United States Coast Guard

Report of the Investigation

into the

ALLISION OF THE TANK VESSEL BOW TRIUMPH (IMO 9669902) WITH JOINT BASE CHARLESTON PIER BRAVO IN THE COOPER RIVER ON SEPTEMBER 5, 2022

MISLE Activity Number: 7568095
MISLE Case Number: 1320684

U.S. Department of Homeland Security

United States Coast Guard

Commandant
United States Coast Guard

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16732/IIA #7568095
05 January 2025

THE ALLISION OF THE NORWEGIAN FLAGGED TANK SHIP BOW TRIUMPH (IMO 9669902) WITH JOINT BASE CHARLESTON PIER BRAVO IN THE COOPER RIVER, SOUTH CAROLINA ON SEPTEMBER 5, 2022

ACTION BY THE COMMANDANT

The record and the report of the investigation convened for the subject casualty have been reviewed. The record and the report, including the findings of fact, analysis, conclusions, and recommendations are approved subject to the following comments. This marine casualty investigation is closed.

ACTION ON SAFETY RECOMMENDATIONS

Recommendation 1: It is recommended that Joint Base Charleston, the Charleston Branch Pilots Association, the United States Army Corps of Engineers (Charleston District), and the National Oceanographic and Atmospheric Administration (NOAA) (Charleston Office of Coastal Management) collaborate to establish a process to share hydrographic data for navigable waters in the vicinity of Cooper River marine terminals that are outside the federally maintained channel.

> **Action:** I concur with the intent of this recommendations. As mentioned in District Seven's endorsement, individual waterway users are responsible for monitoring navigable waters outside the federally maintained channel. The local Harbor Safety Committee is an excellent resource available to individuals responsible for maintaining private aids and waterways.

Recommendation 2: It is recommended that private marine terminals in the Port of Charleston situated outside the current federally maintained channel coordinate to either 1) extend the federally maintained channel or 2) privately coordinate regular condition surveys and maintenance dredging at regular intervals to maintain the navigable waters at an adequate controlling depth to facilitate safe transit.

> **Action:** I concur with the intent of this recommendation. As stated in District Seven's endorsement, the United States Army Corps of Engineers (USACE) only has authority and funding to maintain waterways designated as a Federally Authorized Navigation Projects under the Waterway Resource Development Act. It is incumbent on those who can make a case for the commercial utility/economic benefit of the recommended waterway segment to lobby their legislators for its inclusion as a Federal Project.

Recommendation 3: It is recommended that the Captain of the Port collaborate with the Coast Guard Navigation Center (CG-NAVCEN) to execute a Ports and Waterways Safety Assessment (PAWSA) in the Port of Charleston with a focus on the Cooper River north of the federally maintained channel.

> **Action:** I concur with this recommendation. The Coast Guard Office of Waterways and Ocean Policy (CG-WWM) encourages units to leverage NAVCEN's specialized risk assessment capabilities whenever the analysis need exceeds local capacity. The PAWSA is an ideal tool when part of the Sector's goal is to improve the breadth of stakeholder input into understanding the risks on a local waterway. CG-WWM will remind Sectors that requesting a PAWSA does not need to wait until a Report of Investigation is completed.

Recommendation 4: It is recommended the United States Army Corps of Engineers (Charleston District) initiate a comprehensive study to determine the navigational impact of Pier Bravo on military and commercial ships transiting in the upper Cooper River based on modern traffic density and hydrographic data trends. This study should be completed prior to the issuance of any future repair or reconstruction permits.

> **Action:** I partially concur with the recommendation. In addition to a potential USACE study, CG-WWM recommends that Sector Charleston initiate a Navigation Safety Risk Assessment (NSRA) for Pier Bravo and notify the USACE of their intent to review the existing permit. Per the CY2000 Memorandum of Agreement between the Coast Guard and the USACE regarding Section 10 Permits for Structures or Work in or Affecting Navigable Waters of the United States (Title 33 Code of Federal Regulations Part 322), the Coast Guard may independently re-evaluate the risk to structures because of changes in traffic patterns or after a significant marine casualty or incident in the vicinity. The USACE will fully consider the Captain of the Port's recommendations and proposals when reviewing the need to modify existing permits. This NSRA would also be useful as input to any potential permits for repair or reconstruction of Pier Bravo or as input to the recommended USACE study. A 5-Step NSRA should be completed by the Sector if navigation risk feedback is needed quickly for any permit actions to Pier Bravo that the USACE is reviewing. For a more detailed traffic assessment that is not as time sensitive and extends beyond just Pier Bravo to include the Upper Cooper River, the Sector should coordinate an expanded NSRA with the NAVCEN.
>
> A copy of this investigation and associated recommendations will be sent to the USACE for their consideration.

ACTION ON ADMINISTRATIVE RECOMMENDATIONS

Recommendation 1: It is recommended that the SC Commissions of Pilotage, the SC Department of Labor, Licensing, and Regulation (LLR), or other appropriate State regulatory body, investigate potential violations on the part of the Harbor Pilot and take appropriate disciplinary action, as necessary and appropriate regarding his SC State Pilotage license.

Action: A copy of this investigation and this recommendation will be sent to South Carolina's Commission of Pilotage and Department of Labor, Licensing, and Regulation for their consideration and potential administrative action.

Recommendation 2: Provide a copy of this report to the Parties-in-Interest (PIIs).

Action: I concur with this recommendation. A copy of this investigation and associated recommendations will be provided to all PIIs.

Recommendation 3: It is recommended that Commandant (CG-INV) release the Report of Investigation to the public and post online.

Action: I concur with this recommendation. A copy of this Report of Investigation will be posted on the following website: https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Inspections-Compliance-CG-5PC-/Office-of-Investigations-Casualty-Analysis/Marine-Casualty-Reports/.

A. M. BEACH
Captain, U.S. Coast Guard
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U.S. Department of Homeland Security
United States Coast Guard

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16732
August 27, 2024

ALLISION OF THE TANK VESSEL BOW TRIUMPH (IMO 9669902) WITH JOINT BASE CHARLESTON PIER BRAVO IN THE COOPER RIVER ON SEPTEMBER 5, 2022

ENDORSEMENT BY THE COMMANDER, SEVENTH COAST GUARD DISTRICT

The record and the report of the investigation convened for the subject casualty have been reviewed. The record and the report, including the findings of fact, analysis, conclusions, and recommendations are approved subject to the following comments. It is recommended that this marine casualty investigation be closed.

ENDORSEMENT/ACTION ON RECOMMENDATIONS

Safety Recommendation 8.1.1. It is recommended that Joint Base Charleston, the Charleston Branch Pilots Association, the U.S. Army Corps of Engineers (USACE Charleston District), and the National Oceanographic and Atmospheric Administration (NOAA) (Charleston Office of Coastal Management) collaborate to establish a process to share hydrographic data for navigable waters in the vicinity of Cooper River marine terminals that are outside the federally maintained channel.

> **Endorsement:** Concur with the intent of this recommendation. Accurate hydrographic data is one essential component for safe navigation. However, for navigable waters outside the federally maintained channel, individual waterway users are responsible for monitoring conditions presented for their needs and privately pursuing hydrographic surveys or dredging when necessary.

Safety Recommendation 8.1.2. It is recommended that private marine terminals in the Port of Charleston situated outside the current federally maintained channel coordinate to either 1) extend the federally maintained channel or 2) privately coordinate regular condition surveys and maintenance dredging at regular intervals to maintain the navigable waters at an adequate controlling depth to facilitate safe transit.

> **Endorsement:** Concur with the intent of this recommendation. Absent designation as a Federally Authorized Navigation Project under the Waterway Resource Development Act, USACE has no authority or funding to maintain a waterway. It is incumbent on those who can make a case for the commercial utility/economic benefit of that segment of waterway to lobby their legislators for its inclusion as a Federal Project.

Safety Recommendation 8.1.3. It is recommended that the Captain of the Port collaborate with the Coast Guard Navigation Center (CG-NAVCEN) to execute a Ports and Waterways Safety Assessment (PAWSA) in the Port of Charleston with a focus on the Cooper River, north of the federally maintained channel.

Endorsement: Concur with this recommendation. The last PAWSA was conducted in July 2010 and did not include portions of the upper Cooper River outside the federally maintained channel. Another assessment, focused specifically on areas north of the federally maintained channel in the Cooper River, could gauge the impacts of increased commercial vessel traffic and provide potential justification for expansion of the federally maintained channel.

Safety Recommendation 8.1.4. It is recommended the U.S. Army Corps of Engineers (Charleston District) initiate a comprehensive study to determine the navigational impact of Pier Bravo on military and commercial ships transiting in the upper Cooper River based on modern traffic density and hydrographic data trends. This study should be completed prior to the issuance of any future repair or reconstruction permits.

Endorsement: Concur with this recommendation.

Administrative Recommendation 8.2.1. It is recommended that the SC Commissions of Pilotage, the SC Department of Labor, Licensing, and Regulation (LLR), or other appropriate State regulatory body, investigate potential violations on the part of the Habor Pilot and take appropriate disciplinary action, as necessary and appropriate regarding his SC State Pilotage license.

Endorsement: Concur with this recommendation.

Administrative Recommendation 8.2.2. It is recommended that Commandant (CG-INV) provide a copy of this report to the Parties-in-Interest (PIIs).

Endorsement: Concur with this recommendation.

Administrative Recommendation 8.2.3. It is recommended that Commandant (CG-INV) release the Report of Investigation to the public and post online.

Endorsement: Concur with this recommendation.

Administrative Recommendation 8.2.4. It is recommended that this investigation be closed.

Endorsement: Concur with this recommendation. Coast Guard Seventh District agrees with the analysis and conclusions of the Investigating Officer and the endorsement of the Officer in Charge, Marine Inspection. No further action is required by the Coast Guard.

[redacted]

Nicolette A. Vaughan
Captain, U.S. Coast Guard
Chief, Prevention Division
By direction

U.S. Department of Homeland Security
United States Coast Guard

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16732
March 8, 2024

ALLISION OF THE TANK VESSEL BOW TRIUMPH (IMO 9669902) WITH JOINT BASE CHARLESTON PIER BRAVO IN THE COOPER RIVER ON SEPTEMBER 5, 2022

ENDORSEMENT BY THE OFFICER IN CHARGE, MARINE INSPECTION

The record and the report of the investigation convened for the subject casualty have been reviewed. The record and the report, including the findings of fact, analysis, conclusions, and recommendations are approved. It is recommended that this marine casualty investigation be closed.

COMMENTS ON THE REPORT

1. The allision of the BOW TRIUMPH with Pier Bravo was a significant and preventable accident. Unfortunately, before this investigation was complete and the causal factors fully understood, a subsequent allision occurred between another tanker and Pier Bravo in January 2024. The Charleston Port Complex is an economic driver for the region and a militarily strategic seaport. In both cases, it was only luck that prevented the loss of life, injury, a significant pollution incident, or long-term port disruption. Luck is not a strategy. I am committed to ensuring safety, security, and environmentally responsible operations in the Charleston-based Marine Transportation System (MTS) and have taken immediate actions to preserve the Port's continued economic viability and military utility. These actions included:

    i. Establishment of Cooper River Buoy 72A to mark Shoal 4.

    ii. A Captain of the Port requirement for ships exceeding 10,000 tons or 25 ft of draft to employ a tethered two tug escort while transiting in the upper Cooper River between Pier Bravo and Snow Point.

    iii. Initiated updates to the Coast Pilot to capture the upper Cooper River, from Pier Bravo to Snow Point, as an "area of particular concern."

2. This casualty is a call to action for the entire Charleston port community. It must be understood that any major marine casualty within the Port has the potential to disrupt commercial and military operations, with devastating economic and strategic consequences. The combination of hydrodynamic effects that contributed to this casualty could have been

overcome or avoided by the Pilot if the hydrographic data for Navigable Waterways[1], outside a federally maintained channel, was current and readily available to support best navigational decision making. Therefore, it is incumbent on the entire port community to work collaboratively to ensure that waterways are sufficiently maintained to support the vessels and terminals that rely on them and to share related hydrographic data for the good of all waterway users.

ENDORSEMENT/ACTION ON RECOMMENDATIONS

Safety Recommendation #1. It is recommended that Joint Base Charleston, the Charleston Branch Pilots Association, the U.S. Army Corps of Engineers (Charleston District), and the National Oceanographic and Atmospheric Administration (NOAA) (Charleston Office of Coastal Management) collaborate to establish a process to share hydrographic data for navigable waters in the vicinity of Cooper River marine terminals that are outside the federally maintained channel.

Endorsement: I concur with this recommendation. Accurate hydrographic data is a prerequisite to support prudent navigational decisions and regular chart updates. The Captain of the Port has engaged with the Harbor Safety Committee (HSC) to establish an Upper Cooper River Subcomittee. This subcommittee will provide the necessary framework for these parties to collaboratively develop a data sharing methodology to support regular hydrographic updates.

Safety Recommendation #2. It is recommended that private marine terminals in the Port of Charleston situated outside the current federally maintained channel coordinate to either 1) extend the federally maintained channel or 2) privately coordinate regular condition surveys and maintenance dredging at regular intervals to maintain the navigable waters at an adequate controlling depth to facilitate safe transit.

Endorsement: I concur with the intent of this recommendation. The Coast Guard does not have jurisdiction to require regular condition surveys or maintenance dredging. However, should these activities take place at regular intervals, the risk of adverse hydrodynamic effects would be reduced allowing for potential relief of the current Captain of the Port requirement to employ a tethered two tug escort in the upper Cooper River. I am encouraged that the affected operators have recently chartered a “Private Terminal Group” under the Maritime Association of South Carolina to assist operators in addressing issues related port operations and dredging.

Safety Recommendation #3. It is recommended that the Captain of the Port collaborate with the Coast Guard Navigation Center (CG-NAVCEN) to execute a Ports and Waterways Safety Assessment (PAWSA) in the Port of Charleston with a focus on the Cooper River north of the federally maintained channel.

Action: I concur with this the recommendation. A PAWSA may be a useful tool to identify or confirm risk factors in the upper Cooper River and evaluate potential mitigation measures with a larger segment of the Charleston port community than was involved in this

[1] Navigable waters of the United States are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce (See Title 33 Code of Federal Regulations §329)

investigation. And, while a PAWSA would not in and of itself direct or fund solutions, it may provide leverage for the Port community to pursue them. The Captain of the Port will coordinate with CG-NAVCEN to determine the feasibility and timeline for a PAWSA and socialize with the HSC to determine whether one is necessary.

