ACCIDENT REPORT

Report on the investigation of

the immobilisation and flooding of the dredger

Shearwater

after repeated collisions with the unmanned barge

Agem One

near Kinlochbervie, Scotland

on 9 April 2020

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

SERIOUS MARINE CASUALTY REPORT NO 11/2021 SEPTEMBER 2021

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2012 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 14(14) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

Front cover image courtesy of Northern Dredging Ltd

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AB	-	Able-bodied seaman
AIS	-	Automatic Identification System
COSWP	-	Code of Safe Working Practices for Seafarers
ECS	-	Electronic charting system
ENC	-	Electronic Navigational Chart
ETV	-	Emergency Towing Vessel
gt	-	Gross tonnes
HMPE	-	High modulus polyethylene
IMO	-	International Maritime Organization
kN	-	Kilonewtons
kW	-	Kilowatt
m	-	metre
MBL	-	Minimum breaking load
MCA	-	Maritime and Coastguard Agency
MGN	-	Marine Guidance Note
MLC	-	Maritime Labour Convention, 2006, as amended
mm	-	Millimetre
MSN	-	Merchant Shipping Notice
PFD	-	Personal Flotation Device
PPE	-	Personal Protective Equipment
RNLI	-	Royal National Lifeboat Institution
SCMS	-	Society of Consulting Marine Surveyors
SCV Code	-	The Small Commercial Vessel and Pilot Boat Code of Practice
SOLAS	-	International Convention for the Safety of Life at Sea 1974 (as amended)
SMC	-	Safe Manning Certificate
SMS	-	Safety Management System

STCW	-	International Convention on the Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended
t	-	Tonnes
UK	-	United Kingdom
VHF	-	Very High Frequency
WA	-	Workboat Association
UTC	-	Universal Co-ordinated Time

TIMES: all times used in this report are UTC+1 unless otherwise stated

Image courtesy of Northern Dredging Ltd

Shearwater

Image courtesy of Offshore Workboats Ltd

Agem One

SYNOPSIS

At about 2000 on 9 April 2020, the UK registered dredger *Shearwater* was immobilised after its propeller shafts were fouled by a towline being used to tow the barge *Agem One*. The dredger and barge collided with each other repeatedly resulting in *Shearwater* being holed and flooded, before the towline parted and *Agem One* drifted away. There was no pollution or injury.

Shearwater had been towing *Agem One* in an alongside configuration on a coastal passage when a significant swell was encountered. This made the alongside tow untenable, causing *Shearwater*'s crew to switch to an astern tow. Within minutes of switching, the 80m towline failed. Shortly after reconnecting the towline, it failed again, and the decision was made to abort the planned passage and seek shelter at Kinlochbervie. During the passage to Kinlochbervie the crew had reverted to an alongside tow and, in preparation for entering the narrow channel into the harbour, the towing arrangement was again reconfigured to tow the barge astern. It was during this evolution that the towline became fouled around *Shearwater*'s propeller shafts and the immobilised dredger was damaged. The situation was eventually brought under control after the intervention of a lifeboat, the emergency towing vessel, *Ievoli Black*, and the workboat *Forth Drummer*.

The accident happened because there was insufficient planning, risk assessments or safe systems of work for the towing operation being conducted. *Shearwater* was not suitable for use as a coastal towing vessel especially through hazardous areas such as the Pentland Firth, and the crew did not have the necessary competence to undertake the operation.

Shearwater was too large for certification as a small commercial vessel but under the tonnage requiring a safe manning certificate or safety management system. This investigation has identified that the flag state's arrangements for certifying *Shearwater* using exemptions from the Load Line Regulations did not provide sufficient guidance to assure safe operation of the vessel.

Since the accident, *Shearwater*'s owner has purchased a small tug for use when repositioning barges. Nevertheless, recommendations have been made to *Shearwater*'s owner to assess all on board hazards and provide safe systems of work to mitigate the foreseeable risks, and to ensure the vessel is safely manned. This report also makes a recommendation to the Maritime and Coastguard Agency to ensure that certification of vessels such as *Shearwater* includes the application of all appropriate regulatory conditions relevant to the vessel's intended function and area of operations.

SECTION 1 – FACTUAL INFORMATION

1.1 PARTICULARS OF *SHEARWATER*, *AGEM ONE* AND ACCIDENT

SHIP PARTICULARS		
Vessel's name	*Shearwater*	*Agem One*
Flag State	UK[1]	UK
Classification society/ Certifying Authority	Built under Lloyds Register supervision – not maintained in Class	Society of Consulting Marine Engineers and Ship Surveyors
IMO number	6822216	Not applicable
Type	Grab hopper dredger	Unmanned catamaran barge
Registered owner	Northern Dredging Limited	Offshore Workboats Limited
Manager(s)	Northern Dredging Limited	Northern Dredging Limited
Construction	Steel	Steel
Year of build	1968	1992
Length overall	36.56m	21.0m
Registered length	34.41m	Not applicable
Gross tonnage	342	Not applicable
Minimum safe manning	Not applicable	Not applicable
Authorised cargo	Dredge spoil	Not applicable

VOYAGE PARTICULARS		
Port of departure	Gairloch	
Port of arrival	Loch Eriboll (intended)	
Type of voyage	Transit	
Cargo information	None	Not applicable
Manning	4	Unmanned

MARINE CASUALTY INFORMATION		
Date and time	9 April 2020 at 2000	
Type of marine casualty or incident	Serious Marine Casualty	
Location of incident	58°28.86'N – 005°09.09'W	
Place on board	Propulsion / hull	Bow
Injuries/fatalities	None	None
Damage/environmental impact	Damage to hull and propulsion	None
Ship operation	Towing	Under tow
Voyage segment	On passage	On passage
External & internal environment	Wind: southerly force 3, sea state: short choppy sea and good visibility. Sunset was at 2021	
Persons on board	4	None

[1] Since the accident the vessel has been transferred to the flag of St Kitts and Nevis.

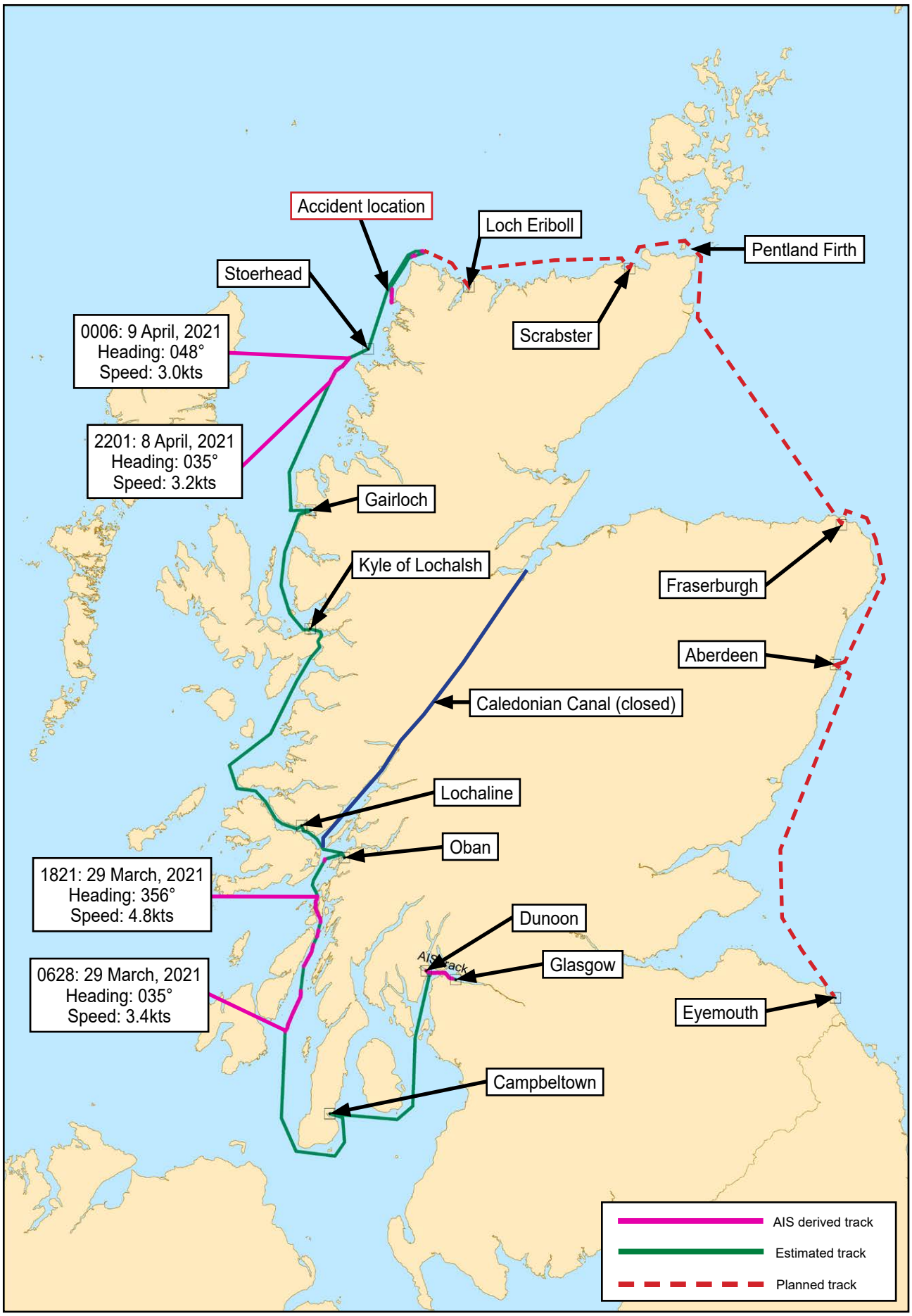

Figure 1: Overview of the actual passage, intended passage and accident location, including AIS data

1.2 BACKGROUND

On 25 March 2020, the grab hopper dredger *Shearwater*, towing the barge *Agem One*, departed from Glasgow, Scotland, intending to transit to Eyemouth, Scotland in a series of short passages **(Figure 1)**. The purpose of the voyage was to reposition for the start of a new dredging contract. There were four persons on board *Shearwater*: the owner[2], the master, an able-bodied seaman (AB) and an excavator driver. *Agem One* was laden with a 45 tonne (t) excavator. Prior to the accident, the dredger and barge stopped at Campbeltown, Oban, Lochaline (where a short period of dredging operations was conducted), Kyle of Lochalsh and Gairloch. At 0800 on 8 April 2020, *Shearwater* and *Agem One* left Gairloch and headed north towards Cape Wrath via a short stopover near Stoerhead **(Figure 1)**.

1.3 NARRATIVE

1.3.1 Events leading up to the collision

Early in the morning on 9 April 2020, *Shearwater* departed from Stoerhead for passage to Loch Eriboll **(Figure 2)**. *Shearwater* was towing *Agem One* alongside (on the dredger's port side) and was proceeding at a speed of between 3 and 5.2 knots (kts). The master was on the bridge and in control of the vessel, and *Shearwater*'s owner was overseeing towing operations. *Shearwater* passed Cape Wrath at about 1030 **(Figure 2)** and started to encounter a long swell with a height of approximately 2.5 metres (m), causing *Agem One* to move heavily against the dredger's side. The alongside towing configuration was judged untenable by *Shearwater*'s owner who ordered that *Agem One* be moved to an astern tow.

The AB and the excavator driver stepped across to *Agem One* from *Shearwater*'s deck and prepared for an astern tow by connecting the shackle on the barge's bridle to the towline's hard thimble eye. Both crewmen then returned to *Shearwater*, *Agem One* was cast off and the 80 metre (m) towline payed out. After *Shearwater* had towed *Agem One* a short distance, the towline broke and the barge drifted free.

