in advance, to permit rescheduling or relocating of any organised events, and again these vessels should be familiar with the marked SSIV location.

Throughout most of the Development area, vessels making minor route deviation to avoid the inspection and maintenance activities will not suffer any significant operational impact. The location of the SSIV will not affect the sea users provided it is positioned between KP6 and KP8. In the worst-case delays are considered possible and are assessed as 'Remote'. The consequence severity is assessed as minor or 'Low'. This results in a 'Broadly Acceptable' assessment and therefore no requirement to consider further risk reduction measures.

Table 5-8 - Disruption risk assessment summary (O&M)

Hazard	Likelihood	Consequence	Risk	Additional RRM	Residual risk
Disruption to established vessel routes and areas	Remote	Low	Broadly Acceptable	NA	Broadly Acceptable

5.3.8 Interactions with vessel anchors (Normal Operations and Maintenance)

During the operational phase, there is a risk that a third-party vessel will drop anchor or lose its holding ground in adverse weather and subsequently drag its anchor over a section of pipeline, cable or subsea infrastructure. In the case of an anchor snagging incident, it is possible that smaller vessels could suffer a risk of foundering should they not be able to free themselves.

Vessel anchoring areas in the vicinity of the Development are captured in Figure 3-2. The figure shows that the pipelines and infrastructure do not encroach on any designated anchorage areas. However, vessels are recorded at anchor (Figure 4-13) at several locations within the study area including directly on the installation corridor for both the Teesside Pipeline and Humber Pipeline (at approximately KP15, and KP10 / KP35 respectively). Seabed conditions also necessitate that the majority of both pipelines are unburied (including surface laid and partially trenched sections), presenting a significant snagging hazard.

Vessel Traffic Service (VTS) is in place at ports to inform and deter vessels from anchoring near the pipelines or SSIV. Industry guidelines are also in place to deter vessels from anchoring in the vicinities of pipelines, cables and subsea infrastructure. During the operational phase of the Development these will be marked on navigational charts and their locations will be familiar to many regular users of the area. It should be noted however that a snagging incident occurred in the Teesport area in summer 2007, where a large vessel dragged anchor across the 2 m depth buried CATS pipeline, having been previously advised via VTS to anchor clear of the hazard.

Both pipelines, and cable, will be buried in the near shore areas to a target depth of 1.5 m (landfall to KP7.1 at Teesside and landfall to KP16.3 at the Humber Pipeline). The majority of the unprotected sections of both pipelines see no anchoring activity along their locations and only very occasional incidents of anchoring in their immediate vicinities. Additionally, further rock placement contingency for surface laid sections, where considered necessary, is also foreseen. Nonetheless significant lengths of both pipelines will be unburied with no protection.

The Teesside Pipeline and cable is to be laid within 100 m of the CATS pipeline (See Figure 3-2) and the CATS incident underlines the potential for interaction with anchors given that the Development will remain in place for at least 25 years. Additionally, it cannot be assumed that all vessels using the area will be aware of the relevant locations throughout its life. Snagging likelihood is therefore considered to be raised, in comparison with the far shorter installation phase, and therefore assessed as occurring as isolated incidents or 'Unlikely'. A consequence severity outcome of 'High' is selected in the worst-case scenario where foundering leads to loss of crew. These combine to present an initial risk of 'Tolerable' if ALARP and the need to consider further risk reduction measures.

The embedded mitigation, industry guidance on safe anchor and fishing practises, pipeline and cable protection or burial where required, and provision of as-built locations of the pipeline and external protection to UKHO (Admiralty) and Kingfisher (KIS-ORCA), combine to reduce snagging risks significantly. Additionally, during consultation it was noted that Teesport Harbour Authority have in the past managed anchoring areas to accommodate existing pipelines, and given that the Teesside and Humber Pipelines will be laid next to existing pipelines, vessels using the area are expected to be aware of the potential hazards and exercise due care and attention. Furthermore, pipeline and cable burial, trenching and rock placement is planned at the majority of recorded anchoring locations seen in the Baseline AIS data, therefore no further measures are considered necessary.

Table 5-9 - Interaction with vessel anchor risk assessment summary (operation and maintenance)

Hazard	Likelihood	Consequence	Risk	Additional RRM	Residual risk
Interaction with vessel anchors	Unlikely	High	Tolerable	No additional RRMs identified	ALARP

5.3.9 Interactions with fishing gear (Normal Operations and Maintenance)

Fishing vessels whose gear becomes snagged on the pipeline, cable or subsea infrastructure may sustain extensive damage or suffer foundering during the installation, commissioning, and decommissioning phases of the Development. Pre-lay preparation such as ploughing may also result in the creation of berms and rock displacement which presents additional seabed hazards to fishing gear.

A large number and variety of fishing vessels are seen throughout the area in the baseline data. Significant levels of actively fishing vessels are seen at various locations on the installation corridors (See Figure 4-15). However, it is noted that the Store and SSIV location see very little fishing activity in the baseline data. AIS data shows that only a small proportion of this was trawler activity, however VMS, vessel sightings and regional fishing information show that the region is extensively fished by dredgers in particular and demersal type fishing vessels, among others, across a range of sizes including particularly over sections of the pipelines which are to be surface laid with no protection.

The pipelines and cables will be buried in the near shore areas (landfall to KP7.1 at Teesside Pipeline and landfall to KP16.3 at the Humber Pipeline) to a target depth of 1.5 m. All external protection measures shall be designed to minimise the risk of snagging insofar as possible. Rock placement has well understood properties that will reliably minimise pipeline and cable exposure and minimise fishing gear snagging, where employed. Regular inspections and maintenance (as required) is intended to be conducted to ensure the subsea assets remain in good condition and suitably protected throughout their operational life. Industry guidance recommends avoidance of demersal fishing over pipelines and cables and other safe practises relating to seabed hazards. This embedded mitigation, combined with the provision of as-built locations of pipeline, cables and external protection to UKHO and Kingfisher (KIS-ORCA) represents substantial risk reduction. As such, the risk of snagging is considered to be suitably reduced, as with the risk of anchor snagging addressed in the previous section. In addition, the appointment of a FLO during the installation phase of the Development provides substantial assurance that fishermen will be aware of the pipeline and cable locations following the installation.

Given the prior promulgation of information on the Development to fishermen, via the FLO, and other notices to mariners including the Kingfisher Bulletin, the probability of interactions with fishing gear is already considered to be considerably reduced. Industry guidance on fishing in the vicinity of pipelines and subsea infrastructure further advises against fishing in close proximity. However, the most intense dredging activity recorded in the baseline data coincides with the surface laid and unprotected sections between approximately KP40 and KP65 on the Teesside Pipeline route and KP25 to KP55 on the Humber Pipeline route. The likelihood of gear snagging is therefore assessed as 'Unlikely' given the expected avoidance of fishing in the vicinity of the pipelines following the effect of promulgation of the pipeline installation etc. The consequences of such an outcome can be severe and are assessed as 'High' due to the potential loss of crew members or vessel. This results in an overall 'Tolerable' risk, which warrants further risk reduction.

It is therefore necessary to consider potential RRMs in addition to those assumed to be in place, to reduce the risk to ALARP. Industry guidance on safe fishing practises combined with trenching and protection where required, represents a comprehensive range of snagging risk reduction measures. It is nonetheless recommended that detailed pipeline and cable protection measures are determined with due consideration of the fishing intensity VMS data compiled in the baseline study (Figure 4-17) and in particular the density of dredging which shows intense activity over some sections of both pipelines (particularly Teesside, approximately KP40 to KP65). It is also recommended that relevant post lay survey data is disseminated to all relevant fisheries organisations and other appropriate stakeholders to further increase awareness.

Table 5-10 - Fishing gear interaction risk assessment summary (operation and maintenance)

Hazard	Likelihood	Consequence	Risk	Additional RRM	Residual risk
Interactions with fishing gear	Unlikely	High	Tolerable	Further or detailed pipeline/cable protection measures to address dredging activity locations of both pipelines Dissemination of relevant post-lay survey data to relevant organisations and stakeholders for information	ALARP

5.4 Cost Benefit Analysis

In accordance with the principles of ALARP, a cost benefit justification of recommended additional risk reduction measures is used to determine their requirement for implementation. The principle of gross disproportion is used to ensure that the risk reduction benefit is proportionate to the cost of implementing a given measure. This appraisal assesses the risk to navigation rather than the public, or individual workers, for example. Similarly, as risks to navigation *generally* are being assessed, numerical frequencies for consequence outcomes cannot be determined and therefore detailed or numerical cost benefit calculations cannot be made here. Nonetheless each of the additional measures recommended in the section above is addressed in this section to provide a basic justification of their implementation, or otherwise. The following Table 5-11 therefore shows the identified impacts to navigation, additional risk reduction measures recommended and a qualitative justification to complete/provide a basic ALARP position against each of the impacts. The outcomes are also captured with the hazard summary table (Appendix 1: Hazard Log).

Table 5-11 - Cost benefit considerations of additional risk reduction measures

Hazard / impact	Project phase	Additional risk reduction measure	Details / justification
Disruption to established vessel routes and areas	Installation and Decommissioning	Ensure Notice to Mariners is transmitted to Port Authorities for further distribution	The cost associated with administrative measures such as issuing notices are not considered grossly disproportionate and therefore the measure is justified.
Interactions with vessel anchors **Vessel drags anchor across exposed pipeline / cable / subsea infrastructure**	Installation and Decommissioning	UKHO temporary and preliminary notices issued to relevant parties prior to installation	The cost associated with administrative measures such as issuing notices are not considered grossly disproportionate and therefore the measure is justified.
Interactions with fishing gear **Fishing activity conducted in vicinity of pipeline / cable / subsea infrastructure**	Installation and Decommissioning	UKHO temporary and preliminary notices issued to relevant parties prior to installation	The cost associated with administrative measures such as issuing notices are not considered grossly disproportionate and therefore the measure is justified.
Vessel Collision **Passing vessel collides with Maintenance vessel (Restricted in its manoeuvrability)**	Normal operations	Case-by-Case Risk Assessment to address collision risk of maintenance activities excluding inspections	The cost associated with risk assessment measures are not considered grossly disproportionate and therefore the measure is justified.
Vessel allision resulting from reduction in under-keel clearance	Normal operations	The location of Endurance Store manifolds is optimised such that allision risk with vessel hulls is minimised through provision of sufficient clearance above the structures at worst case sea states and considering worst case vessel parameters.	Optimisation of the manifold locations is considered to be part of detailed design and carrying no additional cost. Therefore, the measure is justified.

Hazard / impact	Project phase	Additional risk reduction measure	Details / justification
Vessel allision resulting from reduction in under-keel clearance	Normal operations	Trinity House to determine marking requirements	Determination of marking requirements is considered part of detailed design process and does not imply grossly disproportionate cost. Measure justified.
Interactions with fishing gear **Dreger snags gear on across exposed pipeline / cable / infrastructure**	Normal operations	Further or detailed pipeline/cable protection measures to address dredging activity locations of both pipelines	Addressing or identifying pipeline protection requirements is part of detailed design process and therefore not considered to represent disproportionate measures. The measure is therefore justified.
Interactions with fishing gear	Normal Operations	Dissemination of relevant post-lay survey data to relevant organisations and stakeholders for information.	The cost associated with administrative measures such as issuing data are not considered grossly disproportionate and therefore the measure is justified.

5.5 Cumulative and In Combination effects

Cumulative and in-combination effects and future case outcomes have been included by review of future projects potentially affecting or influencing the study area and the wider general area.

5.5.1 In-combination Effects

These effects derive from combinations of scheme-specific impacts which, when acting together, would result in a new or different likely significant effect or an effect of greater significance that one impact would result in when considered in isolation.

The FSA approach employed in this appraisal identifies the appreciable worst-case scenarios for each of the potential impacts to shipping and navigation *generally*, rather than specific to a particular vessels or receptor. The appraisal therefore implicitly covers combined effects and no combination of these present new impacts or impacts greater than those already identified. Combined effects are therefore not addressed further in this assessment.

5.5.2 Cumulative Effects

A large number of projects have been identified within the vicinity of the entire Development that could potentially result in cumulative impacts to all receptors during its construction and operation. A smaller set of projects has been considered for Shipping and Navigation. Initial screening is based on a proximity of 18 km (10 NM) from the Store, Humber Pipeline or Teesside Pipeline routes. This set has been again screened to identify a short list of projects considered to have some potential for cumulative effects. These can be seen in Table 5-12, Table 5-13 and Table 5-14 and are also addressed further below.

Table 5-12 - Projects within 18 km of the Endurance Store

Project	Type	Status	Distance / direction from Endurance Store
Kumatage Field	Oil & Gas Surface Infrastructure	Concept select work stage. 1st gas Q4 2028.	5 km SSW
Hornsea Project Four	OREI	In planning	The Store area overlaps with The Crown Estate (TCE) Lease area currently under agreement for the Hornsea Project Four windfarm[2].
Hornsea Project Four Transmission Asset	Subsea Cable	In planning	13 km SSW

Table 5-13 - Projects within 18 km of Teesside Pipeline locations

Project	Type	Status	Distance / direction from Teesside Pipeline
Kumatage Field	Oil & Gas Surface Infrastructure	Concept select work stage. 1st gas Q4 2028.	5 km SSW
Hornsea Project Four	OREI	In planning	3 km NNW
Dogger Bank C Transmission Asset, Sofia OWF Transmission Asset	Subsea Cable	Consented	The Teesside Pipeline will cross the (currently proposed) cable.
Dogger Bank B Transmission Asset, Dogger Bank A Transmission Asset	Subsea Cable	In planning	The Teesside Pipeline will cross the (currently proposed) cable.

[2] *On 17th June 2023, a commercial agreement was reached with Ørsted (the developer of Hornsea Project Four) to avoid construction of Hornsea Project Four infrastructure within the area of overlap with the Endurance Store*

Project	Type	Status	Distance / direction from Teesside Pipeline
	Subsea Cable	In planning	The Teesside Pipeline will cross the (currently proposed) cable
Eastern Green Link 2 – EGL2	Subsea Cable	In determination	The (currently proposed) cable will cross the Teesside Pipeline.
York Potash Harbour Facilities Order	Shoreside construction	Development consent granted in July 2016	3 km SW

Table 5-14 - Projects within 18 km of Humber Pipeline Locations

PROJECT	TYPE	STATUS	DISTANCE / DIRECTION FROM HUMBER PIPELINE
Kumatage Field	Oil & Gas Surface Infrastructure	Concept select work stage. 1st gas Q4 2028.	13 km SSE
Tolmount export pipeline	Pipeline	Active	<1 km SSE
Hornsea Project Four	OREI	In planning	3 km SSE
Dogger Bank B Transmission Asset	Subsea Cable	In planning	5 km WNW
Scotland to England Green Link – SEGL2	Subsea Cable	In planning	14 km WNW
Hornsea Four Transmission Asset	Subsea Cable	In planning	The (currently proposed) cable will cross the Humber Pipeline.

Kumatage Field

The Kumatage gas field comprises UKCS blocks 42/30d and 43/26c. The plan is to develop the gas reservoir either through a platform or subsea development and associated pipeline(s), and umbilical(s) if required, to tie into existing gas export infrastructure. Final appraisal well location will be subject to seabed survey and detailed design findings. The current timeline of activities is as follows: commitment to appraisal well by 30th September 2022; drilling of appraisal well by 30th September 2024; first gas production by 30th September 2028.

As the location for the surface and seabed infrastructure associated with the Kumatage field development may be positioned close to the Store, and therefore both pipelines, an increase in vessel interactions and potential operational disruption may result. However, vessels associated with the construction, drilling, operation and maintenance of the respective installations are reasonably expected to be well experienced in navigating and operating in the vicinity of surface infrastructure and associated vessel activity. Additionally, the Store is not located in a densely trafficked location (see Figure 4-2) therefore any combined effects are not expected to present a particular issue to passing traffic. No measures or recommendations are therefore considered appropriate with respect to cumulative effects from the Kumatage Field development activities and infrastructure.

Hornsea Project Four

The Store area overlaps with TCE Lease area currently under agreement for the Hornsea Project Four windfarm. On 17th June 2023, a commercial agreement was reached with Ørsted (the developer of Hornsea Four) to avoid construction of Hornsea Four infrastructure within the area of overlap with the Endurance Store. Hornsea Project Four could cover up to 492 km^2 and contain up to 180 wind turbines. It will also be adjacent to existing Hornsea Two windfarm. Construction is set to commence in 2026 prior to first power in 2028.

Drilling activities at the Store are expected to be underway when Hornsea Four is expected to begin construction. Given the proximity and schedules of the respective developments, various steps must be taken to rationalise activity schedules and locations to minimise operational clashes and any related safety risks. This is reasonably expected to form part of the approach from either development and include an appropriate level of communication and cooperation. Given the scale of the windfarm development it is not expected that construction would begin at the locations closest to the Store during any busy periods. Moreover, the location of the subsea infrastructure associated with the Store does not overlap with the Hornsea Four footprint. Nonetheless, vessels associated with these activities are again expected to be well experienced in operating in the vicinity of neighbouring infrastructure and their associated activities with established plans and controls in place to address the risks associated with nearby activity.

The Hornsea Four windfarm may occupy a very large area, particularly as it effectively extends the existing Hornsea two windfarm footprint. The activities associated with the Store such as drilling and pipelay activities represent therefore only an incremental and temporary increase in the footprint of the final surface obstacle which will result from Hornsea Four. The combined effects are therefore not considered to present an additional obstacle and therefore concern or requirement for measures to reduce the impact to shipping and navigation over and above those measures expected to be in place to manage operational disruption and associated safety risk. It is therefore recommended that that the activity schedules for the Store construction are rationalised with that of Hornsea Project Four, at the appropriate time to minimise disruption.

Subsea Cables and Pipelines

The following subsea cables and pipelines have been identified as relevant for consideration of cumulative effects as they are either expected to or may possibly require crossing arrangements. This therefore presents an incremental increase in seabed features which can cause a hazard to fishermen. No recommendations are however considered necessary as the number of crossings are presumed to be minimised and suitably arranged to minimise hazardous potential. Nonetheless the pipelines and cables are captured in Table 5-15 and Table 5-16.

Table 5-15 - Teesside Pipeline crossings

Infrastructure	Diameter	Service
Everest	36"	Gas
Breagh	20"	Gas*
Breagh	3"	Mono Ethylene Glycol (MEG)
Breagh	Unknown	Fibre Optic Cable
Fikspos/Cantat	Unknown	Disused cable
Langeled	44"	Gas
Dogger Bank C, Sofia Offshore Wind Farm	Unknown	Wind farm power export cable (future)
Dogger Bank A, Dogger Bank B	Unknown	Wind farm power export cable (future)
UK-Denmark 4	Unknown	Disused cable
Pangea North	Unknown	Active cable
TATA North Europe	Unknown	Active cable
EGL2	Unknown	HDVC export cable (future)
UK-Germany 6	Unknown	Disused cables

Table 5-16 - Humberside Pipeline crossings

Infrastructure	Diameter	Service
Langeled	44"	Gas
Hornsea 4	Unknown	Wind farm export cable (future)

5.6 Residual Impact

Across all phases of the Development, all initial impacts were assessed to be 'Tolerable if ALARP' or 'Broadly Acceptable' with the exception of reduction in under-keel clearance which was determined to be 'Unacceptable'. Following the implementation of the additional risk mitigation measures identified in section 5.3 and 5.5, the residual impact from all phases of the Development can be considered ALARP.

5.7 Recommendations

The following recommendations resulting from the Shipping and Navigation assessment have been made. The recommendations should be implemented to ensure that impacts to shipping and navigation from the Development are reduced to ALARP. Where recommendations are not implemented justification should made and captured appropriately.

- Trinity House should be consulted to determine the exact marking requirements of the SSIV following finalisation of its location;
- The location of Endurance Store manifolds should be optimised such that allision risk with vessel hulls is eliminated through provision of sufficient clearance above the structures at worst case sea states and considering worst case vessel parameters;
- Notice to Mariners relevant to the Development activities should be passed to both Teesport and Humber Port for further distribution at the appropriate times;
- UKHO temporary or preliminary notices should be issued to relevant parties such that the basic location of the pipelines and subsea infrastructure is captured prior to post lay / As-built survey. Awareness among mariners can therefore be further increased, and industry guidance on anchoring in the vicinity of pipelines can offer maximum effectiveness during the installation phase;
- Case-by-case risk assessment should be made and inform measures required to reduce risks associated with any given unplanned maintenance activity over and above inspection activities;
- Pipeline burial and protection requirements should be determined with consideration of the anchoring patterns as identified in the baseline data;
- Further or detailed pipeline/cable protection measures should be determined with consideration of the fishing intensity VMS data compiled in the baseline study and in particular the density of dredging which shows intense activity over some sections of both pipelines;
- Relevant post lay survey data should be disseminated to all relevant fisheries organisations and other appropriate stakeholders to further increase awareness of seabed hazards and the Development; and
- Schedules of the Endurance Store and pipeline installation activities should be rationalised with the schedule for Hornsea Project Four to minimise disruption and reduce risk to vessel operators using the areas, where the two developments are in close proximity.

6 SUMMARY AND CONCLUSION

Following a review of extensive baseline environment data in the vicinity of the proposed pipelines, cables, Endurance Store subsea structures and SSIV located offshore Teesside and Humberside in the Southern North Sea, NRA adopting a FSA process has identified a number of impacts on shipping and navigation. The assessment captures potential navigation issues resulting from the installation decommissioning and maintenance activities associated with the equipment and infrastructure and comprises both desktop and workshop assessment with stakeholders including Marine Authority MCA and Teesport and Humber Port Harbour Masters. In addition, a number of projects have been identified within the vicinity of the entire Development that could potentially result in cumulative impacts to all receptors during its construction and operation. Initial screening based on a proximity of 18 km (or 10 NM) identified a smaller set of projects which was considered for potential impact to Shipping and Navigation.

The baseline data shows a generally busy area for shipping and navigation. This combines with the scale, complexity and long duration of the Development to result in a number of impacts which require to be tracked and managed. The FSA therefore establishes a Hazard Log which captures the impacts or hazards to shipping and the potential effects, which were determined during workshop sessions with consultees / stakeholders. The Log also captures the risk assessment results which were completed as a desktop exercise. This provides an auditable trail such that the hazards or impacts can be managed, tracked and closed out as appropriate (see Appendix 1: HAZARD Log).

As a busy shipping area, vessels commonly visiting the ports and using the shipping lanes etc are well experienced in navigating hazards and practising good passage planning techniques and procedures. The installation of subsea pipelines and subsea structures is common in the area, and the pipeline is to be laid in the near vicinity of an existing set of subsea pipelines and cables. A comprehensive range of embedded mitigation measures, such as IRPCS, Notice to Mariners, as-built survey data provision to the UKHO and Kingfisher for inclusion on Admiralty Charts and the Kingfisher Information Service, combined with project specific measures, such as guard vessel patrol, appointment of FLO and industry consultation such as part of this assessment, all serve to suitably minimise the risks and impact. For these reasons the risks identified as a result of the installation decommissioning and maintenance activities, such as collision risk or disruption to established vessels routes etc are generally considered to be Broadly Acceptable, or ALARP with additional identified administrative risk reduction measures.

However, the assessment also found the need to consider potential additional measures to further minimise the impact of interactions between the pipelines and fishing gear, specifically dredges. Due to the complexity of pipeline protection requirements and the design development stage, protection arrangements are not fully defined therefore the recommendation is made to consider further measures in relation to dredging activity. These considerations may or may not determine significant changes to such measures already foreseen at this stage of the design development however it should in any case be demonstrable that the potential impacts posed to the dredgers have been suitably addressed for these risks to be considered ALARP.

It should also be noted that the Development involves a large structure (the SSIV) to be placed near the busy location of Teesport. To address the potential impact, a UKC assessment was undertaken as part of this NRA. The UKC identified that given the current project specifications, the SSIV and the Endurance Store manifolds would not present permanent hazards to vessels currently using the area from allision, provided that their locations are optimised to minimise reductions in UKC and are marked appropriately. The FSA recommends to optimise the location of the

Endurance Store manifolds to obtain the most clearance practicable, given the level of detail available on the precise locations. The SSIV is recommended to be positioned between KP6 and KP8 as intended.

In conclusion, the impact to Shipping and Navigation from the Development can be considered ALARP provided that the recommendations identified in Section 5.7 are suitably addressed and incorporated into the Development design as and where appropriate.

REFERENCES

Associated British Ports. (2022). *Grimsby*. Retrieved from https://www.abports.co.uk/locations/grimsby/

bp. (2021). *Net Zero Teesside. Primary Storage Development Plan.*

Bristow Group. (2022). *UK Search and Rescue*. Retrieved September 23, 2021, from https://www.bristowgroup.com/services/uk-search-and-rescue

Dept for Transport and Dept for Environment, Food and Rural Affairs. (2006). *Establishment of Marine Environmental High Risk Areas (MEHRAs) - Protection of United Kingdom Waters from Pollution from Ships.*

DFDS. (2022). *Ferries to Europe*. Retrieved from https://www.dfds.com/en-gb/passenger-ferries/ferry-crossings

IALA. (2021). *International Association of Marine Aids to Navigation (AtoN) and Lighthouse Authorities (IALA) Guideline G1162: The Marking of Offshore Man-Made Structures. Edition 1.0. urn:mrn:iala:pub:g1162:ed1.0.*

IMO. (2018). *Revised guidelines for Formal Safety Assessment (FSA) for Use in the IMO Rule-Making Process - MSC-MEPC.2/Circ.12/Rev.2.* London: IMO.

Lee, J., South, A. B., & Jennings, S. (2010). Developing reliable, repeatable, and accessible methods to provide high-resolution estimates of fishing-effort distributions from vessel monitoring system (VMS) data. *ICES Journal of Marine Science*, *67*(6), 1260–1271.

Marine Accident Investigation Branch. (2008). *Report on the investigation of "Young Lady" dragging anchor 5 miles east of Teesport and snagging the CATS gas pipeline, resulting in material damage to the pipe.*

MCA. (2021a). *MGN 661 (M+F) Navigation - safe and responsible anchoring and fishing practices*. Retrieved from https://www.gov.uk/government/publications/mgn-661-mf-navigation-safe-and-responsible-anchoring-and-fishing-practices

MCA. (2021b). *MGN 654. Offshore Renewable Energy Installations (OREI) safety response.*

PD Ports. (2022). *Renewable Energy*. Retrieved from https://www.pdports.co.uk/commodities/offshore/renewable-energy/

RNLI. (2022a). Retrieved from https://rnli.org/what-we-do/lifeboats-and-stations/our-lifeboat-fleet

RNLI. (2022b). *Redcar Lifeboat Station*. Retrieved from https://rnli.org/find-my-nearest/lifeboat-stations/redcar-lifeboat-station

RNLI. (2022c). *Withernsea Lifeboat Station*. Retrieved from https://rnli.org/find-my-nearest/lifeboat-stations/withernsea-lifeboat-station

Royal Northumberland Yacht Club. (2021). *Sailing Directions, 6th Edition.*

SOLAS. (1974, as amended). International Convention for the Safety of Life at Sea (SOLAS).