Safety Recommendation #4. It is recommended the U.S. Army Corps of Engineers (Charleston District) initiate a comprehensive study to determine the navigational impact of Pier Bravo on military and commercial ships transiting in the upper Cooper River based on modern traffic density and hydrographic data trends. This study should be completed prior to the issuance of any future repair or reconstruction permits.

Endorsement: I concur with this recommendation.

Administrative Recommendation #1. It is recommended that the SC Commissions of Pilotage, the SC Department of Labor, Licensing, and Regulation (LLR), or other appropriate State regulatory body, investigate potential violations on the part of the Habor Pilot and take appropriate disciplinary action, as necessary and appropriate regarding his SC State Pilotage license.

Endorsement: I concur with this recommendation.

Administrative Recommendation #2. It is recommended that Commandant (CG-INV) provide a copy of this report to the Parties-in-Interest (PIIs).

Endorsement: I concur with this recommendation.

Administrative Recommendation #3. It is recommended that Commandant (CG-INV) release the Report of Investigation to the public and post online. It is recommended that this investigation be closed.

Endorsement: I concur with this recommendation.

[redacted]

Christopher M. Nichols
Commander, U.S. Coast Guard
Officer in Charge, Marine Inspection
By Direction

Enclosure: (1) Investigating Officer's Report

TABLE OF CONTENTS

U.S. Department of Homeland Security
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16732
March 8, 2024

ALLISION OF THE TANK VESSEL BOW TRIUMPH (IMO 9669902) WITH JOINT BASE CHARLESTON PIER BRAVO IN THE COOPER RIVER ON SEPTEMBER 5, 2022

EXECUTIVE SUMMARY

On September 5, 2022, at approximately 1602 local time, the tankship BOW TRIUMPH allided with Pier Bravo of Joint Base Charleston in the Cooper River in Goose Creek, South Carolina.

The BOW TRIUMPH was down river in the Cooper River shifting berths from INEOS Aromatics Terminal in Wando, SC to Odfjell Terminal in North Charleston, SC. Upon approaching a sharp left hand bend in the river, adjacent to Joint Base Charleston, the Harbor Pilot maneuvered the ship closer to the riverbank on the inside of the turn and then applied more rudder to execute the turn. Once closer to the inside bank, the BOW TRIUMPH lost all rate of turn and remained on a straight heading toward Pier Bravo on the opposite side of the river, despite additional rudder having been applied. The BOW TRIUMPH did not respond to steering commands due to severe hydrodynamic effects caused by an aggregate shallow water and bank suction that were induced due to close proximity to the riverbank. The Harbor Pilot attempted emergency measures to turn the ship around the bend by momentarily attempting to increase speed, setting the rudder "Full to Port," and engaging the bow thruster. The measures were insufficient in the little time available to correct the ship's heading in the narrow channel. As the bow of the ship proceeded into the bend, it experienced a perpendicular force of flood current against the port bow, counteracting the desired direction of turn. Once allision appeared imminent, the starboard anchor was let go, and the engines were ordered to "Full Astern."

The BOW TRIUMPH allided with the mid-section of Pier Bravo, with approximately 100 feet of the ship's length advancing through a section of pier before it came to a stop. The allision caused extensive damage to Pier Bravo, collapsing approximately a 300 foot section of the pier, releasing concrete and other debris into the Cooper River. Pier Bravo had been inactive for several years at the time of the incident. The BOW TRIUMPH suffered hull plate lacerations above the waterline on the bulbous bow, the forepeak, and No. 1 starboard ballast tanks, which were empty at the time of the incident. After conducting temporary repairs, the ship sailed to Florida for permanent repairs.

The causal factors contributing to this incident were determined to be: 1) The method by which the pilot "tested" the rudder; 2) insufficient under keel clearance to facilitate steering; 3) close proximity to the eastern riverbank; 4) lack of current hydrographic data; 5) presumed flood current steering advantage negated by hydrodynamic effects; and 6) lack of nearby towing vessels to render assistance.

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16732
March 8, 2024

ALLISION OF THE TANK VESSEL BOW TRIUMPH (IMO 9669902) WITH JOINT BASE CHARLESTON PIER BRAVO IN THE COOPER RIVER ON SEPTEMBER 5, 2022

INVESTIGATING OFFICER'S REPORT

1. Preliminary Statement

1.1. This marine casualty investigation was conducted, and this report was submitted in accordance with Title 46, Code of Federal Regulations (CFR), Subpart 4.07, and under the authority of Title 46, United States Code (USC) Chapter 63.

1.2. Seven parties were designated as Parties-in-Interest (PIIs) in accordance with 46 CFR Subpart 4.03-10. The South Carolina (SC) Commissioners of Pilotage for the Lower Coastal Area was designated a PII as the regulator of State pilotage for the Port of Charleston. The Charleston Branch Pilots' Association was designated a PII as the employer of pilots in the Port of Charleston. Goldex Fortune, LTD and Odfjell Management A.S., were designated PIIs as the owner and operator, respectively, of the BOW TRIUMPH. The U.S. Air Force was designated a PII as the owner and operator of Pier Bravo. [redacted] (Charleston Branch Pilot Association Pilot) and [redacted] (McAllister Docking Pilot) were designated as PIIs related to their direct involvement in the casualty and as holders of Merchant Mariner Credentials whose conducts were under investigation.

1.3. The U.S. Coast Guard (USCG) was the lead agency responsible for this investigation and was assisted by the National Transportation Safety Board (NTSB). The USCG Navigation Center (NAVCEN) provided technical assistance with the investigation.

1.4. All times listed in this report are in Eastern Standard Time using a 24-hour format and are approximate. The MISLE incident investigation activity number is 7568095.

2. Vessel Involved in the Incident

Figure 1 Photograph of BOW TRIUMPH on the Cooper River, taken 08 September 2022. Photo: U.S. Coast Guard.

Official Name:	BOW TRIUMPH
Identification Number:	IMO 9669902
Flag:	Norway
Vessel Class/Type/Sub-Type	Tank Ship/Oil and Chemical Tank Ship
Build Year (Keel Laid):	2014
Gross Tonnage:	30,521 GT ITC
Length:	599.3 feet
Beam:	105.6 feet
Draft/Depth:	43.4 feet/63.3 feet
Main/Primary Propulsion: (Configuration/ System Type, Ahead Horsepower)	Slow speed diesel, direct reversible engine, 9,682 ahead horsepower
Owner:	Goldex Fortune LTD 80 Broad Street, Monrovia, Liberia
Operator:	Odfjell Management A.S. Conrad Mohrs Veg 29, Bergen 5072, Norway

3. Deceased, Missing, and/or Injured Persons

3.1. There were no deceased, missing, or injured persons resulting from this casualty.

4. Findings of Fact

4.1. The Incident:

4.1.1. On 05 September 2022, the BOW TRIUMPH was scheduled to shift berths 6.7 nautical miles (NM) downriver on the Cooper River from INEOS Aromatics Terminal (formerly known as BP Cooper River Terminal), Wando, SC, to Odfjell Terminal, North Charleston, SC (see Figure 2). The ship was in a partially loaded condition, with Xylenes in three cargo tanks (No. 3 and No. 7 Starboard and No. 7 Port). All other cargo tanks had been discharged. There were 24 crew members onboard.

4.1.2. Prior to getting underway from INEOS Aromatics Terminal on 05 September 2022, the BOW TRIUMPH deck officers (Master, Chief Officer, 2nd Officer, and three 3rd Officers) approved a voyage plan from INEOS to Odfjell. This included completion of a pre-departure checklist verifying bridge equipment and machinery, tidal predictions, waypoints, and each track leg's course, distance, speed, and under keel clearance (UKC). The track leg along Range D would sail the ship by Joint Base Charleston (JBC) Wharf Alpha on the starboard side and Shoal 4 on the port side (see Figure 2). This track leg was planned for a course of 223 degrees True (°T) at 6.7 knots (kts). The next track leg, along Range C, began adjacent to Woods Point and Pier Bravo and was planned for a course of 145.8°T at 6.7 kts.

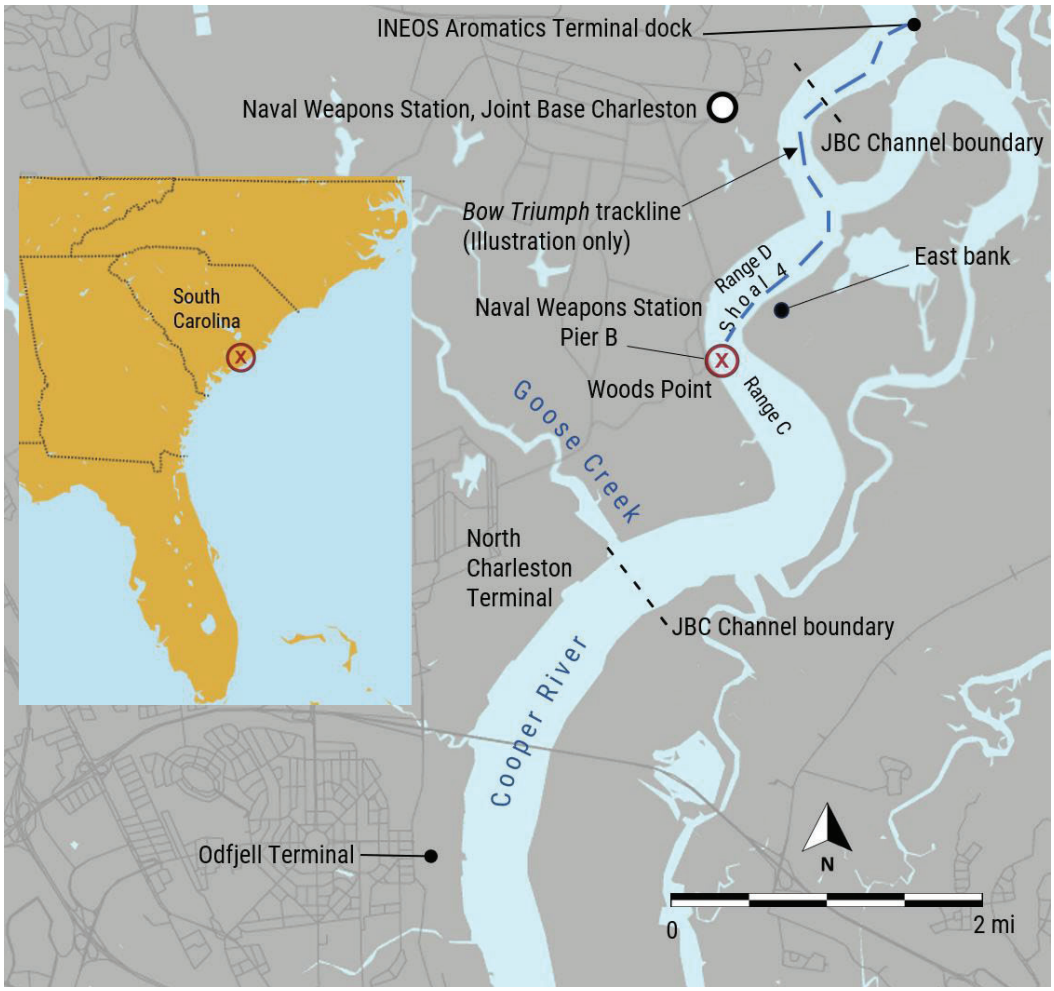


Figure 2 Depiction of the JBC channel within the Cooper River, BOW TRIUMPH's intended voyage, approximate trackline, and site of allision at Pier Bravo near Woods Point. Image: NTSB.

4.1.3. From approximately 1515 to 1525, a Harbor Pilot from Charleston Branch Pilots Association (CBPA) and a Docking Pilot from McAllister Towing & Transportation Co, Inc boarded the BOW TRIUMPH at INEOS Aromatics Terminal. The Harbor Pilot reviewed the Pilot Card and was informed there were no deficiencies with the vessel's propulsion, machinery, steering, or navigation systems.

4.1.4. Upon assignment for the voyage, the Harbor Pilot had been informed by the Agent that the ship's draft was 27' 7". The Pilot Card on 05 September 2022 was in alignment with the draft that the Agent had reported to the Harbor Pilot ahead of the voyage, indicating that the ship had a 1 ft stern trim; the drafts were 26' 7" forward, 27' 1" midships, and 27' 7" aft.

4.1.5. At approximately 1527, the BOW TRIUMPH got underway from INEOS Aromatics Terminal under the command of the Docking Pilot, who also directed the towing vessels CAPT. JIM MCALLISTER (ON 1289659) and JEFFREY MCALLISTER (ON 1271738) to assist as needed. Once the ship was on a downriver heading, the Harbor Pilot took the conn, at approximately 1541. The tugs assisted the vessel off the dock but were then released.

4.1.6. Due to the anticipated docking evolution at Odfjell Terminal, the Docking Pilot remained onboard the bridge; the two towing vessels proceeded ahead of the BOW TRIUMPH towards Odfjell Terminal.

4.1.7. At the time of the transit, the tide was rising and approaching maximum flood current (0.8 kts) on the Cooper River. While transiting down the Cooper River, the BOW TRIUMPH was sailing into the current.

4.1.8. The Harbor Pilot utilized his Portable Pilot Unit (PPU) [1] and visual aids to make navigational decisions and pass rudder commands to the Helmsman, an Able-Bodied Seaman (AB). The ship was not steady on a particular course, due to frequent bends in the river.

4.1.9. Also standing by on the bridge were the Master, 2nd Officer, and a 3rd Officer who was preparing to relieve the 2nd Officer. Two crewmembers, a BOSUN and an Ordinary Seaman (OS) were standing by on the bow to let go the anchors, if needed.

4.1.10. As the ship began to sail downriver, the Harbor Pilot ordered "Half Ahead" (approximately 60 RPM). He navigated the ship around the first two turns without incident, increasing speed from 3 kts to approximately 5 kts. First was a port turn completed between 1547 and 1549 near Red Bank Landing onto Range F. At approximately 1549, the Harbor Pilot ordered Full Ahead speed (approximately 70 RPM). Next, he conducted a starboard turn between 1553 and 1554 near Snow Point onto Range E/D, making approximately 7 kts.