Shearwater's master then manoeuvred to retrieve *Agem One* and the two crewmen once again stepped across to the barge to reattach the tow. The towline had failed at the point of connection to the barge's bridle and the hard eye was observed to be distorted, so the crewmen tied a bowline knot in the towline as an alternative connection. The passage towards Loch Eriboll continued but the towline failed again with *Agem One* needing to be retrieved and the tow reattached once more.

At about 1200, following the repeated failures of the towline, the owner and master decided to abort the passage and head back towards shelter in Kinlochbervie.

1.3.2 Immobilisation, collisions, and loss of the barge

At about 1900, *Shearwater* was just over 3 nautical miles (nm) west of Kinlochbervie **(Figure 2)** with *Agem One* back in an alongside towing arrangement. In this area, there was a moderate breeze, a short, choppy sea and good visibility. A decision was then taken to revert to an astern tow due to the narrow width of navigable water available in the approaches to Kinlochbervie.

[2] The sole director of *Shearwater*'s registered owning company, Northern Dredging Limited, was on board and is referred to as the 'owner' in this report.

Reproduced from Admiralty Charts 1954, 2720 and 1794 by permission of HMSO and the UK Hydrographic Office

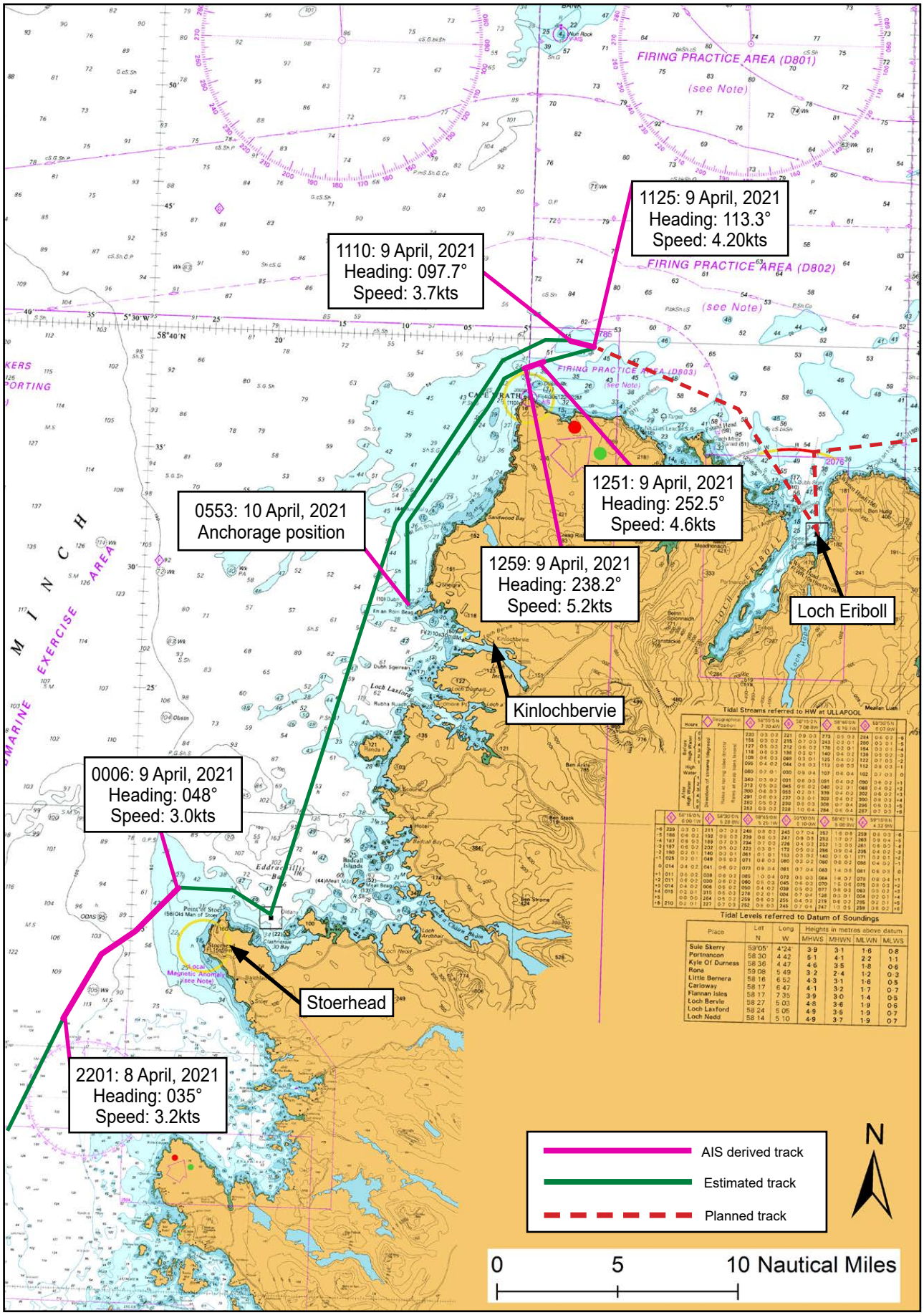

Figure 2: Passage of *Shearwater* and *Agem One* on the day of the accident, including AIS data

Agem One was cast off with the excavator driver on board and the owner and the AB passed the towline from *Shearwater*'s aft deck down to him to connect up. Once connected, the master needed to go astern to close the gap between the dredger and the barge so that the excavator driver could be retrieved back on board.

Prior to applying astern propulsion, the owner, who was on the bridge, asked the AB to confirm that the towline was clear of the water. The AB shouted back that it was, so the master applied astern power on both shafts. When *Shearwater* was adjacent to the barge, the excavator driver scrambled back across on to the dredger's side deck; at the same time, both engines stopped. The master restarted the engines and attempted to engage propulsion but neither engine would clutch in.

The excavator driver then went to the engine room to assess the situation and found that the port shaft was dislodged from the gearbox and the gearbox's casing was damaged. He went to the bridge and briefed the master and the owner about the damaged propulsion. By this time, the owner and master had seen from the aft deck that the shafts were fouled by the towline.

The master was aware that both vessels were then drifting north with the tidal stream at about 1kt and the only safe course of action was to drop the anchor. The port anchor was let go and, as it started to hold, *Shearwater* swung round into the tidal stream; at this point, *Agem One*, which was not under control, made several heavy, damaging collisions with *Shearwater*'s port side. The crew tried to regain control of *Agem One* by securing it alongside *Shearwater* but were unable to do so. *Agem One* was then held briefly astern of the dredger by the fouled towline before drifting free when the towline broke.

When the crew checked *Shearwater* for damage, water was found entering the port side buoyancy space through damage holes in the shell plating **(Figure 3)**.

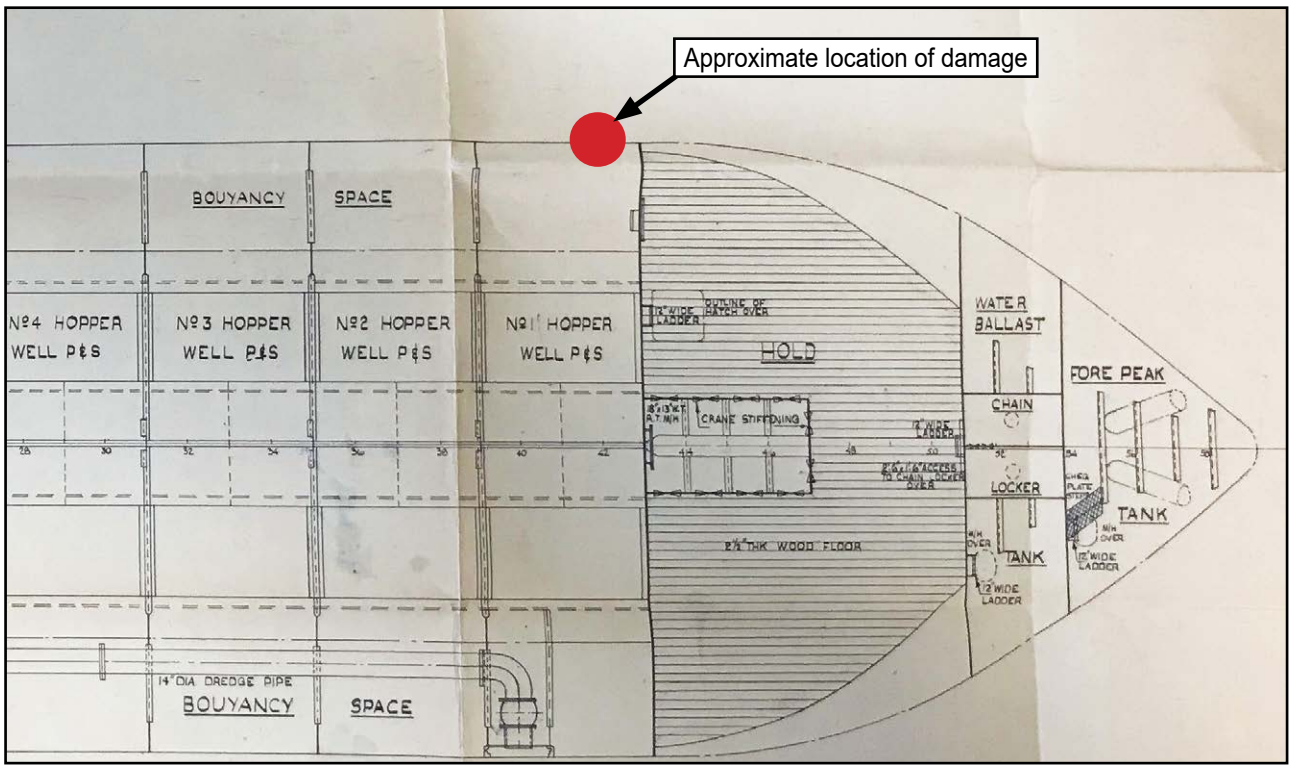

Figure 3: Extract from *Shearwater*'s general arrangement showing the approximate location of damage

1.3.3 Actions after *Agem One* broke free

At 2021[3], the owner called the coastguard to report that *Agem One*, which was unlit, had broken away from *Shearwater* and was drifting free. The owner also reported that *Shearwater* was immobilised, anchored and taking on water. The coastguard requested that the Lochinver RNLI[4] all-weather lifeboat locate and retrieve *Agem One*, and the emergency towing vessel (ETV) *Ievoli Black* was tasked to proceed to assist.

Shearwater's crew tried to pump water out of the flooded port buoyancy space using the fixed bilge system but were unsuccessful, so rigged a portable electric submersible pump instead. The crew also attempted to stem the water ingress with rags and sealant. At 2204, the lifeboat located the drifting *Agem One* and commenced towing it back towards *Shearwater*. The lifeboat reached *Shearwater* at around 0130 on 10 April **(Figure 4)** and held position nearby awaiting the arrival of the ETV.