Teesport. (2021). *Welcome to Teesport*. Retrieved from https://www.teesport.co.uk/

UKHO. (2018). *Sailing Directions North Sea (West) Pilot* (11 ed.).

APPENDIX 1: HAZARD LOG

This hazard log captures the assessment of hazards and impacts relevant to shipping and navigation resulting from the Development. The table includes all hazards identified as part of stakeholder hazard workshops and includes embedded and project specific mitigation identified during the sessions as well additional risk reduction measures identified as part of the desktop exercise, detailed in this report. Initial risk is captured based on embedded mitigation measures established during hazard identification sessions. A residual risk ranking is also captured based on the inclusion of any additional risk reduction measures. Finally, qualitative cost benefit analysis is included to support the residual risk ranking and the basic ALARP position. Detailed narratives supporting each assessment are captured in the main body of this report (see Section 5) however the table here provide a succinct and auditable record of the assessment outcome. Note that although both worst case and most likely outcomes are captured, the assessment is based on the worst case for each hazard / Impact.

Table 0-1 Hazard log

Phase	Hazards	Details / element	Statutory mitigation	Industry practice mitigation	Project specific mitigation	Worst credible outcome	Most likely outcome	Worst case likelihood	Worst case severity	Risk	Additional RRMs	Residual risk	CBA	Consultation notes
Installation and Commissioning / Decom	Vessel Collision Passing vessel collides with installation vessel	Pipeline locations / SSIV / Jackup rig	MSNs COLREGS /SOLAS Lights / Shapes Standard Markings Port Bylaws and General Directions VTS (Vessel Traffic Service) CtL Process	MGNs Route Selection Notice to Mariners Guard Vessels RCZ Notify RR's Ops limits FLO Adverse Weather Guidelines	Consultations CRA (Collision Risk Assessment) CRMP (Collision Risk Management Plan)	Loss of a crew member, or multiple serious injuries Major/Severe damage to infrastructure or vessel Potential for major environmental impact given vessel types	Minor injury(s) to person Minor/Local damage to equipment or vessel	Remote	High	Tolerable If ALARP	No additional RRMs identified	ALARP	NA	Adverse weather guidelines are issued by Humberside and Teesport which is a dynamic response to forecast bad weather. Normally relates to piloted operations closer to the port. Does not extend to proposed pipeline route
Installation and Commissioning / Decom	Disruption to established vessel routes and areas	Pipeline locations / SSIV / Jackup rig	VTS Communication (From Ports)	MGNs Route Selection Notice to Mariners Guard Vessels Notify RR's	Consultations	Substantial delays and diversions	No significant operational impacts	Remote	Medium	Broadly Acceptable	Ensure project passes on Notice to Mariners to ports for further distribution	Broadly Acceptable	The cost associated with administrative measures such as issuing notices are not considered grossly disproportionate and therefore the measure is justified.	Teesside regularly have jackups and other rigs stacked as it is a designated area Most traffic from southeast and plenty of sea room

Phase	Hazards	Details / element	Statutory mitigation	Industry practice mitigation	Project specific mitigation	Worst credible outcome	Most likely outcome	Worst case likelihood	Worst case severity	Risk	Additional RRMs	Residual risk	CBA	Consultation notes
Installation and Commissioning / Decom	Interactions with vessel anchors Vessel drags anchor across exposed pipeline / subsea infrastructure	Pipeline locations / SSIV / Jackup rig		Pipeline Protection Measures Notice to Mariners Guard Vessels Industry Guidance Avoid Anchoring in vicinity of pipelines Adverse Weather Guidelines	Consultations Pipelines are not in any current identified anchorage areas.	Loss of a crew member, or multiple serious injuries Major/Severe damage to infrastructure or vessel	Notable damage to infrastructure or vessel	Unlikely	High	Tolerable If ALARP	UKHO temporary and preliminary notices issued to relevant parties prior to installation	ALARP	The cost associated with administerial measures such as issuing notices are not considered grossly disproportionate and therefore the measure is justified	VTS from Ports regarding anchoring locations
Installation and Commissioning / Decom	Interactions with fishing gear Fishing activity conducted in vicinity of pipeline / subsea infrastructure	Pipeline locations / SSIV / Jackup rig		Pipeline Protection Measures Notice to Mariners + Kingfisher notifications Guard Vessels Industry Guidance on Avoidance of Fishing in the vicinity of Subsea pipelines Adverse Weather Guidelines	Consultations Fishery Liaison Officer (FLO) to be integrated with the project team and beyond FID through to construction	Loss of a crew member, or multiple serious injuries Major/Severe damage to infrastructure or vessel	Notable damage to infrastructure or vessel	Unlikely	High	Tolerable If ALARP	UKHO temporary and preliminary notices issued to relevant parties prior to installation	ALARP	The cost associated with administerial measures such as issuing notices are not considered grossly disproportionate and therefore the measure is justified	Fishing activities in near shore areas not generally dragging but more pots

Phase	Hazards	Details / element	Statutory mitigation	Industry practice mitigation	Project specific mitigation	Worst credible outcome	Most likely outcome	Worst case likelihood	Worst case severity	Risk	Additional RRMs	Residual risk	CBA	Consultation notes
Normal O&M	Vessel Collision Passing vessel collides with Maintenance vessel (restricted in its manoeuvrability)	Pipeline locations / SSIV / Endurance Store subsea infrastructure	MSNs COLREGS /SOLAS Lights and Shapes Port Bylaws and General Directions VTS Communication (From Ports)	MGNs Route Selection Notice to Mariners AIS Broadcast Notification of RR's Wave / Wind limits Adverse Weather Guidelines	Consultations CRA CRMP	Loss of a crew member, or multiple serious injuries Major/Severe damage to infrastructure or vessel	Serious injury to person	Remote	High	Tolerable If ALARP	Case-by-Case Risk Assessment to address collision risk of maintenance activities excluding inspections	ALARP	The cost associated with administerial measures such as issuing notices are not considered grossly disproportionate and therefore the measure is justified	Proximity and crossing agreements part of normal project practice. This to include means of communications
Normal O&M	Disruption to established vessel routes and areas Disruption to multiple vessels due to maintenance vessel activities using established routes	Pipeline locations / SSIV / Endurance Store subsea infrastructure	VTS Communication (From Ports)	MGNs Route Selection Notice to Mariners AIS Broadcast Notification of RR's	Consultations	Repeated delays	No significant operational impacts	Remote	Low	Broadly Acceptable	NA	Broadly Acceptable	NA	Positioning of SSIV close to windfarm would improve / reduce the risk greatly i.e. inside line of windfarm e.g. by KP1.
Normal O&M	Interactions with vessel anchors Vessel drags anchor across exposed pipeline / subsea infrastructure	Exposed Pipeline locations / SSIV / Endurance Store subsea infrastructure	VTS Communication (From Ports)	Pipeline Protection Measures Route Selection Notice to Mariners AIS Broadcast Notify RR's As-Built locations supplied to UKHO Adverse Weather Guidelines	Consultations	Loss of a crew member, or multiple serious injuries Major/Severe damage to infrastructure or vessel	Notable damage to infrastructure or vessel	Unlikely	High	Tolerable If ALARP	No additional RRMs identified	ALARP	NA	Teesside have in the past moved anchoring areas to accommodate existing pipelines (MAIB Ship Young Lady - CATS Pipeline). This done by making use of VTS and where ships are anchoring There are also designated no anchor zones already existing

Phase	Hazards	Details / element	Statutory mitigation	Industry practice mitigation	Project specific mitigation	Worst credible outcome	Most likely outcome	Worst case likelihood	Worst case severity	Risk	Additional RRMs	Residual risk	CBA	Consultation notes
Normal O&M	Interactions with fishing gear Fishing activity conducted in vicinity of pipeline / subsea infrastructure	Exposed Pipeline locations / SSIV / Endurance Store subsea infrastructure		Pipeline Protection Notice to Mariners AIS Broadcast Notify RR's As-Built Locations supplied to Kingfisher (KIS-ORCA) and UKHO Adverse Weather Guidelines	Consultations	Loss of a crew member, or multiple serious injuries Major/Severe damage to infrastructure or vessel	Notable damage to infrastructure or vessel	Unlikely	High	Tolerable If ALARP	Further or detailed pipeline/cable protection measures to address dredging activity locations of both pipelines Dissemination of relevant post-lay survey data to relevant organizations and stakeholders for information	ALARP	Addressing or identifying further pipeline protection requirements is part of detailed design and therefore not considered to represent disproportionate measures. The measure is therefore justified. The cost associated with administerial measures such as disseminating information are not considered grossly disproportionate and therefore the measure is justified	
Normal O&M	Reduction in Under Keel Clearance	Exposed Pipeline locations / SSIV / Endurance Store subsea infrastructure	hazard marked and Relevant Authorities informed	As-Built Locations of pipeline and external protections supplied to UKHO (Admiralty) and Kingfisher (KIS-ORCA)	Consultations Under Keel Clearance Assessment	Loss of a crew member, or multiple serious injuries Major/Severe damage to infrastructure or vessel	Major/Severe damage to infrastructure or vessel	Remote	High	Tolerable	Optimisation of Endurance Store manifold to minimise reduction in under-keel clearance SSIV to be positioned between KP4.25 and KP5	ALARP	Optimisation of the Manifold locations is considered to be part of detailed design and carrying no additional cost. Therefore, the measure is justified. Optimisation of the SSIV location is considered to be part of detailed design and carrying no additional cost. Therefore, the measure is justified.	Running parallel with CATS & Breagh so should be clear Trade-off between closer to shore less large (and density generally) vessel traffic and further offshore will be deeper but more traffic Markings will depend on actual location See above regarding siting next to Windfarm. Will require agreement with Windfarm operator regarding their large vessel access (maintenance and overhauls). Probably will require some marking. Requires further assessment as project develops depending on dimensions and depths. Will require consultation with all regulatory bodies e.g., Trinity House to determine exact marking requirements.

APPENDIX 2: UNDER KEEL CLEARANCE (UKC) ASSESSMENT

6.1 Introduction

This section details the UKC assessment that has been undertaken to support the NRA for the Development. The purpose of the assessment is to determine whether the installation of a variety of subsea equipment (further details in Section 6.2) will allow adequate safe UKC for transiting vessels to overpass, based on a worst-case set of assumptions. The assessment closely follows the method set out in the MCA Policy Paper on Under Keel Clearance included in Annex 3 of MGN 654. Whilst this is primarily intended for offshore renewable energy installations, the principles can be applied more widely to most types of subsea infrastructure. The UKC assessment covers the following elements of the Development:

- SSIV;
- Wellhead trees;
- Subsea manifolds; and
- Other subsea equipment (including monitoring equipment and pig receivers).

Where elements of a project do not allow adequate safe UKC to be achieved by vessels utilising the area at all states of tide, consideration must be given to appropriate charting, marking and notifications to ensure mariners are aware of any obstacles, and the potential effects of any vessel disruption/deviation. This is covered within the relevant sections of the NRA and is not repeated here.

6.2 Method

6.2.1 MCA UKC Assessment Approach

In order to calculate UKC for a particular location the following factors need to be determined:

- CVD: charted vertical depth of proposed infrastructure, taking into account the following:
  - CD: chart datum at proposed installation location (usually Lowest Astronomical Tide (LAT));
  - Dh: maximum potential height of the equipment. This should also incorporate, where appropriate,
  - M: manufacturer defined minimum vertical safety margin ("required above the device to ensure that vessel transits do not damage and/or are detrimental to the equipment;
- Dc: safe clearance depth required by deepest draught vessels using area, which incorporates:
  - Dd: dynamic draught, which itself comprises:
    - Ds: deepest static vessel draught observed in area (determined through MTS);
    - Allowances for the influence of sea state (e.g. maximum wave amplitude);
    - Allowances for the influence of dynamic forces acting on a vessel (e.g. squat and surge); and
  - A 30% safety margin.

A summary diagram source from Annex 3 of MGN 654 illustrating how these factors relate to one another is provided in Figure 7-1.

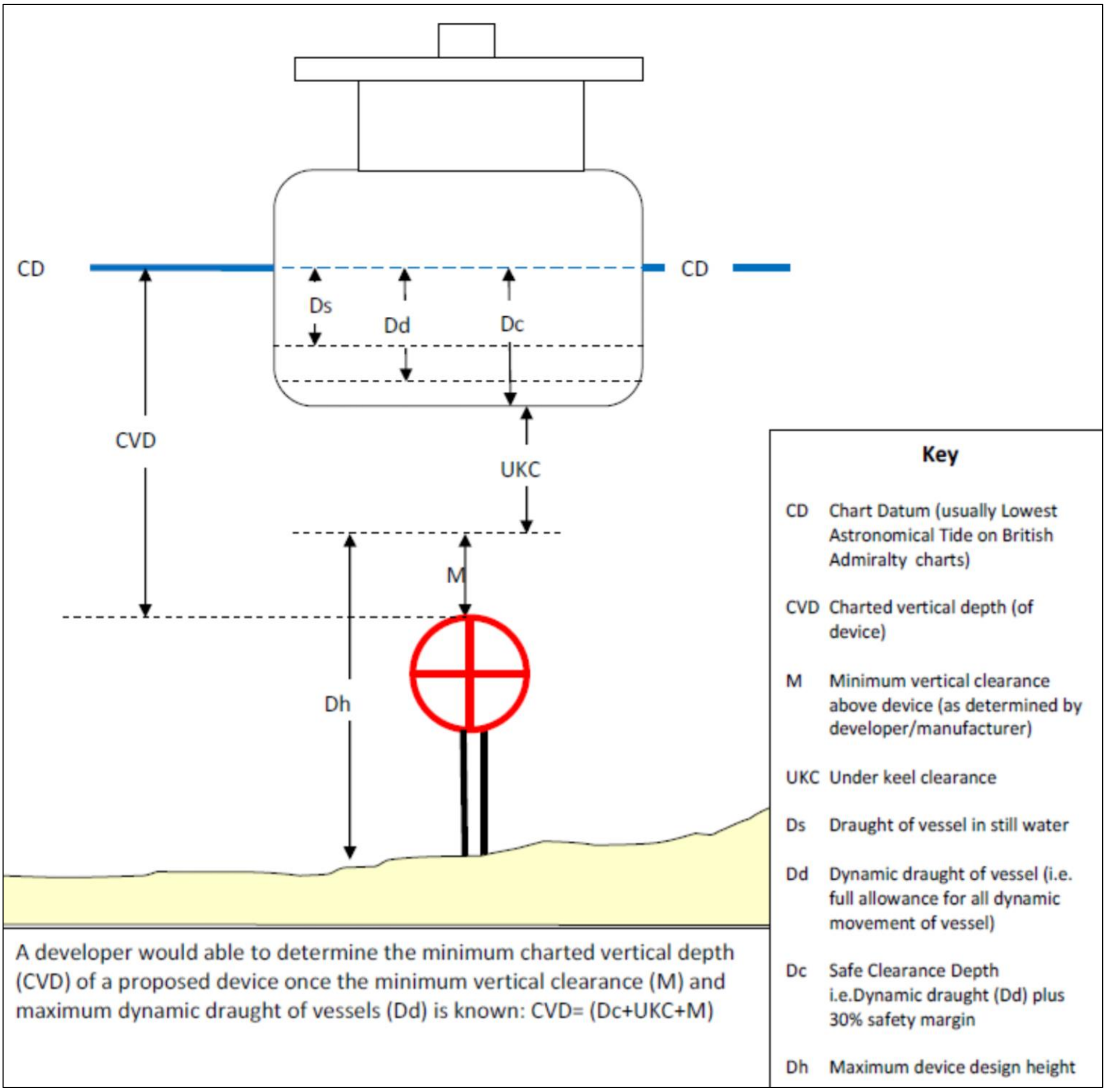


Figure 0-1 MCA UKC assessment approach (source: MCA MGN654 Annex 3)

6.2.2 UKC assesment model

The above principles were incorporated into a bespoke, geospatially-driven UKC assessment model that incorporates AIS data from the MTS, maximum design parameters and locations of proposed subsea infrastructure and location-specific bathymetry and metocean data. Where ambiguity exists regarding the potential location of equipment, the model can be configured to provide a worst-case, mid-case and best-case assessment for a wider area of search, based on the minimum, mean and maximum water depths. The method used to derive each component of the model is set out in Table 7-1 and the scope of the assessment is described in Section 6.2.3.

Table 0-1 UKC assessment model parameters and extraction techniques

Factor	Component	
Dh	The maximum height of subsea infrastructure that may be placed in each assessment area (device height above CD plus M), as described in Section 6.2.	
	CD	Maximum, minimum and mean bathymetry (Lowest Astronomical Tide (LAT)) were extracted for each assessment area from contemporary site-specific survey (Fugro, 2021).
	M	No minimum vertical safety margin data was available at the time of assessment, so a conservative estimate of 2 m has been assumed. The outputs of this study should be reconsidered once this has been established.
Dd	The maximum static draught observed in the vicinity of each assessment area plus full allowance for all dynamic movement of vessel i.e. sum of DS, wave amplitude, maximum squat and surge effects.	
	Ds	The maximum static vessel draught within 2 NM of each assessment area was extracted from the AIS data described in detail in the Marine Traffic Study (Section 4).
	Wave amplitude (m)	For each assessment area, the maximum wave amplitude value was extracted from a spatial 10-year spectral wave model sourced from Bangor University.
	Squat	For each vessel, maximum squat was calculated using the Barrass formula for open water[3], using vessel type specific block coefficients (Bc) adapted from a database procured from MarineTraffic.com and individual vessel speeds associated with transits over each assessment area.
	Surge	A worst-case assumption of 1 m was used to account for the influence of surge.
Dc	30% safety margin was added to the Dd of each vessel before determining which vessel Dd was used as the worst-case in the UKC assessment.	

6.2.3 Scope of assessment

Subsea Isolation Valve (SSIV)

As described in Section 1.2, an SSIV will be installed on the Teesside Pipeline to enable isolation in the unlikely event of a significant leak of CO_2 from the pipeline. The SSIV will require a protective structure and is intended to be fishing friendly. The design of the SSIV and associated protective structure is yet to be finalised, however the dimensions of

[3] Barrass, C.B. and Derrett, D.R. (2012), Chapter 42 - Ship Squat in Open Water and in Confined Channels, Ship Stability for Masters and Mates (Seventh Edition), Butterworth-Heinemann, Pages 367-388.

the SSIV and structure will be a maximum of 16 L x 9 W x 8 H (though it is likely to be 6.5 m H, which has also been assessed here). The exact location of the SSIV is yet to be finalised, but it will be installed on the Teesside Pipeline between KP6 and KP8. For the purposes of this UKC assessment, this section of the pipeline has been divided into 250 m segments, and each assessed against a worst-case (shallowest location per segment), mid-case (mean water depth per segment) and best-case (deepest location per segment).

Wellhead trees

Up to six well head trees will be installed within the Store, five associated with injection wells and a sixth associated with an observation well. Indicative locations for the injection wells have been included in this assessment, as well as two indicative location options for the observation well. The maximum dimension of any one tree is 5 m L x 5 m W x 4 m H.

Co-mingling / four-slot manifolds

At the Store, the electrically powered subsea facilities will comprise two manifolds:

- A crossover co-mingling manifold to combine the flows from the Teesside and Humber Pipelines and distribute it for injection into three wells at the Endurance Store; and
- A 4-slot injection manifold at the Endurance Store connected to the other two injection wells, with the potential to support a further 2 tie-in points. Provides power and communication connection to injection wells and the observation well.

The exact dimensions of the two manifolds are yet to be determined, but maximum height of each manifold will not exceed 6 m. Their location within the Store is also subject to further engineering, so they have been assessed against a worst-case (shallowest location in Store), mid-case (mean water depth in Store) and best-case (deepest location in Store).

Other subsea infrastructure

The Development will require a variety of additional subsea equipment at the Store, including monitoring equipment and a pig receiver at each manifold. This equipment will not exceed 3.25 m in height. Whilst the pig receivers will be fitted as extensions to the manifolds, the exact location of all additional subsea infrastructure is yet to be determined, so has been assessed against a worst-case (shallowest location in Store), mid-case (mean water depth in Store) and best-case (deepest location in Store).

6.3 Results

The results of the UKC assessment are displayed in Table 7-2, Table 7-3, Table 7-4 and accompanying plots showing AIS vessel tracks symbolised by vessel draught are provided in Figure 7-2 and Figure 7-3. It should be noted that the assessment outcomes for the SSIV are based on KP segments of 250 m in length and the subset of vessels directly intersecting those segments. For context, assessment results based on the vessel draughts from vessels occurring within a wider 2 NM buffer surrounding each segment are also presented, though it should be noted that this leads to the incorporation of larger draft vessels operating toward the centre of the main route located in deeper water to the northeast of the KP6 to KP8 SSIV search area. Conversely, for the offshore seabed infrastructure located at the Store, the incorporation of vessels from a wider 2 NM buffer surrounding each point location is considered appropriate, since vessels movements here are far less constrained by bathymetry, potentially reducing their spatial fidelity.

6.3.1 SSIV

Within the SSIV area of search (KP6 to KP8), the results of the assessment show that there is likely to be sufficient UKC to allow safe passage over an 8 m high structure throughout the search area (Table 7-2). Should the final SSIV be 6.5 m in height or less, there will be an associated 1.5 m increase in UKC for the largest draught vessels (Table 7-3).

It should be noted that there are vessels with much larger draughts operating in the main route to the northeast of the study area that would not have sufficient UKC should they venture into the shallower waters between KP6 and KP8, but this is unlikely given that these vessels were exclusively observed further offshore than the search area throughout the study period (Figure 7-2).

Based on these results, there is ample opportunity to place an SSIV of 8 m in height or less within the search area. It is recommended that, as far as practicable, the SSIV should be sited to maximise water depth, whist avoiding traffic associated with the established main route(s) immediately to the northeast of the SSIV area of search. The SSIV should be appropriately charted and accompanied by all relevant notification processes, further consultation and permitting.

6.3.2 Wellhead trees

The UKC assessment demonstrated that there would be more than sufficient UKC above the indicative wellhead tree locations for all vessels recorded within 2 NM, under all cases (Table 7-4). It should be noted that the “footprint” only data in Table 7-1 have been greyed out, because, by virtue of their very precise locations, footprint/AIS transit intersections are extremely limited and unlikely to provide a representative sample.

6.3.3 Manifolds at Endurance Store (location tbc)

The bathymetry within the Store ranges from 41.2 m to 63.22 m, though it generally lies between 50 m and 60 m. The UKC assessment demonstrated that a manifold installed at maximum depth (63.22 m) or mean depth (54.80 m) at the Store, will provide 18.68 m and 10.26 m of UKC to the deepest draught vessel respectively. Locating the manifolds in the shallowest regions (41.2 m) will not provide adequate UKC. It is recommended that the manifolds are sited, as far as practicable, to maximise water depth, and therefore UKC.

6.3.4 Other subsea infrastructure at Endurance Store (location tbc)

The UKC modelling for other subsea infrastructure followed the same approach as was adopted for the manifolds, albeit with a lower maximum device height (3.25 m). As such, the results broadly follow those described above, although structures of 3.25 m in height may achieve marginally acceptable UKC in shallower waters. Nevertheless, it is recommended that siting of the additional subsea infrastructure is optimised to maximise water depth and UKC.