[1] Portable Pilot Unit - A PPU is a compact laptop computer or tablet with electronic navigation and charting software that pilots use for navigation, in addition to the vessel's installed navigation equipment. PPUs are normally equipped with an independent GPS antenna, as well as a plug that allows the unit to access information from the ship's installed systems, such as GPS and automatic identification system (AIS).

4.1.11. At approximately 1558, the Harbor Pilot began preparing for the next turn. This was a sharp turn to port of approximately 77 degrees and would take the ship past Wharf Alpha on Range D and subsequently onto Range C, passing Pier Bravo on the starboard side.

4.1.12. With the ship making approximately 7.7 kts, he reduced power to "Half Ahead" to allow for any necessary reserve power that may have been necessary to complete the turn. Then he ordered "Port 20" degrees to examine the rudder's response and eased to "Port 10" within 10 seconds after seeing a fast and appropriate rate of turn, as shown in Figure 3.

4.1.13. At this time, the ship was towards the port (eastern) side of the channel; the Harbor Pilot was more comfortable maneuvering the vessel towards the port side of the 650 foot-wide channel, due to the location of JBC, including Pier Bravo, on the starboard side of the turn. Additionally, he anticipated that the flood current would set the ship to starboard, against the desired turn to port.

4.1.14. At approximately 1600, the Harbor Pilot ordered "Full Ahead" immediately followed by [rudder] "Amidships." Less than ten seconds later, he ordered "Port 20" to initiate the turn. While the Helmsman was adjusting the helm, the Harbor Pilot began observing that the previous rate of turn had stopped and was not increasing as expected by the "Port 20" rudder command. He checked the rudder angle indicator, which displayed the rudder at Port 20 degrees as ordered. Seeing no rate of turn, less than ten seconds after the "Port 20" command, the Harbor Pilot ordered "Hard Port" (35 degrees).

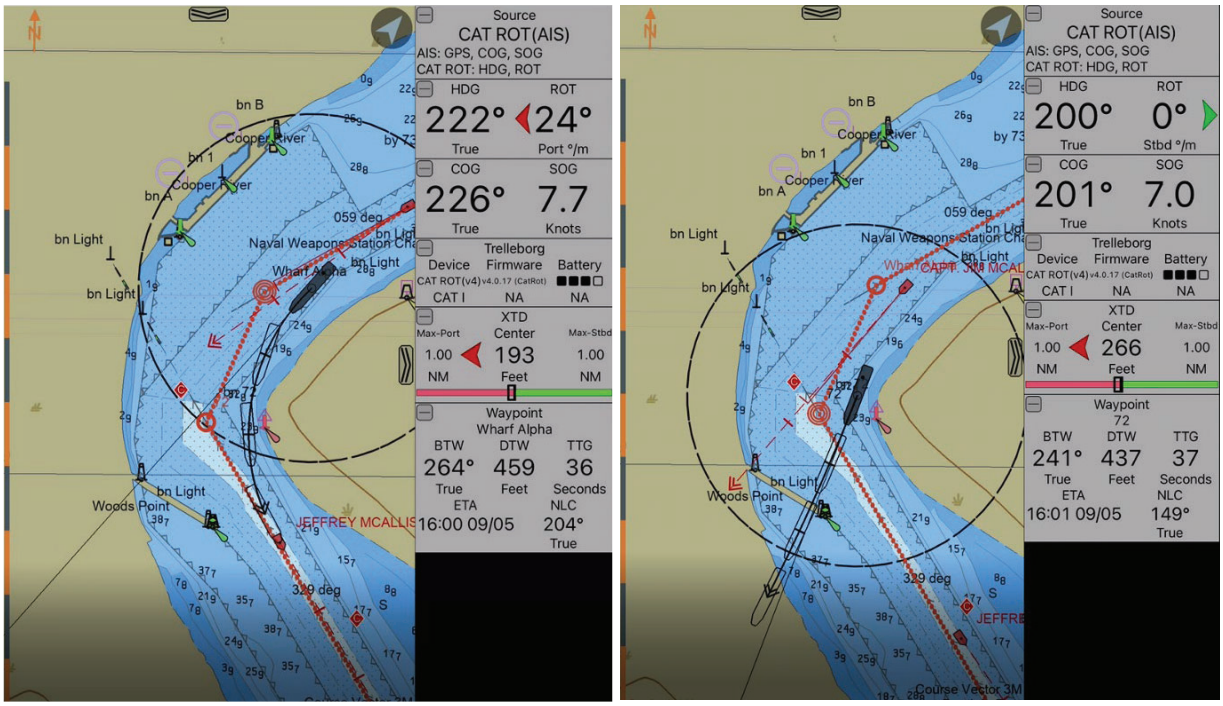
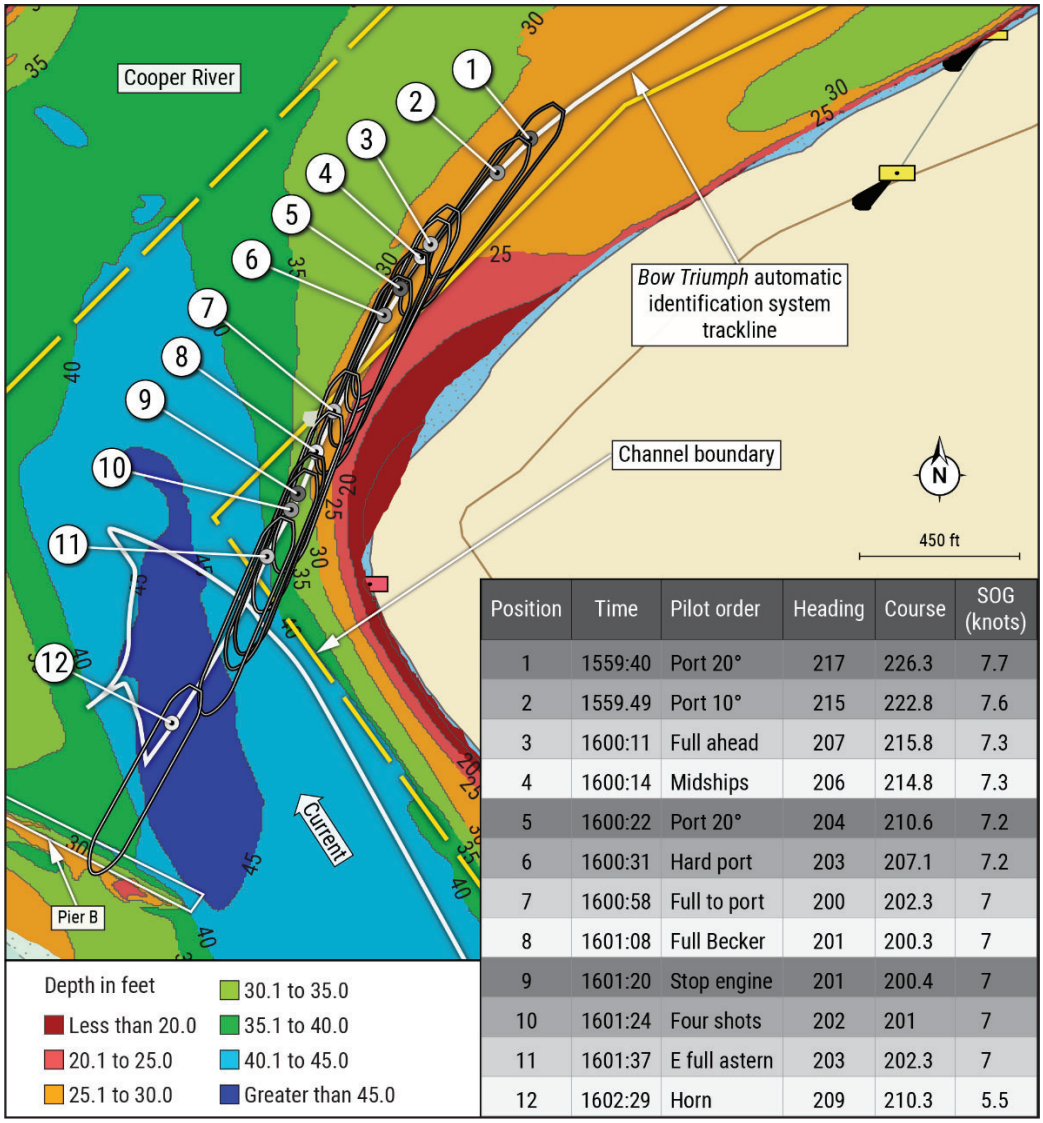


Figure 3 The Harbor Pilot's PPU recordings, showing a significant rate of turn calculated during initial approach with Port 20 degrees rudder (left), followed by no rate of turn, after the rudder had already been at Port 35 degrees for several seconds (right). Images: Harbor Pilot PPU.

4.1.15. The Harbor Pilot, along with the Docking Pilot and Master, continued to observe the indicators and the ship's movement, which was nearly steady on a course of 201-

205°T with a negligible rate of turn. No concerns were verbally expressed by the crew or Docking Pilot during this period. After approximately 20 seconds at 35 degrees, the Harbor Pilot ordered "Full to Port" (45 degrees).

4.1.16. The Helmsman verbally acknowledged the order, but the Voyage Data Recorder shows he did not change the rudder immediately. Approximately ten seconds after the "Full to Port" order was given, the Docking Pilot stated "Full Becker[2]" as a recommendation to the Harbor Pilot. The Harbor Pilot concurred and ordered "Full Becker." Approximately 5-10 more seconds elapsed until the Helmsman moved the rudder to approximately 50 degrees to port, once another (unknown) bridge officer stated, "Full rudder."



Position	Time	Pilot order	Heading	Course	SOG (knots)
1	1559:40	Port 20°	217	226.3	7.7
2	1559.49	Port 10°	215	222.8	7.6
3	1600:11	Full ahead	207	215.8	7.3
4	1600:14	Midships	206	214.8	7.3
5	1600:22	Port 20°	204	210.6	7.2
6	1600:31	Hard port	203	207.1	7.2
7	1600:58	Full to port	200	202.3	7
8	1601:08	Full Becker	201	200.3	7
9	1601:20	Stop engine	201	200.4	7
10	1601:24	Four shots	202	201	7
11	1601:37	E full astern	203	202.3	7
12	1602:29	Horn	209	210.3	5.5

Figure 4 Positions of BOW TRIUMPH (scale approximate) approaching and alliding with Pier Bravo and helm commands, based on Automatic Identification System and Voyage Data Recorder data, overlayed with soundings (in feet, at MLLW) from a 06 September 2022 USACE survey. Image: NTSB/USACE.

[2] A Becker rudder (a flap rudder) consists of a movable rudder with a trailing edge flap activated by a mechanical or hydraulic system, thus producing a variable flap angle as a function of the rudder angle. Source: Practical Ship Hydrodynamics (Second Edition), 2012

4.1.17. At approximately 1601, several orders were given in rapid succession. The Harbor Pilot ordered an emergency stop on the engine. Then the Harbor Pilot and Master both ordered Full Astern and engaged the bow thruster to port. The ship was approximately 300 ft from Pier Bravo and closing distance at approximately 7 kts.

4.1.18. Next, the Harbor Pilot and Docking Pilot simultaneously ordered that the *port* anchor be let go and paid out to four shots[3]. However, the Master then called out to the BOSUN on the bow and ordered him to let go the *starboard* anchor in contravention of the Pilot's order. The Pilots' decision to order the port anchor was based on the desire to gain a port rate of turn on the ship. However, the Master had sighted the tower at the outer end of Pier Bravo and was concerned that letting go the port anchor would swing the bow to port, increasing the risk of alliding with the 270 ft steel tower, endangering the two crew members on the bow.

4.1.19. Upon hearing the order from the Master, the Bosun let go the starboard anchor with the ship 50-150 ft from the pier and closing distance at approximately 7 kts. Approximately 5 seconds later, the Docking Pilot recommended the Master try to set the anchor chain brake. The Master then ordered the Bosun to "set the brake" in order to stop the continued release of anchor chain. The Bosun did so successfully with approximately one shot of anchor chain in the water.

4.1.20. At approximately 1602, the BOW TRIUMPH struck the north face of Pier Bravo at a 90-degree angle, approximately 200 ft from the end of the pier. The ship had forward speed of approximately 6.5 kts on a course of 204°T with the starboard anchor dragging, one shot of anchor chain at "6 o'clock," and engines ordered at Full Astern.

4.1.21. Approximately 30 seconds after the allision, the 3rd Officer sounded the general alarm, which included 5 short blasts of the ship's whistle and an internal alarm throughout the ship. The ship came to a stop after approximately 100 ft of the ship's length advanced through the pier. The crew quickly initiated damage assessments throughout the ship.

4.1.22. BOW TRIUMPH suffered a hull laceration above the waterline, 13' 11" above the keel on the starboard side, to the forepeak ballast tank and No. 1 starboard ballast tank, damaging the hull from frames 81-87 and No. 2 & 3 stringer in No. 1 starboard ballast tank including internal stiffeners. The starboard hull plating was scraped and exposed at frames 84-103. The bulbous bow was punctured and damaged at frames 103-107. A dive survey revealed the bottom hull coating near the bow was scraped in an area slightly port of centerline approximately 7.5" wide x 19.5" tall. The anchor was fouled in the pier debris. Resultant damage was initially estimated at $300,000, but actual costs for repairs were approximately $2.3 million. See Figure 5.

[3] Each "shot" of anchor chain is equivalent to 15 fathoms, or 90 feet, of chain length.

Figure 5 BOW TRIUMPH's damaged starboard bow while moored at Odfjell Terminal in North Charleston on 08 September 2022. Photo: U.S. Coast Guard.

4.1.23. A section of Pier Bravo, approximately 300 ft in length, collapsed due to the impact, including a light pole and several support pilings. The end of the pier, which held the lightning tower, remained undamaged. The total cost to demolish and rebuild the damaged segment was estimated at approximately $27.9 million by the Naval Facilities Engineering Command. This estimate did not include the design costs or Supervision, Inspection, and Overhead (SIOH), which would increase the estimated costs to $32.3 million. See Figures 6 and 7.

Figure 6 Joint Base Charleston Pier Bravo damage facing west. Inset: Witness photograph taken shortly after the contact facing east. (Photo: USACE, Inset: Jacob Wall)

4.1.24. From 1603 to 1620, the Pilots and crew backed the ship off the pier, hawsed the anchor, and maneuvered back into the channel. The Docking Pilot called the CAPT. JIM MCALLISTER and JEFFREY MCALLISTER towing vessels back to assist with the maneuvering. BOW TRIUMPH then proceeded to Odfjell Terminal in North Charleston without assistance and without further incident.

