



Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation

Summary Investigation Report 421/22

Less Serious Marine Casualty

Grounding of the tanker STEN ARNOLD in the fairway of the River Elbe on 21 August 2022

31 July 2024

This summary report within the meaning of Section 27(5) of the Law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Law – SUG) is a simplified report pursuant to the second sentence of Article 14(1) of Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009 establishing the fundamental principles governing the investigation of accidents in the maritime transport sector.

The investigation was conducted in accordance with the above legislation. According to said legislation, the sole objective of this investigation is to prevent future accidents. This investigation does not serve to ascertain fault, liability or claims (Section 9(2) SUG).

This report should not be used in court proceedings or proceedings of the Maritime Board. Reference is made to Section 34(4) SUG.

The German text shall prevail in the interpretation of this investigation report.

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Amendments

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1 FACTUAL INFORMATION

1.1 Photograph of the vessel



Figure 1: Photograph of the STEN ARNOLD¹

1.2 Ship particulars

Name of vessel:	STEN ARNOLD
Type of vessel:	Chemicals/oil products tanker
Flag:	Gibraltar
Port of registry:	Gibraltar
IMO number:	9371610
Call sign:	ZDIB2
Owner:	Stenship KS c/o Rederiet Stenersen
Shipping company:	Stenersen Chartering AS
Year built:	2008
Shipyard:	Jiangnan Shipyard
Classification society:	DNV
Length overall:	144.19 m
Breadth overall:	23.01 m
Draught (max.):	12.4 m
Gross tonnage:	11,935
Deadweight:	16,578 t
Engine rating:	6,300 kW
Main engine:	Wärtsilä 6L46C
Service speed:	14 kts
Hull material:	Steel
Hull design:	Double hull
Minimum safe manning:	12

¹ Source: Hasenpusch Photo-Productions and Agency.

1.3 Voyage particulars

Port of departure:	Amsterdam
Port of destination:	Hamburg
Type of voyage:	Merchant shipping/international
Cargo information:	Petrol
Crew:	16
Draught at time of accident:	$D_{f+a} = 8.55 \text{ m}$
Pilot on board:	Yes
Number of passengers:	None

1.4 Marine casualty or incident information

Type of marine casualty:	Less serious marine casualty, grounding in the fairway of the River Elbe
Date, time:	21 August 2022, 1504 ²
Location:	River Elbe, north-west of fairway buoy 63, Elbe-kilometre 689.7
Latitude/Longitude:	$\phi = 53^{\circ}52.447'N$, $\lambda = 009^{\circ}14.661'E$
Ship operation and voyage segment:	Fairway mode
Consequences:	Paint abrasion, no structural damage

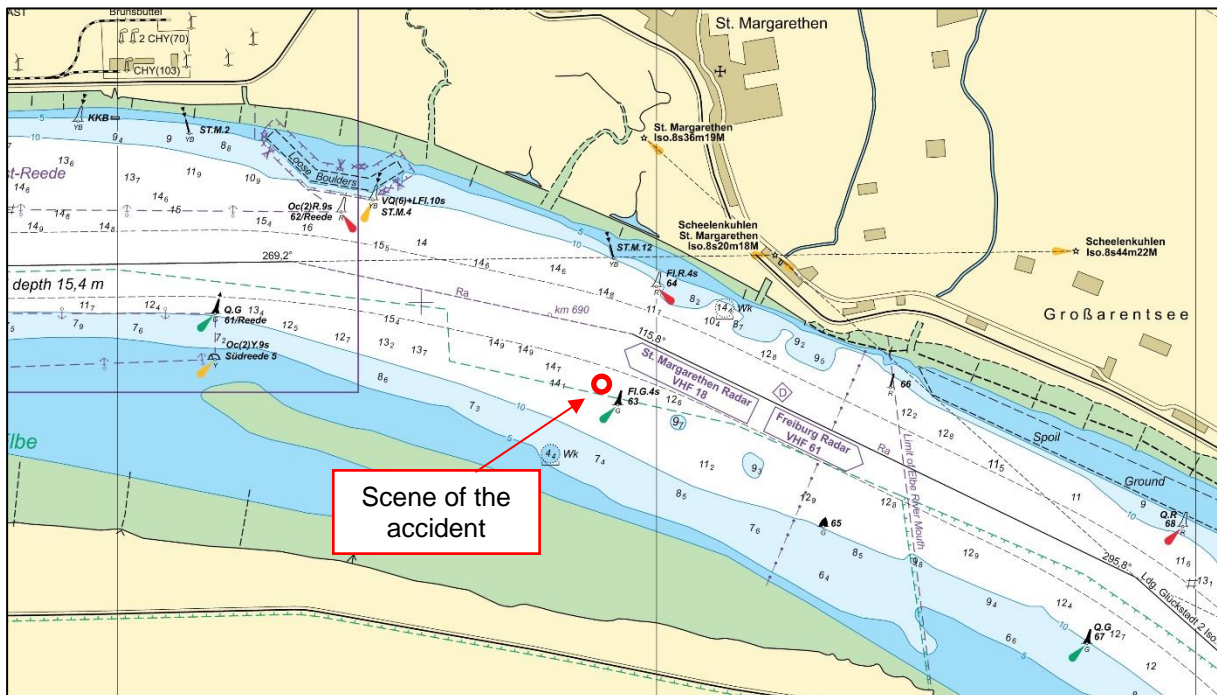


Figure 2: Extract from Navigational Chart DE46³, showing the scene of the accident

² All times shown in this report are Central European Summer Time (CEST) = UTC + 2 h.

³ Source: Federal Maritime and Hydrographic Agency.

2 COURSE OF THE ACCIDENT AND INVESTIGATION

2.1 Course of the accident

The account of the course of the accident is based on statements made by the master and the River Elbe pilot. Investigators from the Federal Bureau of Maritime Casualty Investigation (BSU) also made use of information from the voyage data recorder (VDR), VHF data recorded by Vessel Traffic Service (VTS) Brunsbüttel, and AIS data stored by the Shipping Administration.

The Gibraltar-flagged tanker STEN ARNOLD was sailing from Amsterdam to Hamburg on 21 August 2022. The ship was loaded with 13,925 t of petrol. The first River Elbe pilot boarded the ship at 1050. From this point on, the bridge was manned by the master, an deck officer, and a helmsman. Due to her shallow draught, the ship was not dependent on the River Elbe navigation channel⁴. The pilot transfer took place level with Brunsbüttel at 1440. In addition to the pilot, the bridge was now manned by the Lithuanian master, the Filipino chief mate, and a Filipino rating with watchkeeping proficiency who was at the helm.

After the pilot transfer, the voyage continued at a speed over ground of about 9.4 kts. A ebb current of about 2 kts and 4 Bft west-south-west wind prevailed. Visibility was good.

At 1504, the ship suddenly lost speed and came to a standstill (see Figure 3). Shortly afterwards, the ship's command and the pilot realised that the ship had grounded on an unknown shoal in the fairway. The ship was listing 2-3° to port. The lateral distance to the virtual connecting line between the fairway buoys (green buoy line) was about 120 m.

The JUDITH was sailing slightly astern in the navigation channel and passed the STEN ARNOLD at a safe distance about one minute later.

An ebb current still prevailed when the vessel grounded. The water-level gauge in Brunsbüttel indicated +1.08 m based on Chart Datum. Low tide was at 1616.

The pilot informed VTS Brunsbüttel at 1512 and the latter notified other traffic about the incident and requested due care. At 1528, the Ship Safety Division (BG Verkehr) authorised the vessel to continue her voyage after she refloated on condition that the hull was not damaged and the machinery fully operational. An order concerning an escort tug was also issued.

The crew's reading of the ship's draughts indicated: $D_f = 7.90$ m; $D_{m \text{ port}} = 8.65$ m, $D_{m \text{ starboard}} = 8.05$ m. An aft reading was not possible.