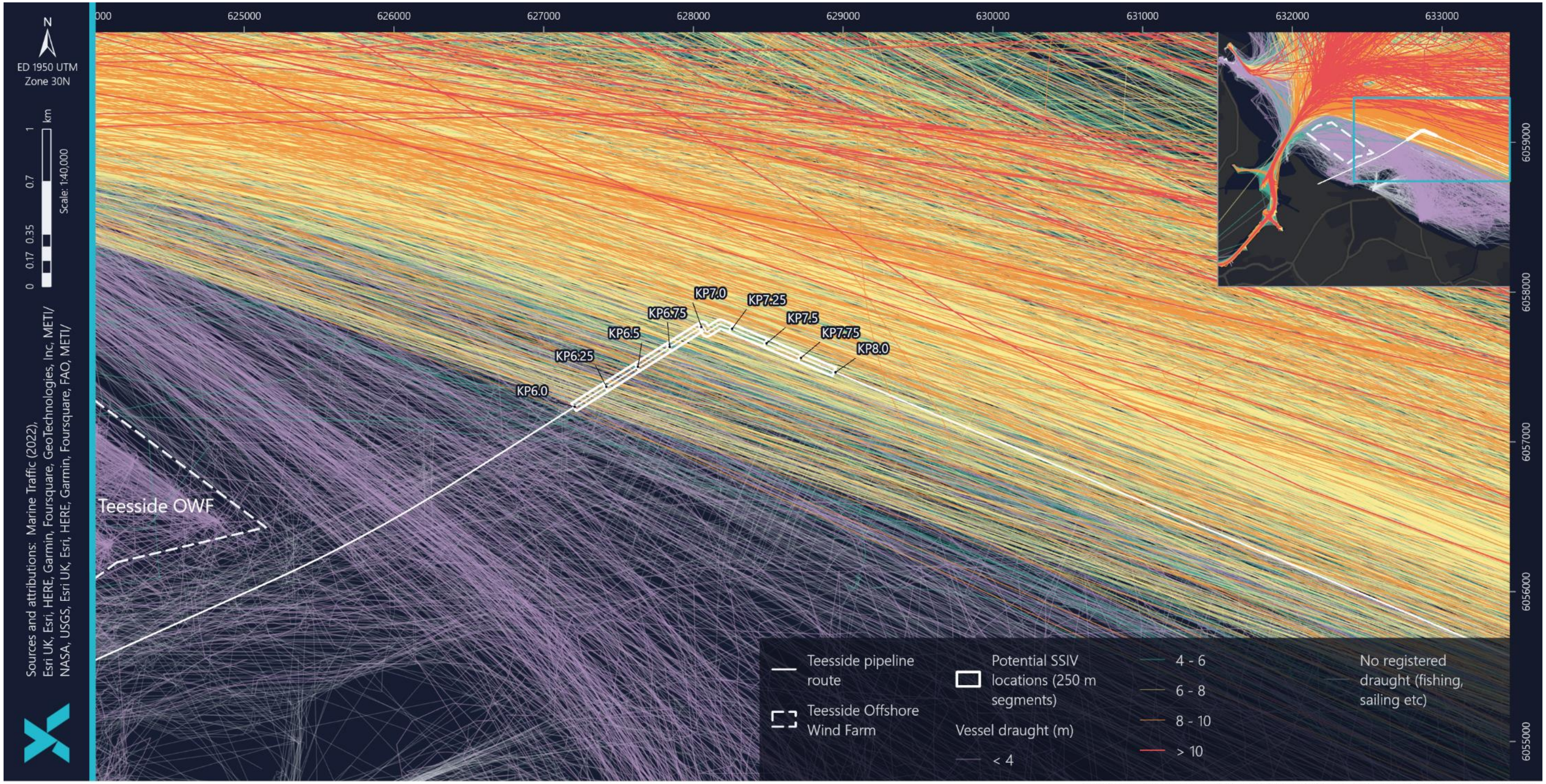


Figure 0-2 Vessel draught distribution in SSIV study area

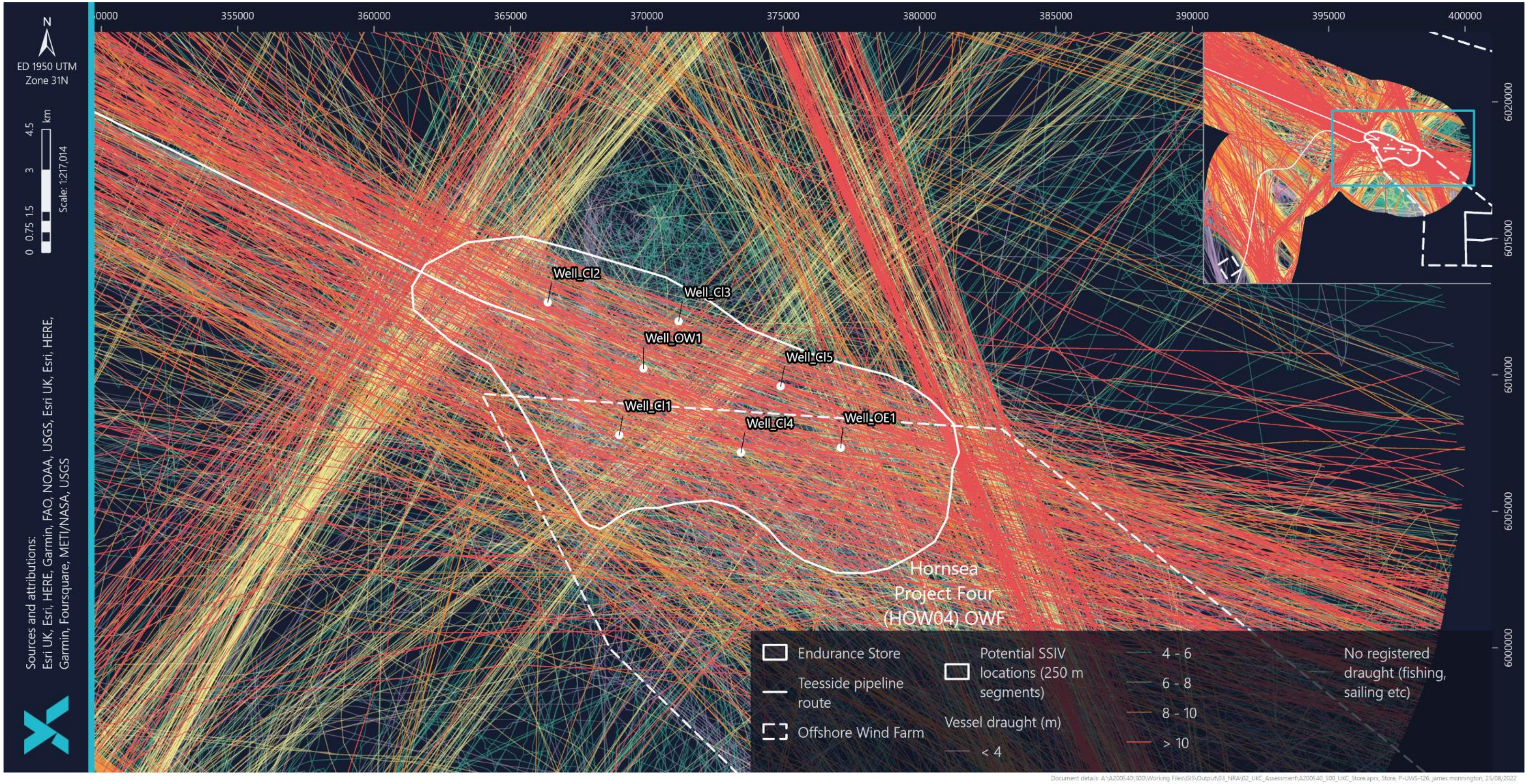


Figure 0-3 Vessel draught at Endurance Store

Table 0-2 UKC assessment results – SSIV 8 m (N.B. AIS data covers period 01/03/2021 to 31/02/2022, draught is from maximum registered draught of any track that intersected potential SSIV location)

Potential SSIV location	Depth (m LAT)			Max device height (m)	Wave amplitude (m)	Vessels within footprint		Vessels within 2 NM buffer		UKC for max draught vessels within footprint			UKC for max draught vessels within 2 NM UKC study area		
	Min	Max	Mean			Count	Max draught (m)	Count	Max draught (m)	Worst case	Mid case	Best case	Worst case	Mid case	Best case
KP6.00-KP6.25	24.81	25.70	25.28	8	2.85	75	8.9	1,590	15.62	0.60	1.07	1.49	-7.56	-7.09	-6.67
KP6.25-KP6.50	25.54	26.57	26.05	8	2.98	87	8.9	1,668	15.62	1.16	1.67	2.19	-7.00	-6.49	-5.97
KP6.50-KP6.75	26.27	27.24	26.70	8	2.98	124	8.9	1,712	15.62	2.11	2.54	3.08	-6.27	-5.84	-5.30
KP6.75-KP7.00	26.97	27.98	27.48	8	2.98	151	8.9	1,753	15.62	2.86	3.37	3.87	-5.57	-5.06	-4.56
KP7.00-KP7.25	27.65	28.68	28.14	8	2.98	98	8.5	1,752	15.62	4.43	4.92	5.46	-4.89	-4.40	-3.86
KP7.25-KP7.50	28.03	28.67	28.36	8	2.98	59	7.45	1,746	15.62	5.83	6.16	6.47	-4.51	-4.18	-3.87
KP7.50-KP7.75	28.44	28.93	28.71	8	2.98	47	8.9	1,741	15.62	4.33	4.60	4.82	-4.10	-3.83	-3.61
KP7.75-KP8.00	28.64	29.25	28.97	8	2.98	49	8.9	1,736	15.62	4.53	4.86	5.14	-3.90	-3.57	-3.29

* Note that 2 NM buffer is included for illustrative purposes. The large draught vessels operating in deeper water beyond the SSIV, but within 2 NM, are highly unlikely to enter occur within the SSIV areas.

Table 0-3 UKC assessment results – SSIV 6.5 m (N.B. AIS data covers period 01/03/2021 to 31/02/2022, draught is from maximum registered draught of any track that intersected potential SSIV location)

Potential SSIV location	Depth (m LAT)			Max device height (m)	Wave amplitude (m)	Vessels within footprint		Vessels within 2 NM buffer		UKC for max draught vessels within footprint			UKC for max draught vessels within 2 NM UKC study area		
	Min	Max	Mean			Count	Max draught (m)	Count	Max draught (m)	Worst case	Mid case	Best case	Worst case	Mid case	Best case
KP6.00-KP6.25	24.81	25.70	25.28	8	2.85	75	8.9	1,590	15.62	2.10	2.57	2.99	-6.06	-5.59	-5.17
KP6.25-KP6.50	25.54	26.57	26.05	8	2.98	87	8.9	1,668	15.62	2.66	3.17	3.69	-5.50	-4.99	-4.47
KP6.50-KP6.75	26.27	27.24	26.70	8	2.98	124	8.9	1,712	15.62	3.61	4.04	4.58	-4.77	-4.34	-3.80
KP6.75-KP7.00	26.97	27.98	27.48	8	2.98	151	8.9	1,753	15.62	4.36	4.87	5.37	-4.07	-3.56	-3.06
KP7.00-KP7.25	27.65	28.68	28.14	8	2.98	98	8.5	1,752	15.62	5.93	6.42	6.96	-3.39	-2.90	-2.36
KP7.25-KP7.50	28.03	28.67	28.36	8	2.98	59	7.45	1,746	15.62	7.33	7.66	7.97	-3.01	-2.68	-2.37
KP7.50-KP7.75	28.44	28.93	28.71	8	2.98	47	8.9	1,741	15.62	5.83	6.10	6.32	-2.60	-2.33	-2.11
KP7.75-KP8.00	28.64	29.25	28.97	8	2.98	49	8.9	1,736	15.62	6.03	6.36	6.64	-2.40	-2.07	-1.79

* Note that 2 NM buffer is included for illustrative purposes. The large draught vessels operating in deeper water beyond the SSIV, but within 2 NM, are highly unlikely to enter occur within the SSIV areas.

Table 0-4 UKC Assessment Results – Endurance Store (N.B. AIS data covers period 01/03/2021 to 31/02/2022, draught is from maximum draught in AIS during journey)

Subsea infrastructure	Depth (m LAT)			Max device height (m)	Wave amplitude (Mm	Vessels within footprint		Vessels within 2 NM buffer		UKC for max draught vessels within footprint			UKC for max draught vessels within 2 NM UKC study area		
	Min	Max	Mean			Count	Max draught (m)	Count	Max draught (m)	Worst case	Mid case	Best case	Worst case	Mid case	Best case
Tree - CI1	52.59	52.90	52.76	4	3.83	1*	5.8*	263	18.2	33.95*	34.12*	34.26*	16.05	16.22	16.36
Tree - CI2	59.26	59.60	59.43	4	4.11	1*	5.8*	251	18.2	40.26*	40.43*	40.60*	22.36	22.53	22.70
Tree - CI3	57.55	57.98	57.73	4	3.71	0*	n/a*	185	17.0	n/a*	n/a*	n/a*	22.98	23.16	23.41
Tree - CI4	51.44	51.68	51.57	4	3.80	2*	5.8*	241	18.2	32.85*	32.98*	33.09*	14.94	5.08	15.18
Tree - CI5	56.02	56.31	56.16	4	3.80	4*	9.92*	256	17.0	31.87*	32.00*	32.16*	21.33	21.47	21.62
Tree - OE1	54.48	54.61	54.55	4	3.91	0*	n/a*	287	18.2	n/a*	n/a*	n/a*	17.84	17.91	17.97
Tree - OW1	57.26	57.36	57.30	4	3.83	1*	5.8*	283	18.2	38.62*	38.66*	38.72*	20.72	20.76	20.82
Manifolds (Store)	41.22	63.22	54.80	6	4.11	920	22.47	1,199	22.5	-2.02	11.56	19.98	-3.32	10.26	18.68
Other (Store)	41.22	63.22	54.80	3.25	4.11	920	22.47	1,199	22.5	1.23	14.81	23.23	-0.07	13.51	21.92

* Point locations used so not suitable for footprint analysis

Appendix N: Fishing Intensity Study

BP Exploration Operating Company Ltd

Offshore Environmental Statement for the Northern Endurance Partnership

Fishing Intensity Supporting Study

ASSIGNMENT **A200540-S00**
DOCUMENT **A-200540-S00-REPT-008**

XODUS

Aberdeen

Xodus House
50 Huntly Street . Aberdeen
AB10 1RS . UK

www.xodusgroup.com

REVISIONS & APPROVALS

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A02	13/06/2023	Re-Issued for Use	JG	FdB	MD	
A01	13/01/2022	Issued for Use	JG	MD	MD	
R02	07/12/2021	Issued for Review	JG	MD	MD	
R01	17/11/2021	Issued for Review	JG	GJ	MD	

CONTENTS

ABBREVIATIONS		4
LIST OF FIGURES		5
LIST OF TABLES		6
EXECUTIVE SUMMARY		7
1	INTRODUCTION	9
1.1	**Background**	**9**
1.1.1	Consultation	9
1.2	**Study Scope**	**11**
2	METHODOLOGY	12
2.1	**Study Area**	**12**
2.2	**Key Data Sources, Data Gaps and Limitations**	**13**
3	COMMERCIAL FISHERIES BASELINE	17
3.1	**Overview of Fishing Activity**	**17**
3.2	**UK Fisheries**	**19**
3.2.1	Overview	19
3.2.2	VMS Data	28
3.2.3	AIS Data	32
3.3	**Non-UK Fisheries**	**34**
3.3.1	France	34
3.3.2	Belgium	36
3.3.3	Denmark	38
3.3.4	Netherlands	40
3.3.5	Germany	42
3.3.6	Sweden	44
4	AQUACULTURE	47
5	FISH AND SHELLFISH SPAWNING AND NURSERY GROUNDS	48
6	SUMMARY AND CONCLUSION	54
7	REFERENCES	56

ABBREVIATIONS

Abbreviation	Definition
AIS	Automatic Information System
bp	bp Exploration Operating Company Ltd
CEFAS	Centre for Environment Fisheries and Aquaculture
CO2	Carbon dioxide
DCF	Data Collection Framework
EIA	Environmental Impact Assessment
ES	Environmental Statement
EU	European Union
HFIG	Holderness Fishing Industry Group
ICES	International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authority
IHLS	International Herring Larval Survey
kWh	Kilo-Watt hours
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
NEIFCA	North Eastern Inshore Fisheries and Conservation Authority
NEP	Northern Endurance Partnership
NFFO	National Federation for Fisherman's Organisations
NM	Nautical Mile
OPRED	Offshore Petroleum Regulator for the Environment and Decommissioning
SFF	Scottish Fishermen's Federation
SICG	Scallop Industry Consultation Group
SNS	Southern North Sea
STECF	Science, Technical and Economic Committee for Fisheries
SWFPA	Scottish Whitefish Producers Association
TAC	Total Allowable Catch
TCA	Trade and Cooperation Agreement
UKCS	UK Continental Shelf
VMS	Vessel Monitoring System

LIST OF FIGURES

Figure 2-1 - Study area 12
Figure 3-1 - Surveillance sightings data by fishing method and nationality (2015 – 2019) (MMO, 2020a) 18
Figure 3-2 - Average landings (£) (2016 to 2020) per ICES rectangle by vessel length, fishing method and species (MMO, 2021a) 22
Figure 3-3 Annual landings (£) (2021) per ICES rectangle by vessel length, fishing method and species (MMO, 2022) 23
Figure 3-4 Average VMS value (£) of UK vessels operating passive fishing methods, demersal trawls and seines, pelagic fishing methods and dredges (2017 – 2020) (MMO, 2022b) 29
Figure 3-5 ICES VMS data (2010 – 2020) (ICES, 2021) 31
Figure 3-6 - Fishing vessel AIS tracklines (2017) (MMO, 2020c) 33
Figure 3-7 - Average annual landings weight (tonnes) (2012 – 2016) for French-registered fishing vessels (EU DCF database, 2019) 35
Figure 3-8 - Annual average fishing effort (hours fished) (2012 to 2016) for French-registered fishing vessels (EU DCF database, 2019) 35
Figure 3-9 - Average annual landings weight (tonnes) (2012 – 2016) for Belgian-registered fishing vessels (EU DCF database, 2019) 37
Figure 3-10 - Annual average fishing effort (hours fished) (2012 to 2016) for Belgian-registered fishing vessels (EU DCF database, 2019) 37
Figure 3-11 - Average annual landings weight (tonnes) (2012 – 2016) for Danish-registered fishing vessels (EU DCF database, 2019) 39
Figure 3-12 - Annual average fishing effort (hours fished) (2012 to 2016) for Danish-registered fishing vessels (EU DCF database, 2019) 39
Figure 3-13 - Average annual landings weight (tonnes) (2012 – 2016) for Dutch-registered fishing vessels (EU DCF database, 2019) 41
Figure 3-14 - Annual average fishing effort (hours fished) (2012 to 2016) for Dutch-registered fishing vessels (EU DCF database, 2019) 41
Figure 3-15 - Average annual landings weight (tonnes) (2012 – 2016) for German-registered fishing vessels (EU DCF database, 2019) 43
Figure 3-16 - Annual average fishing effort (hours fished) (2012 to 2016) for German-registered fishing vessels (EU DCF database, 2019) 43
Figure 3-17 - Average annual landings weight (tonnes) (2012 – 2016) for Swedish-registered fishing vessels (EU DCF database, 2019) 45
Figure 3-18 - Annual average fishing effort (hours fished) (2012 to 2016) for Swedish-registered fishing vessels (EU DCF database, 2019) 45
Figure 5-1 - Nursery grounds of fish species in the Development area (Coull et al, 1998; Ellis et al., 2012) (1 of 2) 49
Figure 5-2 - Nursery grounds of fish species in the Development area (Coull et al, 1998; Ellis et al., 2012) (2 of 2) 50
Figure 5-3 - Spawning grounds of fish species in the Development area (Coull et al, 1998; Ellis et al., 2012) 51
Figure 5-4 - Distributions of brown crab larvae from 1993 and 1999 surveys, where darker shading indicates a higher density (taken from Eaton et al., 2001). 52

LIST OF TABLES

Table 1-1 - Consultation responses received and addressed 10
Table 2-1 Key data sources 14
Table 3-1 - Average landings values (£) by port (2016 to 2020) for the ICES rectangles in the study area (MMO, 2021b) 24
Table 3-2 Average landings values (£) by port (2021) for the ICES rectangles in the study area (MMO, 2022a) 25
Table 3-3 - Number of active vessels by port (2016 – 2020) (MMO, 2021b) 26
Table 3-4 - Operating practices for key fishing methods operated in the study area 27
Table 3-5 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by French-registered vessels within the study area (EU DCF database, 2019) 36
Table 3-6 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by Belgian-registered vessels within the study area (EU DCF database, 2019) 38
Table 3-7 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by Danish-registered vessels within the study area (EU DCF database, 2019) 40
Table 3-8 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by Dutch-registered vessels within the study area (EU DCF database, 2019) 42
Table 3-9 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by German-registered vessels within the study area (EU DCF database, 2019) 44
Table 3-10 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by Swedish-registered vessels within the study area (EU DCF database, 2019) 46
Table 6-1 - Summary of UK Fishing activity in the study area 54
Table 6-2 - Summary of non-UK fishing activity in the study area 55

EXECUTIVE SUMMARY

Xodus Group (Xodus) was commissioned to undertake a fisheries intensity study for bp Exploration Operating Company Ltd (hereafter bp) in the Humber and Teesside areas of the North Sea. This study will inform the environmental impact assessment (EIA) process being undertaken by bp for a carbon capture and storage development, which will consist of an offshore geological storage site ('the Endurance Store') and two carbon dioxide (CO_2) export pipelines (Humber Pipeline and Teesside Pipeline).

This fisheries study aims to help understand the fishing activity around the Development area. This study has reviewed a number of data sources relevant to UK and non-UK fisheries, including landings statistics at an International Council for the Exploration of the Sea (ICES) rectangle scale, to enable the primary fishing methods and key commercial species to be identified, as well as more detailed data on the distribution of fishing value and effort.

The key UK fisheries identified as operating within the study area include:

- Pots and traps – targeting lobster, crab and to a lesser extent whelks;
- Scallop dredging; and
- Demersal trawls and seines – targeting *Nephrops* (Norway lobster) and whitefish (e.g. plaice and whiting).

Pots and traps are dominant in terms of landings values, especially towards the south of Humber area, overlapping the Humber Pipeline. The pots and traps are likely to be operated by vessels both over and under 15 m in length.

Scallop dredging occurs in grounds which encompass the coastal area between Whitby and the Humber, contributing to a large proportion of the landings values in this area. Scallop dredges are predominantly nomadic and activity is cyclical in nature, following seasonal/annual trends in scallop abundance in an area and fishing intensively in one area before moving to another to allow the grounds to recover.

Demersal trawls / seine activity is concentrated to the north of Middlesbrough, north of the Teesside Pipeline route, where *Nephrops* are primarily targeted. Value and effort by vessels operating demersal trawls / seines is high further offshore to the east of the Endurance Store, where *Nephrops* and demersal whitefish species (e.g. plaice) are targeted.

Other fishing methods operated by UK vessels in the study area include pelagic trawls targeting herring on a seasonal basis, drift and fixed nets, gears using hooks and beam trawls. Landings values associated with these methods are considerably less than the fishing methods described previously.

According to landings statistics and active vessel count, the key ports for UK vessels landing from the study area include Bridlington, North Shields, Scarborough, Whitby, Grimsby and Hartlepool.

Non-UK fishing activity is predominantly undertaken further offshore. The non-UK country with the highest landings weights and fishing effort in the study area is France, although landings from vessels registered to Belgium, Denmark, Netherlands, Germany and Sweden are also recorded. In the study area, these vessels typically operate beam trawls, demersal trawls and/or pelagic trawls.

Other key findings of this study include:

- No overlap of the Development area with aquaculture sites, with the closest being approximately 63 km southeast of the Humber Pipeline; and
- The Development area overlaps with several spawning and nursery grounds for key commercial species, including high intensity nursery grounds for cod and whiting, high intensity spawning grounds for cod, lemon sole, sprat and whiting, *Nephrops* and sole and spawning areas for brown crab.

1 INTRODUCTION

1.1 Background

Xodus Group (hereafter Xodus) was commissioned to undertake a fisheries intensity study for bp Exploration Operating Company Ltd (hereafter bp) to support the Environmental Statement (ES) which covers the offshore aspects of the Northern Endurance Partnership (NEP) Development ('the Development') which fall under the remit of the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020, including all infrastructure seawards of Mean Low Water Springs (MLWS).

The Development is located within the UK Southern North Sea (SNS) and consists of offshore carbon dioxide (CO_2) transport and storage infrastructure. The Development consists of three main elements, including an offshore geological storage site, the Endurance Store, approximately 63 km from the nearest coastline, and two CO_2 export pipelines running from Humber ('the Humber Pipeline') and Teesside ('the Teesside Pipeline') to a subsea manifold and well injection site at the Endurance Store. The Humber Pipeline landfalls at Easington[1] and is approximately 100 km in length and the Teesside Pipeline, which landfalls at Coatham Sands, is approximately 142 km in length.

1.1.1 Consultation

Feedback from stakeholders has been ongoing throughout the preparation of the ES and has played an important part in the preparation of the fishing intensity study.

1.1.1.1 Scoping Report

A Scoping Report was submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) in September 2021. The Scoping Report provided a description of the environmental baseline present at the Development and the potential impacts to the receiving environment, including those relevant to commercial fisheries. Relevant stakeholders were provided an opportunity to comment on the Scoping Report and the comments relevant to commercial fisheries and fish and shellfish ecology have been considered for the fishing intensity study. The responses to the comments are provided in Appendix B of the ES.

1.1.1.2 Additional Consultation

In addition to the Scoping Report, consultation with fisheries stakeholders was conducted to ground-truth the information presented within this report. A draft version of the Fishing Intensity Study was submitted to the MMO, Yorkshire Wildlife Trust, National Federation for Fisherman's Organisations (NFFO), Holderness Fishing Industry Group (HFIG), and North Eastern Inshore Fisheries and Conservation Authority (NEIFCA) for comment. A subsequent meeting was held on 11th February 2022, at which representatives from NFFO, HFIG and NE IFCA attended.

The key comments raised during consultation for the fishing intensity study are outlined in Table 1-1.

[1] *This was the location originally approved for the Harbour Energy Tolmount pipeline landfall, prior to its re-routing and subsequent landfall further south into Easington terminal.*

Table 1-1 - Consultation responses received and addressed

Consultee	Form	Summary	Action taken
NFFO, HFIG, NE IFCA	Meeting (11th February 2022)	Meeting held with NFFO, HFIG and NE IFCA at which a draft version Fishing Intensity Study was discussed. The key comments raised included: – Request to remove FisherMap and CEFAS Inshore Fishing Intensity Data as the dataset only captures a small number of fishers through interviews and does not accurately reflect the fishing patterns in the area; – Request to include further information on shellfish presence / distribution within the report, including details on the mass mortality events for crab and lobster; and – Details of where to obtain further data (e.g. plotter data) were provided.	The FisherMap and CEFAS Inshore Fishing Datasets have been removed from this report. Further information on the shellfish presence and distribution is provided in Section 5. The Scottish Fishermen's Federation (SFF), Scottish Whitefish Producers Association (SWFPA), HFIG and Scallop Industry Consultation Group (SICG) were contacted to obtain plotter data. Plotter data for two scallop dredgers was shared by the SFF and shows fishing activities off the east coast of Flamborough Head.
SICG member	Email (7th March 2022)	Email received reporting that scallop dredgers are active in ICES rectangle 37F0.	Noted.
MMO	Written feedback (27th May 2022)	The MMO considers that NEP has used appropriate data sources to describe fishing effort and intensity in the study area and the limitations with the data sources used have been appropriately identified. Furthermore, the spawning and nursery grounds of fishes which overlap the Endurance Store, Teesside Pipeline and Humber Pipeline have been correctly identified using appropriate data sources.	Noted.

Consultee	Form	Summary	Action taken
		Appropriate high quality date sources have been used to describe the study area.	Noted.
		More accurate and recent data on the intensity of herring spawning activity can be acquired by downloading International Herring Larval Survey (IHLS) data from ICES. This can be viewed at the following link: https://www.ices.dk/data/data-portals/Pages/Eggs-and-larvae.aspx?msclkid=ffa06b32c6f511ec88725674c1f88417	Figures illustrating IHLS herring larval abundance data (covering years 2007 – 2018) from Boyle and New (2018) were reviewed and are described in Section 5.
		Figure 3-2 states: "Average annual landings value (£) (2015-2019) by ICES rectangle (MMO, 2020)". It appears that one of the legends is incorrect and should be "Average landings (£) per ICES rectangle by species (2015-2019)	The legend has been amended to "Average landings (£) (2016 to 2020) per ICES rectangle by vessel length, fishing method and species"

1.2 Study Scope

The purpose of this report is to characterise the fishing activity surrounding the Development area. In the context of this report, commercial fishing activity includes activity by licenced fishing vessels undertaken for legitimate capture and sale of finfish and shellfish in the marine environment. This study does not consider recreational or illegal fishing.

This report evaluates the commercial fishing activity surrounding the proposed Development, described in relation to International Council for the Exploration of the Sea (ICES) statistical rectangles. A commercial fisheries baseline is presented, summarising the commercial fishing effort and value for UK and non-UK fisheries in the area. The primary fishing methods operated in the study area, and the associated commercial fish species, are described at the scale of ICES rectangles, and where applicable, a quantitative assessment of the distribution of fishing effort is provided, in relation to the proposed locations for the Development infrastructure.

2 METHODOLOGY

2.1 Study Area

The study area is displayed in Figure 2-1. The study area encompasses the ICES rectangles within which the Development resides. The Endurance Store is located in ICES rectangles 37F0 and 37F1, the Humber Pipeline route is located in ICES rectangles 37F0 and 36F0 and the Teesside Pipeline route crosses ICES rectangles 37E9, 38E8 and 38E9 and also extends into ICES rectangle 37F0 for most of its length.