Image courtesy of RNLI Lochinver Lifeboat Facebook page

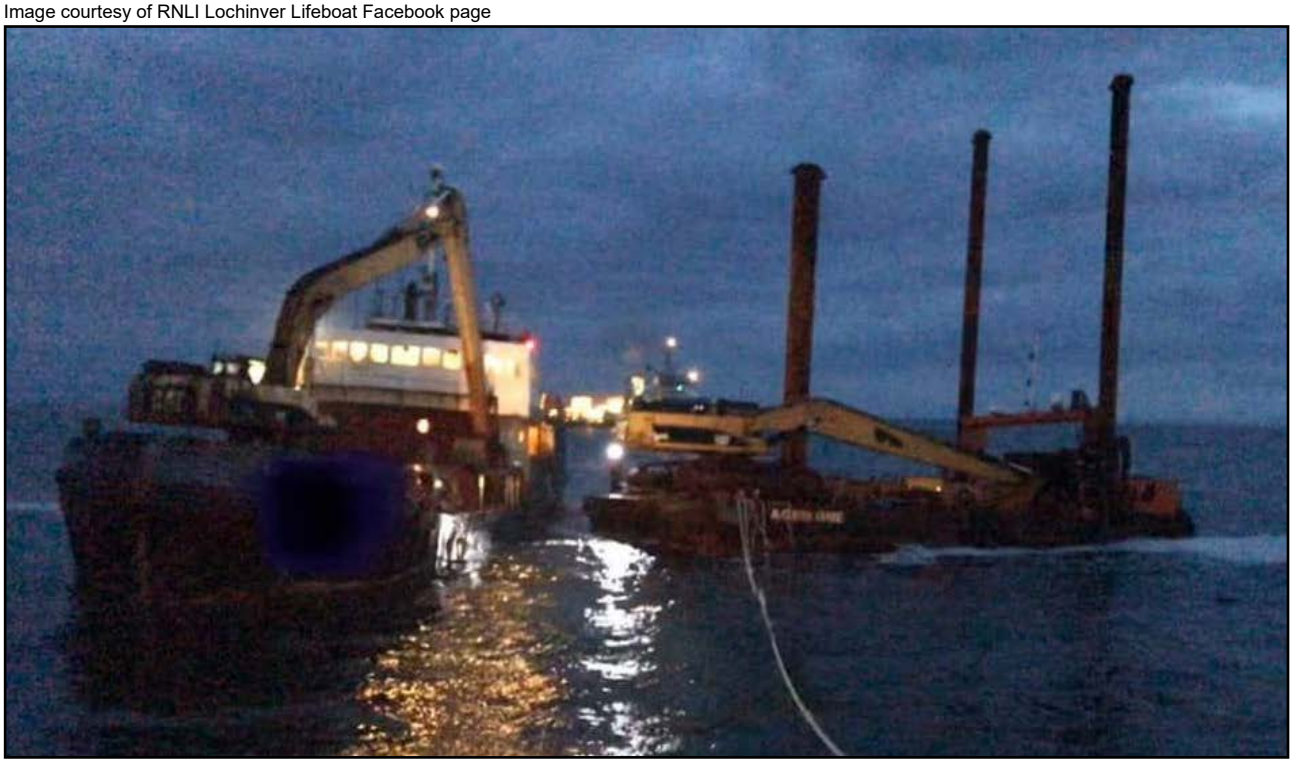

Figure 4: Lochinver lifeboat returning *Agem One* to *Shearwater*

Shearwater's owner informed the coastguard at 0212 that the portable pump was not keeping up with the water ingress and that the dredger had developed a list of between 5 and 10 degrees to port as a result of the flooding. *Ievoli Black* arrived on scene at 0242, then launched a sea boat and transferred two additional portable salvage pumps to *Shearwater*, which were assembled and added to the pumping effort. *Shearwater* was returned to level trim by 0355 and the lifeboat crew prepared to return *Agem One* to the dredger. *Agem One* was secured alongside *Shearwater* at 0547 and the lifeboat headed home; *Ievoli Black* remained standing by to assist.

[3] 2021 was also the time of sunset

[4] Royal National Lifeboat Institution

On board *Shearwater*, the crew rested and waited for the workboat *Forth Drummer*[5] to arrive. *Agem One* periodically made further heavy contact with *Shearwater* causing more damage to the dredger's hull plating. *Forth Drummer* arrived at 1730 and initially towed *Agem One* into Kinlochbervie. *Forth Drummer* then returned to the anchored *Shearwater* and took the dredger in tow bound for Aberdeen; *Ievoli Black* left the scene at 2200 after this tow was established.

At 0512 on 11 April, when transiting the Pentland Firth, *Forth Drummer* reported that *Shearwater* was again taking on water and had developed a list of around 10 degrees. The tow to Aberdeen was aborted and *Shearwater* was taken into Scrabster **(Figure 5)**. Following temporary repairs, the tow was resumed with a second tug, *Shuna*[6], on 16 April. *Shearwater* entered Aberdeen harbour at around 0600 on 18 April and was taken to dry dock where an inspection found the towline wrapped around both propeller shafts **(Figure 6)**, penetration and significant indentation to the port side shell plating and damage to the port shaft and gearbox. *Agem One* was undamaged following the accident and was left at Kinlochbervie anchored by its spud legs; it was eventually retrieved in December 2020.

Figure 5: *Shearwater* entering Scrabster harbour being towed alongside *Forth Drummer*

[5] *Forth Drummer* was a multi-purpose workboat, capable of towing and with a certified bollard pull of 23.5 tonnes

[6] *Shuna*'s bollard pull was 14 tonnes

Image courtesy of Northern Dredging Ltd

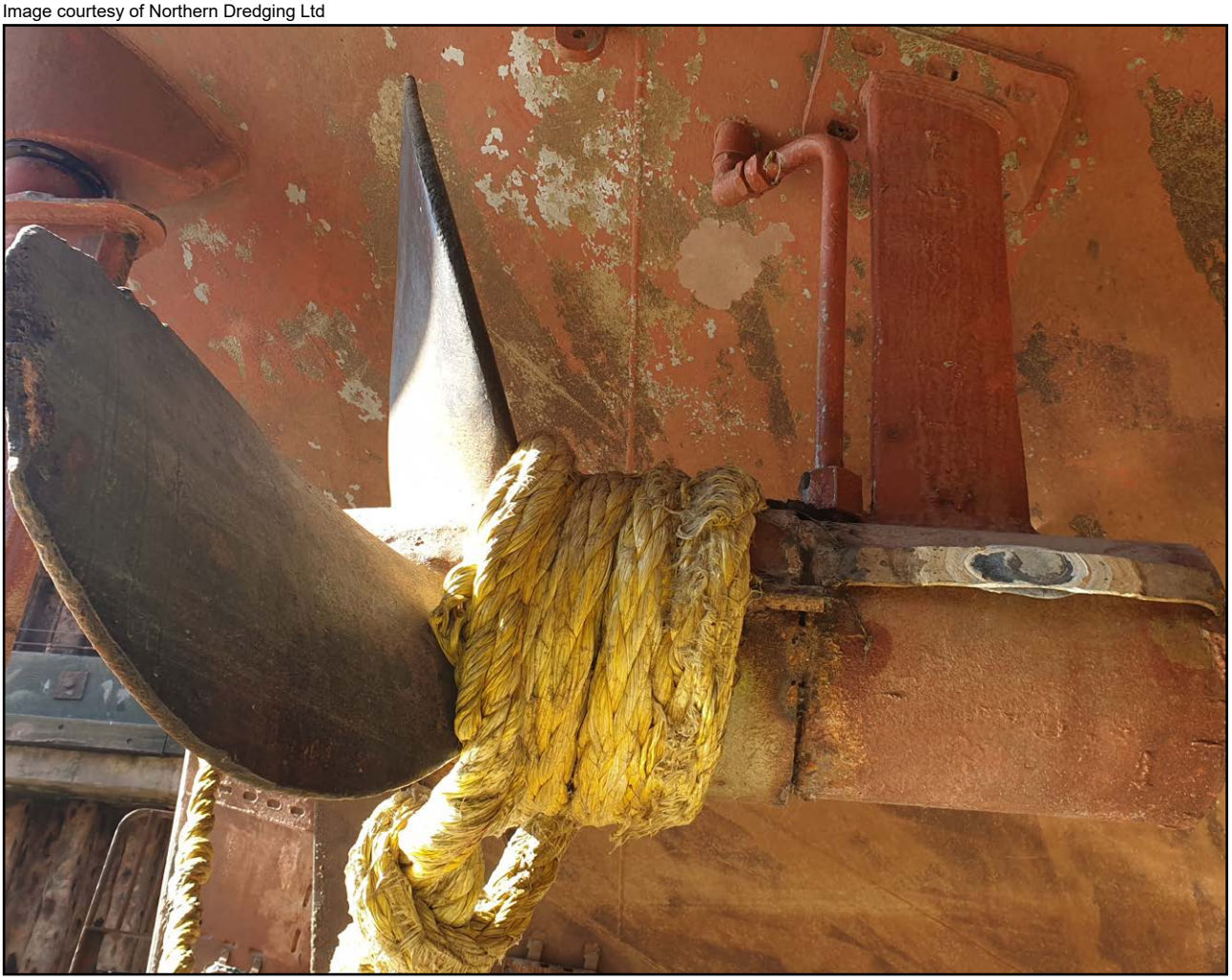

Figure 6: *Shearwater* in dry dock showing the towline around the starboard propeller

1.4 *SHEARWATER*

1.4.1 General description

Shearwater was a UK registered grab hopper dredger built in 1968 at the Hall and Russell shipyard in Aberdeen. *Shearwater* was propelled by two Kelvin six-cylinder diesel engines driving two fixed pitch propellers. Two synchronised rudders were fitted; there was no bow thruster. The total propulsive power was 264 kilowatts (kW). Each side of *Shearwater*'s aft deck was equipped with a fairlead and two sets of double bitt mooring bollards, and a mooring capstan **(Figure 7)**. The capstan was in a poor state of repair and there was no record or certification on board to identify its suitability for towing. Visibility of the aft deck and towing arrangements was only possible from the port and starboard extremities of the bridge where there were aft facing windows.

Shearwater was operated as a harbour dredger in UK ports, excavating dredge spoil and transporting it to spoil grounds. *Shearwater* was fitted with an excavator digger on the forward main deck and had a hopper capacity of 200m^3. Upon reaching the spoil grounds, dredge spoil was discharged through hinged hopper doors at the underside of the hold.

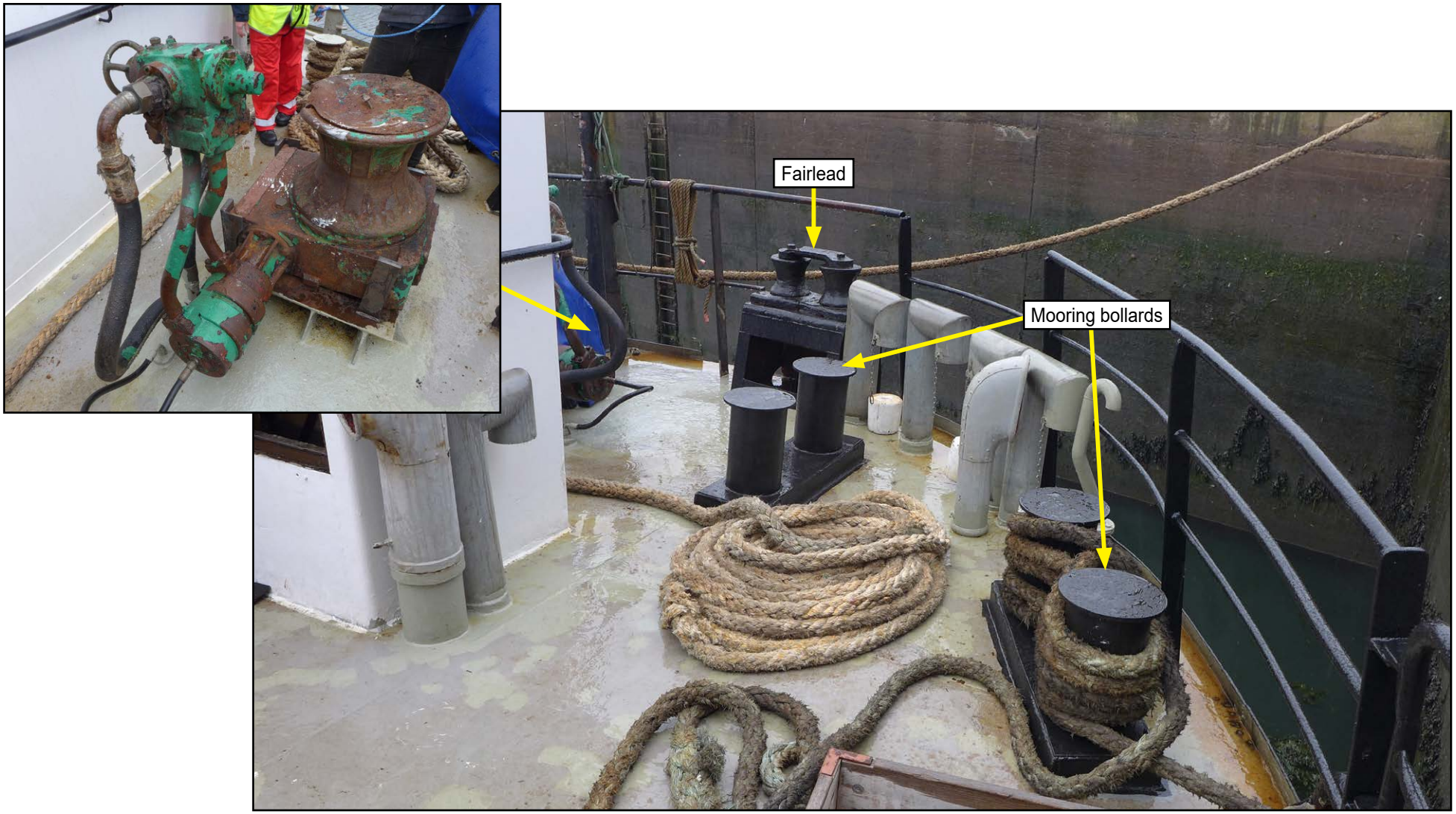

Figure 7: *Shearwater*'s port side aft deck (looking aft) showing mooring equipment used for towing, with capstan inset