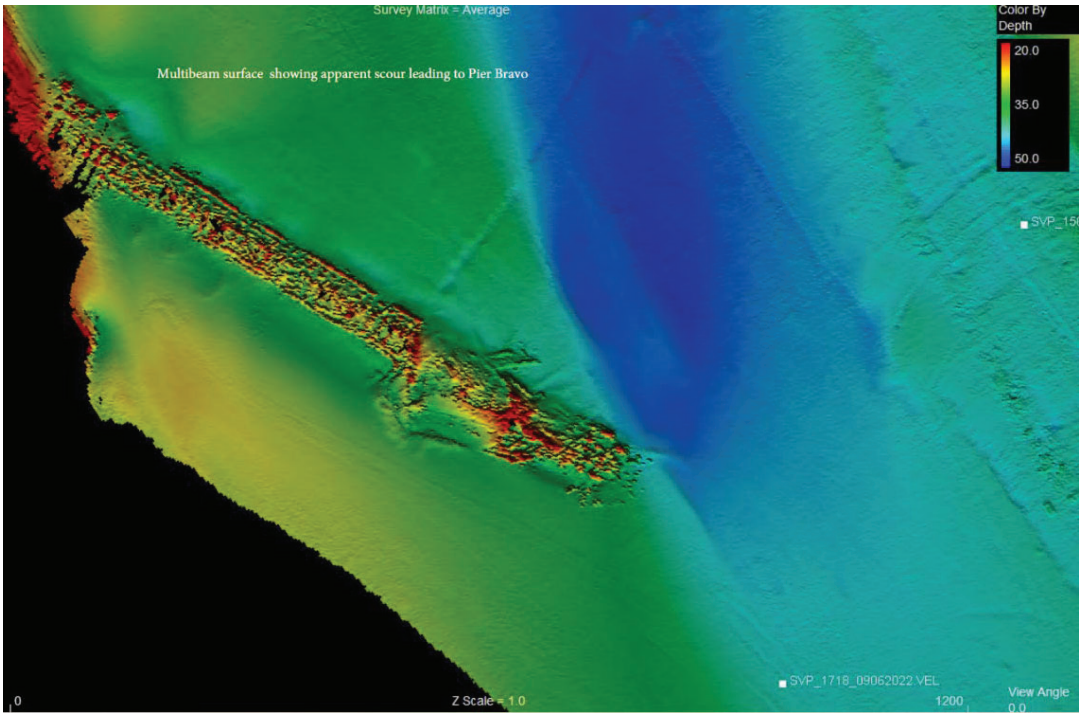


Figure 7 Multibeam survey on 06 September 2022 (one day post-casualty) showing damaged Pier Bravo and evidence of anchor/chain contact with the river bottom. Image: USACE.

4.1.25. Coast Guard personnel conducted a test of the ship's steering gear while moored and found no discrepancies. BOW TRIUMPH was soon relocated to a nearby lay berth

where temporary repairs were conducted. The ship's classification society deemed the repairs sufficient and, in conjunction with the Flag State Administration, authorized the ship to proceed to a shipyard in Florida for permanent repairs.

4.1.26. The Harbor Pilot, Docking Pilot, Master, 2nd Officer, BOSUN, AB, and OS were identified as being directly involved in the incident and were subject to mandatory chemical testing for evidence of drug and alcohol use in accordance with 46 CFR Subpart 4.06. All tests were conducted within the allowable time limits and all results were negative.

4.2. Additional/Supporting Information:

4.2.1. Vessel

4.2.1.1. The BOW TRIUMPH was equipped with a steering system which includes a single fixed-pitch, "right turn" propeller, Becker Marine Systems flap rudder, and bow thruster. The steering gear system was a Rolls-Royce RV 1350-3, composed of one hydraulic rudder actuator, rudder stock, and two pump units which could be operated locally or remotely and simultaneously or individually. The steering pumps and gear were inspected every three months, and the steering gear hydraulic oil tank was inspected every six months by the ship's crew in accordance with the Safety Management System.

4.2.1.2. According to the Pilot Card, the ship's rudder requires 12 seconds to shift from 35 degrees one side to 35 degrees on the other. The Becker Marine Systems manual states that the Becker rudder flap at the trailing edge executes nearly twice the angle of the main rudder blade. At rudder angles of 45 degrees, the flap is at least 90 degrees. When accelerating or sailing at full speed, the manufacturer does not recommend ordering more than 35 degrees, in order to maintain the rudder's maximum side force. During berthing maneuvers, the Becker rudder may be used at a 45 degree or greater angle to act as a stern thruster. The Becker rudder was last inspected in November 2019.

4.2.1.3. The BOW TRIUMPH's echo depth sounder transducer is located directly below the front of the pilothouse and approximately 1 ft starboard of the keel. The front of the pilothouse is positioned 112 ft forward of the stern and 487 ft aft of the bow. The Automated Information Systems (AIS) transponder was in a similar longitudinal position above the pilothouse. The installed rudder angle indicators were visible from the helm, bridge center console, and bridge wings; they were inspected every six months by the ship's crew in accordance with the Safety Management System.

4.2.1.4. The ship's designed minimum steering speed, otherwise known as Dead Slow Ahead, is 4.5 kts; this represents the minimum forward motion the ship needs for the rudder to effectively control the heading. Other design speeds (under loaded conditions) include Full Ahead at 9.1 kts, Half Ahead at 7.7 kts, and Slow Ahead at 6.7 kts. The engine requires 8.6 minutes to completely shift from Full Ahead to Full Astern.

4.2.2. Personnel

4.2.2.1. The Harbor Pilots in Charleston are registered with and assigned to duty by CBPA, which is regulated by the Commissioners of Pilotage for the Lower Coastal Area, a state agency of South Carolina. Harbor pilots are private, independent individuals, paid directly by the ships, at fees which are set by the Commissioners. Each Harbor Pilot maintains a state license and Coast Guard-issued Merchant Mariner Credential with a Federal First-Class Pilotage endorsement. They operate under the authority of one license or the other, based on the pilotage requirements for the ship being sailed. In this case, the Charleston Harbor Pilot was acting under the authority of his state license. The Commissioners do not regulate the Docking Pilots and tug companies which employ them for the purposes of docking and undocking a ship.

4.2.2.2. It is a common practice in the Port of Charleston for both a Harbor Pilot and a Docking Pilot to be onboard during docking and undocking maneuvers. Typically, the Docking Pilot will only be present immediately before, during, and after the maneuvers, while the Harbor Pilot is onboard to conn the ship between the sea buoy offshore and the docking area. Both Pilots speak with the Master when first coming aboard and then announce that they "have the conn" when ready.

4.2.2.3. CBPA's guidelines for minimum acceptable water depth is 1.15 times the vessel's draft. To account for best known channel conditions, CBPA also sets a draft restriction for vessels docking at INEOS terminal. At the time of the BOW TRIUMPH allision, the draft restriction was 29.5 ft. Since tank vessels typically discharge cargo at INEOS, the drafts are usually lower on the outbound voyages.

4.2.2.4. The Harbor Pilot conning the BOW TRIUMPH on 05 September 2022 had 28 years of experience as a qualified Pilot in the Port of Charleston. He estimated sailing approximately 500 times in the upper Cooper River. Most of the voyages had been on tugs with barges, but he attested that, recently, a larger percentage of voyages had been on large "deep draft" ships in this channel, as opposed to smaller tug/barge combinations. The Harbor Pilot estimated completing at least 100 voyages on ships of a similar size to BOW TRIUMPH in the upper Cooper River without incident.

4.2.2.5. In the past two years leading up to the BOW TRIUMPH's allision, the Harbor Pilot sailed ten other vessels of a similar size (drafts ranging from 21'10" to 29'6") in the upper Cooper River (see Figure 8). The vessel with the greatest draft, WAVE KNIGHT (IMO 9168594), got underway from the nearby Wharf Alpha, not INEOS Aromatics Terminal; the THUNDER BIRD (IMO 9318943) sailed from Wharf Alpha as well.

4.2.2.6. This was the Harbor Pilot's first trip onboard BOW TRIUMPH. As he approached the turn, the Harbor Pilot sailed BOW TRIUMPH slightly closer (50-150 yards) to the eastern bank than other vessels he had conned in the previous two years. His initial rudder commands to begin the turn were conducted within the channel boundaries, according to Automatic Identification System (AIS) and Voyage Data Recorder (VDR) data.

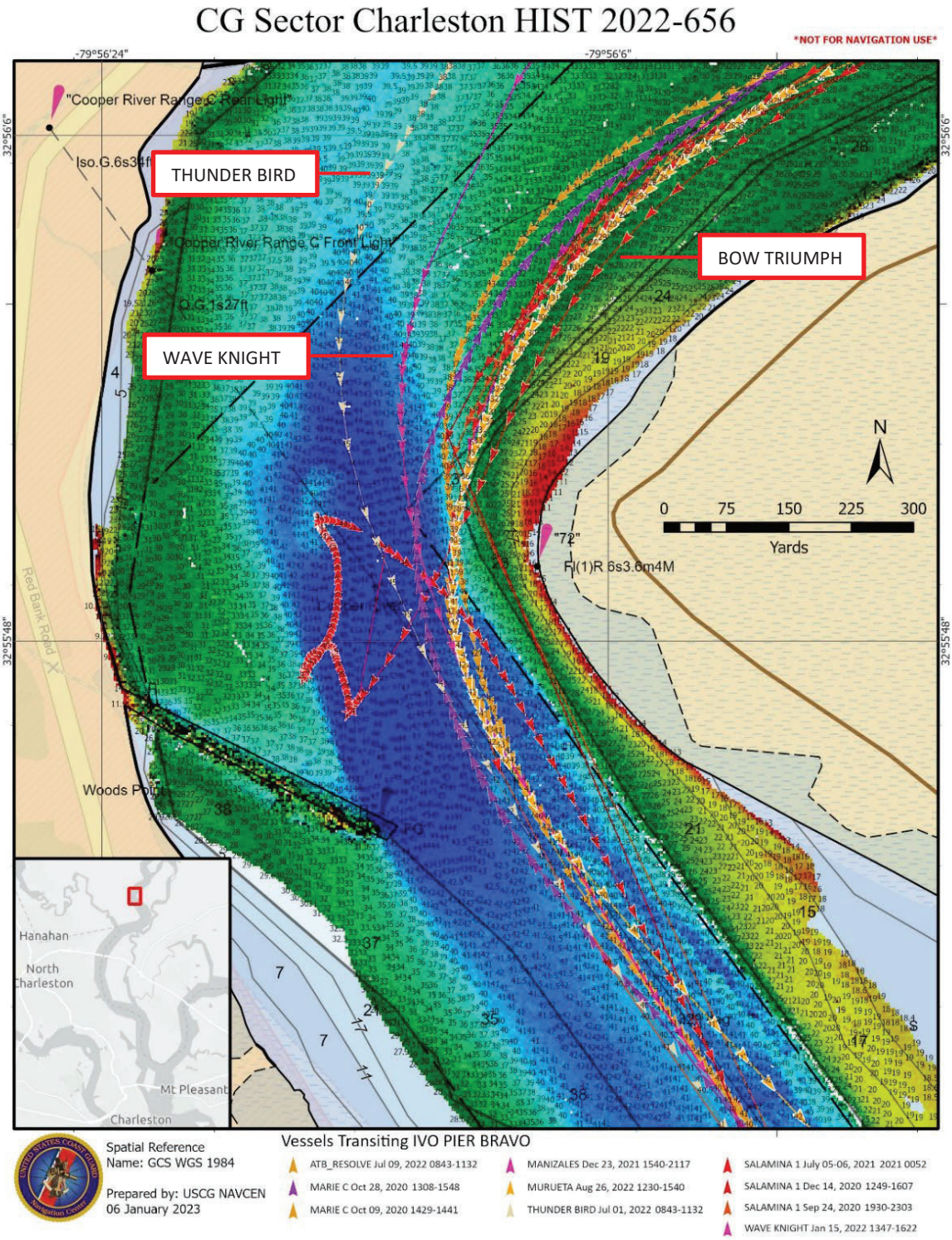


Figure 8 Tracklines of 11 voyages conned by the Harbor Pilot from September 2020 to September 2022, overlayed with 06 September 2022 soundings. Image: USCG NAVCEN; Sounding Data: USACE.

4.2.2.7. The BOW TRIUMPH Master held a certificate as a Master Mariner issued by the Republic of the Philippines. He had been a mariner for 26 years, worked the last 25 years with the same employer, and sailed as Master the previous 3.5 years. He had joined the BOW TRIUMPH for the third time on 25 March 2023. This was his first visit to the Port of Charleston.

4.2.3. Facility

4.2.3.1. Pier Bravo was constructed around 1953 for Naval Ammunitions Depot Charleston to provide two berths (one on each face) for ammunition ships. Upon initial review and approval for the construction in 1952, U.S. Army Corps of Engineers (USACE) noted that the proposed 931 ft pier would extend approximately 500 ft into the Cooper River channel, which was only 600 ft wide at that time. USACE proposed to deepen the channel to 35 ft below Mean Low Water (MLW) and widen it to 500 ft from the end of Pier Bravo to the eastern side of the channel.

4.2.3.2. At the time of construction, this segment of the upper Cooper River was not being used for commercial maritime transport. However, USACE noted in their 1953 permit that an increase of barge traffic and deep draft traffic was probable in the future. The SC Public Service Authority was constructing a steam-electric generating station which would require fuel transport through the river. As such, the Authority had requested studies be conducted to determine impacts to navigation on the Cooper and Santee Rivers. USACE stated: “If it is indicated by such studies that silting will take place to the extent as to affect navigation, then the plans should be changed so that the pier be so constructed as to [ensure] no adverse effect or that assurance be obtained through perpetual maintenance of the proposed channel.” There is no evidence of pre-construction or post-construction studies conducted to determine effects of Pier Bravo on the navigability of the river.