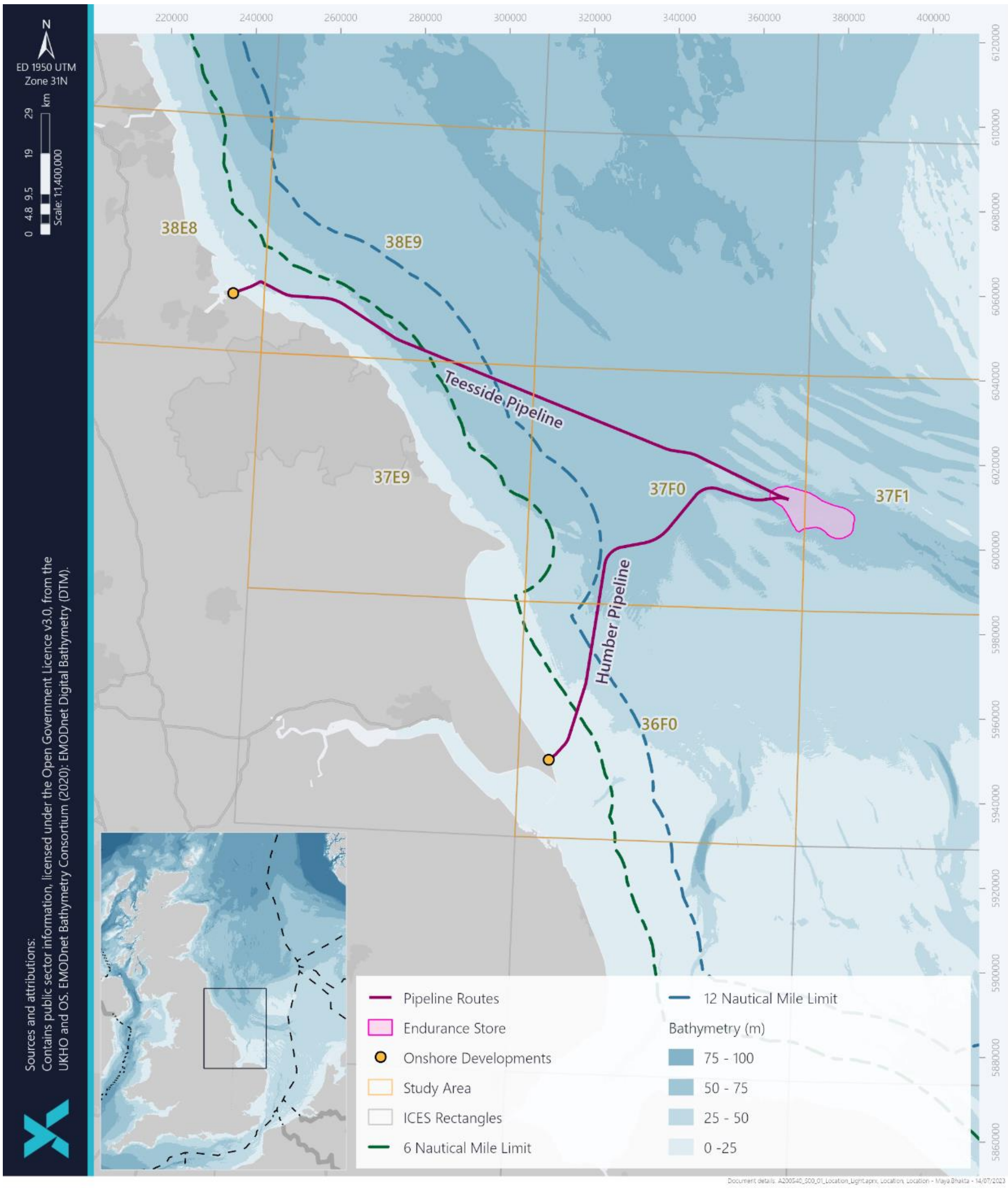


Figure 2-1 - Study area

2.2 Key Data Sources, Data Gaps and Limitations

The key data sources used within this study are listed in Table 2-1., alongside the key limitations for each data source. Data sources were either publicly available or sourced through requests made to the Marine Management Organisation (MMO) and the Centre for Environment Fisheries and Aquaculture Science (CEFAS).

The main data gaps for this study are considered to be as follows:

- UK Vessel Monitoring System (VMS) and Automatic Information System (AIS) data for vessels under 15 m; and
- Consultation data and information (e.g. information on fishing patterns, operating practices etc.).

Due to the paucity in up-to-date spatial data for vessels under 15 m, a quantitative assessment of fishing value and effort for smaller vessels cannot be made. However, a description of the general distribution of activity and the primary fishing methods operated can still be made.

Table 2-1 Key data sources

Data source	Year(s) analysed	Description	Limitations
UK Fisheries			
MMO Surveillance sightings (MMO, 2020a)	2015 - 2019	Fishing vessel sightings from aerial and vessel patrols by fishing method and nationality.	Subject to survey effort, so cannot be used to provide a quantitative assessment of fishing effort.
MMO Fisheries statistics (MMO, 2021a,b; 2022a)	2016 - 2021	Number of active vessels, landings by value (£) and weight (tonnes) by ICES rectangle sourced from logbooks, dockside inspections, landings declarations. The active number of vessels and landings value by port for the study area has also been analysed.	10 m and under vessels are not required to obtain logbooks and so may be underrepresented in this dataset. Data may misrepresent fishing activity for the development area, given the large spatial scale (ICES rectangles) of the data. Data from 2019 to 2021 may have been impacted by COVID and so may not be representative of current fishing practices. The data has been averaged across 5 years to try and minimise this impact.
UK VMS data (MMO, 2022b)	2017 - 2020	Provides fishing effort (kW per hour) and value (£) for UK vessels > 15 m in length, through satellite tracking equipment which is cross-referenced with landings, engine power, and logbook data. The data is anonymised and presented in a 0.05° by 0.05° grid.	Dataset does not include vessels under 15 m. No differentiation between vessels that are fishing or stationary / steaming. Data is filtered to include vessels travelling between 1 and 6 knots to limit the effect this has on the data. ICES rectangles with less than 5 transmissions are not included in the dataset.
UK and EU VMS data (ICES, 2021)	2010 – 2020	ICES has collected relevant VMS and logbook data to produce, as a technical service to OSPAR, updated	Dataset does not include vessels under 12 m.

Data source	Year(s) analysed	Description	Limitations
		spatial data layers on fishing intensity/pressure within the OSPAR Maritime Area This dataset includes UK and EU vessels.	No differentiation between vessels that are fishing or stationary / steaming. Data is filtered to include vessels travelling between 1 and 6 knots to limit the effect this has on the data.
MMO Anonymised derived track lines 2017 (MMO, 2020b)	2017	AIS tracks from fishing vessels provide an indication of the spatial distribution of fishing activity. All EU vessels > 15 m in length are required to have an AIS transponder which transmits details of the vessel's position, speed and course.	Vessels under 15 m may not be represented in the dataset. No information on fishing method is included in the data, and there may be some errors in fishing vessel categorisation.
Non-UK Fisheries			
European Union (EU) Data Collection Framework Database (available via the Science, Technical and Economic Committee for Fisheries (STECF)) (EU DCF database, 2019)	2012 – 2016	Landings statistics, including fishing effort (hours fished) and landings weights (tonnes) provided by EU Member States. Data is derived from official logbook databases which are categorised by ICES rectangle, country, gear and vessel length for fishing vessels participating member states.	Some EU member states provide statistics for vessels over 10 m only.
Aquaculture			
CEFAS Shellfish Classification Zones (CEFAS, 2021)	N/A	This dataset includes mapped shellfish classification zones in England and Wales. Shellfish harvesting areas are classified according to their contamination levels.	-

Data source	Year(s) analysed	Description	Limitations
Aquaculture Production areas (available to view through MMO Explore Marine Plans here: https://explore-marine-plans.marineservices.org.uk/)	N/A	This dataset illustrates Shellfish aquaculture production areas in England and Wales and is available to view on the MMO Explore Marine Plans website.	-
Fish and shellfish spawning and nursery grounds			
Spawning and Nursery Grounds of Selected Fish Species in UK Waters (Ellis *et al.*, 2012)	N/A	Indicative spawning and nursery ground locations around UK waters. These have been overlaid onto the study area to identify overlapping spawning and nursery grounds.	Data does not cover all species and is indicative only.
Fisheries Sensitivity Maps in British Waters (Coull *et al.*, 1998)	N/A		
Updated Fisheries Sensitivity Maps Aries *et al.*, (2014)	N/A	These maps display the likelihood of 0 group aggregations, where 0 group fish represent juvenile fish less than 1 year old.	Data does not cover all species and is indicative only.

3 COMMERCIAL FISHERIES BASELINE

3.1 Overview of Fishing Activity

MMO surveillance sightings by fishing method and nationality provide a general overview of the fishing activity within the study area. It should be noted that, due to the limitations relating to potentially uneven survey effort for the sightings data, this data cannot be used to provide a quantitative assessment of fishing effort and can only be interpreted to provide an indication of the general distribution of activity.

MMO surveillance sightings between 2015 and 2019 are displayed in Figure 3-1. Across the study area, the majority of sightings are of UK vessels, with a limited number of sightings for Belgian and French vessels. Sightings are generally concentrated closer to shore, mainly between the 6 and 12 NM limit across ICES rectangles 37E9 and 37F0 and between the 6NM and 12 NM limit across 38E8 and 38E9.

Beyond the 12 NM limit, the majority of sightings are UK potter / whelkers, scallop dredgers, beam trawlers and trawlers (trawlers (all) and trawlers (demersal / pelagic)), with a limited number of sightings for Belgian beam trawlers and French trawlers. Generally, sightings are lower further offshore in ICES rectangle 37F1 and in the east of ICES rectangle 37F0. Sightings in this area mostly comprise UK beam trawlers and stern trawlers as well as Belgian beam trawlers in the east of ICES rectangle 37F1 and French trawlers along the boundary of ICES rectangle 37F0 and 37F1, just south of the Endurance Store. Closer to shore, just beyond the 12 NM boundary, the densities of sightings increase, comprising of mostly UK potters / whelkers and French and UK trawlers in ICES rectangle 36F0, UK scallop dredgers and potters / whelkers in ICES rectangle 37F0 and UK trawlers (stern trawler (demersal/pelagic), trawler (all) and demersal stern trawler).

Within the 12 NM limit, sightings are concentrated between the 6 and 12 NM limit. Sightings in ICES rectangles 37E9 and 37F0 are dominated by UK scallop dredgers to the south of the Teesside Pipeline route, with sightings for this fishing method also extending up to the south of ICES rectangle 38E9. Sightings across ICES rectangles 38E8 and 38E9 are dominated by trawlers (trawlers (all), stern trawlers (demersal/pelagic) and demersal stern trawlers) and are concentrated to the north of the Teesside Pipeline route. Sightings within the 12 NM limit in ICES rectangle 36F0 are generally present at lower densities, with limited sightings of UK stern trawlers (demersal/pelagic) and potters / whelkers and a single French trawler in the vicinity of the Humber Pipeline.

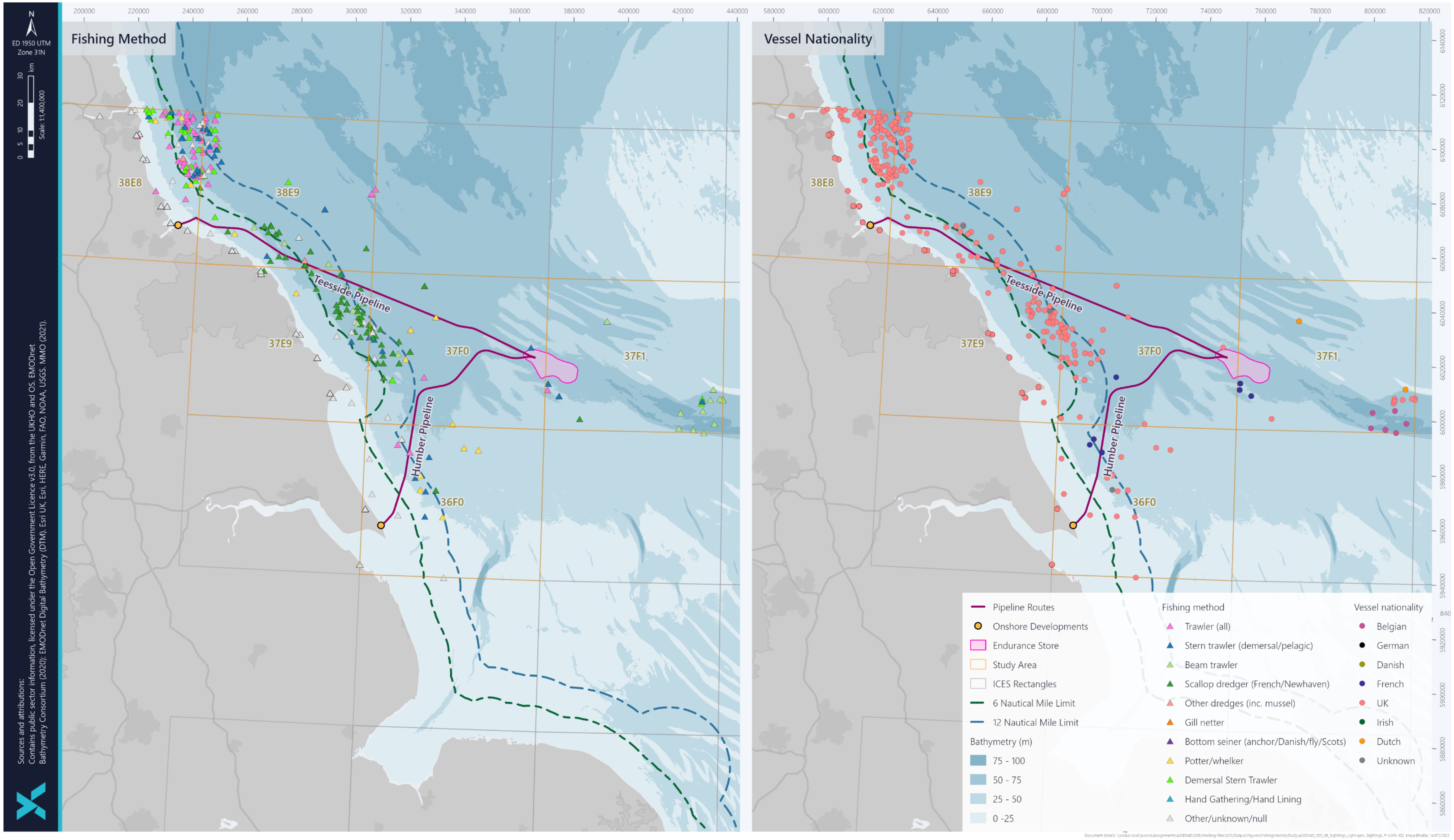


Figure 3-1 - Surveillance sightings data by fishing method and nationality (2015 – 2019) (MMO, 2020a)

3.2 UK Fisheries

3.2.1 Overview

MMO fisheries statistics provide an overview of landings data by vessel length, fishing method and species at an ICES rectangle scale. Further detailed information on the distribution of UK fishing activity at a smaller spatial scale is provided in Section 3.

Landings data from 2016– 2021 have been analysed to ensure the most up to date fisheries statistics have been considered. It is acknowledged that data from 2020, and to a lesser extent in 2021, may not be representative of typical fishing activity due to the potential influence of the COVID-19 pandemic on fishing effort. For this reason, annual landings values have been averaged over a five year-period.

It should also be noted that the 2021 MMO landings data was published in a different format to previous years. Therefore, the landings data from this year have been analysed separately to 2016 to 2020.

3.2.1.1 Landings Statistics by ICES Rectangle

Landings values from 2016-2020 per ICES rectangle have been used to calculate an annual average by vessel length, fishing method, and species, and this data is presented in Figure 3-2. In the study area, average landings values are comparably higher in ICES 36F0 compared with the surrounding ICES rectangles, with considerably lower landings values in ICES rectangle 37F1.

The average landings values by vessel length for 2016-2020 (vessels 10 m and under and over 10 m) indicates that the majority of landings values from ICES rectangles 37F1, and to a lesser extent in 37F0, are from vessels over 10 m (99.9% and 92% of average landings, respectively), with a low proportion of landings values attributed to vessels 10 m and under. Vessels 10 m and under make up a greater proportion of the average landings values in the ICES rectangles closer to shore, including 36F0, 37E9, 38E9 and 38E8, ranging from 27% of average landings values in ICES rectangle 36F0 to 71% of average landings values in ICES rectangle 38E8.

Landings values from 2021 (displayed as an annual sum for this single year instead of an average across multiple years) provides more categorisations of vessel length (Figure 3-3). Most landings values in the ICES rectangles closer to shore (37E9 and 38E8) are from vessels of 8 -10 m, matching the trends from the previous datasets for vessels 10 m and under. In 36F0, vessels between 12 and 15 m contribute to the highest proportion of landings values, followed by 8 – 10 m. In the ICES rectangles further offshore in 37F0 and 37F1, vessels over 10 m account for the majority of landings values. In 37F0, 70% of landings values are associated with vessels over 40 m and in 37F1 56% of landings values are from vessels 12 and 15 m and 44% from vessels 18 to 24 m. Again, this is consistent with the 2016 – 2020 data which shows that vessels over 10 m in length dominate the average annual landings values in ICES rectangles 37F1 and 37F0.

The landings data by fishing method for 2016 – 2020 generally indicate that pots and traps, scallop dredgers and otter trawls are the dominant fishing methods operated in the study area, according to average landings values. Pots and traps make up the largest % of average annual landings values across all rectangles (72%) and is the dominant fishing method by landings values in 36F0, 37E9, 37F0, 37F1 and 38E9 (51-94%). In 37F0, 36F0, 37E9, and 38E9, pots and traps and dredges (assumed to be scallop dredges) are dominant in terms of average landings values, with proportionally lower landings values for otter trawls, which only contributes to 0.2– 10% of average landings values for these ICES rectangles. Other landings contributions in the area include beam trawls, dredges and otter trawls (1%, 26% and 9% respectively in 37F0 and 1%, 5% and 43% in 37F1). Together, these fishing methods contribute to 1.02% of the average landings values in the study area.

Further offshore, in ICES rectangle 37F1, which overlaps with the eastern portion of the Endurance Store, the fishing methods which comprise the majority of average landings values are pots and traps and otter trawls, contributing to 94% of the average landings values in this ICES rectangle. In ICES rectangles 37F0, which the Teesside and Humber pipeline both travel through, pots and traps and dredges make up the largest proportion of landings values with comparably lower landings values for otter trawls compared with ICES rectangle 37F1.

The Humber Pipeline travels and makes landfall through 36F0 where 94% of landing values by gear type is from pots and traps with dredges and otter trawls making up the remaining. ICES rectangle 36F0 also contains the highest landings value for pots and traps in the study area and further analysis of the landings data reveals that the landings from pots and traps in this ICES rectangle contributes to approximately 35% of the landings value for the entire study area between 2016 to 2020. The section of the Teesside Pipeline closer to shore, cuts through sections of three ICES rectangles: 37E9, 38E9 and 38E8. In ICES rectangles 37E9 and 38E9, pots and traps and dredges make up the bulk of landings (64% and 30%, respectively for 37E9 and 61% and 29%, respectively for ICES rectangle 38E9). Unlike the other nearshore ICES rectangles in the study area, ICES rectangle 38E8, which overlaps with the western section of the Teesside Pipeline route closest to shore, contains average landings values which are dominated by otter trawls and pots and traps, with comparably lower landings values for dredges, which only contributes to 0.3% of the average landings values in this ICES rectangle compared with 5 to 30% in remaining ICES rectangles in the study area. This is consistent with the surveillance sightings data which indicates that demersal trawlers are prevalent in ICES rectangle 38E8.

In 2021 (once again used as an annual sum of landings values instead of average) pots and traps contributes the majority of average landings values at all rectangles (61%) with pelagic trawls (23%) and dredging (11%) behind. Other fishing methods make up 0-4% of the average landings contribution (beam trawl, demersal seine, drift and fixed nets, handlines, longlines). In the Endurance Store area in 37F0 pots and traps make up only 14% of landings values and pelagic trawls make up 75% of landings. Further analysis of the landings data indicates that these high landings values for pelagic trawls in ICES rectangle 37F0 are associated with a single month (September).

Average landings values (2016-2020) by species indicate that the dominant species in the study area are lobsters and crabs (*Cancer pagurus*) and lobster. Landings values for these two species are highest in ICES rectangle 36F0, which is consistent with the comparably higher average landings values for pots and traps in this ICES rectangle. Scallops are also a key species in ICES rectangles 37F0, 37E9 and 38E9 which is also consistent with dredges contributing to large proportion of the landings values in these ICES rectangles. Demersal fish species make a proportionally higher contribution to the average landings values in ICES rectangle 37F1 and 38E8, which corresponds with otter trawls making a larger contribution to the average landings values compared to the other ICES rectangles in the study area. After crabs, plaice and *Nephrops* make the largest contribution to the average landing's values in ICES rectangle 37F1. *Nephrops* also make a proportionally high contribution to the average landing's values in ICES rectangle 38E8, contributing to 46% of the landings values between 2016 to 2020. Notably, herring are also present with relatively high landings weights across ICES rectangle 37F0 and 37E9. Further analysis of the landings data shows that herring was landed in these ICES rectangles in September in 2019 and 2020.

The landings values from 2021 generally corroborate those from the previous five years. Most notably, lobster and crabs make up the majority of total landings (36% and 24%), concentrated heavily in 36F0 and 37E9, attributed mostly to the pots and traps, scallops make up a large proportion of landings in ICES rectangles 37E9 and 38E9, and *Nephrops* make up a large proportion of landings in ICES rectangle 38E8. In ICES rectangle 37F0, scallops make up a smaller proportion of landings values in 2021 when compared with the 2016 to 2020 data. This is due to the high proportion (75%) of landings values for herring in this ICES rectangle, landed in September of 2021, corresponding to the high landings values of pelagic trawls. As noted above, there is a pattern of herring landings in September in 2019-2021 which indicates the potential presence of a seasonal fishery for this species.

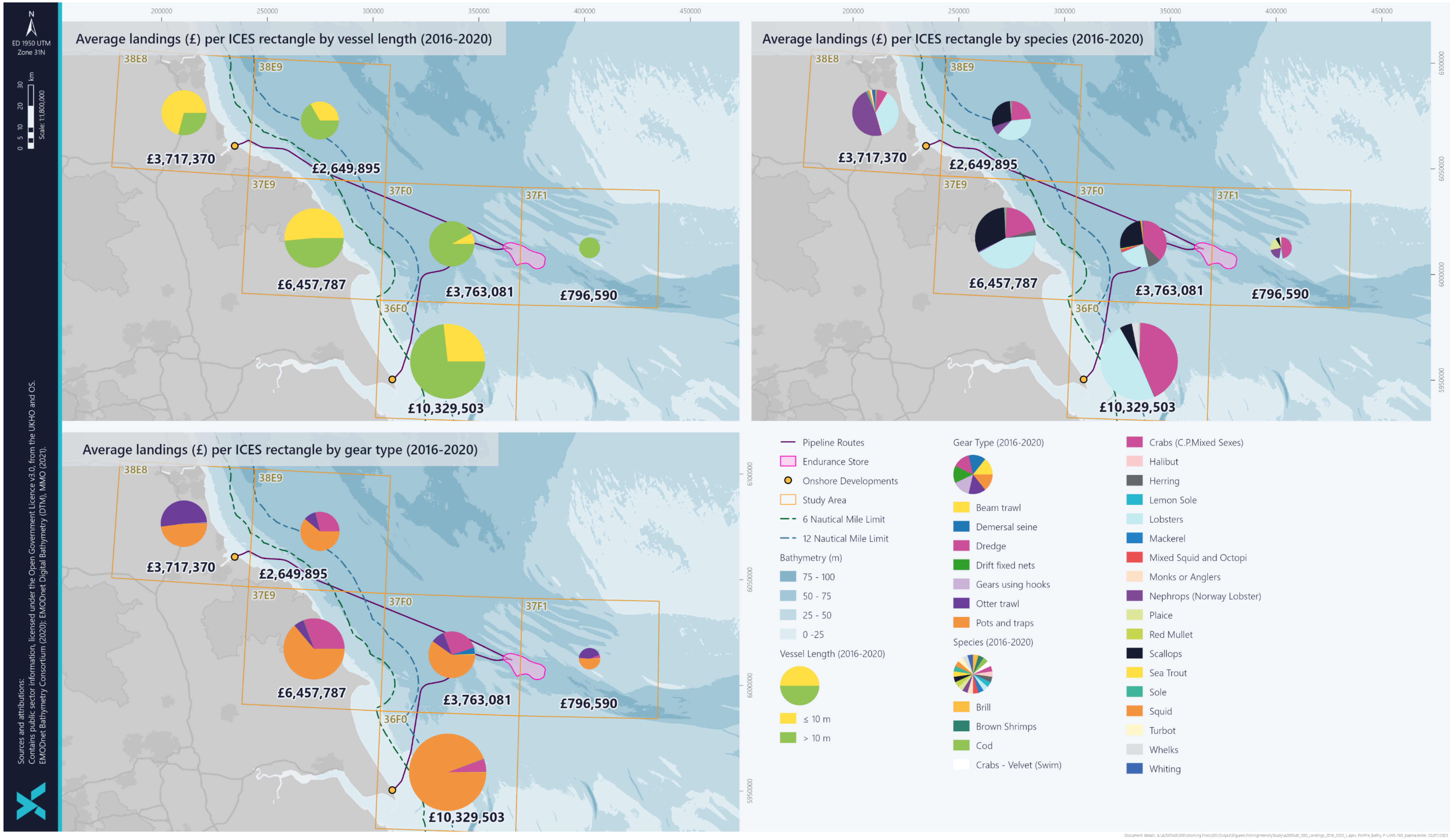


Figure 3-2 - Average landings (£) (2016 to 2020) per ICES rectangle by vessel length, fishing method and species (MMO, 2021a)

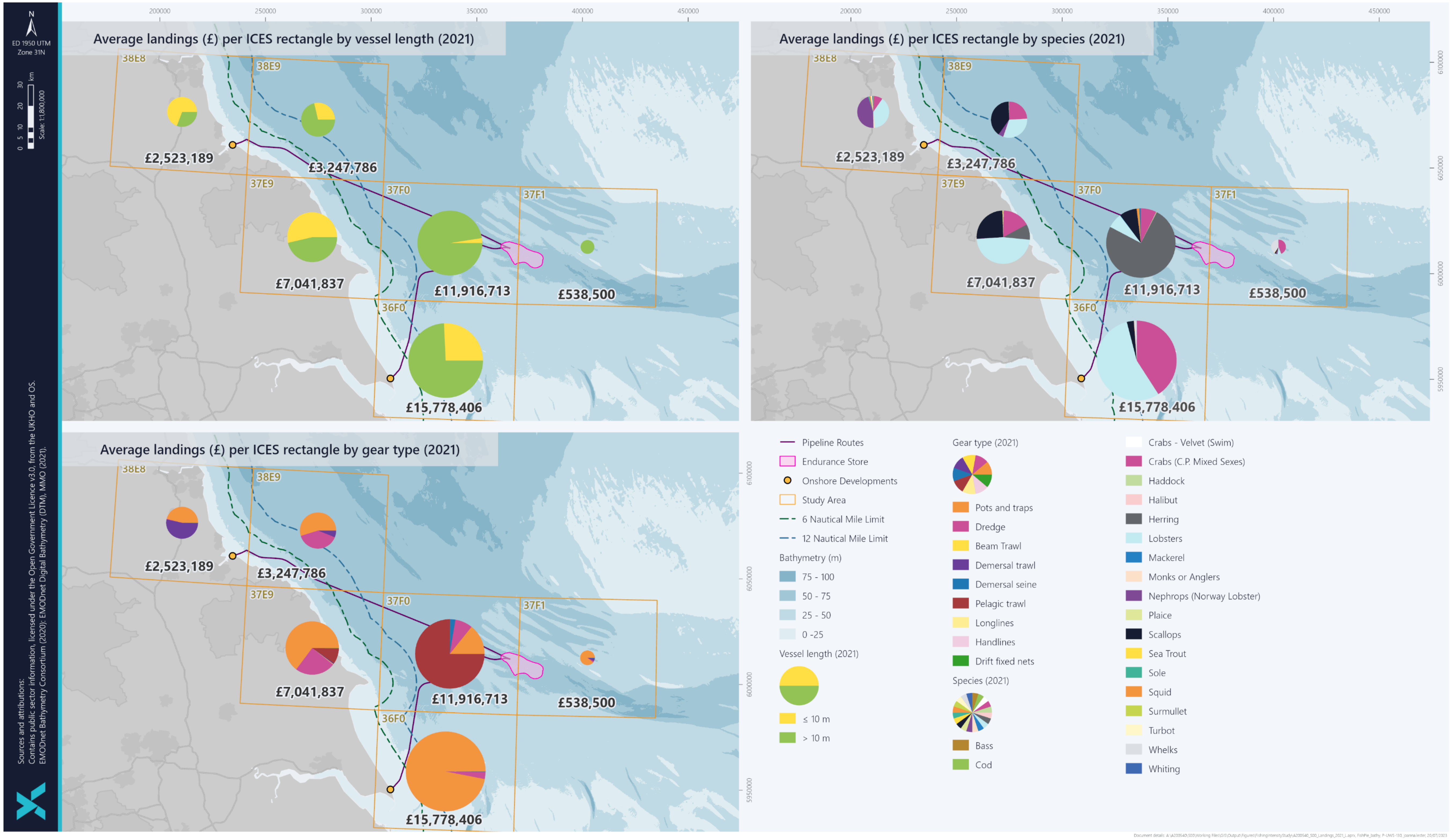


Figure 3-3 Annual landings (£) (2021) per ICES rectangle by vessel length, fishing method and species (MMO, 2022a)

3.2.1.2 Landings Statistics and Vessel Number by Port

Data provided by the MMO for landings values by port (2016 – 2020) have been recorded from the ICES rectangles located within the study area (Table 3-1). Landings from the study area were recorded at 98 different ports. Bridlington is associated with the highest average landings values in the study area, and this is mainly attributed to landings from ICES rectangles 36F0 and 37F0. ICES rectangles closer to Teesside are recorded as having higher landings values in Whitby and Northshields.