To provide a stable platform for a second excavator, *Shearwater* routinely operated in combination with a spud leg barge. When operating with a barge, *Shearwater* would tow the barge into position, the spud legs would be lowered to the seabed, and the excavator on the barge would load dredge spoil into *Shearwater*'s hopper. The barge would then be left in the dredging location while *Shearwater* proceeded to the spoil grounds to discharge the dredge material. *Shearwater* was also used to tow barges when relocating between dredging contracts in different harbours.

1.4.2 Ownership

Shearwater's registered owner was Northern Dredging Limited (Northern Dredging). Northern Dredging's sole owner and director (the owner) had purchased *Shearwater* from Moray Council in 2012[7], when the Council had been considering scrapping the vessel. The owner had made significant personal financial commitments to raise funds to purchase *Shearwater* and sustaining income from dredging contracts was critical to survival of the business.

Prior to purchasing *Shearwater*, the owner had worked in the offshore marine sector and managed a boat building business. The owner oversaw towing and dredging operations on board and was described in *Shearwater*'s risk assessments as the 'operations supervisor'. The owner had no seagoing watchkeeping qualifications but had completed STCW[8] basic safety[9] awareness training.

Shearwater's owner was normally on board when the vessel was at sea and he routinely took control during towing, dredging or close quarters manoeuvring, before handing back to the master for passage to the spoil grounds.

1.4.3 Bilge and salvage pumping

Shearwater was fitted with two electrically powered, Hamworthy Dolphin general service pumps, which were capable of draining the bilges. Each of *Shearwater*'s compartments, including the buoyancy spaces, was equipped with a bilge suction connected to the bilge system. All spaces connected to the bilge system could be pumped out using either of the pumps. A diagram of *Shearwater*'s bilge system, dating from 1968, was displayed in the accommodation space, close to the entrance to the engine room. In addition to the fixed pumps, *Shearwater* carried a petrol engine driven portable salvage pump and a portable electric submersible pump. *Shearwater*'s petrol driven salvage pump was unusable during the emergency as it was damaged by floodwater.

Shearwater's bilge pumping procedure set out the steps required to drain the bilges using the general service pumps. The procedure noted that if one pump failed then the other could be used to pump out spaces connected to the bilge system. In the event of a blackout or failure of both general service pumps, the procedure stated that the portable petrol driven salvage pump was the next preferred option for water

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[7] Northern Dredging was incorporated as a limited company in 2018; prior to this, the registered owner (with the same director) had been Shearwater Holdings Limited. The term 'Northern Dredging' is used throughout this report to describe *Shearwater*'s owning company.

[8] International Convention on the Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended

[9] STCW basic training consists of the following modules: firefighting and fire prevention, personal and social responsibilities, personal survival techniques and elementary first aid.

ingress in spaces other than the forward hold, where the fire pump could be used. The procedure stated that small void spaces could be pumped out with the portable electric submersible pump.

In the 8 years since purchase from Moray Council, *Shearwater*'s main bilge system had never been lined up to pump from the port buoyancy space, either for training or evacuation of bilge water. Furthermore, after the accident, it was established that there were no defects with the bilge pumps or the bilge system other than the 1968 diagram not accurately reflecting the onboard system.

1.4.4 On board safety management

Shearwater was not required to have an approved safety management system (SMS)[10]. *Shearwater*'s load line exemption certificate included the condition that the vessel's '*operation is to be managed ensuring the safety of personnel*'.

A set of risk assessments and procedures were kept on board. The risk assessments included vessel operations and dredging. The risk of man overboard during dredging had been identified with the mitigation stated as '*equipment to enable recovery of man overboard back to the deck to be in immediate readiness'* [sic]. There were no risk assessments or safe systems of work on board for towing operations.

Shearwater's documentation included an emergency checklist for flooding. The flooding checklist detailed a list of actions to be taken and the personnel responsible for those actions. Included on the flooding checklist was the need to broadcast an urgency or distress message, and the need to inform relevant shore authorities. *Shearwater*'s records of exercises and drills indicated that the crew had last undertaken a flooding drill on 28 January 2020.

1.4.5 Transfer of personnel at sea

The Code of Safe Working Practices for Merchant Seafarers (COSWP) was published by the Maritime and Coastguard Agency (MCA) and provided best practice guidance to seafarers. COSWP stated that transferring personnel between two vessels at sea was '*potentially a particularly dangerous manoeuvre and should be avoided where possible*'. The guidance went on to state that if personnel transfers were unavoidable then the task should be risk assessed and appropriate safety measures, including provision of an embarkation point and an agreed boarding procedure, put in place. The guidance also stated that the relative motion of both vessels was critical when judging when to transfer and the master should have constant sight of the transfer area and be in communication with those transferring. COSWP also recommended that vessels undertaking personnel transfers when underway carry equipment to facilitate the recovery of a man overboard.

To set up both the alongside and astern tows and to change between the two methods, crew members routinely stepped between *Shearwater* and *Agem One* at sea. Transfers also took place as part of the emergency recovery after the towline had broken. Personnel transfers took place with *Agem One* alongside *Shearwater* at the dredger's midships point where the freeboard of the two vessels was similar. There was no onboard risk assessment or safe system of work for personnel transfers at sea.

[10] See Section 1.5.1

1.5 CERTIFICATION

1.5.1 Regulatory environment

The Merchant Shipping (Load Line) Regulations 1998[11] (Load Line Regulations) applied to all commercial vessels in UK waters. The purpose of the Load Line Regulations was to ensure that vessels had sufficient freeboard for their intended operations and met minimum standards of seaworthiness and watertight integrity.

The MCA issued codes of practice providing construction and safety requirements for commercial vessels of less than 24m load line length. These codes could be used as an alternative to the Load Line Regulations. Non-passenger vessels over 500 gross tonnes (gt) were subject to additional certification over and above those of the Load Line Regulations, including the requirement for a Safe Manning Certificate (SMC) and an approved SMS. Vessels such as *Shearwater* that were more than 24m in load line length and less than 500gt fell between the codes of practice for small vessels and the requirements for larger vessels. In 2017 the MCA, in collaboration with industry partners, started work to develop a dedicated code of practice for commercial vessels falling between these two regulatory environments. This work was paused in 2018 as the MCA did not have a pathway to deliver the underpinning legislation necessary for a legally enforceable code.

In November 2020, the MCA's Register of Ships and Seamen held records of 512 UK registered non-passenger vessels[12] with a load line length greater than 24m that were also under 500gt. This figure included 150 tugs, 98 workboats, 83 commercial vessels and five dredgers.

1.5.2 UK load line exemption certificates

Where vessels were judged to be seaworthy but not in compliance with the Load Line Regulations, the MCA was empowered to approve exemptions. Vessels requiring exemptions were issued with a UK load line exemption certificate following completion of an MCA survey. Load line exemption certificate validity ranged from 1 month up to a full term of 5 years, and a full survey was required before each new certificate issued. MCA surveyors followed a checklist detailed in an aide-memoire **(Annex A)**, listing all the areas of the vessel and the documentation to be checked.

UK load line exemption certificates stated the provisions of the Regulations or supporting Merchant Shipping Notices (MSN) that the vessel was exempted from, along with any operating conditions, typically area restrictions or weather limitations.

1.5.3 Survey of towed vessels or objects

There were no specific regulations for towing operations in the UK and the safety of vessels being towed at sea was certified via application of the Load Line Regulations. The MCA's Instructions to Surveyors[13] stated that '*any vessel towed to sea must be issued with a load line or load line exemption certificate*'. To be issued with a load line exemption certificate, a vessel due to be towed should be surveyed by an MCA surveyor to ensure that it has sufficient watertight integrity for

[11] Statutory Instrument 1998 No.2241

[12] UK passenger vessels are subject to additional requirements and issued with a passenger ship safety certificate and have been excluded from the total.

[13] MSIS 1 – The load line instructions to surveyors https://www.gov.uk/government/publications/load-line-instructions-msis-1

the proposed tow. There was a specific section in the MCA surveyor's aide-memoire that detailed the scope of the survey for issue of an exemption certificate to vessels being towed **(Annex A)**. The MCA surveyor's aide-memoire included the requirement for a competent towing master to be appointed.

1.5.4 Dredgers

Some aspects of dredgers such as operating with an open hold or at a reduced freeboard were not compliant with the Load Line Regulations. Equally, there were features of dredgers such as the ability to rapidly discharge dredge spoil, which compensated for the apparent load line construction deficiencies. This meant that UK dredgers could be granted exemptions from Load Line Regulation requirements.

The MCA's Instructions to Surveyors included additional stability requirements for dredgers operating with hold spaces open, as well as requirements for dredgers operating at a reduced freeboard. These instructions did not include guidance as to which specific requirements were covered by these exemptions or how they should be recorded on the certificate.

The MAIB has examined a selection of UK load line exemption certificates issued to dredgers other than *Shearwater*. In all examples, the exemptions were limited to the specific parts of the Load Line Regulations or supporting MSNs that the vessel was exempted from. Examples included the requirement for provision of hatchway covers or operating with less than a minimum specified freeboard. The supporting conditions on the certificates examined included general requirements such as restricted area of operations or favourable weather, and specific conditions relating to the operation as a dredger, such as the need for emergency release arrangements to permit rapid jettisoning of the dredge spoil.

1.5.5 *Shearwater*'s certification

From the first certification in 1968 until 2015, *Shearwater* was issued with a series of international load line certificates. In 2015 the MCA recognised that, as a dredger operating with an uncovered hold, *Shearwater* did not comply with the requirements of the Load Line Regulations, and, thereafter, the vessel was issued with UK load line exemption certificates.

Since the change of ownership in 2012, the MCA had issued *Shearwater* with 18 load line exemption certificates. Each certificate was issued following an MCA survey, with most surveys requiring multiple surveyor visits that were necessary when deficiencies were identified requiring rectification before a certificate was issued. These certificates varied in terms of the exemptions, and included one issued in 2017 for a single voyage that offered an exemption from all Load Line requirements. In addition to repeatedly attending *Shearwater*, MCA surveyors had engaged in extensive correspondence with the owner to offer advice and guidance on maintaining standards of safety and certification.