4.2.3.3. The Charleston Development Board was favorable of this project to deepen and widen the channel and stated the importance of keeping the Cooper River accessible to commercial vessels with drafts up to 35 ft, in addition to naval vessels. However, the Board believed that “consideration should be given to how this new channel 500 ft wide will be maintained at a 35-ft depth, as it is their understanding that the Corps of Engineers, U.S. Army, has no present authority to maintain such a channel, nor is there any assurance that the Navy will be able to maintain it in the event that silting occurs.” USACE concluded that the future authorization of a deep-water channel upriver from Pier Bravo was “remote” and the construction of Pier Bravo would not adversely affect commercial vessel navigation.

4.2.3.4. In the 12 months prior to 05 September 2022, there were 15 deep draft vessels that sailed the upper Cooper River to berth at INEOS Terminal (see Figure 9). Two of these vessels, BOW TRIDENT (IMO 9669897) and BOW TRIBUTE (IMO 9669885) were of the same class (i.e. same length, beam, and gross tonnage) as BOW TRIUMPH. On the date of the incident, BOW TRIUMPH began its port turn earlier and sailed slightly to the left of most other vessels which had sailed that year. There have been no other reported incidents amongst these vessels prior to the BOW TRIUMPH incident. However, in January 2024, while this report was being drafted, a second similar incident occurred, resulting in further damage to Pier Bravo.

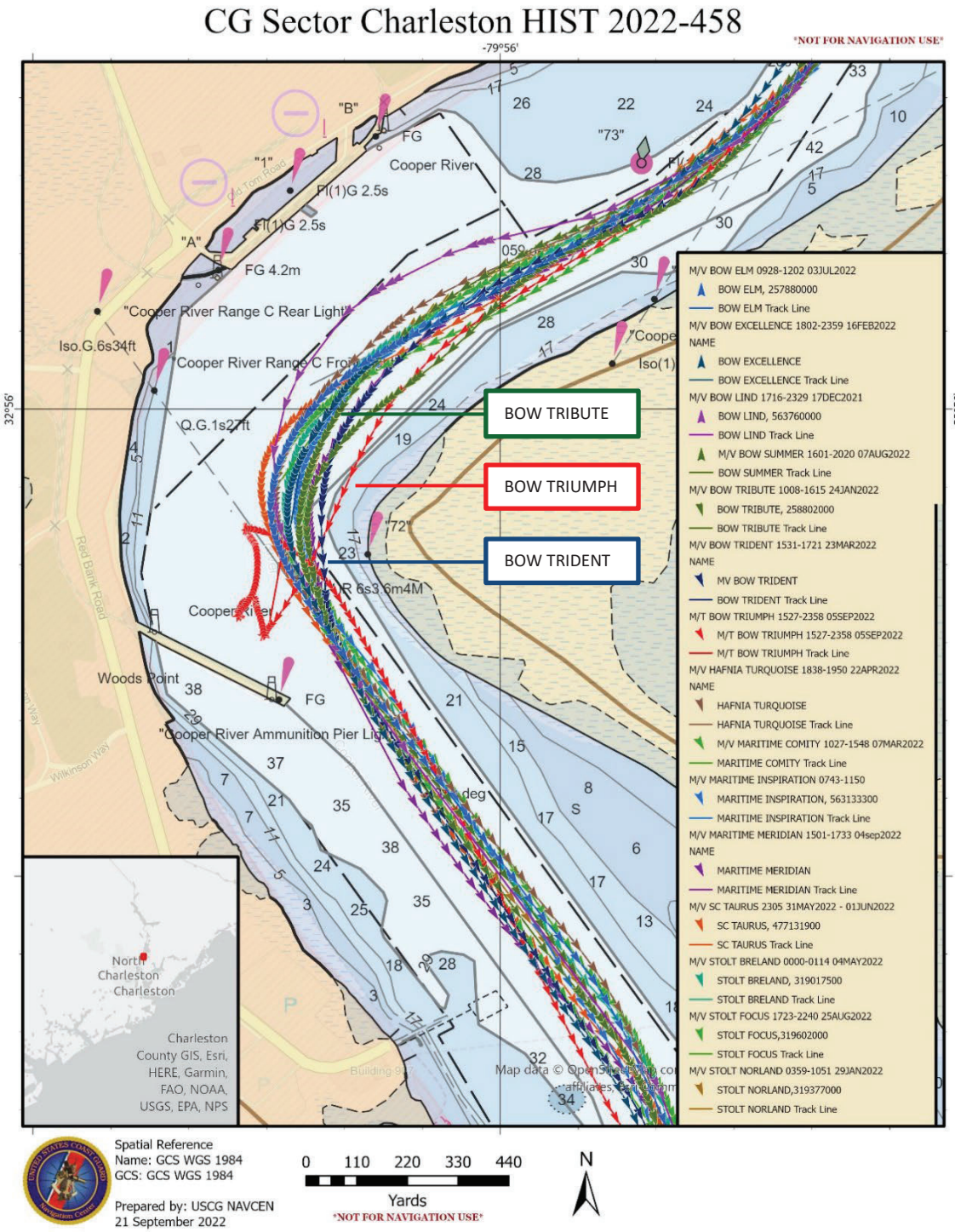


Figure 9 Deep draft vessel downbound voyages between September 2021 and September 2022 in vicinity of Joint Base Charleston. Image: USCG NAVCEN.

4.2.3.5. Pier Bravo was built at a 30-degree angle downstream on the Cooper River from the west bank. It was originally 931 ft x 50 ft but in 1961, a 40 ft x 24 ft extension was permitted by USACE and constructed, along with a 270 ft lightning arrestor tower and five additional dolphins that served as a barrier positioned 15 ft past the end of the pier. The final pier length was 980 ft. The pier included 663 concrete-encased steel H-piles, 12 bollards, 237 fender piles,

floating fenders, rails for railway access, and a fire protection pump house. The piles were designed for a maximum load of 50 tons.

4.2.3.6. The 1961 pier extension permit stipulated: “That if future operations by the United States for the improvement of navigation require an alteration in the position of the structure or work herein authorized, or if in the opinion of the Secretary of the Army it shall cause an unreasonable obstruction to free navigation, the agency having the work in custody shall, upon due notice from the Secretary of the Army, remove or alter it so as to render navigation reasonably, free, easy, and unobstructed.”

4.2.3.7. As of the date of this report, no such study has been conducted post-construction, and USACE has not rendered any such opinion or notice. USACE (Charleston District) attested that post-construction evaluations and modifications are generally limited to the confines of “federally maintained channels.” However, 33 CFR Subpart 325.7(a) states:

“The district engineer may reevaluate the circumstances and conditions of any permit, including regional permits, either on his own motion, at the request of the permittee, or a third party, or as the result of periodic progress inspections, and initiate action to modify, suspend, or revoke a permit as may be made necessary by considerations of the public interest…Among the factors to be considered are the extent of the permittee's compliance with the terms and conditions of the permit; whether or not circumstances relating to the authorized activity have changed since the permit was issued or extended, and the continuing adequacy of or need for the permit conditions; any significant objections to the authorized activity which were not earlier considered;…”

4.2.3.8. A 1981 U.S. Navy Structural Condition Assessment reported widespread deterioration on the steel H-piles and up to 50% corrosion in some areas. No repairs were required, but the report recommended a reinspection every 3 years. There was no documentation of reinspections, but JBC attested that improvements to the pier were made in 1994.

4.2.3.9. A facility analysis in 2001 determined that multiple components of Pier Bravo were deteriorated and required repairs, estimated at $2.2 million. The following conditions were reported, among others (possible scores being Excellent / Good / Fair / Poor): Concrete Piles - Fair; Fender Piles - Fair; Concrete Deck - Good; Bollards – Fair. There is no evidence that any components were repaired or replaced. It is unknown when a vessel last moored at Pier Bravo. At the time of the incident, the pier had only been utilized as a recreational facility for JBC personnel.

4.2.3.10. In September 2022, Pier Bravo was a charted but unlabeled object on Chart 11524 (54th Ed.) near Woods Point. The lighted tower at the end of the pier is charted as "F G 25ft Navy."

4.2.4. Waterway

4.2.4.1. The upper Cooper River, including the channel adjacent to JBC, while considered "navigable waters of the United States[4]" is not part of a "federally maintained channel," which is the authority and funding mechanism under which USACE maintains a particular waterway to its published controlling depth. Navigable waters that are outside a federally maintained channel are dredged, as necessary, at the discretion and cost of other waterway users. The JBC channel extends from Red Bank Landing near the Nuclear Power Training Unit down to the northern edge of North Charleston Terminal (see Figure 10). The federally maintained channel initiates offshore at the Charleston sea buoy, extends through Charleston harbor, and terminates in the Cooper River at North Charleston Terminal. It is maintained by the USACE and surveyed on a quarterly basis.

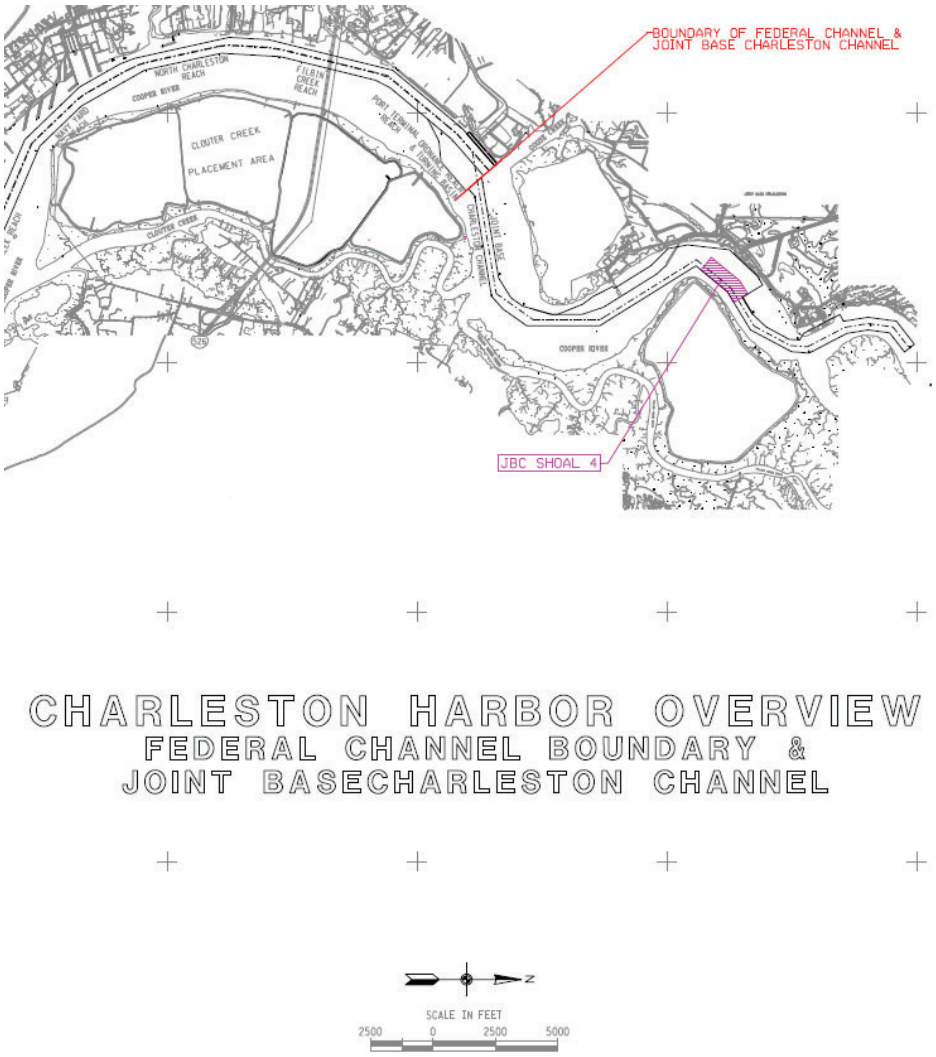


Figure 10 Boundary between the federally maintained channel and JBC channel (red line), and Shoal 4 (pink shade), where the BOW TRIUMPH experienced a loss of turning ability. Image: USACE.

[4] 33 CFR § 329.4 defines navigable waters of the United States as "those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce.

4.2.4.1. Hydrographic survey data for the federally maintained channel is available on the USACE Hydrographic Survey's public website, “eHydro.” Survey data for the JBC channel is not published publicly but transferred to JBC privately under a separate maintenance contract with USACE. As stated in a 2019 dredging permit, the JBC channel is maintained by JBC to provide sufficient depth for safe navigation and berthing of military vessels to support JBC missions and not for any other users of the waterway.

4.2.4.2. Chart 11524 (54th Ed.) listed a 35 ft project depth for the Cooper River, including the JBC channel in vicinity of Ranges D and C. However, there is no defined project depth for the JBC channel by USACE. The USACE’s “allowable” depth at the time of the BOW TRIUMPH allision was 40 ft (40’ required + 2’ allowable overdepth). This included the eastern bank of the river on Range D known as Shoal 4.

4.2.4.3. The Harbor Pilot and Docking Pilot were aware that the Cooper River was historically prone to silting and shoaling in the vicinity of the incident. The Coast Pilot states that both the Federal Channel and JBC Channel “require constant dredging to maintain them at or near project depths, due to the silting of (the) Cooper River.” To maintain sufficient depth for safe navigation and berthing of military vessels to support JBC missions, routine maintenance dredging is required on a 15-20 month rotating cycle.

4.2.4.4. Whether each dredging contract will be executed depends on available funding from the Department of Defense. There is no guarantee that Shoal 4 will be dredged to the allowable depth, but dredging work does occur on Shoal 4 under each JBC maintenance contract. Before the BOW TRIUMPH incident, Shoal 4 was last dredged on 23 March 2021, about 17 months prior. The next dredging work at Shoal 4 was already scheduled for execution under a maintenance dredging contract awarded on 20 July 2022 but had not yet commenced as of 05 September 2022.

4.2.4.5. USACE conducted additional singlebeam hydrographic surveys on JBC Channel in July 2021, September 2021, November 2021, January 2022, and May 2022. USACE provided the data collected from these hydrographic surveys to JBC for their planning and decision-making use. The May 2022 survey showed that silting in the area near Shoal 4, over a period of 14 months, had reduced the depth by more than 10 feet in portions of the JBC channel since it was dredged in March 2021.