Table 3-1 - Average landings values (£) by port (2016 to 2020) for the ICES rectangles in the study area (MMO, 2021b)

Landing port	Average landings value (£) by port (2016 – 2020)						
	36F0	37E9	37F0	37F1	38E8	38E9	Total
Bridlington	6,039,007	770,476	1,564,692	65,468	9,642	4,149	8,453,434
Scarborough	240,731	3,690,598	335,575	122,168	68,137	171,372	4,628,581
Grimsby	2,884,927	19,245	505,938	362,886	2,291	45,857	3,821,144
Hartlepool	201,296	640,225	469,857	4,264	970,252	709,655	2,995,549
Whitby	87,247	953,418	250,626	20,267	17,972	1,269,677	2,599,207
North Shields	2,778	50,115	10,880	45,896	1,315,832	195,361	1,620,862
Hornsea	553,098	111	35,570	0	2,757	0	591,536
Scheveningen	17,295	178,901	284,044	2,401	202	0	482,842
Redcar	0	314	0	0	334,378	23,214	357,905
Boulmer	0	0	0	0	240,899	6,709	247,608
Other	325,063	171,272	289,447	173,214	775,659	224,553	1,959,209

The 2021 landings values by port for the ICES rectangles in the study area are presented in Table 3-2. In general, the same ports in 2021 are associated with the highest landings values from the ICES rectangles within the study area as 2016 to 2020. The main exception to this is the high landings values for Peterhead, Ergesund, Flora and Maloy associated with ICES rectangle 37F0, and further analysis of the data indicates that these high landings values are associated with the high landings of herring by pelagic trawlers in this ICES rectangle in 2021. Lower landings values are associated with Scheveningen and Boulmer in 2021 when compared with 2016 to 2020.

Table 3-2 Average landings values (£) by port (2021) for the ICES rectangles in the study area (MMO, 2022a)

Landing port	AVERAGE LANDINGS VALUE (£) BY PORT (2021)						
	36F0	37E9	37F0	37F1	38E8	38E9	Total
Bridlington	9,589,706	660,725	1,474,874	92,246	0	8,783	11,826,335
Grimsby	3,866,197	30,648	58,111	384,782	1,400	117,348	4,458,487
Scarborough	324,342	3,573,651	257,195	17,023	6,573	252,304	4,431,087
Hartlepool	298,571	870,065	586,156	17,449	576,233	1,355,977	3,704,451
Peterhead	0	665,199	2,261,134	0	4,304	1,154	2,931,790
Whitby	142,640	1,088,608	192,485	1,052	2,551	1,207,841	2,635,177
Egersund	0	0	2,069,611	0	0	0	2,069,611
Floro	0	0	1,407,815	0	0	0	1,407,815
North Shields	0	19,342	0	15,126	9,49,981	172,209	1,156,657
Maloy	0	0	1,046,239	0	0	0	1,046,239
Other	1,556,950	133,599	2,563,089	10,822	982,118	131,236	5,377,814

A breakdown of the number of active vessels landing into the ICES rectangles between 2016 and 2020 in the study area was requested from the MMO via an FOI request in November 2022. The total number of unique vessels counted at ports associated with landings from the ICES rectangles in the study area is provided in Table 3-3 . According to active vessel number, most vessels in the study area are landing into North Shields, Scarborough and Hartlepool. This is attributed to the high vessel counts for North Shields by vessels landing from ICES rectangle 38E8, as well as the high vessel counts for ICES rectangle 37E9 landing in Scarborough.

Table 3-3 - Number of active vessels by port (2016 – 2020) (MMO, 2021b)

Landing port	Number of active vessels by port (2016 – 2020)						
	36F0	37E9	37F0	37F1	38E8	38E9	Total
North Shields	3	13	6	20	136	92	270
Scarborough	39	109	47	9	6	33	243
Hartlepool	13	40	39	4	65	52	213
Whitby	13	69	15	5	10	60	172
Bridlington	54	35	29	4	1	7	130
Grimsby	52	5	22	11	1	3	94
Blyth	1	2	6	2	26	15	52
Redcar		2			34	16	52
Fraserburgh	4	6	9	3	3	13	38
Amble	1	1		1	17	17	37
Other	87	38	51	25	128	86	415

3.2.1.3 Operating Practices

An overview of the operating practices of the key fishing methods associated with landings from the study area is provided in Table 3-4.

Table 3-4 - Operating practices for key fishing methods operated in the study area

Fishing method	Operating practices
Pots and traps	Pots and traps are cages with one or two openings which are set on the seabed in strings, with several pots or traps in a single string. The pots and traps are set on the seabed and hauled several hours later once the pots / traps are 'soaked' (Seafish, 2021).
Scallop dredging	Dredges consist of a solid metal frame with a toothed bar which rakes the seabed to catch molluscs. The molluscs are swept into a holding bag, constructed of metal rings or meshes (Seafish, 2021). Scallop fisheries are targeted by two distinct categories of vessel: smaller vessels with limited operational range and home ports close to scallop grounds, and larger category "nomadic" boats which target grounds around the UK. Scallop dredging vessels which are nomadic operate in a cyclical in nature, following seasonal/annual trends in scallop abundance in an area and fishing intensively in one area before moving to another to allow the grounds to recover.
Demersal trawls/seines (whitefish and *Nephrops*)	Demersal trawls consist of conical nets which are towed on the seabed. There are different variations of demersal trawls, depending on the target species; however, the most common demersal trawl fishing methods within the study area are single-boat bottom otter trawls (Seafish, 2021). The net is held open laterally by trawl doors on either side (otter boards) and vertically by floats attached to the headline of the net. Where the net is in contact with the seabed (groundline), the materials used often depend on the ground conditions and target species (Seafish, 2021). Demersal trawlers working over uneven, rocky grounds may use rockhopper gear, where bobbins (rubber discs) are attached to the groundline. Demersal trawlers which work over soft sandy and muddy substrate (such as Nephrops trawlers) may use lighter materials in the groundline, due to the need to disturb seabed dwelling species in these habitats (Seafish, 2021).
Other	• Drift and fixed nets are passive gear that are set on the seabed and suspended in the water column. Drift nets are not anchored and are allowed to drift with the tide. Fixed nets are fixed to the seabed by anchors ad weights on both ends (Seafish, 2021); • Beam trawlers tow a net from either side of the boat and the mouth of the net is weighted and kept open by a metal beam Seafish, 2021); • Gears using hooks utilise bait set on a hook to attract fish. This may include fishing methods such as pole and line or hook and line fishing (MMO, 2020c); and • Pelagic trawlers tow a conical net through the water column, targeting shoaling species such as herring (Seafish, 2021).

3.2.2 VMS Data

MMO VMS data provides information on the distribution of reported fishing value (£) for UK vessels over 15 m in length, presented as a yearly average between 2017-2020. VMS data for various fishing methods are provided in Figure 3-4.

VMS value for UK vessels operating demersal trawls and seines is shown in Figure 3-4. This data shows higher values for UK vessels operating demersal trawls and seines in three main locations in the study area, including to the east of Endurance Store in ICES rectangle 37F1, within the 12 NM limit across ICES rectangle 37F0 and 37E9 and extending up to the south of ICES rectangle 38E99, and between the 6 and 12 NM limit across ICES rectangles 38E8 and 38E9. VMS value for demersal trawls and seines is particularly high between the 6 and 12 NM limit across ICES rectangles 38E8 and 38E9 to the north of the Humber Pipeline, which corresponds to the high density of surveillance sightings in this area for demersal trawlers as well as the proportionally higher landings values for demersal trawls / seines and *Nephrops* in ICES rectangle 38E8. The Development area largely avoids the three main locations of high value and effort, with the exception of an overlap of the Teesside Pipeline route with an area of moderately high VMS value and effort in the south of ICES rectangle 38E9.

Average VMS value for UK vessels operating dredges is provided in Figure 3-4. This data indicates that higher values and effort are present across the coastal ICES rectangles of 37F0, 36F0, 38E9 and 37E9. These fishing grounds appear to follow the coastline, with the highest values and effort located between the 6 and 12 NM limit across ICES rectangle 37E9 and 37F0. This corroborates the surveillance sightings data and the MMO landings data provided above. Both the Teesside and Humber Pipeline transect these scallop fishing grounds. Notably, scallop dredging vessels are nomadic and activity is cyclical in nature, following seasonal/annual trends in scallop abundance in an area and fishing intensively in one area before moving to another to allow the grounds to recover.

Average VMS values for UK vessels operating pelagic fishing methods are provided in Figure 3-4. This indicates that value and effort is generally low across the study area, with the exception of an area of higher value and effort in west of ICES rectangle 37F0 which overlaps with the mid-section of the Humber and Teesside Pipeline routes. This also corresponds to the higher landings values within ICES rectangle 37F0 for pelagic trawls targeting herring.

Average VMS values for UK vessels operating passive gear (creels, pots and static nets) is provided in Figure 3-4. This data indicates that higher values and effort occur in the south of the study area within ICES rectangle 36F0 and to a lesser extent in ICES rectangle 37F0. This generally corroborates the landings data which indicates that the value of landings for pots and traps is particularly high in ICES rectangle 36F0, which overlaps with the Humber Pipeline. It should be noted that vessels operating passive gear are often smaller vessels which may not be captured in the VMS data. Consultation with HFIG confirmed that a large proportion of the potting fleet are under 15 m in length and will not be represented by VMS data.

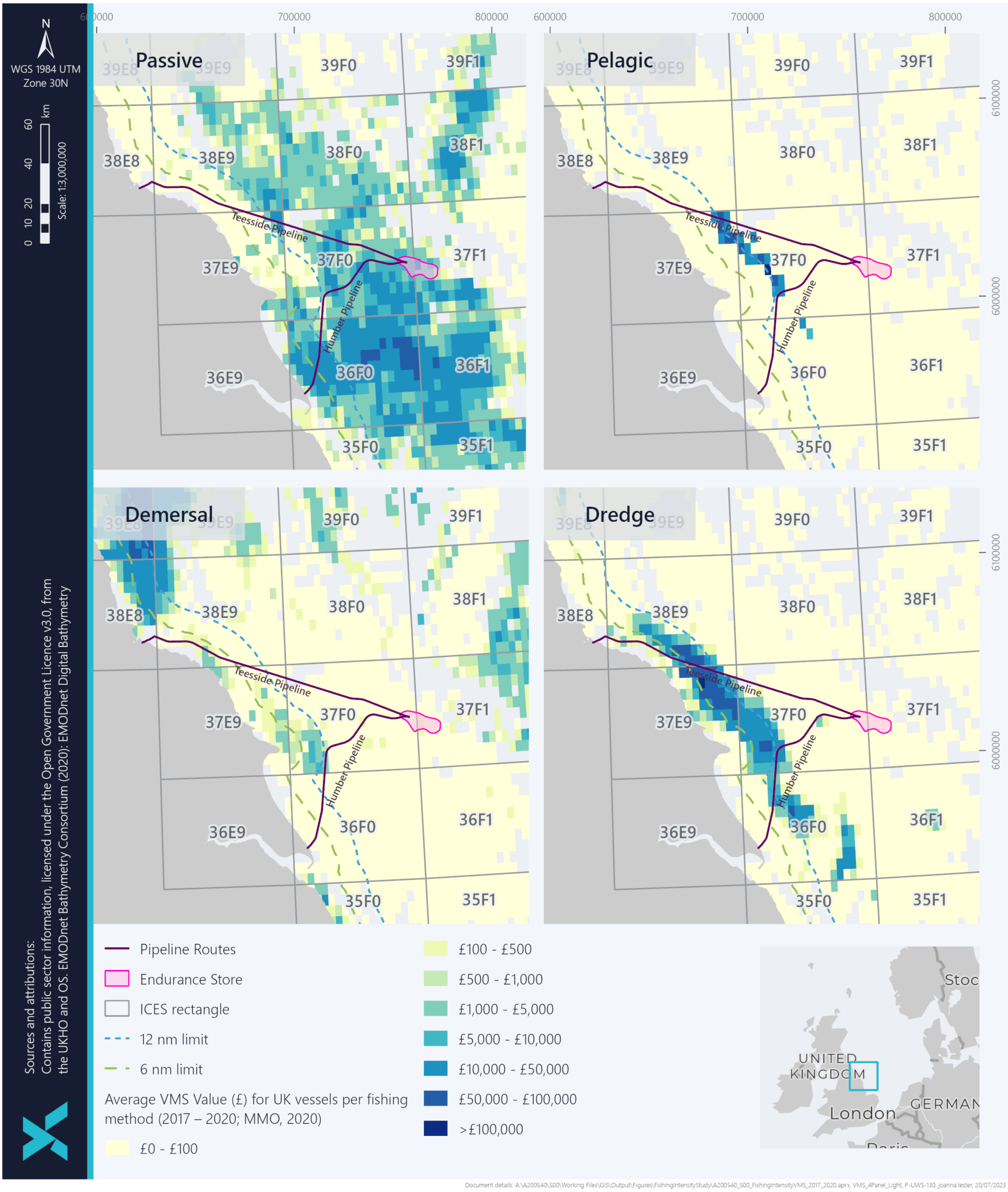


Figure 3-4 Average VMS value (£) of UK vessels operating passive fishing methods, demersal trawls and seines, pelagic fishing methods and dredges (2017 – 2020) (MMO, 2022b)

ICES VMS effort data for EU and UK vessels, described in average annual days fishing, is presented in Figure 3-5. The data show the average number of fishing days (2010 – 2020) at the Endurance Store and the Teesside and Humber Pipelines is relatively low for beam trawls, otter trawls and demersal seines, consistent with the low average VMS values for UK demersal trawlers presented in Figure 3-4. The main concentration of effort for otter trawls and demersal seines is in the southeast of ICES rectangle 37F0 with higher levels of effort for beam trawls in ICES rectangle 37F1 to the east of the Endurance Store. The average days fishing for scallop dredges is highest along the coastline around the 6 to 12 NM limit in ICES rectangles 37E9,37F0 and 38E9, and the Teesside and Humber Pipeline intersecting this area of high effort. This also aligns with the UK VMS data shown in Figure 3-4.

The VMS effort data for pelagic trawls and seines in Figure 3-5 shows the average number of fishing days is concentrated west of the Endurance Store and at sections of the Humber and Teesside Pipelines in the west of ICES rectangle 37F0 and the northeast of ICES rectangle 37E9. This main concentration of effort occurs along the 12 NM limit. The VMS effort data for static/passive gears in Figure 3-5 indicates a relatively low effort across all ICES rectangles with the highest concentrations of effort in 36F0, consistent with the landings data described in Section 3.1 and with the UK VMS data shown in Figure 3-4. Lower effort levels are visible in 37F0, 37F1, 37E9 and 38E9.

The patterns of activity displayed in Figure 3-5, encompassing UK and EU vessels, are generally consistent with those shown in Figure 3-4 for UK vessels only. As described in Section 3.3 the main fishing methods employed by non-UK fisheries are demersal otter trawls, beam trawls pelagic trawls in ICES rectangles 37F0 and 37F1.

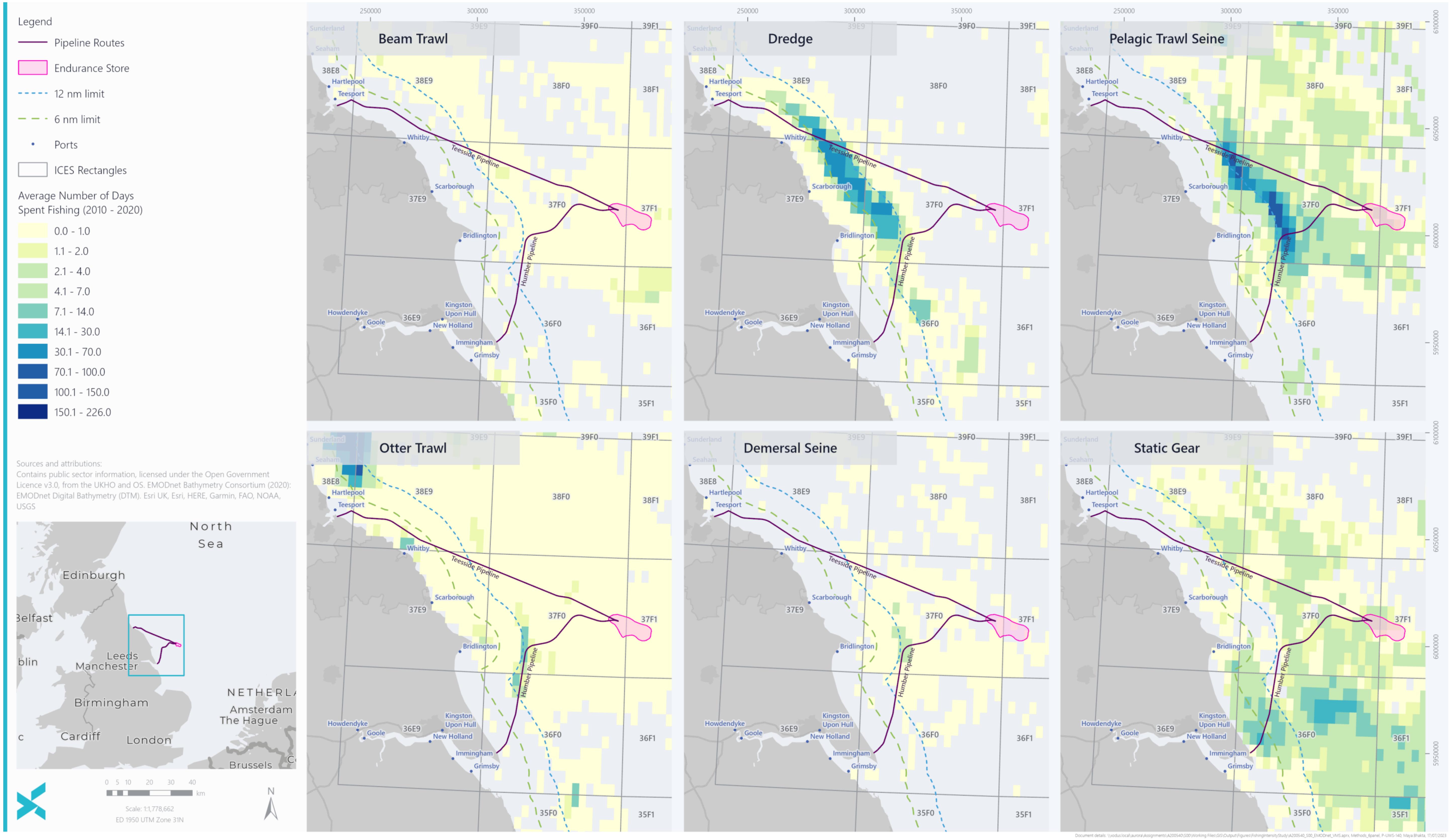


Figure 3-5 ICES VMS data (2010 – 2020) (ICES, 2021)

3.2.3 AIS Data

AIS tracklines for fishing vessels over 15 m in length are provided in Figure 3-6. The tracklines show that a high density of fishing vessels over 15 m travel in and out ports at Bridlington and Scarborough. The tracklines also indicate that fishing vessels over 15 m are concentrated in the nearshore areas proximal to these ports in ICES rectangle 36F0, 37E, 38E9 and 38E8.

No consideration was given to FisherMap and CEFAS inshore fishing activities, after the fishing industry requested to remove these datasets from the assessment.

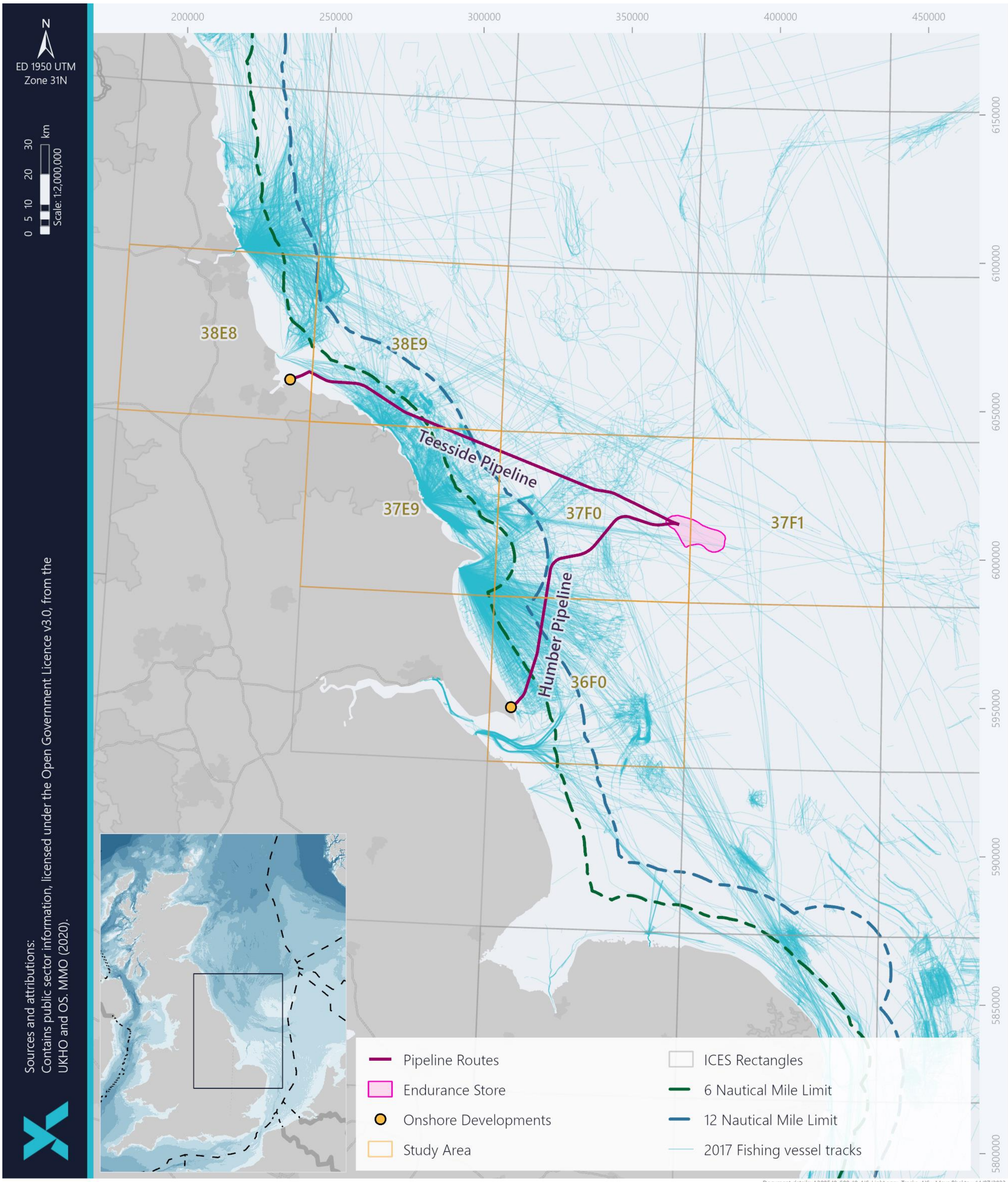


Figure 3-6 - Fishing vessel AIS tracklines (2017) (MMO, 2020c)

3.3 Non-UK Fisheries

Landings weights (tonnes) and fishing effort (hours fished) by ICES rectangle for EU member states is available through the EU DCF database via STECF. Landings weight and effort data that can be queried by country exists from 2012 – 2016, and therefore, this dataset has been analysed to undertake country assessments. Although more recent EU landings data are available, this data has not been utilised as it cannot be queried to identify the country associated with the landings, meaning that UK activity would also be included within the data.