Since 2012, *Shearwater* had not been maintained in continuous certification, and there were periods of time when the vessel was uncertified and out of operation.

The MCA detained *Shearwater* in March 2014 when the owner had proceeded to sea without a suitably qualified master on board. *Shearwater* was also detained in September 2017 after departing from a repair yard in Hythe, Southampton,

without any seagoing certification and was described in the MCA detention report as '*dangerously unsafe*'. After an MCA survey in Plymouth 5 days later, a single voyage load line exemption certificate was issued permitting *Shearwater* to passage to Glasgow for further repairs. *Shearwater* was next certified in May 2018 after a lengthy repair period.

In the spring of 2019, *Shearwater* underwent a period of dry-docking and repairs that included shell plating renewal to the starboard side. Following this maintenance, the MCA noted that the vessel had '*benefitted from additional investment and that the owner was more engaged with the survey process*'. *Shearwater* was then issued with a load line exemption certificate issued in April 2019 with an expiry date of October 2021. This was the certificate in place at the time of the accident, and it exempted *Shearwater* from all requirements of the Load Line Regulations, provided a set of conditions was adhered to. These conditions **(Annex B)** included, inter alia:

- *'Operations to be undertaken in favourable weather.*
- *The persons on board are those persons that form the crew (4).*
- *Passage planning to be completed, with ports of refuge included.*
- *The vessel to manned in accordance with a Class VIIIA vessel.*
- *Adequate hours of rest to be maintained.*
- *Adequate stability is to be maintained for the envisaged conditions.*
- *Safety Management – Vessel operation is to be managed ensuring the safety of personnel.'*

1.6 CREWING

1.6.1 Background

Shearwater was not required to have an approved SMC, and its load line exemption certificate required that it be manned as a Class VIII(A)[14] vessel. With the exception of the single voyage load line exemption certificate issued in 2017, no specific manning requirements were ever recorded on *Shearwater*'s load line and load line exemption certificates. Certificates issued between November 2013 and July 2016 carried the condition that voyages were limited to 12 hours duration. This condition was introduced by the MCA in recognition of the fact that *Shearwater* routinely only carried a single watchkeeper.

When owned by Moray Council, *Shearwater* had operated with a crew of five. After the change of ownership, the MCA had discussed appropriate manning levels with the owner and directed him to the guidance contained in MSN 1767 – *Hours of Work, Safe Manning and Watchkeeping Revised Provisions*[15], which stated that '*the number of certificated officers, and certificated and non-certificated ratings must be sufficient to ensure safe and efficient operation of the ship at all times*'. For a

[14] MCA defines Class VIII(A) vessels as – *ships (other than ships of VIII(A)(T), IX, IX(A), IX(A)(T), XI and XII) engaged only on voyages which are not international voyages.* https://www.gov.uk/guidance/vessel-classification-and-certification#merchant-ships-classification-and-certification

[15] MSN 1767 was withdrawn in 2015 and replaced with MSN 1868

near coastal vessel of less than 500gt such as *Shearwater*, MSN 1767 suggested a minimum of two crew with an STCW officer of the watch qualification, to ensure sufficient bridge watchkeeping capability.

Shearwater's owner discussed manning levels with the MCA again in 2016. There was no recorded conclusion to this discussion. *Shearwater* did not require a dedicated engineer as the total engine power was less than 350kW.

1.6.2 Crew at the time of the accident

Shearwater's master was a Croatian national who held an STCW II/2 master (unlimited) certificate of competency issued in Croatia, with a certificate of equivalency issued by the MCA. The master's previous experience was primarily on tankers and *Shearwater* was his first dredger command. The master had completed two previous contracts on board *Shearwater*, and he joined the vessel for his third contract in January 2020. During a previous contract in January 2019 and due to the master's lack of towing experience, the owner amended the master's contract to state that '*the master shall not take any form of liability…from any accident or incident happening during towing vessels or barges due to his experience*'.

Shearwater's AB was a Polish national. He held an STCW II/4 certificate issued in Poland, which enabled him to act as a rating forming part of a navigational watch. This was the AB's second contract on *Shearwater* and his first with this master.

Shearwater's excavator driver had been working on the vessel as a permanent crew member since 2013. He had completed the STCW basic training courses in sea survival, fire-fighting, first-aid and security awareness. Although the excavator driver had no formal marine engineering qualifications and there was no requirement for the dredger to carry a dedicated engineer, he was familiar with the vessel's propulsion and auxiliary systems, and assisted the master and owner with engineering tasks.

1.6.3 Working patterns

Hours of work and rest for seafarers were set out in the IMO's Maritime Labour Convention (MLC), 2006 as amended, which came into force for UK registered vessels in August 2014. Hours of rest were required to be at least 10 hours in any 24-hour period and a minimum of 77 hours in any 7-day period. The primary purpose of minimum hours of rest was to combat against fatigue, which is detrimental to safety. Hours of work and rest records were not consistently maintained on board; after the accident, some records were made available to the MAIB but not covering the passage from the Clyde to the accident.

Shearwater's watch routines varied according to the work being undertaken. For repositioning voyages, the crew planned to work for 12 to 14 hours per day and then rest at night. When dredging, the working hours depended on the local constraints of the dredging location and the distance to the spoil ground. A typical pattern would be to dredge for 6 hours at a time, 3 hours either side of each high tide. From time to time, when there was a long distance between the dredging location and the spoil grounds, the vessel crew had included a mate. On transit voyages when a mate was employed, the master and mate worked a 6-hour watch cycle.

1.7 *AGEM ONE*

Agem One was a UK registered spud leg, catamaran barge built in 1992 **(Figure 8)**. *Agem One* was owned by Offshore Workboats Limited and was operated by Northern Dredging under a charter agreement. This agreement required the charterer to use a '*tug of suitable size and capability'* when towing the barge.

Image courtesy of Offshore Workboats Ltd.

Figure 8: *Agem One* showing location of spud legs

Agem One could be fitted with different equipment according to the charterer's needs, and it had three spud legs that could be lowered to the seabed in shallow water to form a stable platform. At the time of the accident, *Agem One* was laden with an excavator weighing 45t, which was owned by Holy Loch Marina and leased to Northern Dredging.

Agem One had been examined by a surveyor registered with the Society of Consulting Marine Engineers and Surveyors (SCMS) under the authority of the MCA's Brown Code[16], and issued with a workboat certificate permitting operation as an unmanned barge. *Agem One*'s certificate had a number of operating conditions including that the tow preparations must be to the '*satisfaction of the tow master*' and that the barge must operate in full compliance with the approved stability book. The certificate also stated that '*this certificate is equivalent to a UK load line exemption certificate.*'

[16] The MCA's Brown Code was a code of practice for the safety of small workboats and pilot boats, published in 1997 and developed by MCA as an alternative to application of the Load Line Regulations for workboats of less than 24m load line length.

Agem One's stability book was approved by SCMS and assessed the barge against the stability criteria in the MCA's Small Commercial Vessel and Pilot Boat Code of Practice (SCV Code)[17]. The stability book included a standard stability condition for towing the barge with spud legs raised and carrying an excavator[18].

In 2015 *Agem One* capsized when being towed by a tug. The barge was towed to port in the upturned condition where it was righted and later recommissioned.

1.8 PASSAGE PLANNING

1.8.1 Guidance

SOLAS[19] Chapter V Regulation 34 applied to all vessels on all voyages and required that, prior to proceeding to sea, the master was to ensure that the intended voyage had been planned, taking into account the guidance in the IMO's Resolution A.893(21) *Guidelines for Voyage Planning.* This guidance stated that *'the development of a plan for voyage or passage, as well as the close and continuous monitoring of the vessel's progress and position during the execution of such a plan, are of essential importance for safety of life at sea, safety and efficiency of navigation and protection of the marine environment*.'

The guidance subdivided passage planning into four key stages: appraisal, planning, execution, and monitoring. The initial voyage planning appraisal stage involved the gathering of all information relevant to the intended voyage. The next stage required the detailed planning of the whole voyage from berth to berth. The third and fourth stages were the effective execution of the plan and monitoring the vessel's progress during the implementation phase.

The Pentland Firth **(Figure 1)** is the sea passage between the Scottish mainland and the Orkney Islands. The area is notorious for extreme tidal and sea conditions that must be considered when passage planning. For vessels planning a passage through the Pentland Firth, Admiralty Sailing Directions (North Coast of Scotland Pilot) (NP52) emphasised the strength of the tidal streams and the resultant confused and violent seas. There was a particular hazard for low-powered vessels and the sailing directions stated that '*another factor of safe navigation of Pentland Firth is availability of sufficient power to overcome the strengths of the tidal streams*'.

The admiralty chart of the area[20] contained a warning notice about the hazards in the Pentland Firth stating that '*tidal streams, with eddies and turbulence, run strongly through the Pentland Firth. Rates of up to 16kt have been reported…*' A recommendation on navigation also printed on the chart stated that '*mariners intending to use the Pentland Firth should be aware of very strong tidal streams and sets within the area. Difficulties can be encountered when transiting either with or against the tide.*'

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[17] The Small Commercial Vessel and Pilot Boat Code of Practice (SCV Code) was published in 2004 by the MCA as an Annex to Marine Guidance Note (MGN) 280(M): *Small Vessels in Commercial Use for Sport or Pleasure, Workboats and Pilot Boats – Alternative Construction Standards*.

[18] *Agem One*'s approved towing stability booklet allowed for an excavator weight up to 51.3t

[19] International Convention on the Safety of Life at Sea, 1974, as amended

[20] Chart 1954 – Scotland North Coast – Cape Wrath to Pentland Firth

1.8.2 *Shearwater*'s passage plan

Shearwater's primary means of navigation was paper charts. The passage plan on board *Shearwater* consisted of a list of hand written positions with the courses and distances inbetween. There was no information on anticipated navigational hazards, speeds, predicted tidal streams or aids to navigation. The intended route was plotted on a paper chart and replicated on the vessel's electronic charting system (ECS) **(Figure 9)**. The master used 4kts as the planning speed for passages towing a barge. Evidence from automatic identification system (AIS) data **(Figures 1** and **2)** indicated that *Shearwater*'s passage speeds were between 3kts and 5.2kts.

Shearwater had completed a dredging contract in the river Clyde and the next contracts were in Lochaline, Isle of Mull, then Eyemouth, on the east coast of Scotland. The owner had previously used the Caledonian Canal to reposition *Shearwater* from one side of Scotland to the other **(Figure 1)**. At the time of this planned passage, the Caledonian Canal was closed due to the COVID-19 pandemic.

Shearwater's master had not been through the Pentland Firth before although the owner had some prior experience of the area from diving trips. There was a 1968 edition of the Admiralty Tidal Stream Atlas on board *Shearwater*, but there was no copy of NP52 on board.

1.9 TOWING

1.9.1 International guidance

The IMO's circular MSC/Circ.884 of 1998 provided guidelines for the planning, preparation, and standards for safe seagoing towage. This guidance detailed responsibilities regarding towing and stated that the operation should be overseen by a competent towing master with procedures in place to minimise the risk to personnel. The guidance also stated that in preparation for the tow an inspection should be carried out by the tow master. IMO and industry guidance indicated that 500m[21] was a minimum towline length in benign coastal waters.

1.9.2 Workboat industry guidance

The Workboat Association (WA) guide *The Use of Workboats for Towage* provided industry best practice for towing by workboats[22], including towing of unpropelled barges in harbour and at sea.