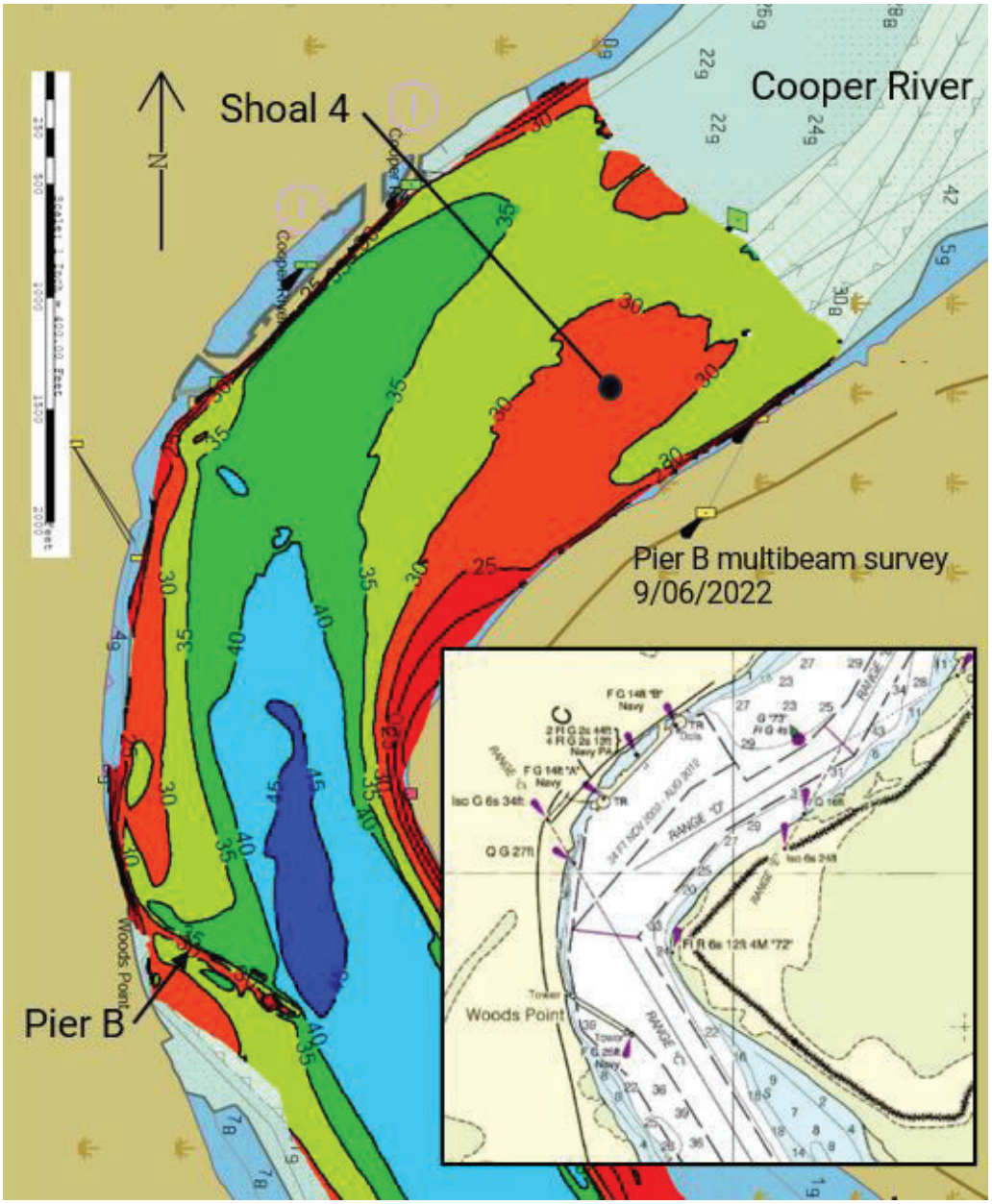


Figure 11 Results from the 06 September 2022 multi-beam survey in vicinity of Joint Base Charleston and Pier Bravo, showing shoal of 30 ft and under in the channel, one day post-casualty. Image: USACE. Inset: NOAA Chart 11527.

4.2.4.6. One day after the BOW TRIUMPH incident, USACE conducted a condition survey of Shoal 4, followed by a pre-dredge multibeam survey on 28 September 2022. Figures 4, 8, & 11 display data from the 06 September 2022 survey, showing that silting in the area of Shoal 4, over a period 17 months, had reduced the depth by more than 10 feet in portions of the JBC channel.

4.2.4.7. An 11 January 2023 singlebeam condition survey indicated that the JBC channel on Range D had shoaled to depths of 35-39 ft. A 16 May 2023 singlebeam condition survey showed that depths within the channel boundary had decreased to as little as 29 ft (see Figure 12).

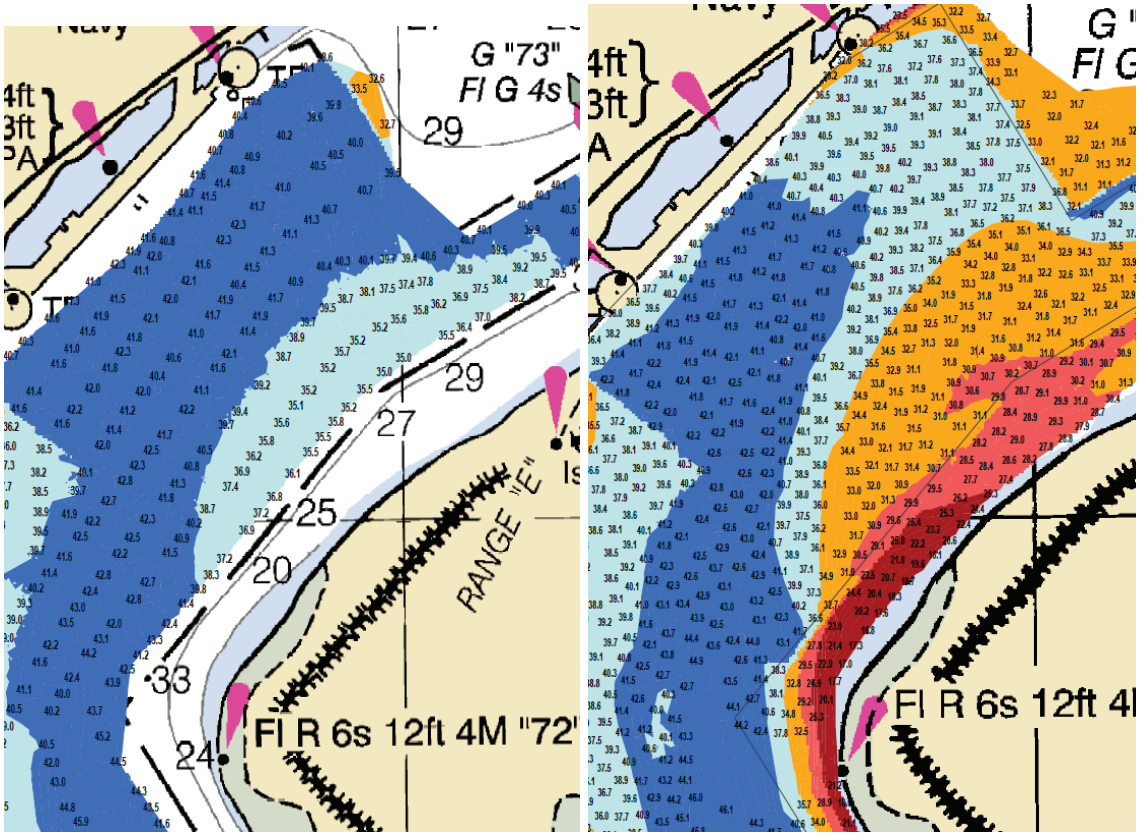


Figure 12 Survey data from January 2023 (left) and May 2023 (right) showing a rapid rate of shoaling on the eastern bank of JBC Channel on Range D following the November 2022 dredge work. Images: USACE.

4.2.4.8. Each Pilot is responsible for routinely updating survey data in their PPUs. The CBPA occasionally requests JBC channel surveys from USACE to make available for the Pilots. On the date of the BOW TRIUMPH incident, CBPA Pilots were referencing USACE sounding data from a 15 November 2021 survey. This data had been uploaded into the Harbor Pilot's PPU. As displayed in Figure 13, this survey indicated significant shoaling on Range D, with depths as low as 30 ft near Shoal 4. Soundings under 40 ft are shown in light and dark red.

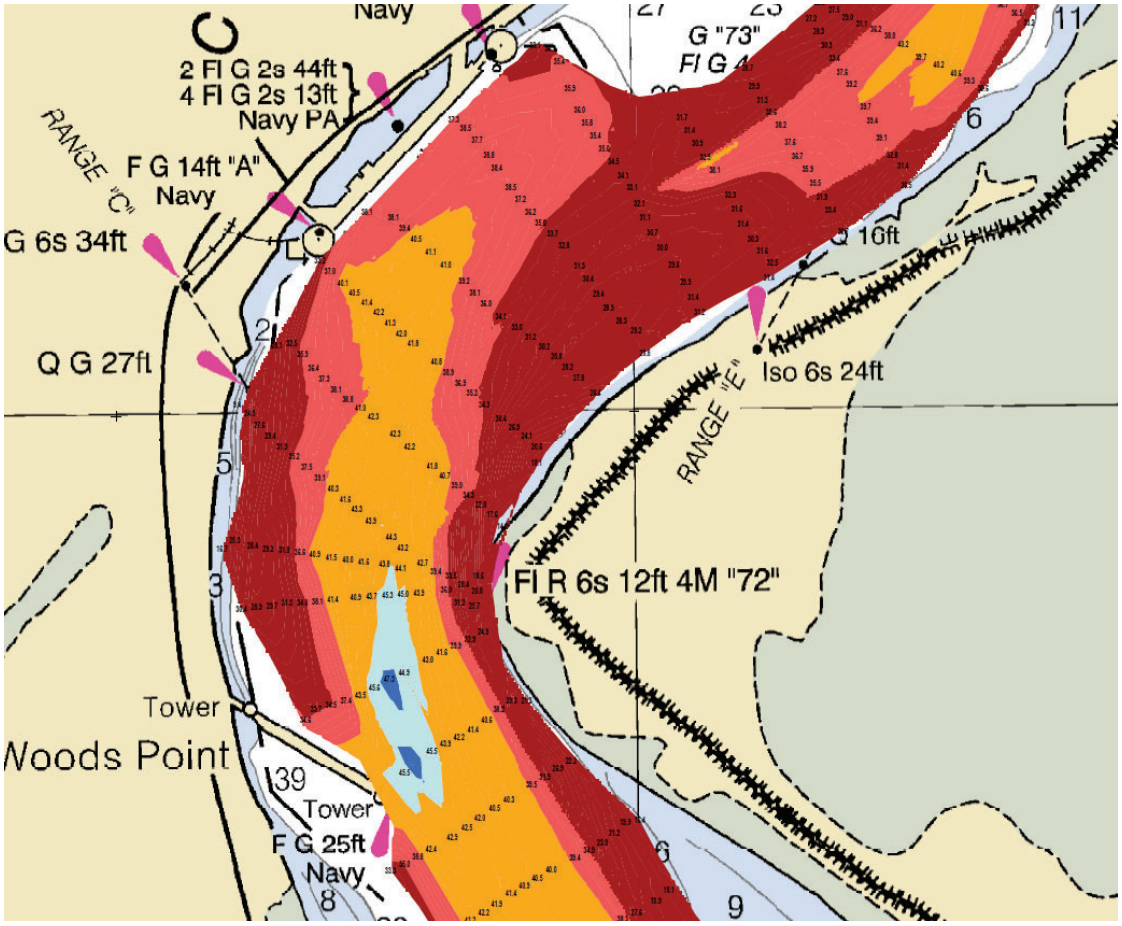


Figure 13 November 2021 soundings, depicting <40 ft in the channel (light red) and <35 ft (dark red) in the channel and along Shoal 4, with depths as low as 27 ft along the eastern edge of the channel. Image: USACE.

4.2.4.9. Between March 2021 and May 2022, USACE conducted an internal shoaling analysis of JBC Channel to detect impacts from the "Post 45" deepening project in the Port of Charleston. They concluded that the shoaling was consistent compared to pre-project conditions. USACE also conducted a trend analysis for Shoal 4 silting recorded over the past 15 years. This showed that the shoal historically grows at a rapid pace in the first year post-dredging, then levels out. The silting observed in Shoal 4 was determined by USACE to be consistent with expected shoaling rates. They were unaware of any navigational issues in the JBC channel reported by other ships.

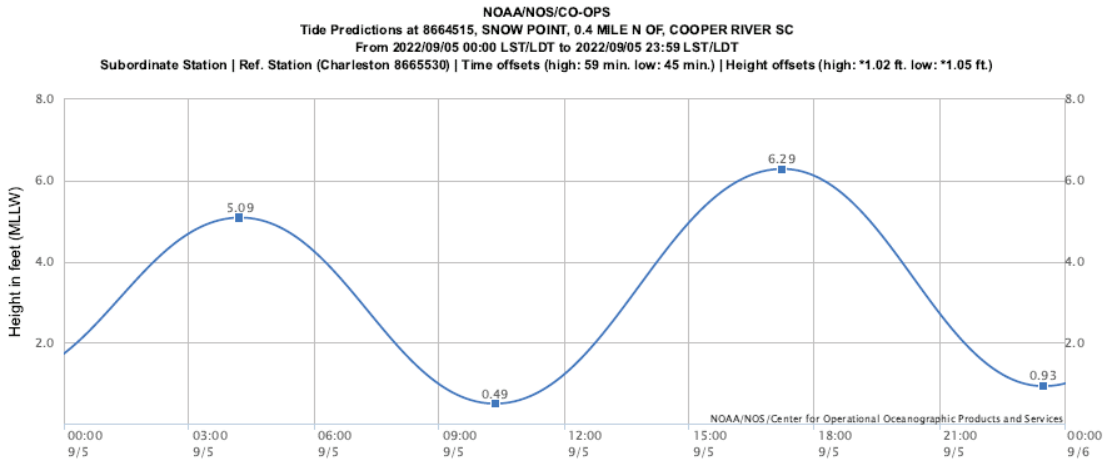
4.2.4.10. Chart 11527 and the Electronic Navigation Chart (ENC) have not been updated with JBC channel area soundings since 2011. The National Oceanic and Atmospheric Association (NOAA) did not provide comment on the method of sourcing hydrographic data for non-federally maintained channels.