⁴ Dredged deeper channel for ships with greater draught.

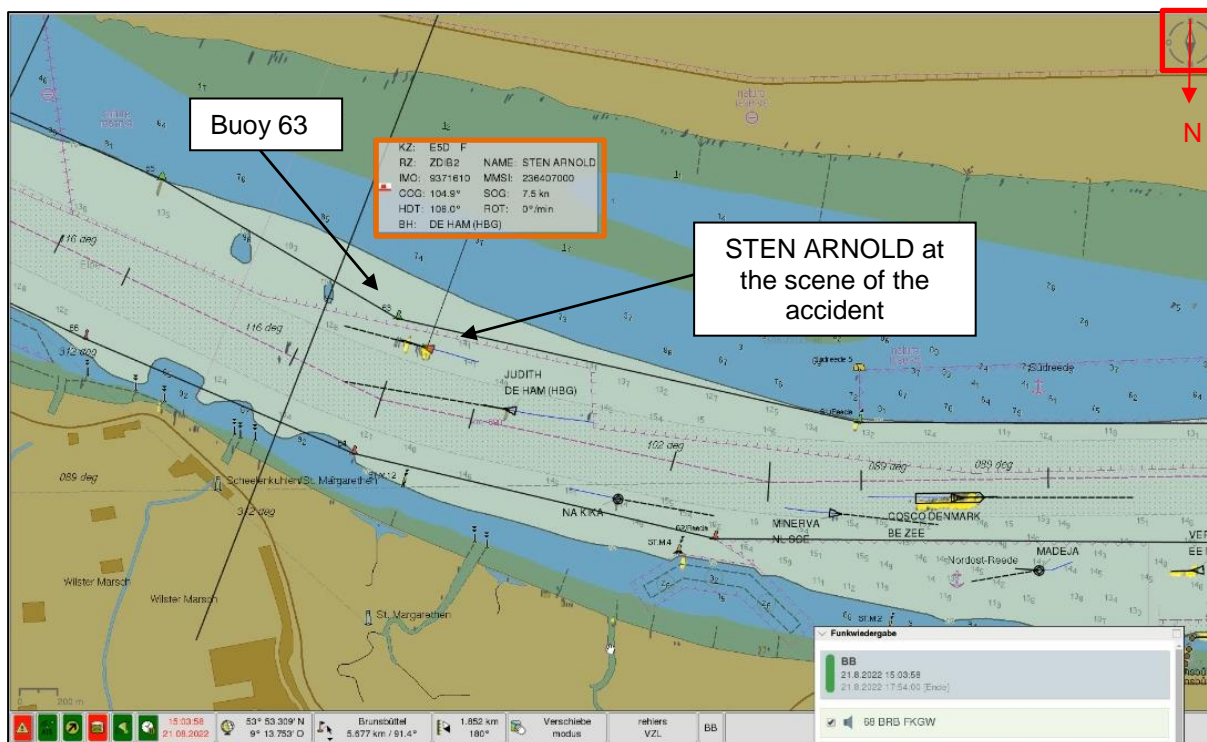


Figure 3: Screenshot taken from VTS Brunsbüttel's recording at 150358⁵

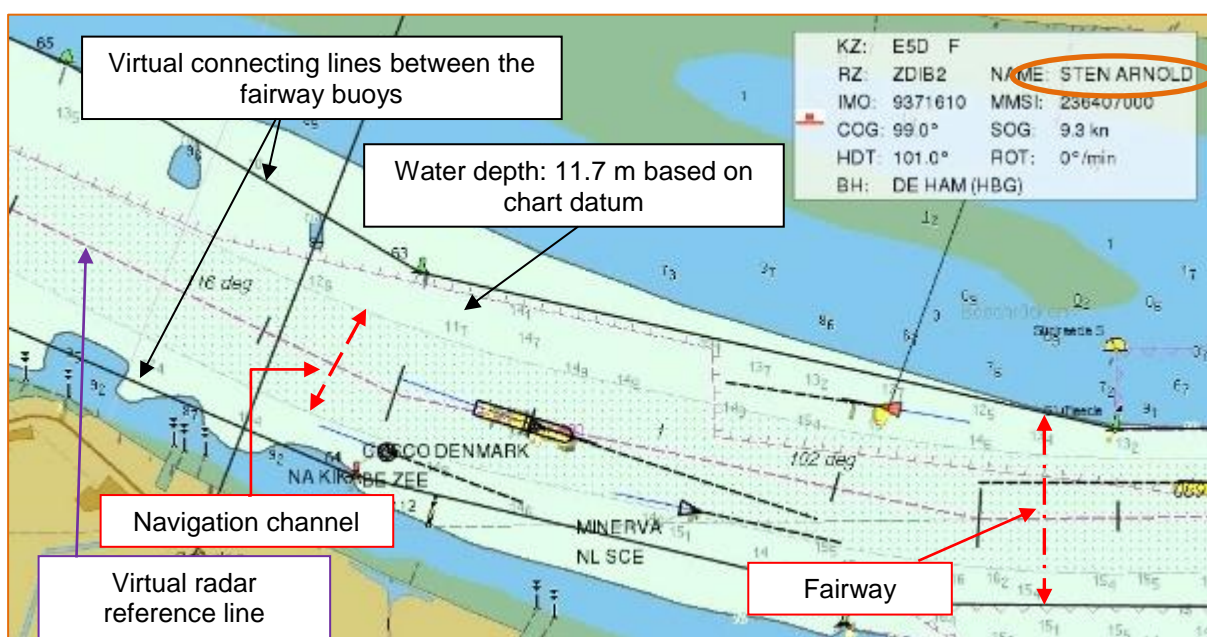


Figure 4: Explanatory notes to Figure 3⁶

⁵ Source: Figures 3 and 4: WSA Elbe-Nordsee. Please note the orientation of the images.

⁶ Chart datum: In accordance with an international agreement, the chart datum (CD) in BSH navigational charts for the German North Sea coast and adjacent tidal areas was switched to Lowest Astronomical Tide (LAT) in 2005. High and low tide levels calculated for the German reference points in BSH tide tables have been based entirely on LAT since 2005. https://www.bsh.de/DE/PUBLIKATIONEN/_Anlagen/Downloads/Nautik_und_Schiffahrt/Sonstige-nautische-Publikationen/Neues-Seekartennull.html (5 June 2023).

The VTS then assigned the escort tug role to the FAIRPLAY 35 at 1542. At 1703, the ship's command confirmed to the VTS that the safe condition was met, as required. The vessel was floating at 1738 and the VTS allowed her to proceed to Hamburg. The STEN ARNOLD passed the Hamburg state border at 2015 and made fast at a finger pier in Hamburg's Kattwykhafen port facility at 2122.

Waterways and Shipping Office Elbe-Nordsee responded to the discovered shoal that same evening by ordering its multi-purpose vessel NEUWERK to shift buoy 63 200 m to the north.

2.2 Findings of the investigation

2.2.1 STEN ARNOLD

Waterway Police Cuxhaven notified the BSU of this marine casualty on the afternoon of 21 August 2022. The STEN ARNOLD was called on to investigate the circumstances surrounding the grounding at her berth in Hamburg on 22 August 2022. No irregularities were found. The shipping company later provided information from the ship's VDR. The ensuing analysis showed that the incident had completely surprised the ship's command and pilot. Moreover, it was in no way foreseeable, as there was no information about the shoal in the ship's electronic chart (an ECDIS⁷ with the latest issue and revision status). The charts used on board and the electronic charts used in the pilot's portable pilot unit (PPU) were based on WSA Elbe-Nordsee's sounding chart of 8 April 2022, which did not reflect conditions in the fairway on the day of the accident.