It is acknowledged that fishing activity in the study area by non-UK vessels between 2012 – 2016 may not be representative of activity following the UK's withdrawal from the EU. Following the UK's withdrawal from the EU, EU fishing vessels no longer have equal access to fish between the UK 12 and 200 NM limit, as this area no longer forms part of EU waters. Non-UK vessels now require licences to fish in UK waters, as per the Trade and Cooperation Agreement (TCA) which came into force on 1 January 2021 and Section 16 of the Fisheries Act 2020. During a transition period up to 2026, licenced EU vessels have access to fish specified Total Allowable Catch (TAC) and non-quota stocks in UK waters between 12 and 200 NM limit and in areas where vessels have historic fishing rights between the 6 and 12 NM limit. Gradual changes to quota shares and TACs will also occur between 2021 and 2026, including a gradual reduction of EU quota shares within UK waters and the transfer of 25% of EU's fishing rights in UK waters to UK fleets (European Commission, 2020; European Council, 2021). Following the transition period, annual consultations will take place to determine access for EU vessels in UK waters and quota shares.

As a result of the expected reduction in EU quota shares for fishing in the UK waters, it may be expected that non-UK fishing activity may decline in coming years as a result of the reduction in EU quota shares and therefore fishing activity between 2012 and 2016 may overestimate the non-UK fishing activity occurring in the study area.

Section 3.3.1 to 3.3.6 below describe the average annual landings weights and fishing effort for non-UK fisheries according to the EU DCF data.

3.3.1 France

The average annual landings weights (tonnes) and fishing effort (hours fished) (2012 to 2016) for French-registered vessels in the study area are displayed in Figure 3-7 and Figure 3-8. French-registered vessels were operational in ICES rectangle 36F0, 37E9, 37F0, 37F1 and 38E9 and no landings were recorded in ICES rectangle 38E8.

Landings weights and fishing effort by French-registered vessels were comparably higher in ICES rectangle 37F0 than in the remaining ICES rectangles in the study area. In terms of average landings weights, pelagic trawls were dominant (contributing to 72% of landings values in the study area); however, average fishing effort (hours fished) was dominated by demersal otter trawls (contributing to 65% of the average hours fished). Other fishing methods operated to a lesser extent within the study area include demersal seines, pots and traps and trammel nets. These fishing methods together contribute to 27.6% of the average landings weights and 0.38% of the average fishing effort.

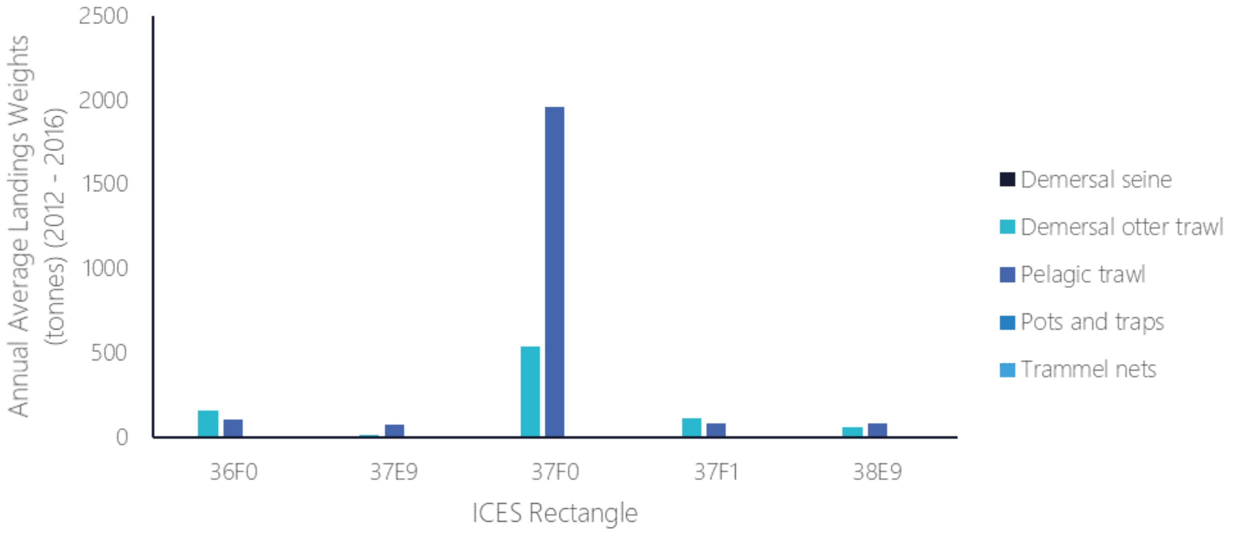


Figure 3-7 - Average annual landings weight (tonnes) (2012 – 2016) for French-registered fishing vessels (EU DCF database, 2019)

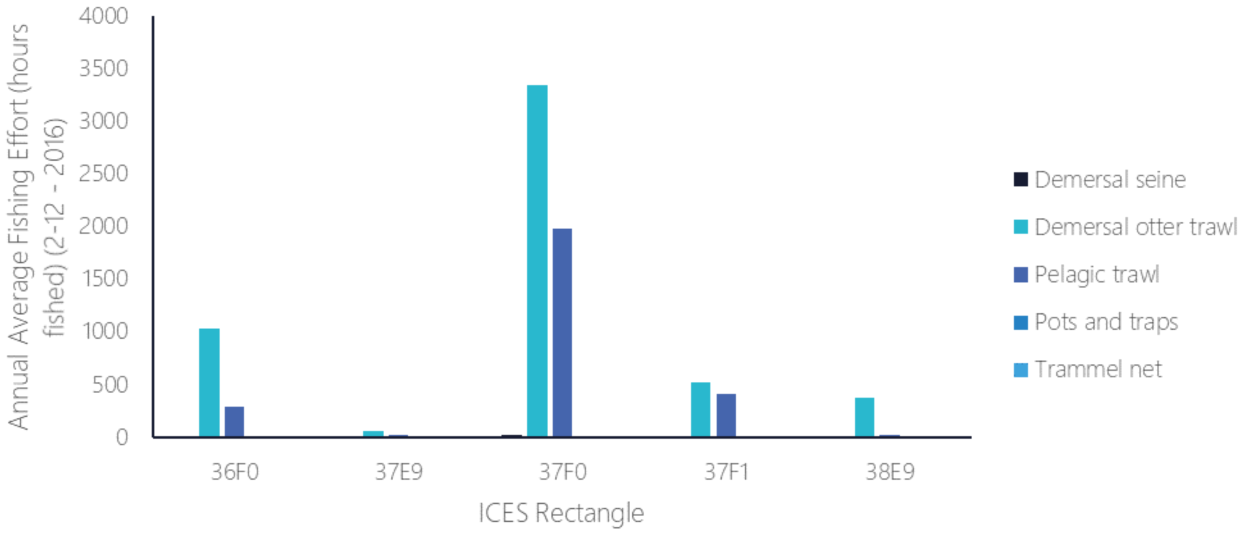


Figure 3-8 - Annual average fishing effort (hours fished) (2012 to 2016) for French-registered fishing vessels (EU DCF database, 2019)

Average annual landings weights were dominated by herring targeted by pelagic trawls, mackerel, targeted by pelagic and demersal otter trawls and whiting, predominantly targeted by demersal otter trawls (Table 3-5). Landings weights for these species were highest in ICES rectangle 37F0, corresponding to the higher effort levels sustained within this ICES rectangle.

Table 3-5 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by French-registered vessels within the study area (EU DCF database, 2019)

Scientific name	Common name	36F0	37E9	37F0	37F1	38E9	Total
Clupea harengus	Herring	54.6	71.5	1665.8	1.3	78.2	1871.4
Merlangius merlangus	Whiting	126.8	8.0	414.5	81.4	35.9	666.6
Scomber scombrus	Mackerel	61.4	1.8	376.1	104.3	10.8	554.4
Melanogrammus aeglefinus	Haddock	2.1	1.1	11.0	3.4	7.1	24.7
Gadus morhua	Cod	2.2	0.5	5.7	0.2	3.2	11.7
Pleuronectes platessa	Plaice	0.8	0.1	3.8	2.2	0.8	7.7
Trachurus spp	Jack and horse mackerels	2.1	0.1	3.1	0.2	0.5	5.8
Loliginidae, Ommastrephidae	Various squids	2.9	<0.1	2.6	<0.1	0.1	5.6
Limanda limanda	Common dab	1.6	<0.1	2.7	0.1	0.3	4.8
Microstomus kitt	Lemon sole	0.6	0.1	1.6	0.3	0.8	3.5
Other		4.1	0.3	9.0	3.2	1.5	18.0

3.3.2 Belgium

Most of the landings weights and fishing effort by Belgian-registered vessels between 2012 and 2016 were recorded in ICES rectangle 37F1 and 38E9. No landings were recorded in ICES rectangles 37E9 and landings in ICES rectangle 38E8 were only recorded in 2012.

Landings weights and effort were dominated by beam trawls which contributed to 98% of the landings weights in the study area, with comparably lower landings and fishing effort for demersal otter trawls, which were recorded in ICES rectangle 37F1 only (Figure 3-9 and Figure 3-10).

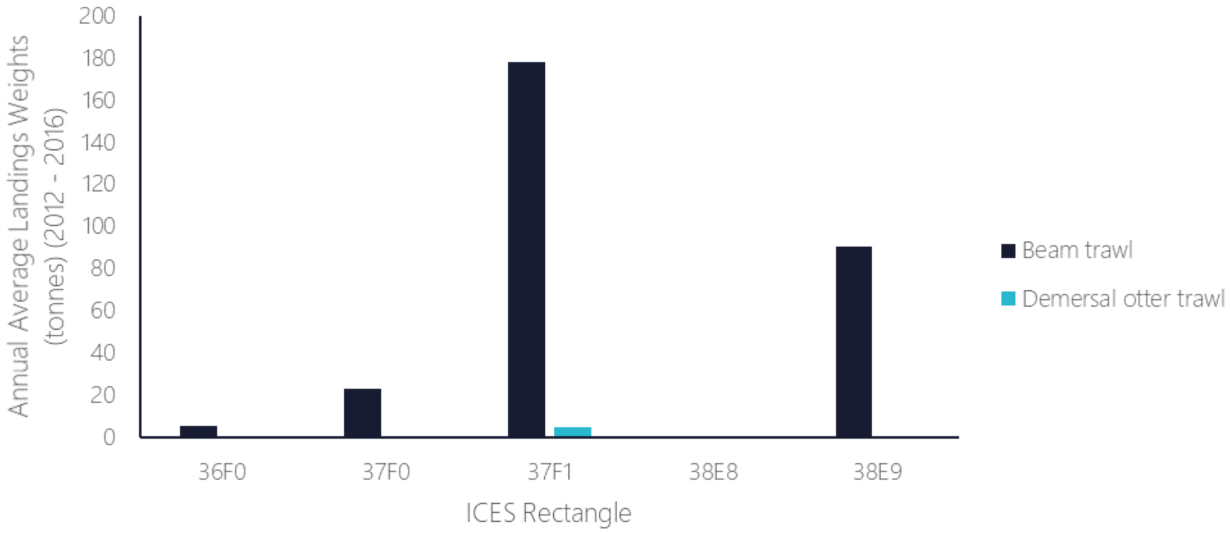


Figure 3-9 - Average annual landings weight (tonnes) (2012 – 2016) for Belgian-registered fishing vessels (EU DCF database, 2019)

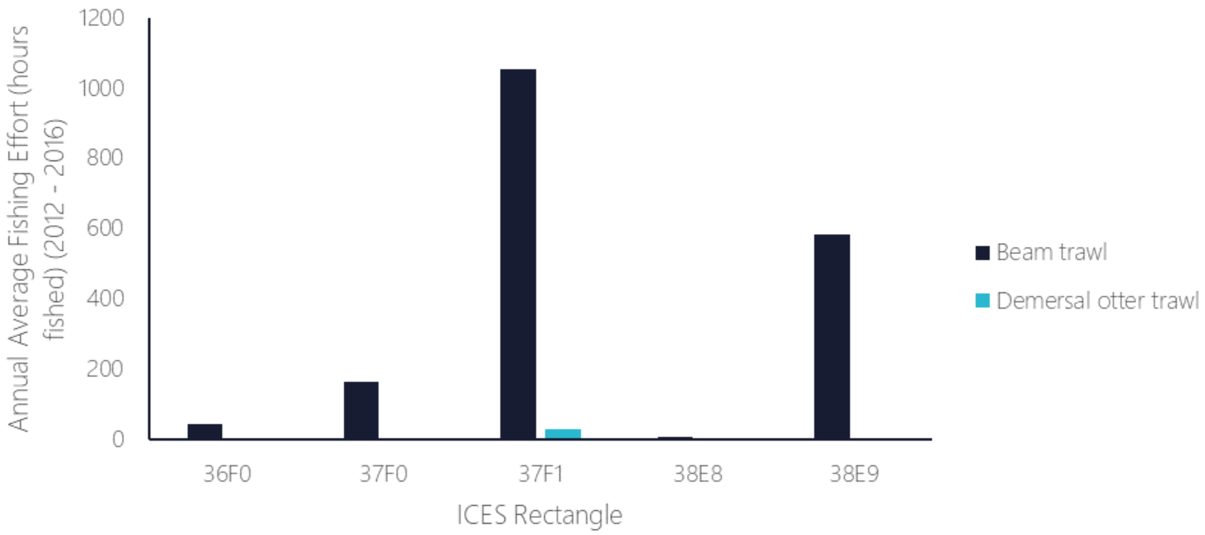


Figure 3-10 - Annual average fishing effort (hours fished) (2012 to 2016) for Belgian-registered fishing vessels (EU DCF database, 2019)

The key species targeted by Belgian-registered vessels include plaice, sole and edible crab, all targeted by beam trawls (Table 3-6). Most of the species listed as having the highest average landings weights from Belgian-registered vessels within the study area are demersal flatfish, which corresponds with the primary fishing method for Belgian vessels in the study area being beam trawls.

Table 3-6 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by Belgian-registered vessels within the study area (EU DCF database, 2019)

Scientific name	Common name	36F0	37F0	37F1	38E8	38E9	Total
Pleuronectes platessa	Plaice	2.7	8.6	115.4	0.2	35.7	162.4
Solea solea	Sole	0.6	1.8	17.0	<0.1	5.9	25.3
Cancer pagurus	Edible crab	0.1	2.0	15.0	0.1	6.2	23.3
Microstomus kitt	Lemon sole	0.2	2.6	3.8	0.1	10.4	17.1
Gadus morhua	Cod	0.4	1.6	5.9	<0.1	4.6	12.5
Lophiidae	Anglerfish	0.1	0.7	2.7	<0.1	8.6	12.2
Scophthalmus maximus	Turbot	0.1	0.4	4.7	<0.1	2.6	7.8
Scophthalmus rhombus	Brill	0.1	0.9	4.7	<0.1	1.9	7.7
Limanda limanda	Common dab	0.2	1.7	1.3	<0.1	2.1	5.2
Melanogrammus aeglefinus	Haddock	<0.1	0.7	0.2	<0.1	3.7	4.7
Other		0.5	1.9	12.1	0.1	8.5	23.1

3.3.3 Denmark

Danish-registered vessels are operational in ICES rectangles 36F0, 37E9, 37F0, 37F1 and 38E9 (Figure 3-11 and Figure 3-12). No landings weights or fishing effort for Danish-registered vessels were recorded in ICES rectangle 38E8.

The majority of average landings weights and effort for Danish-registered vessels occur in ICES rectangles 37F0 and 37F1 and are dominated by demersal otter trawls and to a lesser extent pelagic trawls. Demersal otter trawls contributed to 75% of the landings weights by Danish-registered vessels in the study area and 83% of the hours fished. Demersal seines are also operated in the study area, although effort levels are comparably lower than demersal otter trawls and pelagic trawls, contributing to 0.5% of the hours fished by Danish-registered vessels in the study only.

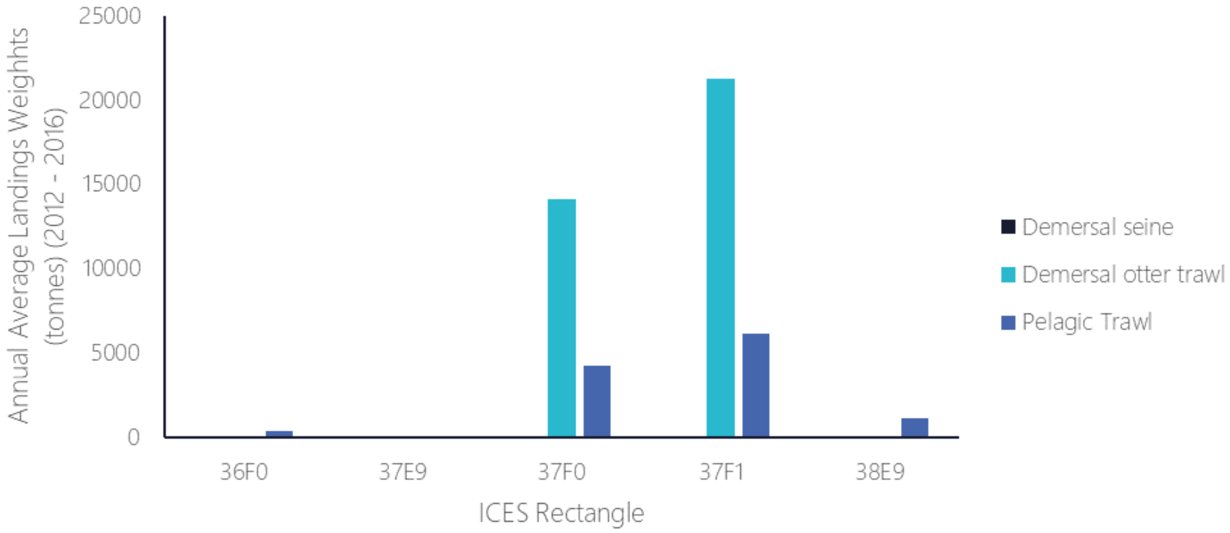


Figure 3-11 - Average annual landings weight (tonnes) (2012 – 2016) for Danish-registered fishing vessels (EU DCF database, 2019)

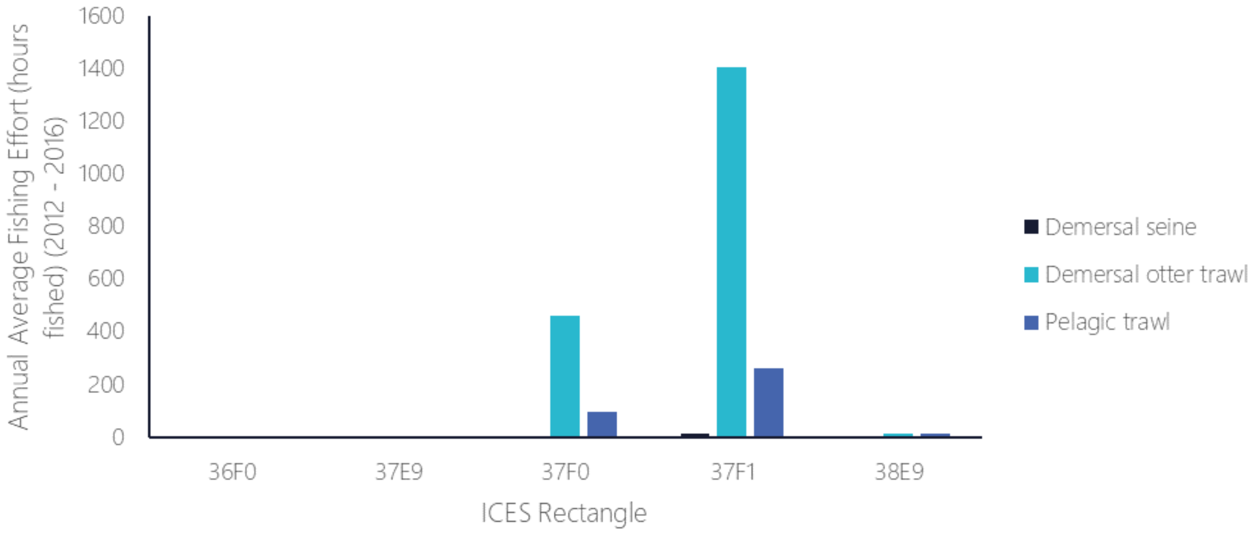


Figure 3-12 - Annual average fishing effort (hours fished) (2012 to 2016) for Danish-registered fishing vessels (EU DCF database, 2019)

Average landings weights are dominated by sandeel caught by demersal otter trawls in ICES rectangles 37F0 and 37F1. Herring caught by pelagic trawls dominate ICES rectangle 38E9, and average landings weights for this species are also relatively high in ICES rectangle 37F0 (Table 3-7).

Table 3-7 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by Danish-registered vessels within the study area (EU DCF database, 2019)

Scientific name	Common name	36F0	37E9	37F0	37F1	38E9	Total
Ammodytes spp	Sandeel	<0.1	10.7	3067.2	5251.2	<0.1	8329.1
Clupea harengus	Herring	72.5	0.1	560.7	53.8	218.5	905.6
Sprattus sprattus	Sprat	<0.1	0.1	34.7	128.5	<0.1	163.3
Merlangius merlangus	Whiting	<0.1	<0.1	5.7	28.5	<0.1	34.2
Scomber scombrus	Mackerel	<0.1	<0.1	0.7	10.9	<0.1	11.7
Limanda limanda	Common dab	<0.1	<0.1	3.4	2.8	<0.1	6.1
Eutrigla gurnardus	Grey gurnard	<0.1	<0.1	3.4	1.8	<0.1	5.2
Engraulis encrasicolus	European anchovy	<0.1	<0.1	1.6	0.7	<0.1	2.3
Hippoglossoides platessoides	Amer. plaice(=Long rough dab)	<0.1	<0.1	0.0	1.7	<0.1	1.7
Chelidonichthys lucerna	Tub gurnard	<0.1	<0.1	1.1	0.5	<0.1	1.6
Other		<0.1	<0.1	<0.1	3.4	0.6	4.1

3.3.4 Netherlands

Dutch-registered vessels are operational in ICES rectangle 36F0, 37E9, 37F1 and 38E9 (Figure 3-13and Figure 3-14). No landings weight or fishing effort by Dutch-registered vessels were recorded in ICES rectangle 38E8 between 2012 and 2016.

The average landings weights in ICES rectangle 37F0 contribute to the majority of average landings weights in the study area (87%). Average landings weights are dominated by pelagic trawls; however, fishing effort is dominated by beam trawls. Demersal seines and demersal otter trawls are also operated within the study area, although to a lesser extent, together contributing to 0.6% of the landings weights and 15% of the fishing effort by Dutch-registered vessels.

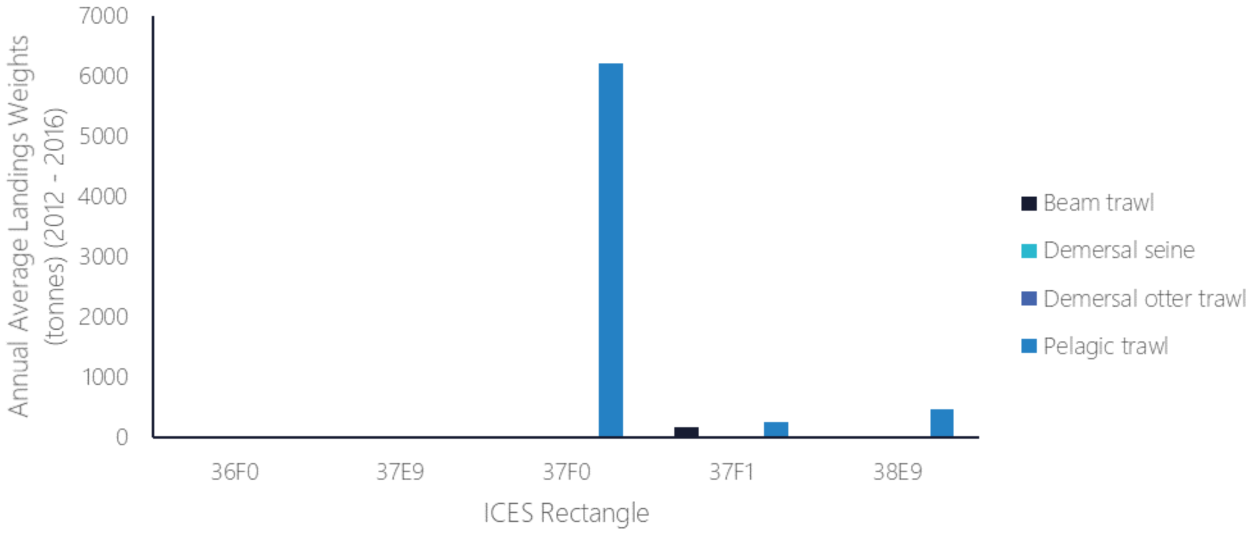


Figure 3-13 - Average annual landings weight (tonnes) (2012 – 2016) for Dutch-registered fishing vessels (EU DCF database, 2019)

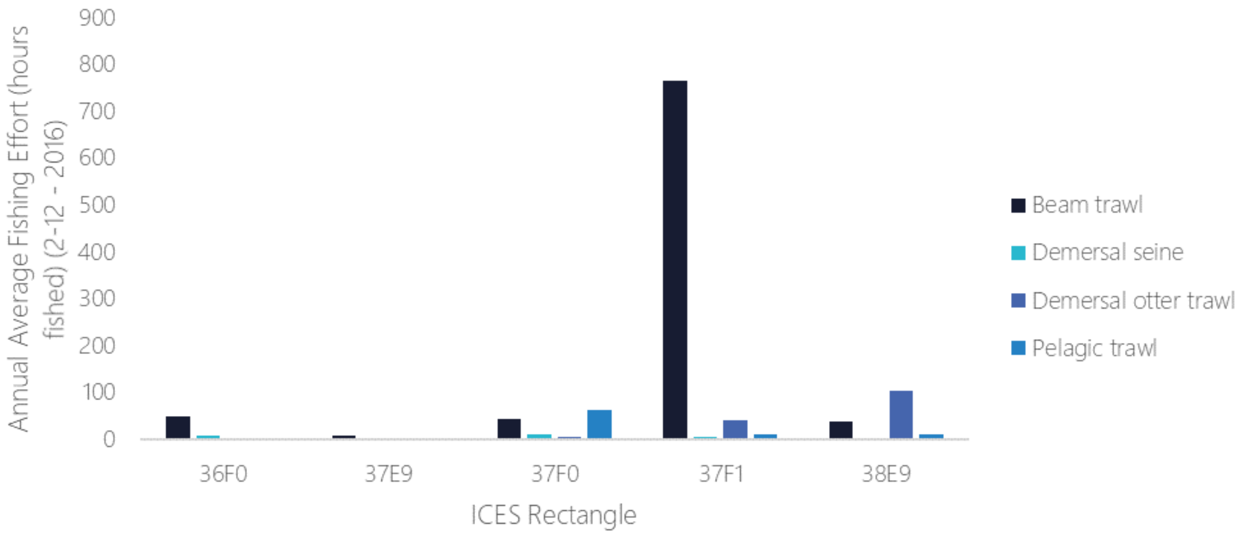


Figure 3-14 - Annual average fishing effort (hours fished) (2012 to 2016) for Dutch-registered fishing vessels (EU DCF database, 2019)

Average landings weights were dominated by herring, caught by pelagic trawls in ICES rectangle 37F0 (Table 3-8). Average landings weights for plaice, and to a lesser extent sole, caught by beam trawl were also dominant in ICES rectangle 37F1 which sustains relatively high effort levels for beam trawling by Dutch-registered vessels.