The WA guidance advised that the tow length needed to be adequate for the sea conditions considering the potential for generation of snatch[23] in the towline. The guidance also advised that '*manufacturer's instructions must be carefully followed, particularly with respect to chafe*' if high modulus polyethylene (HMPE) towlines were used and that all towlines should be monitored and adjusted regularly to prevent chafe. Guidance promoted the fitting of anti-chafe devices such as abrasion

[21] IMO MSC Circ/884 provided the formula for tow length = bollard pull ÷ minimum breaking load x 1800. This formula also appears in DNVGL-ST-N100 industry guidance which further stated that the minimum length of tow should not be less than 650m in normal weather conditions, and a minimum of 500m in benign coastal weather conditions. The formula to calculate tow length could not be used on board *Shearwater* as the vessel's bollard pull was unknown.

[22] Although *Shearwater* was not certified as a workboat, *Agem One* was, making the WA guidance relevant for this nature of tow

[23] Snatch is the generation of large dynamic forces in a towline as it comes taught. Snatch can be countered by the use of long towlines where the catenary acts a damper, or the use of a pennant (or 'stretcher') made of a material with greater elongation characteristics that the main towline and providing additional elasticity.

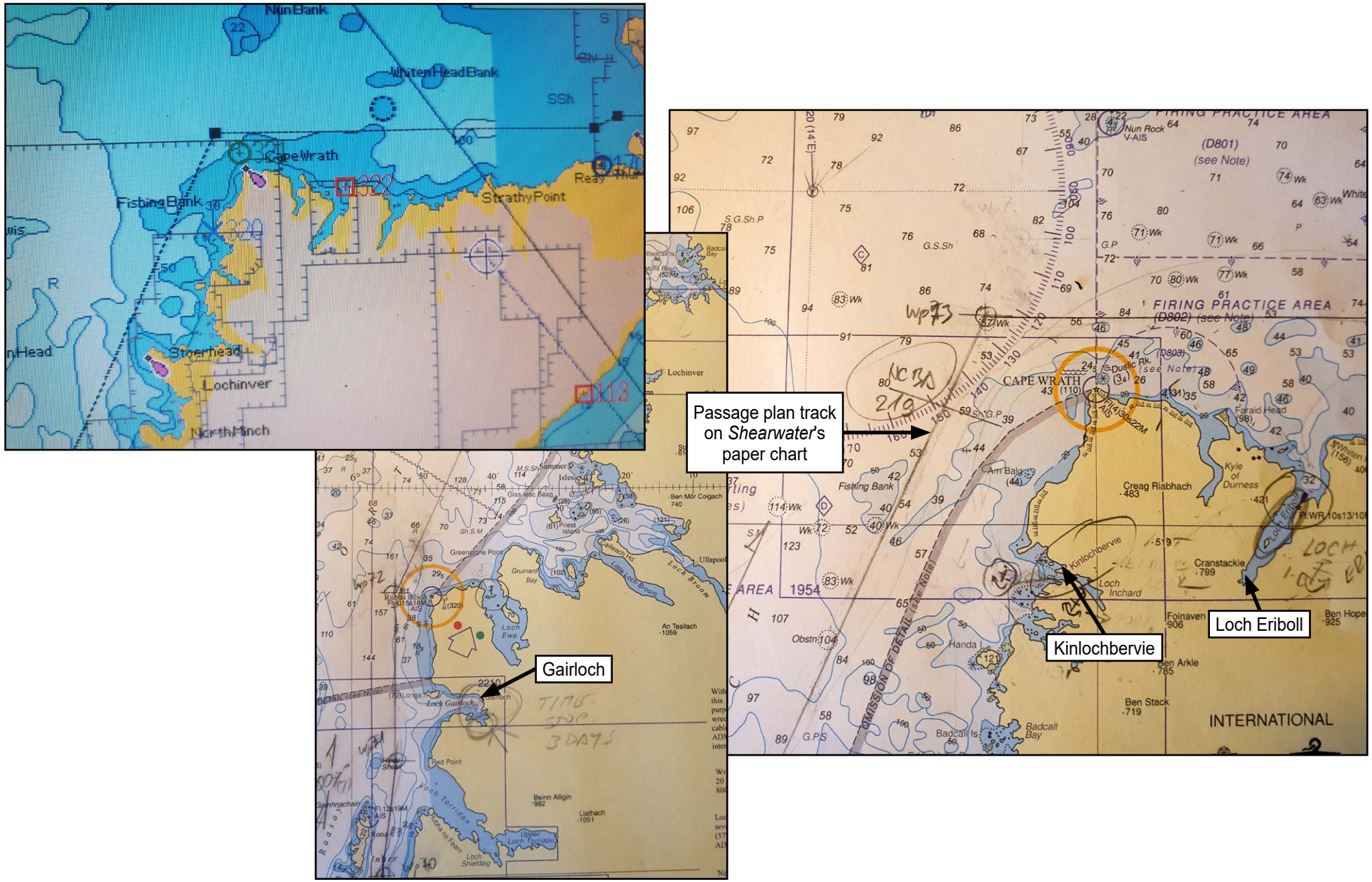

Figure 9: Images of paper and ECS charts in use and on board *Shearwater* showing the intended track from the passage plan

resistant sleeves or chains in high wear areas. The guidance also detailed the importance of contingency plans for adverse weather, the need to plan for specific requirements at all ports of call, including ports of refuge and the need for risk assessments to cover all aspects of the operation. The WA guidance stated that tow plans containing details of the tow, towing equipment, route for the tow and emergency plans should be prepared by the tow master.

The WA guidance stated that the crew and tow master must be sufficiently experienced and competent for the planned operation. The guidance suggested that competence could be established by reference to the master's experience of towing operations and by holding an MCA towing endorsement. *Shearwater*'s master did not hold an MCA towing endorsement.

1.9.3 The tow plan

Shearwater's tow plan **(Annex C)** intended that *Agem One* would be towed alongside when conditions permitted and otherwise in an astern tow arrangement. The weather limits in the tow plan were a maximum of force 4 winds for both tow configurations, and wave heights of less than 1m for alongside towing and 1.75m when towing astern. The plan also included a list of potential ports of refuge and noted that extra care should be taken going through the Pentland Firth. The diagram of the alongside tow described it as a '*hip (side) tow*' and indicated that the tow configuration was for '*categorised waters*[24] *and sheltered conditions*'. For towing astern, the tow plan stated that an 80m kevlar towline would be in use; the associated diagram showed that a polyester towline would be used. The towline in use was HMPE.

The tow plan included a note that the excavator on *Agem One* should be removed at Lochaline unless '*perfect conditions*' were forecast for the remainder of the voyage. When *Shearwater* departed from Lochaline the excavator could not be removed due to local COVID-19 restrictions.

The safety section of the tow plan included the requirements that crew be trained on the snapback and crush zones on *Shearwater* and *Agem One*, and that full personnel protective equipment (PPE) was to be worn on deck. Crew members wore personal flotation devices (PFD) when on deck and on the barge. The tow plan did not include details of emergency towing arrangements or procedures.

The tow plan did not state the communications arrangements during towing operations. Hand-held very high frequency (VHF) radios were carried on board *Shearwater*, although communications during towing evolutions was primarily by voice.

1.9.4 Towing arrangements

During the passage, *Shearwater* towed *Agem One* both alongside and astern. Towing alongside involved attaching the barge directly to the dredger by means of ropes at the bow and stern, and spring lines to take the barge's weight. Where swell was present, there was a risk of interaction between the vessels, so the alongside method was restricted to harbours and calm coastal water towing.

[24] Categorised waters refers to inland waterways and UK harbour areas that are not classified by the MCA as the open sea.

On the day of the accident the astern tow was set up according to *Shearwater*'s tow plan **(Annex C)**. The towline was attached to a port mooring bollard on the aft deck of *Shearwater* and then led through a fairlead. This meant the vessels' separation was about 80m on the day of the accident. At the barge end, the towline was attached to a steel wire rope bridle with a shackle, the bridle was attached to mooring points on either side of the forward end of the barge.

1.9.5 Towline material

Shearwater's towline was an 80m long section of 64 millimetre (mm) diameter HMPE with a hard thimble eye at one end. The manufacturer's datasheet stated that the rope's MBL was 3210 kilonewtons (kN) equating to 327.3t; the rope was buoyant with an elongation of 1%. *Shearwater*'s owner purchased the rope in 2019 from a surplus dealer and had used it for towing on one previous occasion.

HMPE rope has many applications in both marine and non-marine sectors and is recognised as having a high strength to weight ratio and low elongation at breaking. The low elongation characteristics of HMPE ropes mean that dynamic loading can introduce shock loads resulting in overload. For this reason, HMPE should be used in combination with a pennant (or 'stretcher') to reduce vulnerability to dynamic snatch loading.

Knots in HMPE ropes can introduce weak points in a towing system and the use of a bowline may reduce the breaking strength of the rope by up to 25%. The parted manufactured eye of *Shearwater*'s towline was not recovered from *Agem One* in the aftermath of the accident so the exact failure mechanism could not be determined.

1.9.6 Emergency towing arrangements

Agem One's emergency towline was designed to be rigged such that it could be streamed astern of the barge and picked up in the event of failure of the main towline. The line could then be used to recover the barge in the event of the main towline failing, without having to transfer crew to the barge. *Agem One*'s emergency towline was not rigged or streamed on the day of the accident.

1.9.7 Authority to tow

As part of preparation to tow a barge in May 2014, *Shearwater*'s owner had approached the MCA to discuss the dredger's suitability for towing. An MCA review of the situation identified the factors that should be considered by the owner prior to using *Shearwater* for towing, including stability, crew competence, tow planning, manoeuvrability, load line limitations and the need to witness a trial tow as *Shearwater* was not a tug. Following this review, the MCA advised the owner that he would need risk assessments and safe systems of work for towing, taking the identified factors into consideration; a load test of *Shearwater*'s bollards was also required. The MCA also advised the owner that if towing was to become a regular occurrence, then the terms of the load line exemption certificate would need to be changed. This intention was not followed up by either the owner or the MCA and *Shearwater*'s load line exemption certificate that was in force at the time of the accident made no reference to towing.

The owner did commission a naval architecture consultancy to conduct a set of strength calculations on *Shearwater*'s aft deck bollards. The report of these tests concluded that a barge about 20m in length could be towed from the aft deck bollards in calm weather. The results of the strength calculations were communicated to the MCA. *Shearwater* did not have a certified bollard pull value.

1.9.8 MCA voluntary towage endorsement scheme

MGN 468(M) sets out the details of the MCA recognised voluntary towage endorsement scheme. The scheme was developed to help ensure that crew engaged in towage operations have the necessary skills to manage the additional risks of towing operations. The scheme had different endorsement levels to reflect the type of towage to be conducted, including:

- '***General Towage Endorsement*** *– towing and pushing in categorised waters or in limited coastal areas*.
- ***Sea Towage Endorsement*** *– towage of vessels or floating objects at sea*'.

The endorsement required minimum levels of relevant towage sea service, which were 120 days for the 'general' towage endorsement, and a further 180 days with a minimum of 12 separate sea towage operations for the 'sea' towage endorsement.

1.10 RELEVANT PREVIOUS ACCIDENTS

1.10.1 Loss of a crewman overboard from the motor tug *Endurance*

On 5 February 2013, a crewman from the UK registered motor tug *Endurance* fell overboard in rough seas near Beachy Head, England. The crewman fell when attempting to transfer to the unmanned motor cruiser *Sirius M* with a replacement towline after the original towline had parted. Despite efforts by the tug's skipper and a search and rescue operation, the crewman was not recovered, and his body was found some weeks later.

The MAIB's investigation[25] identified that the attempt to reconnect a towline between *Endurance* and *Sirius M* was a desperate and ill-considered measure brought about by factors including poor towing practices and a lack of planning, risk assessment and emergency preparedness. The findings included that the risks of the crewman transferring to the unmanned tow had not been appreciated and that the original towline parted due to chafe abrasion because the arrangements did not follow good practice.