2.2.2 Federal Waterways and Shipping Administration (WSV)

The Federal Waterways and Shipping Agency (GDWS⁸) is the WSV's directorate responsible for the maintenance of federal waterways and safety of maritime traffic. As subordinated organisational units in the various regions of Germany, the respective waterways and shipping offices are responsible for the specific tasks. Waterways and Shipping Office Elbe-Nordsee was established in 2021 as part of the reform at the WSV and the duties of the former WSAs Cuxhaven, Tönning and Hamburg have been consolidated there.⁹

Like its predecessors, WSA Elbe-Nordsee – as well as the Hamburg Port Authority, which is responsible for the Hamburg section of the River Elbe – has been tasked with completing and maintaining the necessary adaptation of the navigation channel to the draughts of today's large container vessels. Responsibility for maintaining navigable conditions also applies to the fairway, i.e. the area extending beyond the navigation channel marked by fairway buoys. This requires the collection, transportation and

⁷ ECDIS: Electronic Chart Display and Information System.

⁸ Generaldirektion Wasserstraßen und Schifffahrt.

⁹ More information on the duties of WSA Elbe-Nordsee can be found here: https://www.wsa-elbe-nordsee.wsv.de/Webs/WSA/Elbe-Nordsee/DE/4_Elbe-Nordsee/1_UeberUns/ueberuns_node.html (6 June 2023).

depositing of large quantities of sediment.¹⁰ The sediment is transported to areas known as transfer or relocation sites.

For support in the planning, implementation, and monitoring, WSA Elbe-Nordsee and the Hamburg Port Authority (HPA) are able to draw on the expertise of the Federal Institute of Hydrology (BfG) and the Federal Waterways Engineering and Research Institute (BAW).

2.2.3 Discovery of the shoal in the fairway

After the shoal in the fairway was discovered as a result of the STEN ARNOLD running aground, the BSU requested the last sounding chart produced before the incident and an up to date sounding chart from WSA Elbe-Nordsee. The WSA then provided the sounding chart of 8 April 2022 (Figure 5) and that of 23 August 2022 (Figure 6).

The sounding charts showed that there are transfer sites in the fairway and that transfer site 689_4 is situated north of buoy 63. This is followed upstream by transfer site 689_5 HPA. It can be seen in Figure 6 that the shoal in question is in the area of transfer site 689_4.

The GDWS advised that transfer site area 686 to 690 has existed since 2008. Transfer site 689_4 was established on 30 December 2021 following the former 689_3's division into 689_4 and 689_5 HPA for logistical reasons.

According to the technical concept¹¹, transfer sites should be set up in areas with a sufficient water depth to allow dredgers with a deeper draught to access and manoeuvre in them. Furthermore, they should only have a minor impact on adjacent fairway areas. Continuous erosion by the river or tides is also important to ensure that certain sediments are removed again so as to allow dredging sites to be used for a long time. Finally, the distance to the dredging site should not be too great. The above points, and in particular the often insufficient water depths outside the fairway mean that most of the transfer sites in the River Elbe are located within the fairway.

The composition of the sediment of the shoal discovered near buoy 63 was not investigated, as the WSA was more concerned with removing it as quickly as possible using a dredger.¹² However, it was assumed that it was a (medium) sandy material¹³.

¹⁰ For more information, see https://www.kuestendaten.de/Tideelbe/DE/Startseite/Startseite_Portal_Tideelbe_node.html (6 June 2023).

¹¹ GDWS, Outstation North: Interim technical concept for maintenance dredging in the tidal Elbe district, as at 27 June 2016, p. 18.

¹² The shoal was removed in the week following the accident.

¹³ See also subsection 2.2.4.

Ref.: 421/22

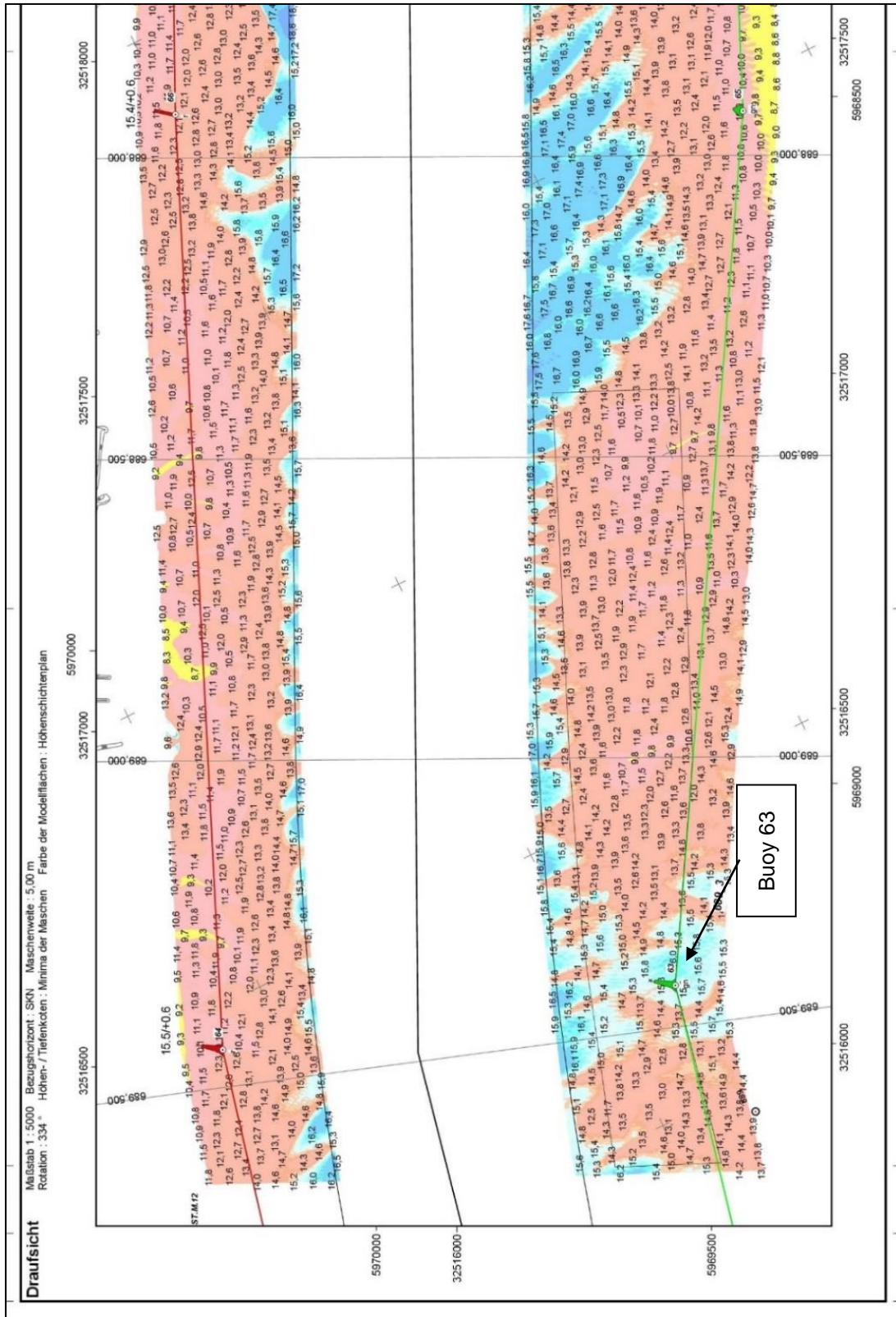


Figure 5: Extract from the sounding chart of 8 April 2022¹⁴

Extract from: *Lower Elbe fairway, traffic control, buoys 63-67, km 685.47 to km 689.81*. Scale: 1:5000.
 Date of last measurement: 7 April 2022. Notes by the BSU.

¹⁴ Source: WSA Elbe-Nordsee.