4.2.4.11. The INEOS Aromatics Terminal has no oversight of waterway conditions and relies on the professional opinions of CBPA to make decisions regarding when it is safe to sail a given ship on the Cooper River. When scheduling ships to dock at INEOS, the staff utilizes a ship vetting process that includes communicating the maximum draft of their dock to the vessel operator and/or agent and referring them to CBPA for the most accurate waterway information. INEOS schedules only one vessel at the dock at a time.

4.2.4.12. The Coast Guard Navigation Center can facilitate Ports and Waterways Safety Assessments (PAWSAs) in a local Marine Transportation System (MTS) for the purposes of providing input to navigation-related projects; further MTS goals of improved coordination and cooperation between government and private sector; strengthening Harbor Safety Committees; and supporting Coast Guard Captains of the Port (COTPs) in promoting waterways activities. The most recent PAWSA for the Port of Charleston was conducted in July 2010 and did not focus on the upper Cooper River outside the federally maintained channel.

4.2.5. Environment

4.2.5.1. On this date, the tidal current reached a maximum flood of 0.81 kts at 1602. The height of tide was approximately 6 ft above Mean Lower Low Water (MLLW) at 1600 (see Figure 13). According to the ship's voyage plan, the corrected water depth for WP8 was predicted to be a 32 ft minimum, which accounted for a 6 ft height of tide (HoT). The ship's dynamic draft was expected to be 29 ft with a UKC of 3 ft on Range D, the lowest expected UKC of the voyage plan. The Remarks for WP8 stated "Navigate within the fairway or channel. Monitor UKC. NO GO AREA Outside buoyed Channel," as similar to other WP remarks. The Voyage Plan also showed graphs indicating that as the ship's speed increases, squat increases and UKC decreases. The minimum UKC required by the ship's operating company was 1.6 ft.



Note: The interval is High/Low, the solid blue line depicts a curve fit between the high and low values and approximates the segments between.
Disclaimer: These data are based upon the latest information available as of the date of your request, and may differ from the published tide tables.

High/Low Tide Prediction Data Listing

Station Name: SNOW POINT, 0.4 MILE N OF, COOPER RIVER, SC
Action: Daily
Product: Tide Predictions
Start Date & Time: 2022/9/5 00:00
End Date & Time: 2022/9/5 23:59

Source: NOAA/NOS/CO-OPS
Prediction Type: Subordinate
Datum: MLLW
Height Units: Feet
Time Zone: LST/LDT

Date	Day	Time	Hgt	Time	Hgt	Time	Hgt	Time	Hgt
2022/09/05	Mon	04:13	5.09 H	10:20	0.49 L	17:14	6.29 H	23:30	0.93 L

Figure 13 NOAA Tide Predictions for Snow Point, approx. 1700 yds upriver from the turn at Range C, showing high tide at 1714 of 6.29 ft above MLLW and the tide at 1600 to be approximately 6 ft above MLLW. Image: NOAA.

4.2.5.2. BOW TRIUMPH began its turn into the bend where the MLLW depth was about 28 to 30 ft and depths off the ship's port side were less than 28 ft. With the added 6 ft HoT, the actual water depth would have been approximately 34-36 ft and no more than 34 ft off the ship's port side. At the time and position the

Harbor Pilot began his turn, the actual water depth would have been approximately 34 ft. Incorporating a calculated squat of 1.4 ft, the ship's aft draft would have measured 28.96 ft, assuming the planned speed of 6.7 kts. Based on the ship's speed of 7.7 kts on Range D, the squat and aft draft may have been greater as the ship approached the turn. On the most shallow part of its path, the BOW TRIUMPH sailed through depths as low as 30 ft.

4.2.6. Hydrodynamic Effects

4.2.6.1. The Nautical Institute's "Shiphandler's Guide" describes hydrodynamic effects on ships maneuvering in shallow water, which may cause considerable changes in the handling characteristics:

"As a rough guide it can be assumed that a ship may experience shallow water effect when the depth of water is less than twice the draft, i.e. the under keel clearance is less than the draft itself. Serious cases of shallow water problems have however, been experienced with larger under water clearances, especially at high speeds, sometimes with dire consequences!"

4.2.6.2. As discussed in "Review of Practical Aspects of Shallow Water and Bank Effects" published by The Royal Institution of Naval Architects, the definition of shallow water varies amongst experts, and real-world studies to prove the effects have been scarce. Some define shallow water as when the ratio of water depth (h) to ship's draft (T) is 3 or less. The World Association for Waterborne Transport Infrastructure distinguishes shallow water as when $h/T < 1.5$ and very shallow water as when $h/T < 1.2$. For example, a ship with a draft of 30 ft operating in a 42 ft deep channel would be represented by $h/T = 42/30 = 1.4$ (shallow water environment). When applying these definitions of shallow water and very shallow water, it is believed that a hydrodynamic effect can be "very significant in shallow water and dominate the ship's behavior in very shallow water."

4.2.6.3. All ships making forward way through water cause pressure changes in the surrounding water as it is displaced around and under the ship. According to the Shiphandler's Guide, as a ship turns in shallow water, water pressure builds more on the side towards the turn, aft of the pivot point, due to the restricted water flow under the keel. The rudder force then must overcome a much larger lateral resistance and is therefore considerably less efficient. At the bow, because of the reduced UKC, water which would normally pass under the ship is restricted, so there is a buildup of pressure, both ahead of the ship and on the starboard bow. "This now upsets the balance between the ship's forward momentum and longitudinal resistance … and pushes the pivot point back" from its location about 25% aft of the bow. As the pivot point moves further aft, the lever on which the propeller/rudder is pushing decreases in length. "With the combination of these two effects, the ship is rapidly losing the rudder efficiency enjoyed in deep water."

4.2.6.4. Shallow water has generally been known to increase turning diameters and decrease rate of turn, according to "Review of Practical Aspects of Shallow Water and Bank Effects." One study indicated that when $h/T = 1.25$, turning

diameter may increase 60-100%; when h/T = 1.5-1.75, it may increase 30%. The Harbor Pilot was also familiar with this overall concept.

4.2.6.5. Bank effect is another interaction, described by the Shiphandler's Guide, observed by ships maneuvering close to a vertical obstruction, such as a shoal or riverbank. While making forward headway, water flow down the side of a ship creates positive pressure forward of the pivot point and negative pressure aft. This is inconsequential at open sea, but in a channel, the resultant forces can attract a ship's stern toward the bank and yaw the bow away from the bank. "It can be very difficult to break out of its hold, the ship requiring constant corrective rudder and power, sometimes hard over, in order to control heading. Excessive speed must be avoided as, yet again, it is a crucial factor in creating a 'bank effect' problem, because the magnitude of the forces varies with the square of the ship's speed or water flow." Though bank effect is often experienced in waterways with steeply sided banks, the Shiphandler's Guide explains: "To a ship running in shallow water, with adjacent but gently shelving mud or sand banks [such as the eastern bank of the Cooper River], such as low-lying estuarial areas…the effect can be far more insidious and violent."

4.2.6.6. Squat effect is additionally discussed by Shiphandler's Guide as an interaction experienced in shallow water, causing a ship's bow or stern to trim lower. With a more restricted amount of water flowing beneath a ship, the water is forced under the bow at a higher velocity, creating lower pressure and decreased buoyancy. The pivot point is moved further aft, and steering capability is reduced. In certain squat situations, typically when speed is "excessive," a ship may sheer quickly from one side to the other when counter helm is applied, causing a chain reaction and a rapid loss of control. Maintaining an even trim or a slight stern trim is generally preferred by professional shiphandlers to maximize steering control.

4.2.6.7. The Commissioners of Pilotage for the Lower Coastal Area Policy and Procedures Manual serves as the primary governance document for CBPA Pilots. Among other requirements, it states: "Pilots should consider the effects of speed of the vessel being piloted to include but not be limited to the following: (a) Effects of squat; (b) Effects of surge; (c) Presence of other watercraft; (d) Bank effects; (e) Effects of cushioning; (f) Effects of suction; (g) Visibility; (h) Vessel maneuvering characteristics; (i) Presence of endangered species; (j) Regulated navigation requirements."

5. Analysis

5.1. *Failure to navigate in the center of the channel*. Upon reaching Range D, the Harbor Pilot sailed the BOW TRIUMPH to the left of the center of the channel and began applying port rudder early, in comparison with other pilots (Figure 9) and with his own prior voyages (Figure 8). The Harbor Pilot justified his choices through multiple points.

First, the initial "Port 20" and "Port 10" was not applied to begin the turn onto Range C; he only intended to observe the responsiveness of the rudder in preparation to start the turn. However, he did not follow those commands with any starboard rudder to recenter the ship in the channel after the test was completed which resulted in a marginal port turn that brought the ship closer to the east bank and Shoal 4. Second, he wanted to stay well clear of Wharf

Alpha and any adjacent JBC property or assets. It should be noted that there were no vessels at Wharf Alpha at the time of the casualty. Historical trackline data showed that most vessels of similar sizes had sailed closer to JBC while on Range D and without incident. Third, the Harbor Pilot anticipated that flood current around the bend would set the ship to starboard, presenting an allision risk with Pier Bravo, and so wanted to provide ample space to complete the turn by approaching from the left side of the channel.

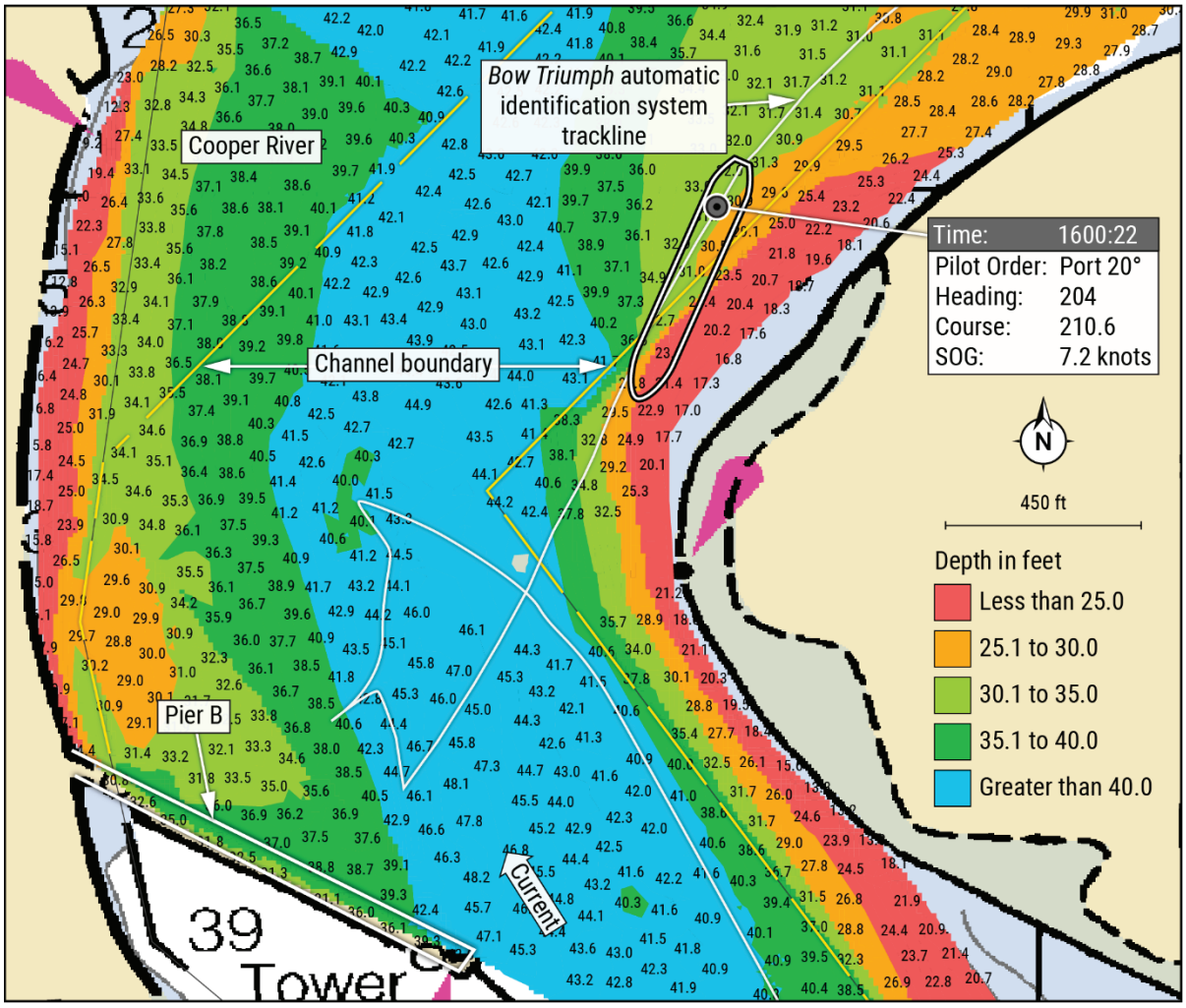


Figure 14 Position of the Bow Triumph (approximate scale) at 1600:22, based on AIS data, about the time the Harbor Pilot noticed that the rate of turn was not increasing. Pilot order is from the ship's VDR. Soundings (in feet, at MLLW) were recorded during the 06 September 2022 USACE survey. Image: NTSB

5.2. *Hydrodynamic effects.* Based on the BOW TRIUMPH's proximity to Shoal 4 and the 6 ft HoT, the ship likely began its turn where the channel was as shallow as 34 ft, causing a UKC of 5 ft or less. CBPA's policy for minimum water depth ($1.15T<h$) was marginally met, as $1.15(28.96) = 33.3$ ft. Applying the commonly accepted principle that shallow water affects maneuverability when $h/T < 1.5$, it is clear that the BOW TRIUMPH ($h/T = 34/28.96 = 1.17$) could have lost turning capability due to its path over Shoal 4. Once the ship sailed even closer to the eastern riverbank, the UKC may have been as low as 1 ft.

It is very likely that this condition was further exacerbated by undesirable bank effect caused by the ship's close proximity to the eastern bank of the river. Had the Harbor Pilot approached the turn to Range C with the ship positioned closer to the center of the channel, the ship would have likely avoided or experienced diminished effects from the shallow water

and bank suction effects induced by Shoal 4.