1.10.2 Foundering of the dredger *Abigail H*

On 2 November 2008, the 50-year-old grab hopper dredger, *Abigail H,* flooded and foundered when alongside in Heysham. The MAIB's investigation[26] found that the cause of the foundering was progressive flooding through a leak in the engine room. The flooding went unnoticed primarily because the regulations that applied to *Abigail H* did not require engine room bilge alarms to be fitted.

[25] MAIB Report 13/2014

[26] MAIB Report 15/2009

Abigail H was over 24m in length and under 500gt and the investigation also observed that the regulations for vessels of this size were complicated and that information from many sources needed to be drawn together to achieve the desired effect of safe operations. The report stated that this contrasted with workboats and fishing vessels, where the regulations, presented as codes of practice, made the requirements clear to owners, and implementation straightforward for surveyors. The report went on to recognise that consolidating the regulations applicable to vessels greater than 24m registered length and less than 500gt into a code of practice would be a substantial task, but that doing so would offer multiple benefits to the MCA and owners.

1.10.3 Capsize and sinking of the cement carrier *Cemfjord*

On 2 January 2015, the Cyprus registered cement carrier *Cemfjord* capsized and foundered in the Pentland Firth with the loss of all eight crew. The MAIB's investigation[27] identified that *Cemfjord* was lost in violent sea conditions and the rapid nature of the accident meant that no distress message was issued and there was no time for the crew to abandon ship.

The MAIB's investigation also established that the severe conditions were predictable and commonly experienced in the area.

[27] MAIB Report 8/2016

SECTION 2 – ANALYSIS

2.1 AIM

The aim of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 OVERVIEW

When seeking shelter during a coastal passage towing a laden barge, the dredger *Shearwater* lost propulsion when its propeller shafts were fouled by its own towline; thereafter, control of the situation was lost, and there was nothing the crew could do to prevent heavy and damaging collisions with the barge.

This section of the report will discuss the circumstances of the accident and explain the contributing factors including poor planning, unsafe towing practices and insufficient emergency preparation. *Shearwater*'s crew lacked the competence necessary to undertake a towing operation of this nature and the vessel was also unsuitable for the task. The MCA's arrangements for *Shearwater*'s certification using exemptions from the Load Line Regulations will also be discussed.

2.3 IMMOBILISATION AND COLLISIONS

Irrespective of the AB's report that the rope was clear of the water and that the rope itself was buoyant, applying astern propulsion when a loose towline was in the water between the dredger's stern and the barge meant that fouling the propeller shafts was almost inevitable. A natural, safe instinct when towing must always be to avoid going astern over your own towline.

Despite the fact that the crew had switched over from an alongside towing configuration to an astern tow previously in the day, there was no safe plan for this evolution and the master's priority, on this occasion, was to recover the stranded crew member back on board *Shearwater* from the barge, hence the need to go astern to bring the vessels together. The fouling of the propellers was coincident with the excavator driver scrambling back on board the dredger.

The owner had returned to the bridge after the towline had been passed down to the excavator driver on the barge. This meant that the evolution on the aft deck was unsupervised. Routinely the owner would check such evolutions, but on this occasion he was not there and did not check the situation with the towline himself. Even if the owner had assessed the situation, the risk of fouling the propellers would still have been very high in the circumstances.

Once both shafts were fouled by an extremely strong rope, there was no prospect of restoring propulsion and this became clear after the excavator driver had witnessed the engine room damage. Thereafter, the only safe course of action was to anchor *Shearwater*. This action may have stabilised the situation for the dredger, but it resulted in the collision and flooding when the heavy, sharp-edged barge was out of control. There was little prospect of the crew regaining control of the barge at this point, and further damaging collisions occurred before the barge drifted away and the towline, which was fouling the propellers, parted. With *Shearwater* anchored

and powerless there was no plan or safe course of action for the crew to recover the situation; the nature of this emergency then required an extensive effort by a lifeboat, an ETV and a workboat to be recovered.

The hazards associated with this operation had not been assessed or recognised and, therefore, there was no safe system of work to control the risks. This happened primarily due to the lack of crew experience with coastal towage and their inability to recognise and mitigate such risks. After a long, tiring day, and in an effort to seek shelter, the unplanned and unsupervised confusion with ad-hoc procedures meant that the fouling of the propellers and subsequent collision were effectively inevitable.

2.4 TOWING

2.4.1 Tow planning

There are many potential hazards involved in towing a laden barge, including the potential for towline failure, capsize of the barge or even capsize of the towing vessel. To manage these risks, coastal towing requires suitable equipment, skilled crew, and a robust plan. The tow plan should include details of the towing equipment, tow route and emergency plans.

Although *Shearwater*'s owner had prepared a tow plan **(Annex C)**, this was not based on any recognised planning framework such as the IMO's Circular or the WA guidance. The tow plan indicated that the alongside tow was to be used in '*sheltered conditions*'. Although the initial part of the voyage on the day of the accident was sheltered, the area around Cape Wrath and beyond was exposed to the risk of ocean swells. It was not appropriate to attempt to tow *Agem One* alongside in these areas, as evidenced by the difficulties the crew actually encountered.

Furthermore, the tow plan did not adequately address the tow set up; at 80m long, the rope in use was far too short given industry guidance that 500m was a practical minimum for coastal towing. Additionally, the plan referred to Kevlar and polyester towlines when, in fact, an HMPE line was in use. Deployment of a short HMPE rope without a 'stretcher' made the rig very vulnerable to snatch loading, risking failure.

The plan also did not contain procedures to be followed in an emergency, which resulted in extremely hazardous personnel transfers in deteriorating conditions to recover the drifting barge. Additionally, although the plan discussed snap back and crush zones, these were not defined and there was no guidance or deck markings on either vessel to show where these hazards were.

Not following recognised guidance meant that the tow plan was wholly inadequate for the towing operation being considered. This happened primarily because of the owner's lack of familiarity with coastal towing and his ambition to press ahead with the voyage. Equally, the master did not challenge the towing plan; however, the owner was on board making all the key decisions and had effectively discharged the master of any responsibility for towing by the employment contract amendment [Section 1.6.2].

2.4.2 Towline failure

Although the initial failure of the towline near Cape Wrath did not directly contribute to the accident, it started the chain of events that led to the collisions. The cause of the towline parting has not been determined and the failed end of the rope was not recovered from *Agem One*, so it was not inspected or assessed. Nevertheless, given the very strong HMPE rope in use, a tension overload can be discounted. The reported distortion of the hard eye suggests that the towing bridle and shackle may have been incompatible potentially generating a twisting movement that distorted the eye. Equally, the absence of a stretcher or sufficient length to generate a catenary, meant the towline would have been susceptible to snatch loading. With the hard eye reported as distorted, the towline would have been vulnerable to chafe abrasion caused by the barge's bridle shackle.

The reported subsequent failures, including after *Shearwater* had anchored, were almost certainly due to abrasion when the HMPE rope had been tied in a knot, and then severely damaged by the propellers.

Although the towline failures did not directly contribute to the accident, they can be attributed to inappropriate practices including insufficient tow length and onboard securing arrangements that introduced a risk of snatch and chafe.

2.4.3 Suitability of *Shearwater* for coastal towing

Purpose-built tugs are highly manoeuvrable, fitted with dedicated towing equipment and have sufficient power to tow at adequate speeds to maintain forward progress and manoeuvre out of danger if required. The charter contract between *Agem One*'s owner and *Shearwater*'s owner required that a tug of a '*suitable size*' should be used when it was towed.

When towing *Agem One*, *Shearwater* could only maintain a speed of between 3 and 5.2kts. At these low speeds, *Shearwater*'s manoeuvrability was reduced and it would have been very challenging to make headway in any adverse wind and tide. Without a winch that was certified as suitable for towing, there was also no practical method of adjusting the towline's length. Monitoring the tow would also be very difficult as *Shearwater*'s bridge did not have purpose-built visibility aft.

Shearwater was designed and built as a small harbour dredger and lacked the power or towing equipment to undertake a coastal towing operation, especially given the hazards associated with the Pentland Firth.

2.5 EMERGENCY RESPONSE

2.5.1 Loss of control of the barge

Although *Agem One* was fitted with an emergency towline, this had not been prepared or streamed astern which meant that there was not a safe method for recovering the barge when the main towing arrangement failed. This occurred on at least two occasions and, without an emergency towline, the crew had to undertake an ad-hoc procedure involving unsafe personnel transfers to recover the situation. When the towline parted after the propeller shafts were fouled, *Agem One* was drifting free as a hazard to other shipping and a very significant task for the lifeboat to recover.

2.5.2 Bilge pumping

It is vital for the safe operation of any vessel that floodwater, which creates an immediate hazard, should be reliably pumped out using all available means. *Shearwater*'s emergency pumping procedure stipulated the use of the general service pumps in the first instance to counteract flooding. Despite the crew attempting to use this system it could not be made to function. The flooded space had a bilge suction and there were no defects with the system. However, the crew lacked the familiarity necessary to make the system work effectively in an emergency. The main bilge system had not been lined up to pump from the port buoyancy space for 8 years. This was exacerbated by the absence of a dedicated engineer, or a crew member formally delegated responsibility for machinery systems, and the diagram that dated from 1968 not accurately reflecting the onboard system. Furthermore, once the portable electric pump started to take effect, this was relied upon for dealing with the emergency. The petrol driven salvage pump could not be used having been damaged by the water ingress.

2.5.3 Raising the alarm

Shearwater's owner only raised the alarm when *Agem One* broke away for the final time, because of a concern that the unlit barge represented a hazard to other vessels. However, prior to this, the crew had been struggling for many hours with towline failures, culminating in immobilisation and flooding.

On board *Shearwater*, there was an illusion of control, where the owner persistently believed that the situation could be resolved without external assistance. However, the onboard flooding checklist included a reference to raising the alarm, which underpins the analysis of the absence of control, and that the procedure itself was not being followed.

2.6 CREW COMPETENCE

Coastal towing is a skilled job, requiring suitably experienced and competent crew and *Agem One*'s certification required tow preparations to be to the '*satisfaction of the tow master*'.

In the absence of a formal definition of what constituted a tow master, and in line with the WA towing guidance, the MCA's voluntary towage endorsement scheme provided a suitable guide for the experience necessary. *Shearwater*'s owner had no formal training in towing operations and his towing experience was less than the suggested 120 days required to meet the standard for general towage under the MCA's scheme, let alone the 300 days required for sea towage. Additionally, the majority of the owner's towing experience was restricted to harbour towing. *Shearwater*'s master had no prior towing experience using a dredger and was wholly reliant on the owner to manage the towing operations. Thus, there was no-one onboard suitably experienced to act as the tow master and effectively supervise the towing operation.

Furthermore, the MCA had, in their discussions and subsequent conversations with *Shearwater*'s owner in 2014, identified that crew competence for towing was an issue that needed to be addressed if the vessel was to be used more regularly for towing. However, this was not followed up by either the owner or the MCA. Despite his experience on the vessel, *Shearwater*'s owner was not a qualified professional

seafarer. Although he was on board, the owner had employed professional crew to operate the vessel for him, but they were not suitably qualified and experienced for the intended operations. Equally, the MCA placed no obligation on the owner to ensure that a suitable crew were manning the vessel, despite the potential that *Shearwater* was likely to be used for towing.

Even where a suitably qualified and experienced tow master is on board, the master has overall responsibility for the vessel and should make the final decisions on passage planning and safe operations. Although effectively discharged by the owner from any responsibility for towing due to his lack of experience, the master still had a role to plan and execute other aspects of the vessel's operations and management, including safe navigation. However, an awkward situation of divided responsibility between the owner and the master existed, with an untidy lack of clarity over who was in overall control. Ultimately this undermined the master's position and created an unhelpful and potentially unsafe absence of authority.