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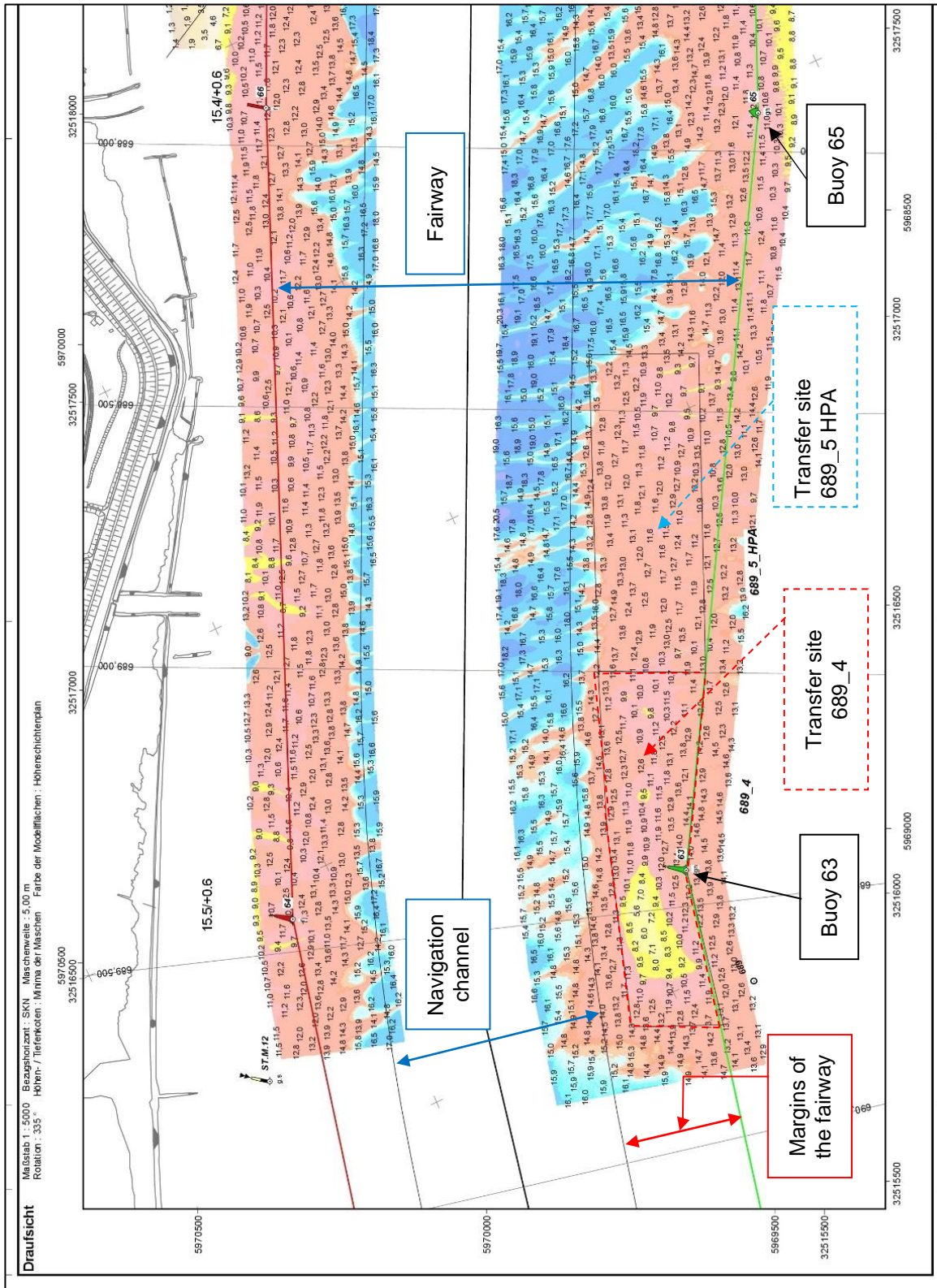


Figure 6: Extract from the sounding chart of 23 August 2022¹⁵

Extract from: *Lower Elbe fairway, traffic control, buoys 63-67, km 685.42 to km 689.87*. Scale: 1:5000
 Date of last measurement: 22 August 2022. Notes by the BSU.

¹⁵ Source: WSA Elbe-Nordsee.

The above transfer sites are not shown in the official navigational charts – neither in electronic form nor in paper form. An enquiry with the Elbe Pilot Association revealed that contours of the transfer sites are not shown in the electronic bathymetric ENC¹⁶ used in portable pilot units, either.

2.2.4 Causes of a shoal

The following consideration refers primarily to the fairway's margins. These include areas between the navigation channel and fairway buoys (see Figure 6).

The 23 August 2022 sounding chart (Figure 6) shows that the water depth at the sedimentation's highest point is just 5.6 m below chart datum (CD). A comparison with the previous sounding operation of 8 April 2022 (Figure 5) shows that sedimentation at this point increased by about 9 m within 136 days. The period in which the transfer site was used actively was even shorter according to the WSA, stating that it was only used again from 1 July 2022 because the area was closed prior to that due to the red herring spawning season.¹⁷

The investigators' initial assumption that the dredgers had always deposited the dredged material in the same place was refuted by the GDWS. Firstly, dredging companies are reportedly instructed to distribute dredged material evenly. This is reportedly monitored by dredging supervisors¹⁸, who accompany the vessel. Secondly, it would not be technically possible. Although smaller dredgers¹⁹ may still be able to operate on this shoal at high tide²⁰, it would reportedly not be possible to open the hopper doors. On the other hand, it is reportedly not possible for large dredgers to operate in the area with the discovered shoals. The transfer site had also reportedly not been approached with partial loads and they had reportedly not waited for high tide before operating there.

The BAW underlined the statement with regard to dredgers operating at the transfer site. Their evaluation of the data available in the dredging operations monitoring programme confirmed that relocations to this transfer site had been distributed across the site with a minor tendency toward its north-western section. However, the BAW added that this was reportedly only an indication, as the vessels would drift with the current during the transfer process.

¹⁶ Electronic Navigational Chart (ENC) is the official name for official hydrographic vector data: https://www.bsh.de/EN/TOPICS/Surveying_and_cartography/Nautical_cartography/Electronic_charts/electronic_charts_node.html;jsessionid=C8E67453E8225191E302C8D2344371FE.live11313 (25 April 2024).

¹⁷ Dredging was not conducted in areas 1 to 3 (Wedel, Lühesand, Juelssand) and 5 to 7 (Pagensand, Steindeich, Rhinplate) from 7 April to 30 June 2022. The restriction from 15 April to 30 June 2022 to protect red herring was also within this period.

¹⁸ Trained staff of WSA Elbe-Nordsee who determine dredged material quantities and compositions and/or test them using simple methods and take samples for subsequent testing in the laboratory.

¹⁹ According to information given by WSA Elbe-Nordsee: MEUSE RIVER, max. depth = 8.25 m; VOX ARIANE, max. depth = 7.80 m; UILENSPIEGEL, max. depth = 9.80 m; UTRECHT, max. depth = 10.40 m.

²⁰ The available water depth would then be 9.1 m.

To give the reader a basic understanding of the process, a rough description of sediment transport on the Lower Elbe, also referred to as 'the tidal Elbe', i.e. the area from the weir in Geesthacht to Cuxhaven, follows. Various sediments²¹ have always been transported in different quantities in the River Elbe. On the one hand, this is caused by headwaters, i.e. water masses flowing from inland toward the North Sea that carry material from the upper reaches. Sediment transported by the headwaters also settles in the area of the Port of Hamburg. In particular, this happens when the amount of headwater is low due to low rainfall in inland areas and therefore not sufficient to transport sediment beyond the Hamburg area. On the other hand, large quantities of sediment, mainly sand with different grain sizes, are transported from the North Sea further and further upstream with each tide. This is known as 'tidal pumping'. Sediment transported upstream as a result of tidal pumping mixes with sediment transported downstream by the headwater.