Table 3-8 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by Dutch-registered vessels within the study area (EU DCF database, 2019)

Scientific name	Common name	36F0	37E9	37F0	37F1	38E9	Total
Clupea harengus	Herring	<0.1	14.9	6197.6	234.3	449.1	6896.0
Pleuronectes platessa	Plaice	3.7	0.4	3.1	118.1	2.2	127.4
Solea solea	sole	2.3	0.5	1.1	30.2	0.9	35.0
Ammodytes spp	Sandeel	<0.1	<0.1	<0.1	20.8	<0.1	20.8
Scomber scombrus	Atlantic mackerel	0.1	1.4	14.3	0.9	<0.1	16.7
Merlangius merlangus	whiting	5.7	<0.1	4.9	2.2	1.3	14.1
Microstomus kitt	Lemon sole	0.1	<0.1	0.4	4.4	1.6	6.5
Scophthalmus maximus	Turbot	<0.1	0.2	0.0	4.8	0.4	5.3
Limanda limanda	Common dab	0.1	0.7	0.3	4.1	0.2	5.3
Nephrops novergicus	Norway lobster	<0.1	<0.1	<0.1	0.8	3.6	4.4
Other		1.8	0.1	4.3	8.3	3.3	17.8

3.3.5 Germany

German-registered vessels are operational in ICES rectangles 36F0, 37E9, 37F0, 37F1 and 38E9 (Figure 3-15 and Figure 3-16). No German-registered vessels were operational in ICES rectangle 38E8 between 2012 and 2016.

Landings from pelagic trawls operational in ICES rectangle 37F0 contribute to the majority of landings within the study area, however, fishing effort is dominated by demersal otter trawls in ICES rectangle 37F1. Beam trawls are also operated within the study area, but to a lesser extent, contributing to 0.04% of landings weights and 17% of the fishing effort.

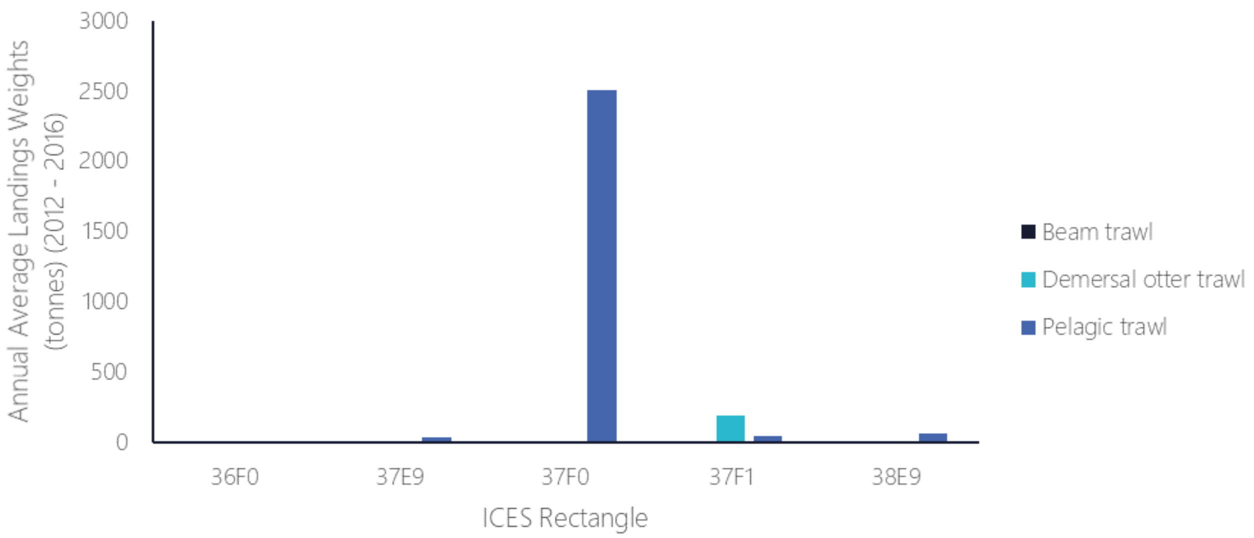


Figure 3-15 - Average annual landings weight (tonnes) (2012 – 2016) for German-registered fishing vessels (EU DCF database, 2019)

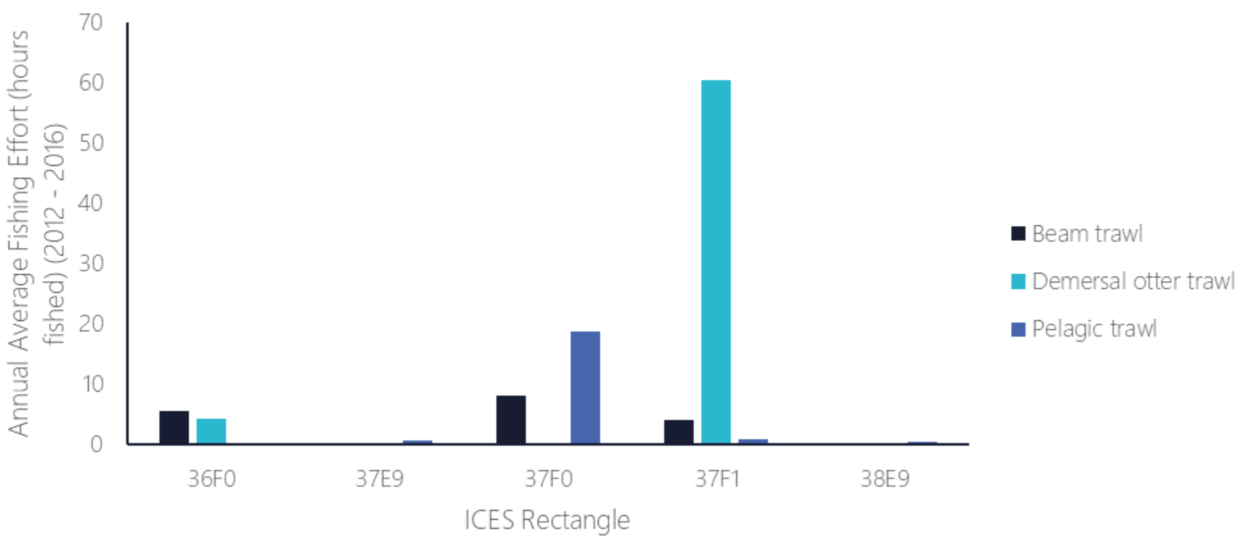


Figure 3-16 - Annual average fishing effort (hours fished) (2012 to 2016) for German-registered fishing vessels (EU DCF database, 2019)

Average landings weights by German-registered vessels were dominated by herring caught by pelagic trawls in ICES rectangle 37F0, which contribute to the majority of average landings weights in the study area (Table 3-9). Landings weights for sandeel caught by demersal otter trawlers in ICES rectangle 37F1 are also relatively high in comparison to other species.

Table 3-9 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by German-registered vessels within the study area (EU DCF database, 2019)

Scientific name	Common name	36F0	37E9	37F0	37F1	38E9	Total
Clupea harengus	Herring	<0.1	36.2	2502.6	44.7	61.0	2644.4
Ammodytes spp	Sandeel	<0.1	<0.1	<0.1	183.6	<0.1	183.6
Pleuronectes platessa	plaice	0.2	<0.1	<0.1	5.1	<0.1	5.3
Crangon crangon	Common shrimp	0.2	<0.1	0.3	<0.1	<0.1	0.4
Nephrops norvegicus	Norway lobster	0.2	<0.1	<0.1	0.1	<0.1	0.2
Solea solea	Sole	<0.1	<0.1	<0.1	0.1	<0.1	0.1
Scomber scombrus	Mackerel	<0.1	0.1	0.1	<0.1	<0.1	0.1
Merlangius merlangus	whiting	<0.1	<0.1	0.1	<0.1	<0.1	0.1
Microstomus kitt	Lemon sole	<0.1	<0.1	<0.1	0.1	<0.1	0.1
Limanda limanda	Common dab	<0.1	<0.1	<0.1	0.1	<0.1	0.1
Other		0.1	<0.1	<0.1	0.1	<0.1	<0.1

3.3.6 Sweden

In the study area, average landings weights and fishing effort were only recorded for Swedish-registered vessels in ICES rectangles 37F0 and 37F1 between 2012 and 2016 (Figure 3-17 and Figure 3-18).

Average landings weights were dominated by pelagic trawls in ICES rectangle 37F0 and demersal otter trawls in ICES rectangle 37F1 (Figure 3-17). In ICES rectangle 37F0 average fishing effort for demersal trawls and pelagic trawls is similar; however, in ICES rectangle 37F1, fishing effort by demersal otter trawls was dominant (Figure 3-18).

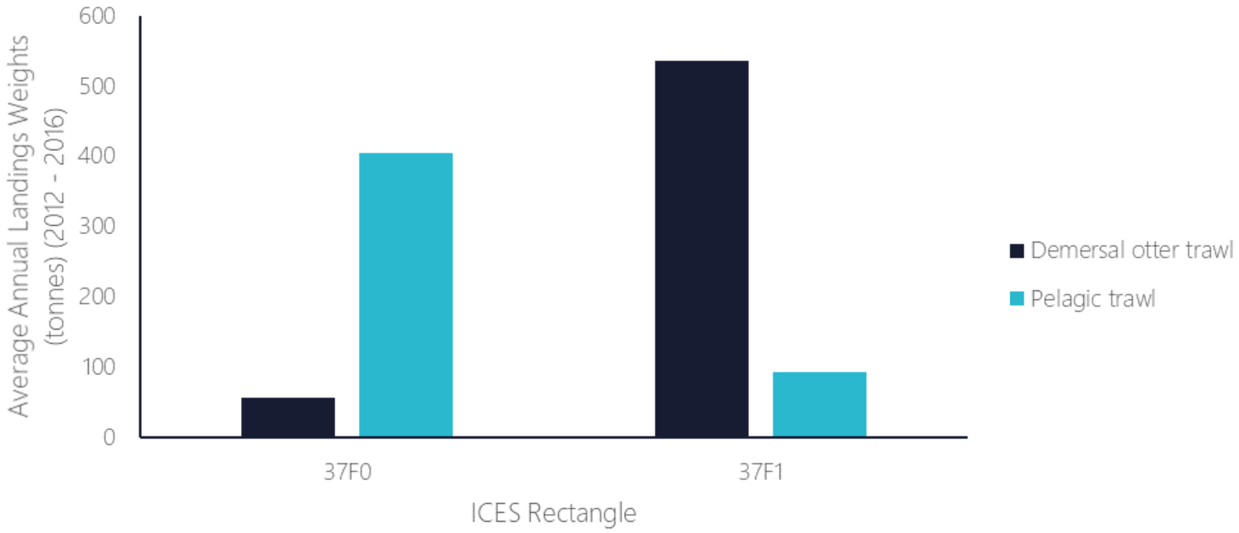


Figure 3-17 - Average annual landings weight (tonnes) (2012 – 2016) for Swedish-registered fishing vessels (EU DCF database, 2019)

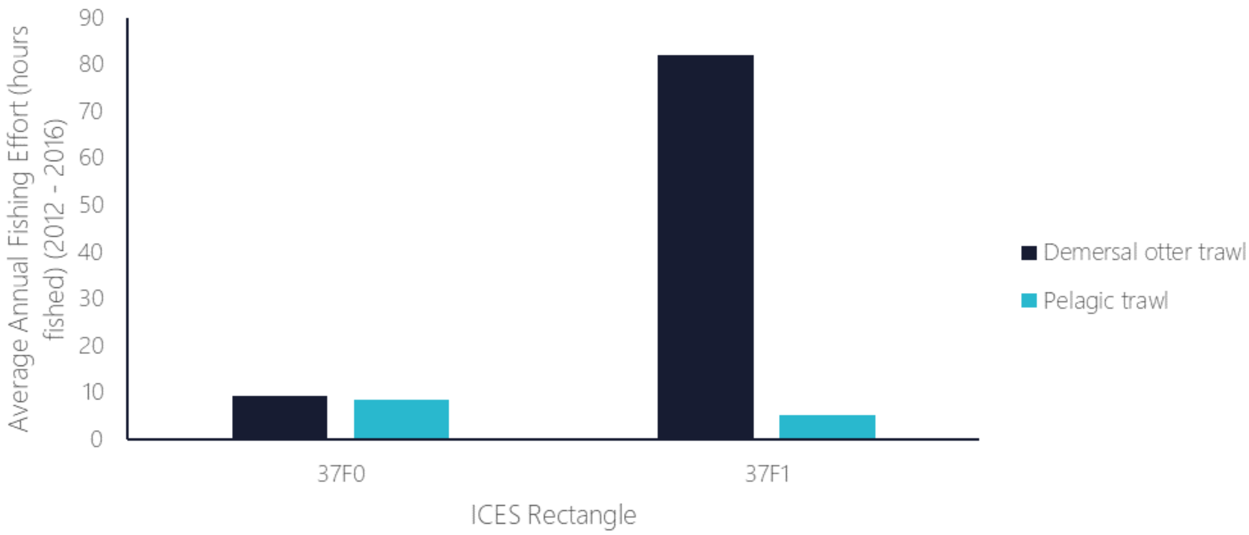


Figure 3-18 - Annual average fishing effort (hours fished) (2012 to 2016) for Swedish-registered fishing vessels (EU DCF database, 2019)

The average landings weights by species for Swedish-registered vessels generally corroborate the landings data by fishing method, indicating that average landings weights in ICES rectangle 37F1 are dominated by sandeels caught by demersal trawls and average landings weights in ICES rectangle 37F0 are dominated by herring caught by pelagic trawls (Table 3-10).

Table 3-10 - Average annual landings weights (tonnes) (2012 – 2016) for the top 10 species caught by Swedish-registered vessels within the study area (EU DCF database, 2019)

Scientific name	Common name	37F0	37F1	Total
Ammodytes spp	Sandeels	55.0	534.0	589.0
Clupea harengus	Herring	404.0	4.0	408.0
Sprattus sprattus	Sprat	<0.1	88.2	88.2
Trisopterus esmarkii	Norway pout	<0.1	1.8	1.8
Scomber scombrus	Atlantic mackerel	<0.1	<0.1	<0.1
Actinopterygii	Freshwater fishes	<0.1	<0.1	<0.1

4 AQUACULTURE

No aquaculture sites have been identified in the vicinity of the Development. The closest shellfish classification zone, associated with an aquaculture harvesting area for cockles, is located approximately 63 km southeast of the Humber Pipeline at Frieston to Wainfleet.

5 FISH AND SHELLFISH SPAWNING AND NURSERY GROUNDS

The Endurance Store is located in in high intensity nursery areas for cod *Gadus morhua* and whiting *Merlangius merlangus*, and low or undetermined intensity nursery areas for herring *Clupea harengus*, lemon sole *Microstomus kitt*, sandeel *Ammodytes marinus*, sprat *Sprattus sprattus*, anglerfish *Lophius piscatorius*, blue whiting *Micromesistius poutassou*, mackerel *Scomber scombrus*, European hake *Merluccius merluccius*, and spurdog *Squalus acanthias* (Coull *et al.*, 1998; Ellis *et al.*, 2012).

The Endurance Store is located within spawning grounds for cod, lemon sole, sprat and whiting. The Endurance Store also overlaps a high intensity spawning location for plaice *Pleuronectes platessa* and sandeel. Spawning periods of plaice, cod and sprat are driven by environmental cues; Peak spawning for plaice occurs from January to February. For cod, peak spawning is between February and March and peak spawning for sprat is from May to June (Coull *et al.*, 1998; Ellis *et al.*, 2012).

Along the Teesside Pipeline route, the species using the area as nursery grounds and for spawning are much the same with a few exceptions. European hake are exclusively found further offshore therefore, while they are found in the Endurance Store area, they are not noted as using the area along the Teesside Pipeline route for spawning or as nursery grounds (Coull *et al.*, 1998; Ellis *et al.*, 2012). Additional to the other species present at the Endurance Store, *Nephrops*, plaice and ling *Molva molva* may be present at points along the Teesside Pipeline route using the area as nursery grounds. *Nephrops* also use the area for spawning grounds further north, overlapping with the Teesside Pipeline route close to landfall (Coull *et al.*, 1998; Ellis *et al.*, 2012). The Teesside Pipeline route also overlaps with the Banks herring spawning grounds. *Nephrops* spawn all year round but peak between April and June and herring spawn between August to October (Coull *et al.*, 1998; ICES, 2017).

The same species are present along the Humber Pipeline route as at the Endurance Store with the exception again of European hake which is absent from the pipeline. Plaice use the area for nursery grounds, common to both export pipelines and absent from the Endurance Store area (Coull *et al.*, 1998; Ellis *et al.*, 2012). With regards to species which may use the area for spawning, sole *Solea solea* are unique to the Humber Pipeline route and confined to the nearshore area. They are recorded as being present along the coast south of Flamborough and peak spawning effort occurs in April (Coull *et al.*, 1998; Ellis *et al.*, 2012). The Banks herring spawning ground also overlaps with the Humber Pipeline route.

The spatial distribution of species' spawning and nursery grounds in relation to the Development is shown in Figure 5-1, Figure 5-2 and Figure 5-3.

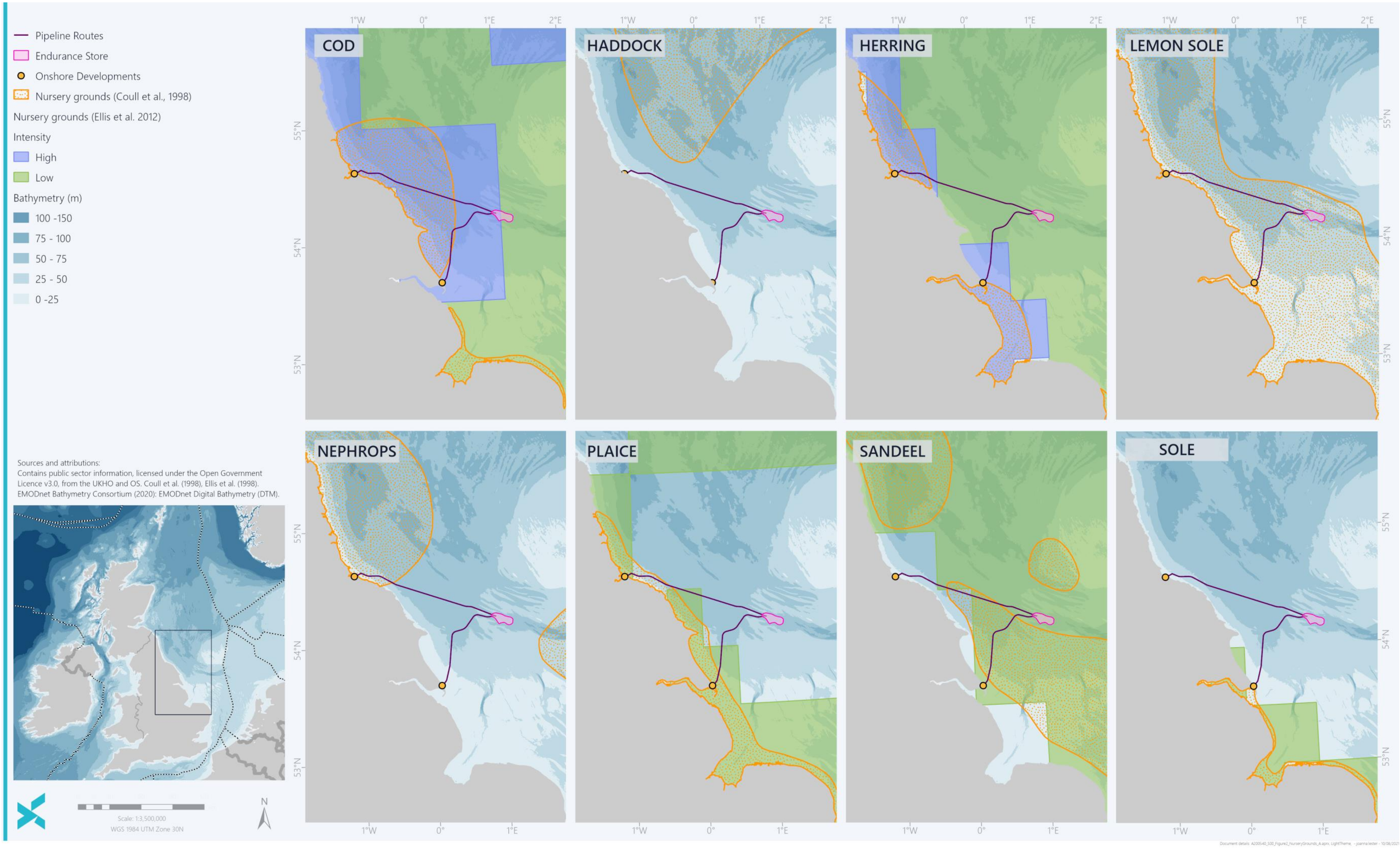


Figure 5-1 - Nursery grounds of fish species in the Development area (Coull et al, 1998; Ellis et al., 2012) (1 of 2)

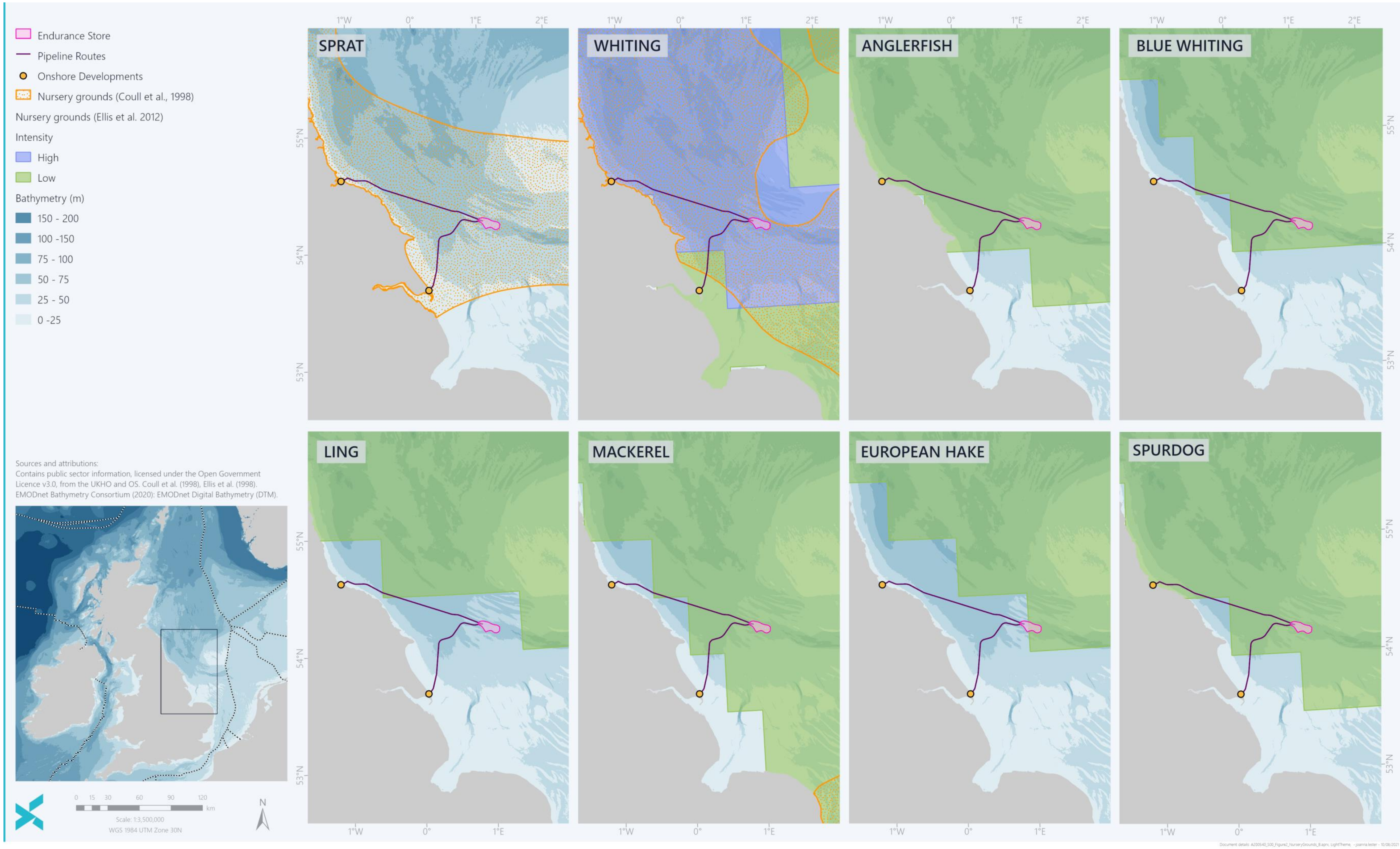


Figure 5-2 - Nursery grounds of fish species in the Development area (Coull et al, 1998; Ellis et al., 2012) (2 of 2)

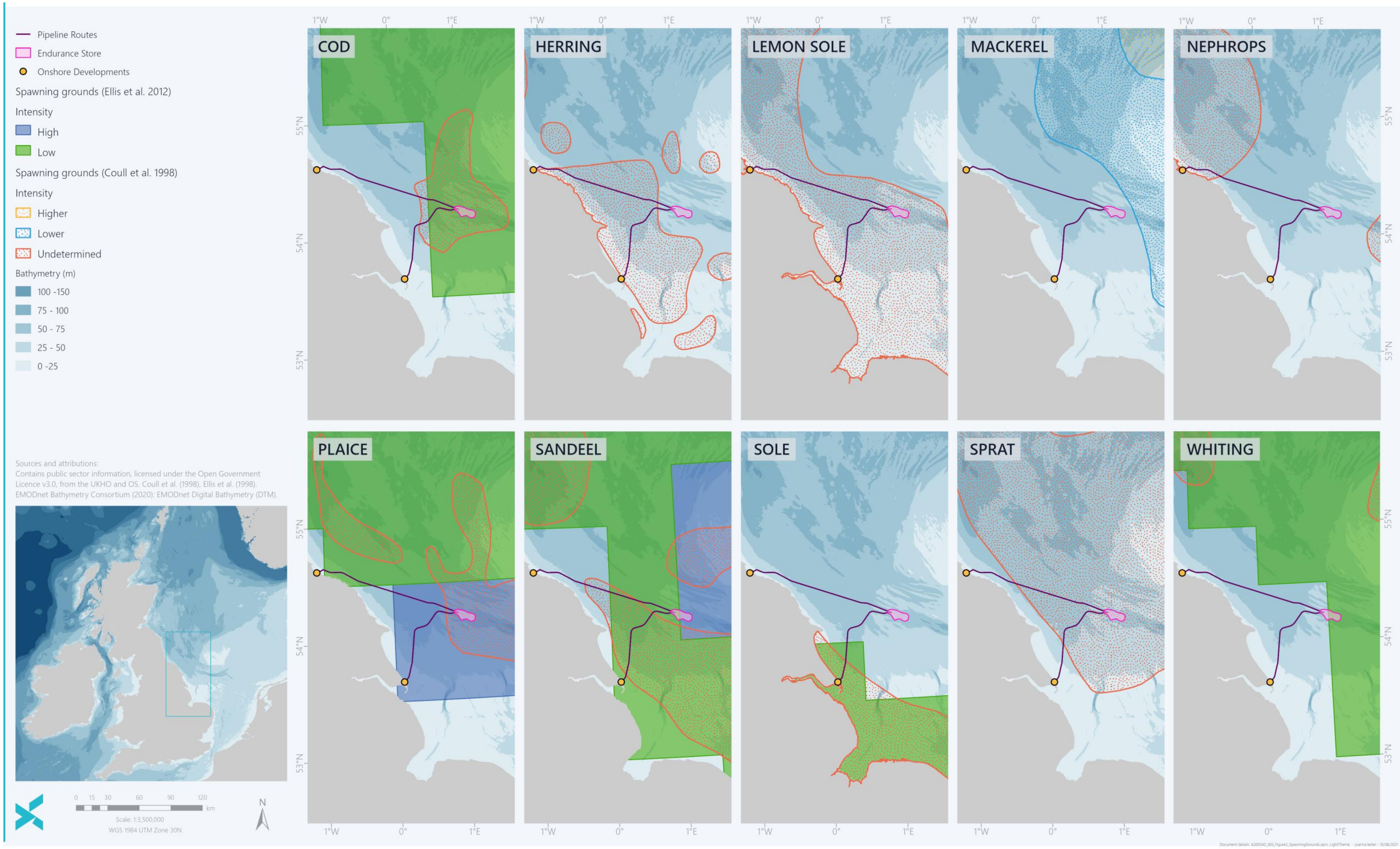


Figure 5-3 - Spawning grounds of fish species in the Development area (Coull et al, 1998; Ellis et al., 2012)

A review of available data on juvenile fish was undertaken by Aires *et al*. (2014), taking into account the findings of Ellis *et al*. (2012) and Coull *et al*. (1998) together with findings from the National and International Bottom Trawl Surveys, the Beam Trawl Survey, IHLS and other standalone surveys. The findings summarise the probability of aggregations of group 0 fish (those in the first year of their lives) around the UKCS. Within the Development area and surroundings, there is a low probability of juvenile plaice, sole, whiting, haddock, cod, sprat, herring, hake, angler fish, mackerel, horse mackerel, Norway pout and blue whiting (Aires *et al*., 2014). Further data on herring spawning areas can also be derived from IHLS data on the abundance of herring larvae < 11 mm (i.e. newly hatched larvae). Heat maps showing larvae per m^2, collected during IHLS surveys between 2007 and 2017, are presented in Boyle and New (2018). The heatmaps indicate that herring larvae have been recorded across the spawning area identified by Coull *et al*., (1998) that overlaps with the Teesside and Humber Pipelines. Herring larvae are concentrated to the north of this spawning area, around Flamborough Head, and this area is traversed by both the Teesside and Humber Pipelines. Annual heatmaps also indicate a high-degree of inter-annual variation, with higher densities of herring larvae in some years compared to others (Boyle and New, 2018).