5.3. *Lack of current hydrographic data outside the federally maintained channel*. The upper Cooper River is a region located outside the boundaries of the USACE federally maintained channel. Within the federal project, the Port of Charleston receives quarterly surveys and frequent dredging to ensure project depths of 45-50 feet are maintained. In the upper Cooper River, individual users of the channel are responsible for monitoring the channel for their needs and pursuing hydrographic surveys or dredging when necessary. JBC has long partnered with the USACE to ensure the channel is sufficiently maintained for the navigational needs of federally owned and operated vessels berthing at Joint Base Charleston facilities.

JBC has no obligation to share hydrographic data related to its channel maintenance on the Cooper River. To maintain awareness of the channel conditions outside the federally maintained channel, CBPA has periodically requested and ascertained JBC's hydrographic data directly from USACE, who is under contract with JBC to perform periodic conditional surveys. This has resulted in some data sharing, at irregular intervals, but was cited by JBC to present potential legal and security risks if shared. Finally, because the data for private projects is not published on USACE's public "eHydro" website, the Pilots were not always aware when surveys or dredging had been completed near Joint Base Charleston, hence the ad-hoc agreement. This resulted in a situation where the PPUs were not always updated with the most recent data following a condition survey.

CBPA was aware that Shoal 4 had historically shoaled more than other parts of the river but was not apprised of the most current condition survey data. The September 2022 survey data revealed that BOW TRIUMPH sailed through water which was approximately 10 feet shallower than what the November 2021 data displayed on the Harbor Pilot's PPU. Had the Harbor Pilot been fully aware of the current channel conditions, he may have opted for a track line closer to the center of the channel and Shoal 4 to maintain a sufficient UKC. Furthermore, from a policy perspective, CBPA would have likely adjusted the draft restriction for piloted vessels on the upper Cooper River.

5.4. *Flood current exhibiting forces onto the side of the ship*. It is a common practice for CBPA to schedule outbound voyages on the upper Cooper River during a narrow window of time when the tide is high and the flood current is strong. This environment is preferable due to the enhanced maneuverability provided by increased water flow over the ship's rudder. Sailing downriver on an ebb tide could present a dangerous risk, coupling a lower height of tide with less water flowing over the rudder. While the flood current can improve a ship's maneuverability, sharp turns in a narrow channel present another risk factor for which the Pilot must compensate.

The Harbor Pilot attempted to approach the turn from Range D to Range C towards the port side of the channel to allow extra room in case the flood current pushed the ship to starboard, toward Pier Bravo. While this strategy could be effective, it is predicated on the ship receiving sufficient water flow over the rudder to support maneuverability without any opposing hydrodynamic effects (e.g., shallow water effect, bank effect and squat). If a ship's bow first encounters a current from a perpendicular vector, with no additional water flow over the rudder, the rudder will have to work harder to counteract the resistance on the bow in order to turn the ship.

Due to the hydrodynamic effects experienced at Shoal 4, the BOW TRIUMPH entered the sharp bend in the river at an angle perpendicular to the oncoming flood current, instead of the more direct approach that would have been experienced if the ship were positioned closer to the center of the channel. While the Harbor Pilot was attempting to "break" the forces of the shallow water and nearby bank to gain a port rate of turn, the bow of the ship began experiencing an opposing force to starboard, further prohibiting any meaningful rate of turn from being achieved. The port side of the ship was exposed to an oncoming perpendicular flood current for approximately 1.5 minutes before the allision occurred. As a result, and when combined with the aggregate hydrodynamic effects, the ship maintained heading at 200-202°T until the starboard anchor was let go, and the bow turned slightly to starboard. Had the BOW TRIUMPH sailed downriver on a slack tide or successfully approached the sharp bend at a shallower angle, as most other past vessels had, the Harbor Pilot may have been able to achieve a sufficient rate of turn and possibly mitigated or avoided the allision.

5.5. *Lack of towing vessels available to assist with maneuvering*. At the time of the incident, there was no requirement by the Coast Guard or by CBPA for ships to be escorted or assisted by towing vessels in the upper Cooper River. However, the Pilots indicated during interviews that they could have lessened or prevented the incident by employing towing vessel assistance through the turn. This option was feasible given that towing vessels often sail nearby the inbound and outbound ships, due to their involvement in the docking and undocking evolutions. Both local towing vessel companies, McAllister Towing & Transportation Co, Inc and Moran Towing Corporation, maintain a fleet of harbor tugs in the Cooper River. Due to the uncertain hydrographic data in the upper Cooper River, the Harbor Pilot indicated he would prefer towing vessel escorts in all future transits.

In the case of BOW TRIUMPH (as well as other tank vessels in some cases), the two towing vessels involved in the undocking evolution at the INEOS Terminal were also scheduled to assist with the upcoming docking evolution at the Odfjell Terminal downriver; consequently, they were sailing approximately 0.5-1 NM ahead of the BOW TRIUMPH. After the allision occurred, the towing vessels quickly maneuvered back upriver to assist the BOW TRIUMPH in backing off the pier and safely getting back underway. Had the towing vessels been escorting the BOW TRIUMPH and tethered to the ship throughout the voyage, they would have likely been able to correct the ship's heading and prevent the allision entirely.

6. Conclusions

6.1. Determination of a Cause

6.1.1. The initiating event for this casualty occurred when the BOW TRIUMPH experienced hydrodynamic effects and lost all rate of turn while the rudder was set to "Port 20." The Harbor Pilot was unable to "break" the ship from the forces preventing the turn, even with an engine kick and "Full Becker" rudder. The factors contributing to the Harbor Pilot's inability to turn the ship were:

6.1.1.1. The method by which the pilot "tested" the rudder;

6.1.1.2. Insufficient under keel clearance to facilitate steering;

6.1.1.3. Close proximity to the eastern bank; and

6.1.1.4. Lack of current hydrographic data.

6.1.2. Despite the Harbor Pilot's efforts to regain a rate of turn and then to stop the ship, the BOW TRIUMPH ultimately allided with the north face of Pier Bravo in its mid-section. The factors contributing to the allision were:

6.1.2.1. Presumed flood current steering advantage negated by hydrodynamic effects; and

6.1.2.2. Lack of nearby towing vessels to render assistance.

6.2. Violations of Law by Credentialed Mariners – The Harbor Pilot's decision to sail in proximity to the port side of the channel and apply port rudder too early could be considered negligent. There were several recent successful voyages made by other pilots and, subsequently, the same pilot, in which vessels were kept towards the center or starboard side of the channel and completed the turn by Pier Bravo without incident. Although the Harbor Pilot holds a valid U.S. Coast Guard-issued Merchant Mariner Credential, he was acting under the authority of his State Pilotage License at the time of the incident. As such, the Coast Guard does not have a clear jurisdictional path to investigate any potential violations made by the Harbor Pilot. However, according to the Pilot's procedural manual, the South Carolina Commissioners of Pilotage for the Lower Coastal Area may initiate an investigation, pursuant to SC Code Section 54-15-300, and report the Coast Guard's findings to the SC Department of Labor, Licensing, and Regulation (LLR) Division of Professional and Occupational Licensing for further investigation and possible disciplinary actions, pursuant to SC Code Section 40-1-80.

6.3. Violations by Members of the Coast Guard – There were no violations by any members of the Coast Guard.

6.4. Violations Subjecting Parties to a Civil Penalty – There were no violations subjecting any parties to civil penalties.

6.5. Violations of Criminal Law – There were no violations of criminal law.

6.6. Need for New or Amended Laws/Regulations – There was no identified need for new or amended laws or regulations.

6.7. Unsafe Actions or Conditions that Were Not Causal Factors – In the minutes leading up to the allision, the Docking Pilot who was standing by in the pilothouse of the BOW TRIUMPH began to call out recommended actions to the Harbor Pilot, even though he did not have the conn of ship at the time. While his interjections could have caused confusion to the helmsman, there is no evidence they contributed to the incident, and they may have helped mitigate the unfolding situation.

7. Actions Taken Since the Incident

7.1. Immediately following the incident, CBPA recommended that all Harbor Pilots sailing deep draft ships on the upper Cooper River be escorted by two towing vessels (untethered) while in vicinity of Shoal 4.

7.2. On 16 September 2022, CBPA requested a temporary buoy ("72A") be placed at Shoal 4 until dredging operations could be completed. U.S. Coast Guard Aids to Navigation Team

(ANT) Charleston set this buoy in position as requested on 20 September 2022. After dredging began in October 2022, the temporary buoy was removed. A permanent buoy was requested on 29 March 2023 by CBPA and accordingly processed for approval through the Coast Guard Seventh District. On 03 January 2024, Local Notice to Mariners 04/24 formally established "Cooper River Lighted Buoy 72A," and ANT Charleston placed the buoy on 17 January 2024 (see Figure 15).

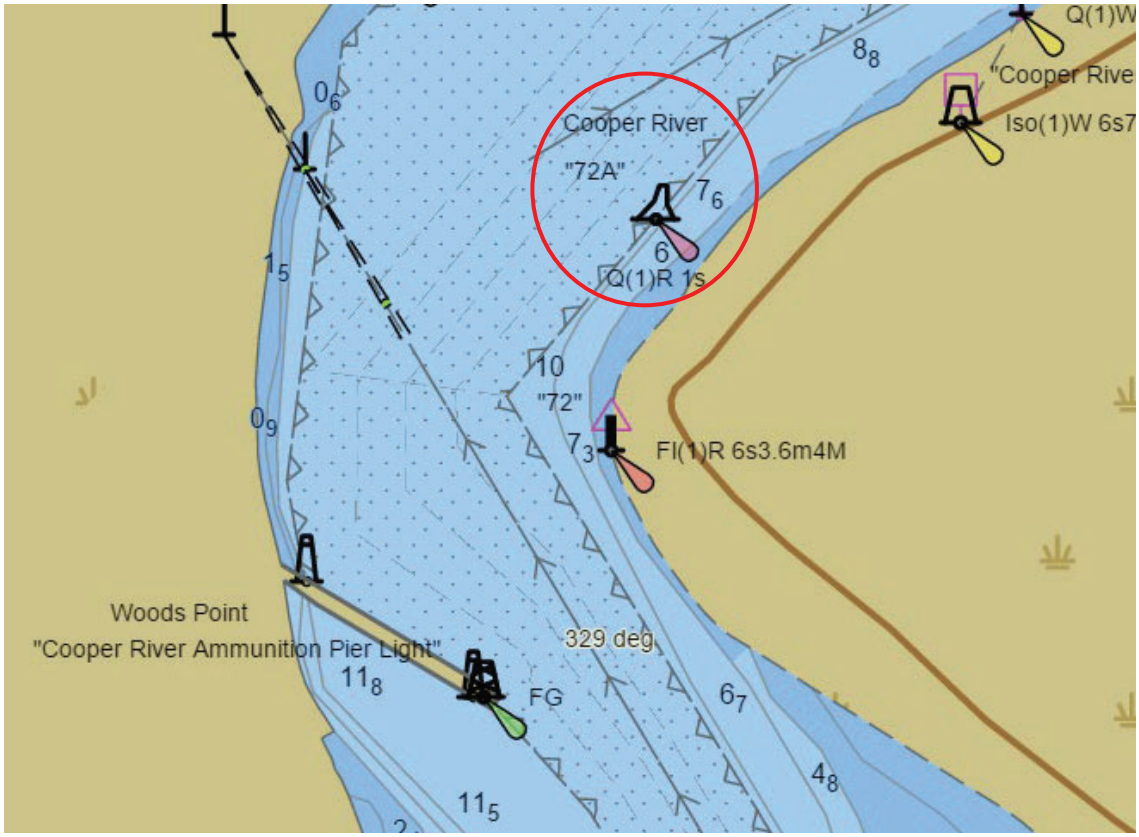


Figure 15 Excerpt from ENC US5SC1LO with the newly established buoy Cooper River "72A" circled in red. Image: NOAA/U.S. Coast Guard

7.3. On 14 January 2024, another tank vessel, HAFNIA AMESSI (IMO 9719745) also struck Pier Bravo after having taken a similar track line to BOW TRIUMPH. On 23 January 2024, Coast Guard Sector Charleston Captain of the Port established a restriction on all vessels transiting the upper Cooper River with drafts exceeding 25 ft or tonnage greater than 10,000 GT ITC. Vessels meeting this criterion are now issued Captain of the Port Orders requiring two tethered tugs while transiting between Woods Point and Red Bank Landing.

7.4. On 25 January 2024, the Charleston Area Harbor Safety Committee approved the establishment of an Upper Cooper River Terminal Subcommittee to further explore potential long-term solutions and facilitate collaboration amongst upper Cooper River private facilities and federal stakeholders.

8. Recommendations

8.1. Safety Recommendations

8.1.1. It is recommended that Joint Base Charleston, the Charleston Branch Pilots Association, the U.S. Army Corps of Engineers (Charleston District), and the National

Oceanographic and Atmospheric Administration (NOAA) (Charleston Office of Coastal Management) collaborate to establish a process to share hydrographic data for navigable waters in the vicinity of Cooper River marine terminals that are outside the federally maintained channel.

8.1.2. It is recommended that private marine terminals in the Port of Charleston situated outside the current federally maintained channel coordinate to either 1) extend the federally maintained channel or 2) privately coordinate regular condition surveys and maintenance dredging at regular intervals to maintain the navigable waters at an adequate controlling depth to facilitate safe transit.

8.1.3. It is recommended that the Captain of the Port collaborate with the Coast Guard Navigation Center (CG-NAVCEN) to execute a Ports and Waterways Safety Assessment (PAWSA) in the Port of Charleston with a focus on the Cooper River north of the federally maintained channel.

8.1.4. It is recommended the U.S. Army Corps of Engineers (Charleston District) initiate a comprehensive study to determine the navigational impact of Pier Bravo on military and commercial ships transiting in the upper Cooper River based on modern traffic density and hydrographic data trends. This study should be completed prior to the issuance of any future repair or reconstruction permits.

8.2. Administrative Recommendations

8.2.1. It is recommended that the SC Commissions of Pilotage, the SC Department of Labor, Licensing, and Regulation (LLR), or other appropriate State regulatory body, investigate potential violations on the part of the Habor Pilot and take appropriate disciplinary action, as necessary and appropriate regarding his SC State Pilotage license.

8.2.2. It is recommended that Commandant (CG-INV) provide a copy of this report to the Parties-in-Interest (PIIs).

8.2.3. It is recommended that Commandant (CG-INV) release the Report of Investigation to the public and post online.

8.2.4. It is recommended that this investigation be closed.

[redacted]rd

Investigating Officer