The processes described above are known to have changed with the progressive expansion of the River Elbe, i.e. the deepening of the navigation channel. The amount of 'artificially' moved sediment has increased, as in addition to the dredging required to reach planned depths and widths in the navigation channel, landslides, and other natural adjustments to the river bed occur as a result of altered tidal dynamics, which must also be compensated by dredging.

As all the resulting dredged material cannot be deposited ashore or in the North Sea, it is transported to other areas of the Lower Elbe. These relocation or transfer sites are selected based on the structure of the dredged material. A rough distinction can be made between cohesive and non-cohesive sediment. Cohesive sediment refers to extremely fine-grained soil constituents, such as clay, clayey silt, and silt.²² The assumption is that they remain in suspension for a long time after they have been relocated to a transfer site and are then distributed over a large area by the currents. Non-cohesive sediment refers to sands, gravels, stones, and mixtures thereof.²³ The assumption here is that they will sink quickly due to their own weight and thus remain at the transfer site. However, if there is little headwater, tidal pumping can also cause cohesive sediments to be transported very far upstream again. This movement of sediment gives rise to the need for so-called recirculation dredging. To reduce the need for recirculation dredging, transfer sites further away from Hamburg are now being used. However, the current volume of headwater also plays a role when selecting a transfer site for the various types of dredged material. The transfer site in question, 689_4, is one of the sites further away from Hamburg. It is generally advantageous, as it is in the area of the River Elbe that is dominated by an ebb current, which begins downstream of St. Margarethen (or Scheelenkuhlen).

²¹ Sediments in the geoscientific sense are various mineral (inorganic) and/or organic loose materials that – after being transported shorter or longer distances by gravity or a flowing medium – are deposited (accumulate) on dry land or at the bottom of a body of water:
https://de.wikipedia.org/wiki/Sedimente_und_Sedimentgesteine (6 June 2023).

²² See DIN 18 196.

²³ Ibid.

2.2.5 Use of the transfer site 689_4

The analysis of the documents submitted by the GDWS revealed that the four dredgers that were deployed (see footnote 18) transported 2,664,721 m³ of dredged material to transfer site 689_4 during the period 1 July to 21 August 2022. This dredged material originated from dredging sections²⁴ 1 (Wedel to Tinsdal, km 638.9 to 644) to 3 (Juelssand, km 649.5 to 654.5). The smaller VOX ARIANE was mainly deployed in dredging section 3 and moved 365,519 m³, for example.

In the past, mainly cohesive sediments were dredged from the navigation channel in both sections.²⁵ However, the BfG's impact forecast of 2017²⁶ showed that the morphological²⁷ development of the fairway area in dredging section 10 (Scheelenkuhlen, Elbe-km 685.5 to km 689.8) is influenced by the depositing of large quantities of sandy dredged material in the transfer site area 686/690. It should be noted that a total of four transfer sites are in dredging section 10. Two of them are located on the right-hand side of the fairway, i.e. in the northern area. The impact forecast indicates an increased build-up of individual shoals in the area of the fairway in dredging section 10 for several years. The BfG therefore assumed that the continued depositing of large quantities of sandy dredged material would result in a continued build-up of individual shoals.

The extent to which changes in elevation can occur is described in the technical concept for maintenance dredging²⁸. According to that, an elevation change rate of ± 8 cm/day was determined for individual subaquatic dunes in the sandy navigation channel in dredging section 10. This is usually 1-5 cm/day. Since no dredged material is deposited in the navigation channel, these changes in height arise solely from naturally transported sediment.

²⁴ The River Elbe is divided into dredging sections from Hamburg. Transfer site 689_4 is located in the area of dredging section 10.

²⁵ Based on: BfG: Impact forecast for the depositing of dredged material in transfer site area 686/690 between Elbe-km 686 and 690, pages 27 ff. and 41 ff.; Koblenz, 20 June 2017.

²⁶ BfG: Impact forecast for the depositing of dredged material in the transfer site area 686/690 between Elbe-km 686 and 690, page 159. Koblenz, 20 June 2017.

²⁷ *The river morphology describes the formation of the channel, the bed structure, the bank reinforcement, the bed substrate and to some extent the adjacent floodplain.* Taken from <https://www.biodivers.ch/de/index.php/Grundlagen> (retrieved: 15 May 2024).

²⁸ GDWS, Outstation North: Interim technical concept for maintenance dredging in the tidal Elbe district of 27 June 2016. Page 15.

As already discussed, it is assumed that cohesive sediments do not settle at the transfer site. However, a comparison of the two soundings (Figures 5 and 6) shows that in addition to the resulting elevation north-west of buoy 63, scouring in the area of buoy 63 has also been filled in and that the water depths have been reduced by between 0.5 m and 3 m in other areas of this transfer site on the left-hand side of the fairway. Supported by the observations below, this could indicate that a larger quantity of non-cohesive sediment was transported to the area.

This also occurred in dredging sections 1 and 3 during the current adjustment of the navigation channel, which began in 2019. It was found during the accompanying investigations that the composition of the dredged material had changed. This is indicated by the findings of a BfG report²⁹ (see Tables 1 and 2) published in December 2022. According to this report, the ratio of sand to silt in dredging section 3 has reversed in the years observed.

Table 1: Composition of dredged material in dredging section 1

Dredging section 1	2020	2021	2022
Silt [%]	76	92	95
Sand [%]	24	8	5

Table 2: Composition of dredged material in dredging section 3

Dredging section 3	2020	2021	2022
Silt [%]	83	37	14
Sand [%]	17	63	86

WSA Elbe-Nordsee stated that the scale of the changes in the individual dredging cycles was reportedly not recognisable or quantifiable to begin with. *In places where it was determined for individual cycles that non-cohesive dredged material (sand) was primarily transported in the respective dredging operation, sand transfer sites³⁰ located further upstream were used for relocation wherever possible (capacity of the relocation sites, sounding capacities for observing the relocation sites). However, it is reasonable to assume that the percentage of sand in cycles categorised as cohesive (silt) was also significantly higher on average. On the one hand, this could not be determined/quantified on the actual dredgers. On the other hand, recirculation dredging would have been increased with regard to the cohesive constituents if these cycles had not been transferred at St. Margarethen.*

²⁹ BfG: Determination of homogeneous areas in the tidal Elbe; results from hold sampling in the period July 2020 to August 2022. 6 December 2022.

³⁰ BfG: Impact forecast for the depositing of sandy dredged material in the Lower Elbe (official area of WSA Hamburg), 2 November 2015.

It is also relevant that there is no impact forecast for the effects of the transfer of large quantities of cohesive dredged material in navigation channel sections upstream of St. Margarethen. For the sand transfer sites [further upstream]³¹, the sand dredging quantities were far higher than originally envisaged in the Annex to the technical concept for maintenance dredging³² and the possible scope for action fully utilised.

2.2.6 Monitoring mechanisms

Given the findings of the impact forecast and risk of the further development of individual shoals identified therein, the BfG concluded that the monitoring programme must be adapted accordingly and transfer sites sounded regularly at a frequency of 4-6 times per year, in particular when depositing large quantities of dredged material comprising non-cohesive sediment.³³

Based on this, *inter alia*, a technical concept for monitoring water depths³⁴ has been developed at the GDWS to maintain depths in the navigation channel and other navigated waters. The navigable waterways are divided into sounding areas depending on their purpose, importance, and the respective morphological activity. These sounding areas are assigned sounding area codes, which form the basis for the prioritisation of tasks defined in the technical concept.

Navigation channels with a dredging cycle ≤ 5 years are assigned the code 100. Navigation channels with a dredging cycle ≥ 5 years have the code 200. These two areas always have priority and are sounded most frequently. The entire area of the fairway next to the navigation channel is assigned the code 300. Four soundings per year are scheduled for areas with the code 300. Accordingly, the 2022 annual work plan provided for four soundings in the area of buoys 63 to 67 (km 685.5 to 689.6), which includes the transfer site 689_4. Transfer sites in the area of the fairway next to the navigation channel are not subject to a higher sounding frequency.