Brown crab (*Cancer pagurus*) larvae surveys conducted in 1999 along the English North Sea coast indicate that the key spawning area for this species is located 70 km southeast of Flamborough Head (Figure 5-4) (Eaton *et al*., 2001). The spatial pattern of brown crab larvae correlates to areas with seabed temperature above 7°C at the time of hatching. The Teesside and Humber Pipelines traverse this spawning area for brown crab (Eaton *et al*., 2001).

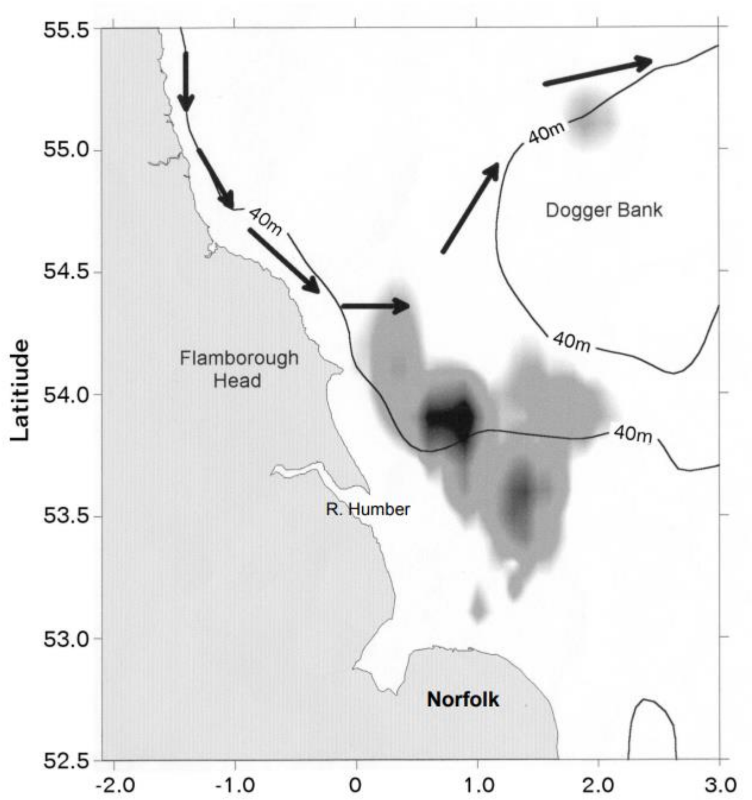


Figure 5-4 - Distributions of brown crab larvae from 1993 and 1999 surveys, where darker shading indicates a higher density (taken from Eaton et al., 2001).

Mass mortality events for crab and lobster occurred between October and December 2021 and an investigation into the cause of this mortality indicated that chemical pollution, sewage or infectious aquatic animal diseases were likely the cause of the events (DEFRA, 2022). Surveys conducted in the area in January 2022 have recorded healthy crabs in the region at reduced numbers than previously observed. More recent mortality events have also been recorded by NE IFCA at South Gare and Tees, nearby to the landfall for the Teesside Pipeline (NE-IFCA, 2022). Limited information on these events is available during the time of writing.

6 SUMMARY AND CONCLUSION

This study has reviewed several data sources to understand the commercial fishing baseline in the Development area. For UK fishing vessels, the fishing method of greatest value and effort is considered to be pots and traps, targeting lobsters and crabs. This fishing method comprises the majority of landings across the study area with the highest landings values in ICES rectangle 36F0. VMS data indicates that value and effort for vessels over 15 m operating static gear is high within ICES rectangle 36F0. The two other primary fishing methods operated by UK vessels in the study area are scallop dredging and demersal trawls/seines, targeting demersal whitefish and *Nephrops*. Scallop dredging is primarily operated in ICES rectangles 37F0, 37E9 and 38E9 and to a lesser extent in 36F0. The VMS data and surveillance sightings data indicates that the scallop grounds are adjacent to the coastline, extending from northeast of Whitby down to the east of the Humber, meaning there will likely be an overlap with the two pipeline routes. UK demersal trawls and seines are primarily operated in ICES rectangle 38E8, targeted for *Nephrops*, and VMS data indicates the presence of fishing grounds to the north of the Teesside Pipeline route in ICES rectangle 38E8. Demersal trawls / seines are also a key fishing method in ICES rectangle 37F1, which is targeted for plaice and *Nephrops*.

According to landings statistics and active vessel count, the key ports for UK vessels landing from the study area include Bridlington, North Shields, Scarborough, Whitby, Grimsby and Hartlepool.

A summary of the UK fishing activity in the study area and the operating practices for these methods is provided in Table 6-1.

Table 6-1 - Summary of UK Fishing activity in the study area

Fishing method	Prevalence in study area
Pots and traps	• Landings data indicates that this fishing method is operated across all ICES rectangles in the study area with highest landings values in ICES rectangle 36F0; • Key species include lobster and crabs, with whelks also caught in ICES rectangle 36F0; and • VMS data indicates high effort and value for passive vessels over 15 m across ICES rectangle 36F0. Also assumed that vessels under 15 m using pots and traps are operated within study area which are not included within this dataset.
Scallop dredging	• Contribute to a high proportion of landings values in ICES rectangles 37E9, 37F0 and 38E9; • VMS and surveillance sightings data indicate that the effort is concentrated between the 6 and 12 NM limit across ICES rectangle 37E9 and 37F0, extending into the south of ICES rectangle 38E9 and north of ICES rectangle 36F0.
Demersal trawls/seines (whitefish and *Nephrops*)	• Landings data indicates that this fishing method contributes to a high proportion of landings value in ICES rectangles 37F1 and 38E8; • Key commercial species include *Nephrops* and plaice, as well as other whitefish species. Landings of *Nephrops* in ICES rectangle 38E8 are especially high compared to remaining ICES rectangles in the study area; and • VMS data indicates that effort and value for demersal trawls/seines is concentrated in the north of ICES rectangle 38E8 and to the west of ICES rectangle 37F1.

Fishing method	Prevalence in study area
Other	Other fishing methods operated by UK vessels in the study area included pelagic trawls, drift and fixed nets, beam trawls and gears using hooks. Although these methods make up a small proportion of the landings values in the study area, with the exception of pelagic trawls in ICES rectangle 37F0. The landings data for 2019 to 2021 indicates the potential presence of a seasonal herring fishery in ICES rectangle 37F0.

Landings weights and effort from 2012 to 2016 were analysed for non-UK fishing vessels. Fishing activity by non-UK vessels in the study area is primarily undertaken in the ICES rectangles further offshore, including 37F0 and 37F1, although effort by Belgian beam trawlers is also relatively high in ICES rectangle 38E9. No non-UK landings were recorded in ICES rectangle 38E8. A summary of the country assessments is provided in Table 6-2.

Table 6-2 - Summary of non-UK fishing activity in the study area

Country	Summary of fishing activity in study area
France	• Landings weights and effort is concentrated in ICES rectangle 37F0. • Key fishing methods include demersal otter trawls and pelagic trawls, targeting herring and mackerel (pelagic trawls) and whiting (demersal trawls).
Belgium	• Landings weights and effort are dominated by beam trawls in ICES rectangles 37F1 and 38E9; and • Key commercial species are plaice and sole, as well as other demersal fish species.
Denmark	• Landings weights and effort were dominated by demersal otter trawls and pelagic trawls in ICES rectangle 37F0 and 37F1; and • Key commercial species include sandeel (targeted by demersal otter trawls) and herring (targeted by pelagic trawls).
Netherlands	• Landings weights were dominated by pelagic trawls in ICES rectangle 37F0, however, beam trawls were dominant in terms of fishing effort in ICES rectangle 37F1; • Key commercial species are herring and plaice.
Germany	• Landings weights were dominated by pelagic trawls in ICES rectangle 37F0 and fishing effort was dominated by demersal otter trawls in ICES rectangle 37F1; and • Key commercial species include herring (targeted by pelagic trawls) and sandeel (targeted by demersal trawls).
Sweden	• Landings weights and fishing effort were recorded in ICES rectangles 37F0 and 37F1 only; • Landings weights and effort were dominated by demersal otter trawls and pelagic trawls; and • Key commercial species include sandeels (targeted by demersal otter trawls in ICES rectangle 37F1) and herring (targeted by pelagic trawls in ICES rectangle 37F0).

This study has also reviewed data sources relevant to aquaculture and fish and shellfish spawning grounds. There are no aquaculture sites in the vicinity of the Development. There are several fish and shellfish spawning and nursery grounds which overlap with the development, including high intensity nursery areas for cod and whiting, high intensity spawning grounds for plaice and sandeel and spawning areas for brown crab.

7 REFERENCES

Aires, C., González-Irusta, J.M., Watret, R. (2014) Updating Fisheries Sensitivity Maps in British Waters. Scottish Marine and Freshwater Science Vol 5 No 10. Edinburgh: Scottish Government, 88pp. DOI: 10.7489/1555-1

Boyle, G., and New, P. (2018). ORJIP Impacts from Piling on Fish at Offshore Wind Sites: Collating Population Information, Gap Analysis and Appraisal of Mitigation Options. Final report – June 2018. The Carbon Trust. United Kingdom. Available from: https://prod-drupal-files.storage.googleapis.com/documents/resource/public/ORJIP%20Piling%20Study%20Final%20Report%20Aug%202018%20%28PDF%29.pdf [Accessed 06/06/2022].

CEFAS (2021). Shellfish Classification Zones of England and Wales. Available from: https://data.cefas.co.uk/view/79 [Accessed 01/11/2021].

Coull, K.A., Johnstone, R. and Rogers, S.I. (1998). Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.

DEFRA (2022). Update on investigation into the deaths of crabs and lobster in the North East. Press Release. Available from: https://www.gov.uk/government/news/update-on-investigation-into-the-deaths-of-crabs-and-lobster-in-the-north-east [Accessed 06/06/2022].

Eaton, D.R., Addison, J.T., Milligan, S.P., Brown, J. and Fernand, L.J. (2001). Larvae surveys of edible crab (*Cancer pagurus*) off the east coast of England: implications for stock structure and management. The Life History, Dynamics and Exploitation Exploration of the Sea of Living Marine Resources: Advances in Knowledge and Methodology CM 2001/J:14. Available from: https://www.ices.dk/sites/pub/CM%20Doccuments/2001/J/J1401.pdf [Accessed 06/06/2022].

Ellis, J.R., Milligan, S., Readdy, L., South, A., Taylor, N. and Brown, M. (2010). Mapping the spawning and nursery grounds of selected fish for spatial planning. Report to the Department of Environment, Food and Rural Affairs from Cefas. Defra Contract No. MB5301

EU DCF Database (2019). Data by quarter-rectangle: Tables and maps of effort and landings by ICES statistical rectangles for 2012 to 2016. Available from: https://stecf.jrc.ec.europa.eu/dd/effort/graphs-quarter [Accessed 01/11/2021].

European Commission (2020). Information about access of EU fishing vessels to the UK waters as of 1 January 2021. Available from: https://ec.europa.eu/oceans-and-fisheries/news/information-about-access-eu-fishing-vessels-uk-waters-1-january-2021-2020-12-31_en [Accessed 30/11/2021].

European Council (2021). Fish Stocks Shared Between the EU and the United Kingdom. Available from: https://www.consilium.europa.eu/en/policies/eu-fish-stocks/eu-uk-fishing-quotas/ [Accessed 30/11/2021].

ICES (2017). Stock Annex: Herring (Clupea harengus) in Subarea 4 and divisions 3.a., autumn spawners (North Sea, Skagerrak and Katte-gat, eastern English Channel). Available from: https://www.ices.dk/sites/pub/Publication%20Reports/Stock%20Annexes/2018/her.27.3a47d_SA.pdf [Accessed 13/01/2021].

ICES (2021). ICES Publication Reports Fishing Intensity Data Outputs.

MMO (2020a). Surveillance sightings data from 2015 to 2019.

MMO (2020b) Anonymised derived track lines 2017.

MMO (2020c). UK Sea Fisheries Statistics 2020. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1020837/UK_Sea_Fisheries_Statistics_2020_-_AC_checked.pdf [Accessed 12/11/2021].

MMO (2021a). 2016 to 2020 UK fleet landings by ICES rectangle. Available from: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2021 [Accessed 09/06/2023].

MMO (2021b). Landings from rectangles by 36F0, 37F0, 37F1, 37E9, 38E8 and 38E9 by port, 2026 to 2020 by port of landing.

MMO (2022a). 2021 UK fleet landings by ICES rectangle. Available from: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2021 [Accessed 09/06/2023].

MMO (2022b). Fishing Activity for over 15 m United Kingdom Vessels (2017-2020).

NE IFCA (2022). Shellfish Mortality Update. Available from: https://www.ne-ifca.gov.uk/press-releases/shellfish-mortality-april-2022-update [Accessed 06/06/2022].

Seafish (2021). Fishing Gear Database. Available from: https://www.seafish.org/responsible-sourcing/fishing-gear-database/ [Accessed 01/11/2021].

Appendix O: Vessel Emissions

Vessel emissions from the Development (fuel use and emissions factors derived from IP (2000) and EEMS (2008))

Activity	Vessel type	No. vessels	Days / vessel	Total fuel use (tonnes)	Emissions (tonnes)							
					CO_2	N_2O	CH_4	CO_2e	CO	NMVOC	SO_2	NO_X
Teesside Landfall (Worst case)												
Option: HDD or Microtunnel	Jackup Barge	1	360	7920.0	25106.4	1.7	1.4	25608.0	124.3	19.0	95.0	467.3
	Support Vessel	1	360	6480.0	20541.6	1.4	1.2	20952.0	101.7	15.6	77.8	382.3
	Pipelay Vessel	1	90	3150.0	9985.5	0.7	0.6	10185.0	49.5	7.6	37.8	185.9
	Dive Support Vessel	1	90	1620.0	5135.4	0.4	0.3	5238.0	25.4	3.9	19.4	95.6
Total				**19,170.0**	**60,768.9**	**4.2**	**3.5**	**61,983.0**	**301.0**	**46.0**	**230.0**	**1,131.0**
Humber Landfall (Worst case)												
Option: HDD	Jackup Barge	1	360	3960.0	25106.4	1.7	1.4	25608.0	124.3	19.0	95.0	467.3
	Support Vessel	1	360	3240.0	20541.6	1.4	1.2	20952.0	101.7	15.6	77.8	382.3
	Pipelay Vessel	1	90	3150.0	9985.5	0.7	0.6	10185.0	49.5	7.6	37.8	185.9
	Dive Support Vessel	1	90	1620.0	5135.4	0.4	0.3	5238.0	25.4	3.9	19.4	95.6
Total				**19,170.0**	**60,768.9**	**4.2**	**3.5**	**61,983.0**	**301.0**	**46.0**	**230.0**	**1,131.0**
Pipeline Installation												
Nearshore pipeline surveys	Nearshore Survey Vessel	2	14	504.0	1597.7	0.1	0.1	1630.0	7.9	1.2	6.0	29.7
Dredge nearshore trenches prior to pipelay	BHD	4	50	3400.0	10778.0	0.7	0.6	10993.0	53.4	8.2	40.8	200.6
	Support tug to tow BHD to / from site	4	50	3400.0	10778.0	0.7	0.6	10993.0	53.4	8.2	40.8	200.6
	CSD	2	14	504.0	1597.7	0.1	0.1	1630.0	7.9	1.2	6.0	29.7
	Split Hopper Barge	2	14	616.0	1952.7	0.1	0.1	1992.0	9.7	1.5	7.4	36.3
Maintenance of dredged trenches and pre-sweeping	TSHD	2	14	504.0	1597.7	0.1	0.1	1630.0	7.9	1.2	6.0	29.7
Backfill nearshore trenches following nearshore pipelay	BHD	2	50	1700.0	5389.0	0.4	0.3	5497.0	26.7	4.1	20.4	100.3
	TSHD	2	14	504.0	1597.7	0.1	0.1	1630.0	7.9	1.2	6.0	29.7
Offshore pipeline surveys (pre-lay, as-laid, as trenched, as-built, metrology), boulder clearance, crossing preparation	ROV Support Vessel	1	180	3240.0	10270.8	0.7	0.6	10476.0	50.9	7.8	38.9	191.2
Sweep seabed and boulder clearance as required along offshore pipeline route	SCAR Plough / TSHD / Grab Dredger	1	110	1980.0	6276.6	0.4	0.4	6402.0	31.1	4.8	23.8	116.8
Pipelay	Lay Barge – shallow water	1	135	2970.0	9414.9	0.7	0.5	9603.0	46.6	7.1	35.6	175.2

Activity	Vessel type	No. vessels	Days / vessel	Total fuel use (tonnes)	Emissions (tonnes)							
					CO_2	N_2O	CH_4	CO_2e	CO	NMVOC	SO_2	NO_X
	Lay Barge – deep water	1	355	12425.0	39387.3	2.7	2.2	40174.0	195.1	29.8	149.1	733.1
	Anchor Handling Vessel	3	490	7350.0	23299.5	1.6	1.3	23765.0	115.4	17.6	88.2	433.7
	Pipe Carrier	6	30	3960.0	12553.2	0.9	0.7	12804.0	62.2	9.5	47.5	233.6
Protection: - pipeline ends over winter - cable prior to trenching - infield flowline ends during installation	Guard Vessel	4	360	1008.0	3195.4	0.2	0.2	3259.0	15.8	2.4	12.1	59.5
Offshore pipeline trenching	Towed Plough	1	30	540.0	1711.8	0.1	0.1	1746.0	8.5	1.3	6.5	31.9
Rock placement	DP Fallpipe Vessel	2	30	900.0	2853.0	0.2	0.2	2910.0	14.1	2.2	10.8	53.1
	Side Stone Installation Vessel	2	30	900.0	2853.0	0.2	0.2	2910.0	14.1	2.2	10.8	53.1
Installation and protection of tie-in spool pieces between pipelines and subsea infrastructure	DSV/ROV Support Vessel	1	210	3780.0	11982.6	0.8	0.7	12222.0	59.3	9.1	45.4	223.0
Power & communications cable and SSIV cable lay & trench	Shallow Water Vessel	1	20	360.0	1141.2	0.1	0.1	1164.0	5.7	0.9	4.3	21.2
	Cable Lay Vessel	1	35	630.0	1997.1	0.1	0.1	2037.0	9.9	1.5	7.6	37.2
Supply equipment and material	Supply Vessel	1	150	750.0	2377.5	0.2	0.1	2425.0	11.8	1.8	9.0	44.3
Total				**51,925.0**	**164,602.3**	**11.4**	**9.3**	**167,892.0**	**815.2**	**124.6**	**623.1**	**3,063.6**
Subsea Infrastructure Installation												
Seabed surveys	ROV Support Vessel	1	12	216.0	684.7	0.0	0.0	698.0	3.4	0.5	2.6	12.7
Install SSIV and manifolds, pile SSIV and manifolds	Heavy Construction Vessel	1	18	360.0	1141.2	0.1	0.1	1164.0	5.7	0.9	4.3	21.2
	Safety Standby Vessel	1	18	13.0	41.2	0.0	0.0	42.0	0.2	0.0	0.2	0.8
Install infield flowlines and tie-in spools	Lay Barge	1	30	1050.0	3328.5	0.2	0.2	3395.0	16.5	2.5	12.6	62.0
	Anchor handling Vessel	3	30	450.0	1426.5	0.1	0.1	1455.0	7.1	1.1	5.4	26.6
	Trench / backfilling Vessel	1	30	540.0	1711.8	0.1	0.1	1746.0	8.5	1.3	6.5	31.9
	Support Vessel	1	30	540.0	1711.8	0.1	0.1	1746.0	8.5	1.3	6.5	31.9
Total				**3,169.0**	**10,045.7**	**0.7**	**0.6**	**10,246.0**	**49.8**	**7.6**	**38.0**	**187.0**
Drilling												
Rig move	Anchor Handling Vessel	2	36	360.0	1141.2	0.1	0.1	1164.0	5.7	0.9	4.3	21.2
	Tow Vessel	1	36	648.0	2054.2	0.1	0.1	2095.0	10.2	1.6	7.8	38.2
Drilling	Drilling Rig	1	370	6660.0	21112.2	1.5	1.2	21534.0	104.6	16.0	79.9	392.9

Activity	Vessel type	No. vessels	Days / vessel	Total fuel use (tonnes)	Emissions (tonnes)							
					CO_2	N_2O	CH_4	CO_2e	CO	NMVOC	SO_2	NO_X
	Safety Standby Vessel	1	370	259.0	821.0	0.1	0.0	837.0	4.1	0.6	3.1	15.3
	Supply Vessel	1	106	1908.0	6048.4	0.4	0.3	6169.0	30.0	4.6	22.9	112.6
	Spot Hire Vessel	1	74	1332.0	4222.4	0.3	0.2	4307.0	20.9	3.2	16.0	78.6
Helicopter flights	S-92 helicopter	1	264	140.0	442.3	0.0	0.0	451.0	1.2	0.3	1.7	0.0
Seabed survey	ROV Support Vessel	1	1	18.0	57.1	0.0	0.0	58.0	0.3	0.0	0.2	1.1
Total				**11,325.4**	**35,898.7**	**2.5**	**2.0**	**36,615.0**	**176.8**	**27.2**	**135.9**	**659.9**
Commissioning												
Wellheads & subsea infrastructure	ROV Support Vessel	1	50	900.0	2853.0	0.2	0.2	2910.0	14.1	2.2	10.8	53.1
Pipeline	ROV Support Vessel	1	100	1800.0	5706.0	0.4	0.3	5820.0	28.3	4.3	21.6	106.2
	DSV	1	21	378.0	1198.3	0.1	0.1	1222.0	5.9	0.9	4.5	22.3
Total				**3,078.0**	**9,757.3**	**0.7**	**0.6**	**9,952.0**	**48.3**	**7.4**	**36.9**	**181.6**
Operations												
Well water washing	ROV Support Vessel	1	14 x 25	6300.0	19971.0	1.4	1.1	20370.0	98.9	15.1	75.6	371.7
	Safety Standby Vessel	1	14 x 25	245.0	776.7	0.1	0.0	792.0	3.8	0.6	2.9	14.5
Retrieval and maintenance of landers	ROV Support Vessel	1	3 x 25	1350.0	4279.5	0.3	0.2	4365.0	21.2	3.2	16.2	79.7
Store monitoring: seismic (6 surveys of 8 weeks over 25 years of operation)	Seismic Survey Vessel	1	56 x 6	6048.0	19172.2	1.3	1.1	19555.0	95.0	14.5	72.6	356.8
	ROV Support Vessel	1	56 x 6	6048.0	19172.2	1.3	1.1	19555.0	95.0	14.5	72.6	356.8
Store monitoring: 4D gravity (baseline survey: 28 days; up to 5 surveys of 14 days over 25 years of operation)	ROV Support Vessel	1	28 + 5 x 14	1764.0	5591.9	0.4	0.3	5704.0	27.7	4.2	21.2	104.1
Pipeline integrity & inspection surveys (5 days every 5 years over 25 years of operation)	ROV Support Vessel	2	5 x 5	900.0	2853.0	0.2	0.2	2910.0	14.1	2.2	10.8	53.1
Internal pipeline integrity & inspection operations (14 days every 7 years over 25 years of operation)	Dive Support Vessel	2	14 x 4	2016.0	6390.7	0.4	0.4	6518.0	31.7	4.8	24.2	118.9
Total				**24,671.0**	**78,207.1**	**5.4**	**4.4**	**79,769.0**	**387.3**	**59.2**	**296.1**	**1,455.6**
Total Development Vessel Emissions				**132,508.4**	**420,048.8**	**29.2**	**23.8**	**428,440.0**	**2,079.3**	**318.0**	**1,590.1**	**7,809.7**