2.7 PASSAGE PLANNING

Effective passage planning requires consideration of a broad range of documentary evidence and the preparation of a comprehensive and safe plan. Effective passage plans are also dynamic in their execution, taking variable elements such as weather and tidal streams into account as the voyage progresses.

Shearwater's written passage plan was insufficiently detailed and lacked any information about the potential navigational hazards. The route plotted on the paper charts and the ECS **(Figure 9)** was an overall construct of the complete voyage and not berth to berth passage plans for each day. This was not a plan that would safely underpin critical safety-related decision making during the passage.

Evidence from AIS suggests that *Shearwater* towing *Agem One* was passaging at between 3kts and 5.2kts. These are speeds where the tidal stream is critical to the plan and, in effect, any predicted stream of more than about 1kt would be significant. With strong tidal streams predicted in the Pentland Firth (information that could have been identified on board from the chart), the passage ahead would have appeared unachievable when passing Cape Wrath. Therefore, it was probably most fortunate for the crew, that the swell and the towline failure forced abandonment of the voyage before reaching the challenging conditions local to the Pentland Firth.

Closure of the Caledonian Canal and the inability to offload the excavator in Lochaline, both a result of COVID-19, introduced significant new risks to the plan, specifically the need to pass through the potentially treacherous Pentland Firth. Both these events demanded a formal reappraisal of the plan and consideration could have been given to cancelling the voyage altogether for safety reasons or chartering a tug to relocate the barge instead of using *Shearwater* for towing. However, the owner's decision was to press ahead with the voyage in order to undertake the dredging contract in Eyemouth. Having made significant progress with the repositioning voyage, the owner was likely to be motivated to continue to the destination and deliver the forthcoming contract. Equally, the decision to press ahead with the voyage in the face of emergent new hazards went unchallenged by the master, who had a critical role of planning and executing the passage. This almost certainly occurred because the master lacked experience of the industry sector and the local hazards, and the owner was on board and making all the key decisions. Furthermore, the nature of Northern Dredging's organisation meant there was also no external governance of the vessel's operations.

Shearwater's passage plan was over-ambitious and unsafe. The plan itself did not address or mitigate the foreseeable navigational hazards and insufficient consideration was given to amending or cancelling the passage as the situation evolved. The owner was driven by a desire to complete the voyage in order to commence the next contract and the master did not sufficiently challenge the owner's decision making, or deliver a safe plan.

2.8 SAFE MANNING

The MCA's requirement for the safe manning of *Shearwater* was unclear. The load line exemption certificate required *Shearwater* to be manned in accordance with the requirements for a Class VIII(A) vessel and also stated that there should be a crew of four. However, there was no elaboration as to what these statements meant in practice, or the level of qualifications required by each member of the crew. Moreover, working at sea must be guided by the MLC requirement to provide a minimum of 10 hours rest in any 24-hour period, necessitating a minimum of two watchkeepers whenever a vessel is expected to be at sea for periods where the minimum rest requirements of a lone watchkeeper are not achievable.

In the 8 years that the owner had operated *Shearwater*, its manning had been discussed internally by the MCA several times, and concerns had been raised about the vessel operating with a single officer of the watch. Other than a short-lived restriction on *Shearwater*'s certificate limiting voyages to 12 hours duration, these concerns had not been dealt with and the required safe manning arrangements were never clarified or included in MCA documentation.

Shearwater's owner had, prior to this accident, recognised that a second bridge watchkeeper was required when operating in areas with long transits to the spoil grounds, but he had not employed a mate for this repositioning voyage. However, evidence from AIS indicated that passages exceeding the MLC requirement were undertaken with only one watchkeeper on board. Campbeltown to Oban is 99nm and would have taken between 21 and 29 hours based on typical speeds being achieved by *Shearwater* towing *Agem One* at the time. This was a period of time underway that exceed the MLC requirement where only one suitably qualified watchkeeper was on board. With only a stop of a few hours at Stoerhead, *Shearwater* had also effectively been at sea for about 36 hours when the first break occurred in the towline.

Without detailed guidance, *Shearwater*'s owner was able to crew the vessel as he saw fit, rather than in accordance with a clearly defined code. Scant regard was paid on board to the minimum rest requirement of the MLC, introducing a severe risk of crew fatigue. Having made good progress, the owner was motivated to sustain the passage in the face of adversity, such as not being able to offload the excavator, and irrespective of the hazards ahead.

2.9 SAFETY MANAGEMENT

The safe operation of a vessel is delivered through effective safety management by identifying hazards, assessing risks and implementing safe systems of work.

Underway personnel transfer, with the associated hazards of crushing or man overboard, is a good example of an operation requiring an assessment of the risk and a safe system of work. Industry guidance also existed for this operation, which suggested that it should only be conducted when absolutely necessary.

Changing the tow configuration during the voyage and setting up the tow after towline failures required the transfer of crew between *Shearwater* and *Agem One* when the dredger was underway. This was an unsafe practice that occurred because the risks had not been assessed and no safe system of work existed. Without a formal requirement for a safety management system and only a remark on the load line exemption certificate requiring the vessel to be managed '*ensuring the safety of personnel*', there was insufficient guidance or supervision of safe operations on board *Shearwater*.

2.10 FLAG STATE OVERSIGHT

In November 2020, *Shearwater* was one of 512 vessels on the UK register that fell between the small vessel codes of practice and the SOLAS regulations. The potential benefits of a consolidated code of practice for vessels above 24m load line length and below 500gt were highlighted in the MAIB's report in 2009 after the loss of *Abigail H*. In collaboration with industry partners, the MCA developed such a draft code of practice; however, this was paused in 2018 due to the lack of a pathway to develop the underpinning legislation necessary for an enforceable code. This meant that the requirements for manning and safety management for *Shearwater* were linked to conditions on the dredger's load line exemption certificate, despite these areas not falling within the scope of the Load Line Regulations.

Load line exemption certificates set out those parts of the regulations that are suspended for the vessel in question; however, *Shearwater*'s certificate exempted the vessel from all requirements of the Load Line Regulations, including requirements for annual survey and minimum freeboard, and contained no reference to dredging or towing. There were also significant inconsistencies in *Shearwater*'s previous certificates with some making reference to the vessel's operation as a dredger and others not. Disapplying all requirements of the Load Line Regulations was not appropriate for an 18-month certificate for a vessel of *Shearwater*'s age and history.

In 2014, *Shearwater*'s owner approached the MCA to discuss undertaking the coastal towage of a barge. As a result of this discussion, the owner commissioned a set of strength calculations for the bollards but there was no follow up by either party to finalise the issue and determine the towing conditions. Although there is a section on towing in the MCA surveyor's aide-memoire, this was only applied on surveys of towed objects; there was no prompt for surveyors to consider vessels used for towing. As *Agem One* was certified in its own right, no load line exemption, with consequent consideration of the towing vessel, was required. Equally, *Shearwater*'s load line exemption certificate made no reference to the use of *Shearwater* for towing at sea.

Shearwater was well known to MCA surveyors, having been previously detained, and, in the 8 years since purchase, had been issued with 18 certificates. Throughout this time there were several discussions and extensive correspondence albeit with no documented resolution between the owner and MCA surveyors about the operation of the vessel, including appropriate manning and suitability for towing. Unfortunately, the owner had not demonstrated a strong commitment to the MCA's governance, evidenced by repeated detentions for unsafe operations. Nevertheless, at the most recent survey in 2019, the MCA had noted his improved engagement with the survey process.

In summary, despite the MCA's extensive and detailed engagement with *Shearwater*'s owner, the issues of manning, towing and safety management were left unresolved and did not result in enhanced vessel requirements or additional conditions on *Shearwater*'s load line exemption certificate. The MCA's surveyors invested time and energy on *Shearwater*'s technical details; however, the wider picture of safe operations were not effectively addressed. *Shearwater*'s load line exemption certificate did not provide sufficient guidance to assure safe operations and created an environment where the owner felt able to operate the dredger broadly as he saw fit, rather than safely in accordance with a recognised code of practice.

SECTION 3 – CONCLUSIONS

3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. *Shearwater*'s hull was breached, and the vessel flooded after several heavy collisions with the towed barge *Agem One*. The collisions occurred because control of the barge was lost when *Shearwater* was immobilised. [2.3]

2. *Shearwater* was immobilised when astern propulsion was applied with the towline was in the water. This happened because the crew did not have a safe system of work for connecting the tow. [2.3]

3. *Shearwater*'s towing operations were not effectively planned or safely executed. This happened primarily because industry best practice was not followed, and the crew lacked the competence necessary to undertake an operation of this nature or fulfil the role of tow master. [2.4.1, 2.6]

4. *Shearwater*'s crew did not respond effectively to the emergency. They were not properly prepared to deal with the towline failure, and were unable to use the fixed bilge system effectively due to a lack of familiarity with this critical safety system. [2.5]

5. *Shearwater*'s passage plan was over-ambitious, unsafe and did not effectively address the potential hazards. In particular, the owner intended to press ahead with a potentially untenable voyage through the Pentland Firth after the situation had changed. The owner was motivated to continue the voyage in the face of adversity, despite the emerging risks. [2.7]

6. *Shearwater* was not safely manned for the intended voyage, and evidence from AIS indicates that the vessel was underway for unacceptably long periods with only one bridge watchkeeper on board, risking fatigue. [2.8]

7. *Shearwater*'s master and owner did not have a robust process of identifying hazards, assessing risks and developing safe systems of work. This happened primarily because there was no requirement for a safety management system. [2.9]

8. The MCA's load line exemption certificate did not provide sufficient guidance to assure safe operation of the vessel. Exempting *Shearwater* from all conditions of the Load Line Regulations was inappropriate, and the certificate's conditions were insufficiently detailed with respect to manning and safety management. Additionally, the certificate did not set conditions for *Shearwater*'s operation as a dredger or towing vessel. [2.10]

9. The absence of specific flag state guidance on the safe operation of the vessel created an environment where the owner felt able to operate the vessel broadly as he saw fit, rather than safely in accordance with a recognised code of practice. [2.10]

3.2 SAFETY ISSUES NOT DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. Without sufficient power or towing equipment, *Shearwater* was not suitable for use as a coastal towing vessel, especially given the potentially severe conditions likely to be encountered in the Pentland Firth. [2.4.3]

2. The towline failures resulted from inappropriate towing practices that introduced a significant risk of snatch and chafe. [2.4.2]

SECTION 4 – ACTION TAKEN

4.1 ACTIONS TAKEN BY OTHER ORGANISATIONS

The **owner of *Shearwater*** has:

- Purchased a small tug for use when repositioning barges, which means that *Shearwater* is no longer required to be used for coastal towing.
- Updated the onboard documentation for the bilge system.
- Introduced further familiarisation training of machinery systems for all crew and new joiners.
- Introduced a requirement for the master to operate bilge pumping systems and propulsion machinery.
- Commenced the process of obtaining a voluntary towage endorsement for one master to operate the small tug.

SECTION 5 – RECOMMENDATIONS

The **Maritime and Coastguard Agency** is recommended to:

2021/123 Adopt measures to ensure that the certification of vessels over 24m load line length and under 500gt includes the application of all appropriate regulatory conditions taking full account of the vessel's intended function and area of operations.

Northern Dredging Limited is recommended to:

2021/124 Undertake risk assessments for all intended operations to identify hazards, and ensure that safe systems of work are in place to mitigate all foreseeable risks. Additionally, procedures should be in place for all potential emergencies.

2021/125 Ensure that company vessels are safely manned by a master and crew members who are suitably qualified and experienced for the operations being undertaken, and that obligations for hours of work and rest are met.

Safety recommendations shall in no case create a presumption of blame or liability

Marine Accident Report