The sounding frequency depends on the significance of the area to traffic, morphological activity, and the uncertainty of depth information. Observations from the previous year are considered during the annual planning so as to respond to changes. Current events such as storm surges should be responded to as needed. The technical concept also states that the navigation channel must always be sounded using internal capacities. If internal resources are insufficient, it should be possible to utilise the sounding vessels of other authorities. If there is a continuing need, sounding tasks in the peripheral areas can also be outsourced to third parties. However, this is only possible if the authority expects its own sounding vessels to be out of service for more than four weeks. Derogations are permitted in the case of imminent danger.

³¹ Note by the BSU:

³² Ibid.

³³ BfG: Impact forecast for the depositing of dredged material in the transfer site area 686/690 between Elbe-km 686 and 690, 20 June 2017, p. 201.

³⁴ Reference technical concept for a hydrography and quality management system (aQua).

2.2.7 Sounding vessels

The most recent traffic control sounding operation in the area of transfer site 689_4 took place on 7 April 2022. The resulting sounding chart did not exhibit any anomalies. The lowest depth was 9.7 m below CD³⁵ (see Figure 5). The next sounding should have taken place in July 2022. However, this was not carried out due to the technical and personnel-related restrictions described below.

WSA Elbe-Nordsee has three sounding vessels. These are basically intended for different areas of operation (open sea, sheltered waters, shallow waters) based on their design. As part of the GDWS's initial statement on the grounding of the STEN ARNOLD, the competent department analysed and submitted the actual operating times of the three sounding vessels in the period 1 April to 22 August 2022 to the BSU. This period comprises 98 working days per vessel and a total of 294 operating days.

In fact, the sounding vessel GRIMMERSHÖRN (year built: 2009) had 18 maintenance-³⁶ and eight personnel-related days lost during the above period. This also included three days for a scheduled call at a shipyard at the end of the period under consideration.

For the sounding vessel STICKERS GAT (year built: 2014), 63 maintenance- and 22 personnel-related days lost were recorded during the period.³⁷

The sounding vessel WEDEL (year built: 2007) had 36 maintenance- and seven personnel-related days lost during the period referred to.

This means that the vessels were not in service for 154 days (52.4% of the total operating time) during the period under consideration.

If the sounding vessel WEDEL is not in service, then a mobile multi-beam echo sounder can be deployed via the workboat PIROL (call sign: DK3310, year built: 2004). However, the PIROL had a scheduled call at the shipyard from 9 May 2022. This call was extended until 8 September 2022 due to unforeseen additional repairs and long spare part delivery times. This was evidently also the case with the long maintenance-related absences of the STICKERS GAT (5 April to 10 May 2022 and 1 July to 18 August 2022).

According to the competent department, the end of each period was not foreseeable or extended for unforeseeable reasons. Accordingly, no action was taken to have services provided by a third party. Instead, attempts were reportedly made to account for labour requirements through shift reallocations and adjustments.

³⁵ An increase of 6 dm at mean low water results in a water depth of 10.3 m.

³⁶ Means days lost due to scheduled maintenance or unforeseen technical issues.

³⁷ The days lost mentioned here and for the other vessels were not consecutive. With one exception, they were always below the four-week threshold (see subsection 2.2.6.).

In the opinion of the GDWS, the actions of the WSA were consistent with the *specifications of the technical concept, in particular with regard to hydrography. The sounding interval for the site [the discovered shoal] was incorporated into the traffic control sounding operation and approved by the GDWS. The sounding operation should have taken place on 7 July 2022. The sounding interval was exceeded due to a loss of sounding capacity. The subsequent prioritisation of the navigation channel with available sounding capacities is consistent with specifications.*

During a conversation with representatives of WSA Elbe-Nordsee in July 2023, it was also pointed out to the BSU's investigators that when third parties are commissioned, it reportedly takes much more time for them to process and provide the data – up to 14 days. In contrast, internal personnel would report anomalies on the day of the sounding operation and an up to date sounding chart would be available on the next day at the latest.

2.2.8 Risk assessment by the GDWS

The GDWS does not believe that the shoal in the vicinity of buoy 63 was caused by the 'overloading' of transfer site 689_4 due to an excessive amount of non-cohesive material being deposited in this area. Rather, in its statement the GDWS referred to the following points as being the cause: *Since the approval of the navigation channel adjustment (January 2022), increased sediment incursions have been identified over large areas in all dredging sections and in the embankment area, in particular. In addition to the constituents from the morphological lag³⁸ of the navigation channel adjustment expected in the planning approval, probable causes are primarily the strong storm surges³⁹ that occurred during this spring and the persistently too low discharge [BSU note: low headwater] from the Elbe catchment area this year. The morphological lag would only account for a fraction of the observed sediment quantity. The storm surges have an impact on the increased availability of sediments; the persistently low discharge also increases the amount of new sedimentation in the tidal Elbe. Notably, the sedimentation comprises increasingly sandy material and is also occurring in locations that do not correspond with past experience. The WSA could not have anticipated such a development on this scale. Even with the sounding operation on 23 August 2022, the strong drifting detected at this point did not correspond to what the WSA could have expected (inter alia, based on its extensive experience with sedimentation in the River Elbe).*

³⁸ Refers to and encompasses the changes to the water bed that occur after dredging work involved in deepening and widening the navigation channel due to landslides and changing currents. It also includes the effects of underwater sedimentation areas.

³⁹ *In the winter months of 2021/22, there were 16 storm surges on the German North Sea coast, equalling three times as many as the long-term mean. The storm surges occurred in clusters, with one storm surge followed by the next within 48 hours. Six storm surges occurred from 30 January to 7 February, two of which were severe. This was followed shortly afterwards by seven storm surges from 17 to 22 February, the longest storm surge sequence since 1990. They were caused by a number of successive strong storm fronts with gale-force winds from a north-westerly direction. In addition, strong squalls on the night of 19 February led to an extremely severe storm surge in Hamburg, the likes of which only occur once every five years based on the long-term mean. Extract from the Federal Maritime and Hydrographic Agency (BSH) press release dated 1 November 2022.*

The GDWS went on to state that since the use of transfer sites in the area of kilometres 686 to 690 in 2008, such an increase in shoaling had reportedly never been seen during the quarterly sounding operations. Accordingly, they reportedly saw no reason to increase the frequency of sounding operations in the fairway. In contrast, changes in the navigation channel were reportedly much more dynamic. For this reason, a sounding operation was carried out there every 14 days.

In its statement, the GDWS summarised: *The sedimentation with sandy material increased due to unforeseeable events. The shoaling in this location came as a surprise to the WSA, which as competent authority has been familiar with the changes in the River Elbe for decades and documents them on an ongoing basis. The maintenance strategy has responded to these changes by intensifying sounding operations and expanding capacity [see subsection 2.2.1]. To establish traffic safety, the response to the grounding event was immediate.*

During the conversation with representatives of WSA Elbe-Nordsee, they stated that the existing personnel and technical equipment are reportedly usually sufficient to complete the tasks. This also applied to the situation in 2022, when the amount of sediment that had to be moved rose sharply and shipping police measures thus increased.⁴⁰ During the most recent deepening works in the River Elbe, additional posts were reportedly created in the areas of navigation, hydrology, among the crews of the sounding vessels and in the dredging office. There had also reportedly been no job cuts as part of the general downsizing currently seen at the Federal Administration. To remain an attractive employer, adequate pay reportedly makes an important contribution to staff retention and development. In this respect, there is strong competition with the private sector. The representatives of the WSA stated that the so-called 'publicly controlled enterprise', i.e. the handling of tasks by internal staff, should definitely be retained because it is reportedly far more responsive than outsourcing the maintenance of waterways to third parties.

In principle, the number of sounding vessels is reportedly also sufficient. If a sounding vessel is absent, then another vessel (the PIROL) could be deployed. However, to maintain the availability of the sounding vessels, the representatives of the WSA consider it necessary to start a new construction programme.

2.2.9 Navigation channel

Although the STEN ARNOLD grounded in the fairway and not in the navigation channel, this report will also consider the area of the fairway, which is important for vessels with a large or maximum draught.

The increase in sandy material transported upstream by tidal pumping and storm surges discussed in subsection 2.2.4 of this report also had a major impact on the navigability of the navigation channel, especially in 2022. The reduced depths found there during the frequent sounding operations are publicised through so-called shipping police measures. These are directed at pilots and vessel traffic services on

⁴⁰ At the beginning of the works to deepen the navigation channel, it was assumed that dredging would increase by 10%. The average volume in the years prior was 13,000,000 m³. Some 25,000,000 m³ was dredged in 2022.

the River Elbe. They do not form part of the navigational warnings or notices to mariners.

Shoals are localised and described in the respective shipping police measures. Associated shipping police orders then regulate whether speed should be reduced in these areas and/or whether shoals should be avoided to the north or south, for example. The structure of such a shipping police measure is shown below using 167/22 as an example.

Schifffahrtspolizeiliche Maßnahme Nr. 167/22 vom 09.06.2022
Integrierter Peilplan Auftragsnummer Fr105113 2206 vom 09.06.2022,
Bereich Tonne 105 bis 113.

	Tonnenbereich / Fahrinnen-Km	Position	Minder- tiefe (SKN-)	Abwei- chung
a)	113 – 105 / 649,5 – 654,5	Gesamte Fahrrinne	14,70m	-0,7m
b)	113 – 109 649,5 – 651,8	50m bis 100m südlich der Ra- darlinie	14,60m	-0,8m
c)	113 – 109 649,5 – 651,8	100m südlich der Radarlinie bis zum Fahrinnenrand	14,10m	-1,3m
d)	112 – 110 650,8 – 652,3	50m bis 120m nördlich der Radarlinie	14,40m	-1,0m
e)	112 – 110 650,8 – 652,3	120m nördlich der Radarli- nie bis zum Fahrinnenrand	14,20m	-1,2m
f)	108 – 106 652,9 – 654,0	110m nördlich der Radarli- nie bis zum Fahrinnenrand	14,20m	-1,9m
g)	105 – 107 653,8	190m südlich der Radarlinie bis zum Fahrinnenrand	14,20m	-1,2m

Aufgrund der Eintreibungen in den o.a. Bereichen wird folgende
Schifffahrtspolizeiliche Verfügung erlassen:
Alle Fahrzeuge mit einem Tiefgang von 11,90 m und mehr haben die
Bereiche **unter c), d), e), f) und g) zu umfahren sowie,**
die übrigen Bereiche zu umfahren oder mit äußerster Vorsicht und stark
reduzierter Geschwindigkeit zu passieren.
**Die Schifffahrtspolizeilich Maßnahme Nr. 137/22 vom 13.05.2022 ist
hiermit aufgehoben.**
Im Auftrag

Figure 7: Example of a shipping police measure

This indicates the discovery of seven shoals in the area of buoys 105 to 113.

A comparison of the shipping police measures for 2021 and 2022 shows the strong impact of the morphological lag after the deepening of the navigation channel started in July 2019 and the other discussed processes, as well as the necessary sounding and dredging activities arising from that.

For example, in 2021 WSA Elbe-Nordsee issued 198 shipping police measures for its area of responsibility (from buoy 13 to buoy 125). These included 545 separate shoal discoveries. In 2022, as many as 325 shipping police measures contained more than 1,289 separate shoal discoveries (see Diagrams 1-4).

It should be noted that these measures did not all have a simultaneous impact on the situation in the River Elbe navigation channel, as shoals were usually promptly cleared by dredging or water injection, which then resulted in the respective measure being lifted.

Broken down by buoy area, the shipping police measures in 2021 and 2022 were distributed according to the below diagrams.

Diagram 1: Summary of shipping police measures in 2021

(Broken down by buoy area.)

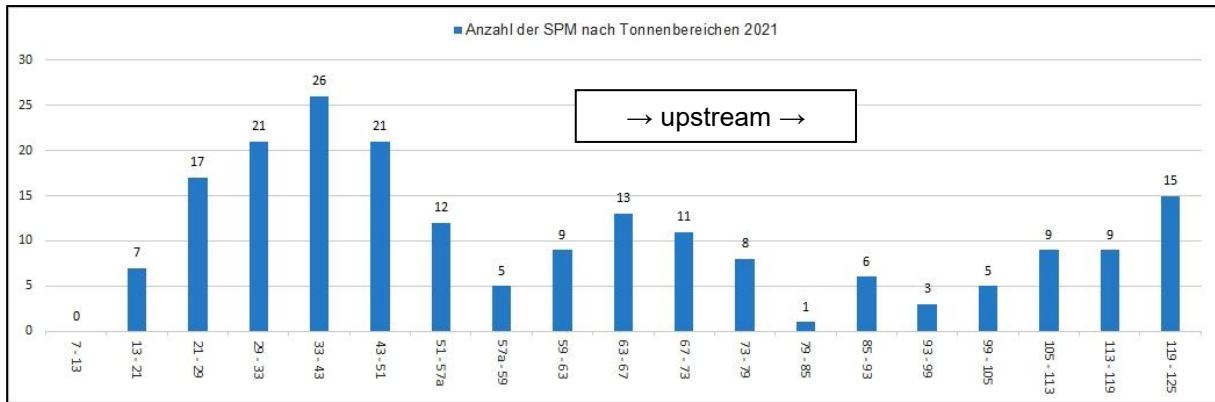


Diagram 2: Summary of separate discoveries by buoy area in 2021

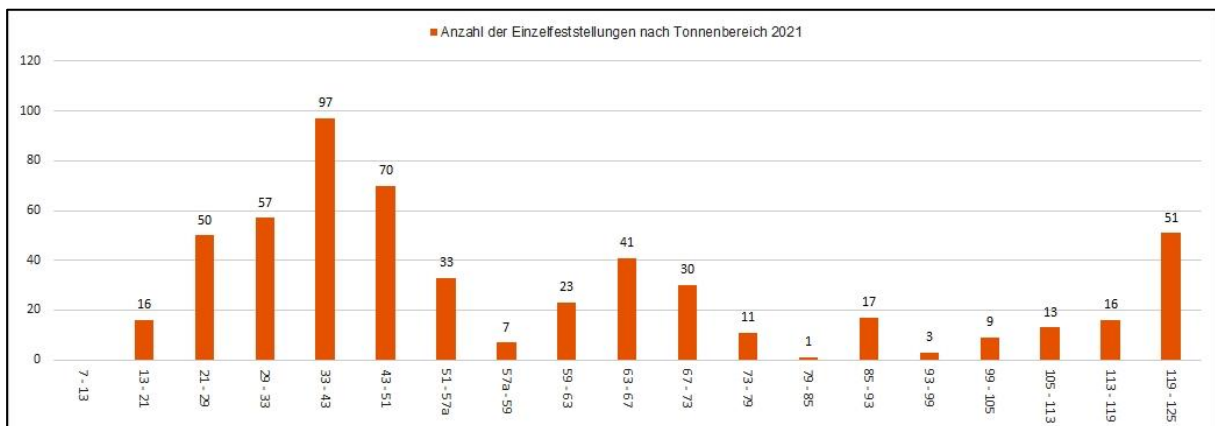


Diagram 3: Summary of shipping police measures in 2022

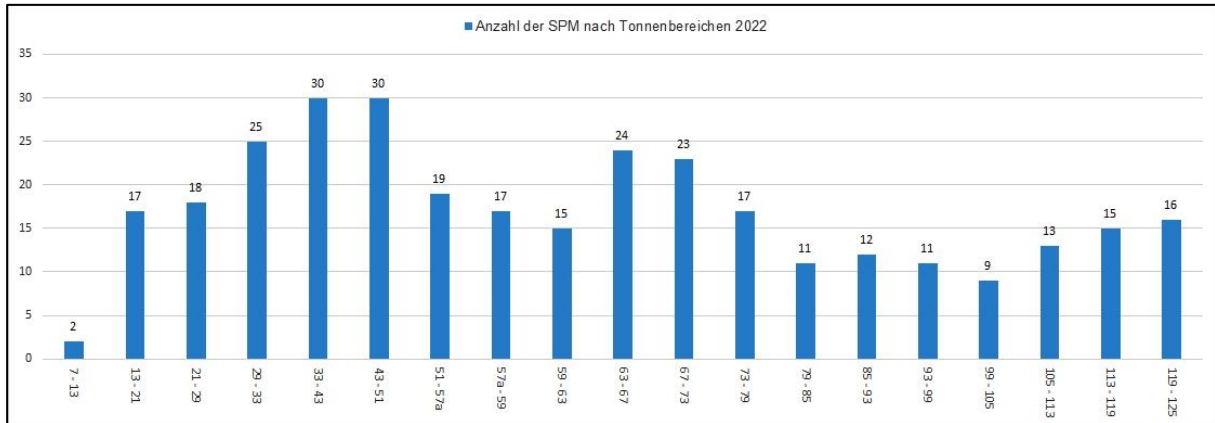


Diagram 4: Summary of separate discoveries by buoy area in 2022

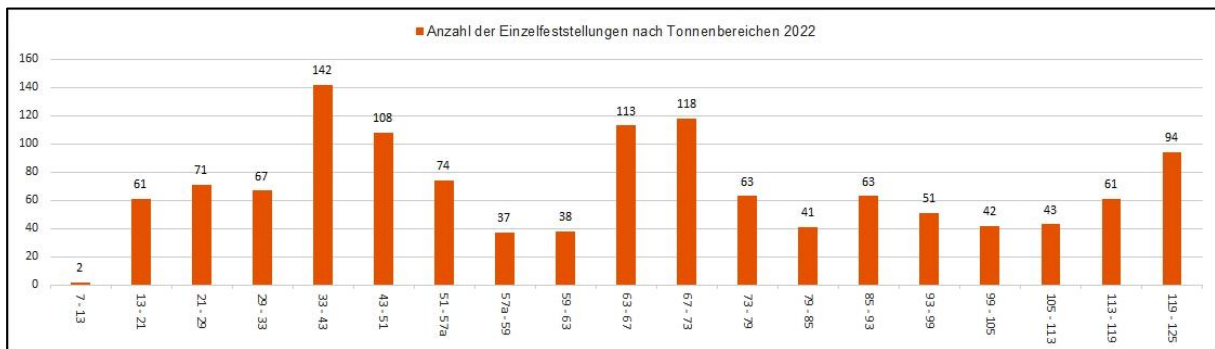


Diagram 4 shows that buoy area 63 to 67 was one of the three areas with the majority of separate discoveries in 2022. This gives a clear indication of the amount of sediment that moved and settled there.

During the course of the investigation, WSA Elbe-Nordsee reported that the situation had changed significantly in 2023. As of the end of July 2023, only 66 shipping police measures were necessary in the entire area, for example.

2.2.10 Elbe pilots

The investigators also sought contact with the Elbe Pilot Association in connection with this investigation. The alderman and another pilot were available for consulting. The pilots presented their approach to the incorporation of shipping police measures into their daily work and the tools they use. Shipping police measures can now also be displayed in the portable pilot unit, for example. However, since this can limit the clarity of the display, shipping police measures are also available to the radar pilots, enabling them to refer to the information when supporting their colleagues who are advising on board vessels that rely on the navigation channel.

The alderman vividly illustrated the conflict he believes pilots are confronted with. The information on the navigational chart is relevant for the ship's crew. However, they refer to the depths shown in the plan for the navigation channel. Ship's commands therefore assume that the navigation channel can also be navigated with the existing draught, depending on the tide. A certain time frame is then available for this. However, if there

are shoals in the fairway, which are only indicated in shipping police measures and which only the pilot is aware of, then responsibility for safe passage would pass to the pilots. Speed reductions in areas with shoals (so-called slow-speed sections) can also result in the ship not being able to adhere to the planned time frame and thus possibly not reaching the port. Here too, the alderman believed that the pilot's position vis-à-vis the ship's command was extremely precarious.

2.2.11 Actions taken

WSA Elbe-Nordsee moved buoy 63 back to its intended position on 2 September 2022 after the shoal was cleared and completion of a control sounding on 31 August 2022.

The GDWS notified in its statement that WSA Elbe-Nordsee had increased dredging capacity through additional calls for tender. In addition, the HPA agreed to temporarily take charge of sounding and dredging works for the first 15 km downstream of the Hamburg port boundary in 2023 and 2024.⁴¹ This section accounts for 20-25% of WSA Elbe-Nordsee's maintenance dredging.

One immediate measure was that the sounding frequency was increased to up to 14-day intervals in the area between Elbe-km 686 and 690, especially at active transfer sites. In addition, transfer sites 689_4 and 689_5 HPA were moved further upstream. They now have the designations 689_6 and 689_7.

In addition, the navigational depth in the navigation channel on the tidal Elbe was reduced by one metre. This has simplified resource management within the existing dredger fleet. As a result, the GDWS expects greater reliability with regard to maintaining the planned depths in the navigation channel and thus also a reduction in the number of shipping police measures. The GDWS introduced the reduction in permissible draughts with a lead time of four to six weeks. This was to give ship operators the opportunity to prepare for this when planning routes and loading ships.

⁴¹ The BSU has no information on how they will proceed in the coming years.

3 CONCLUSIONS

Running aground in the fairway near buoy 63 on the River Elbe came as a complete surprise to the crew of the STEN ARNOLD. Moreover, the pilot had no way of averting the incident, as the more detailed navigational chart in his PPU did not contain any information about it, either.

Responsible for maintaining the fairway with its organisational unit WSA Elbe-Nordsee, which is in charge of the River Elbe up to the North Sea, the GDWS was also surprised by the development of the shoal. Despite many years of experience with sediment transport in the River Elbe, this rapid development was unexpected. Since the dredgers did not operate at transfer sites 689_4 and 689_5 HPA due to the restriction from 15 April to 30 June 2022 to protect red herring, the WSA Elbe-Nordsee assumed that only minor changes would take place there.

The GDWS now assumes that the low inflow of headwater, which continued in 2022, facilitated the changes seen. However, the increased number of storm surges in that year are considered to be the main cause. Although the information available to the BSU indicates that no storm surges occurred in the period from April to August 2022, it is assumed that sand set in motion during the previous storm surges was still 'in circulation' and that tidal pumping had transported it further upstream.

The failure to discover the shoal was facilitated by the cancellation of the sounding operation at the area in question scheduled for 7 July 2022. The cancellation was due to technical and personnel-related losses of sounding vessels belonging to the authorities. Overall, this led to a reduction in ship operating time of more than 50% in the period under review. Most of these days lost were due to technical reasons. To compensate for the resulting lack of sounding capacity, the WSA acted in accordance with the specifications of the technical concept and traffic safety was prioritised to the benefit of the navigation channel.

After analysing the accident, the GDWS implemented the measures described in subsection 2.2.11. The BSU assumes that these adjustments will be sufficient to guarantee the safety of shipping in the fairway going forward. Accordingly, safety recommendations will not be issued.