Attachment G

Ship Simulation Study, Searsport Harbor

OFFSHORE WIND PORT - SITE SELECTION SEARSPORT, MAINE

RECORD OF SHIP SIMULATIONS CONDUCTED JUNE 2024

Prepared for:

MaineDOT

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EXECUTIVE SUMMARY

In support of continued efforts by Maine Department of Transportation (MDOT) to develop port infrastructure for the offshore wind industry, two alternative locations have been proposed for a new marine terminal near Searsport, ME. The ability of vessels to safely arrive and depart under a wide variety of weather conditions is one of the critical characteristics of any marine terminal, and thus, one of the critical comparisons to be made when deciding between two alternative marine terminal options for the project. The locations assessed were Mack Point and Sears Island.

On June 11th and 12th, 2024, full mission bridge ship simulations were conducted at the United States Maritime Resource Center (USMRC) in Middletown, RI. All simulations were conducted by active Penobscot Bay & River pilots.

The two port concepts evaluated in this study are illustrated in Figure ES-1. In general, the terminals are near each other, approximately 0.5 miles apart. The navigation conditions vary only with respect to the final approach, turning, and berthing; i.e., transit from the ocean is the same for both berths.

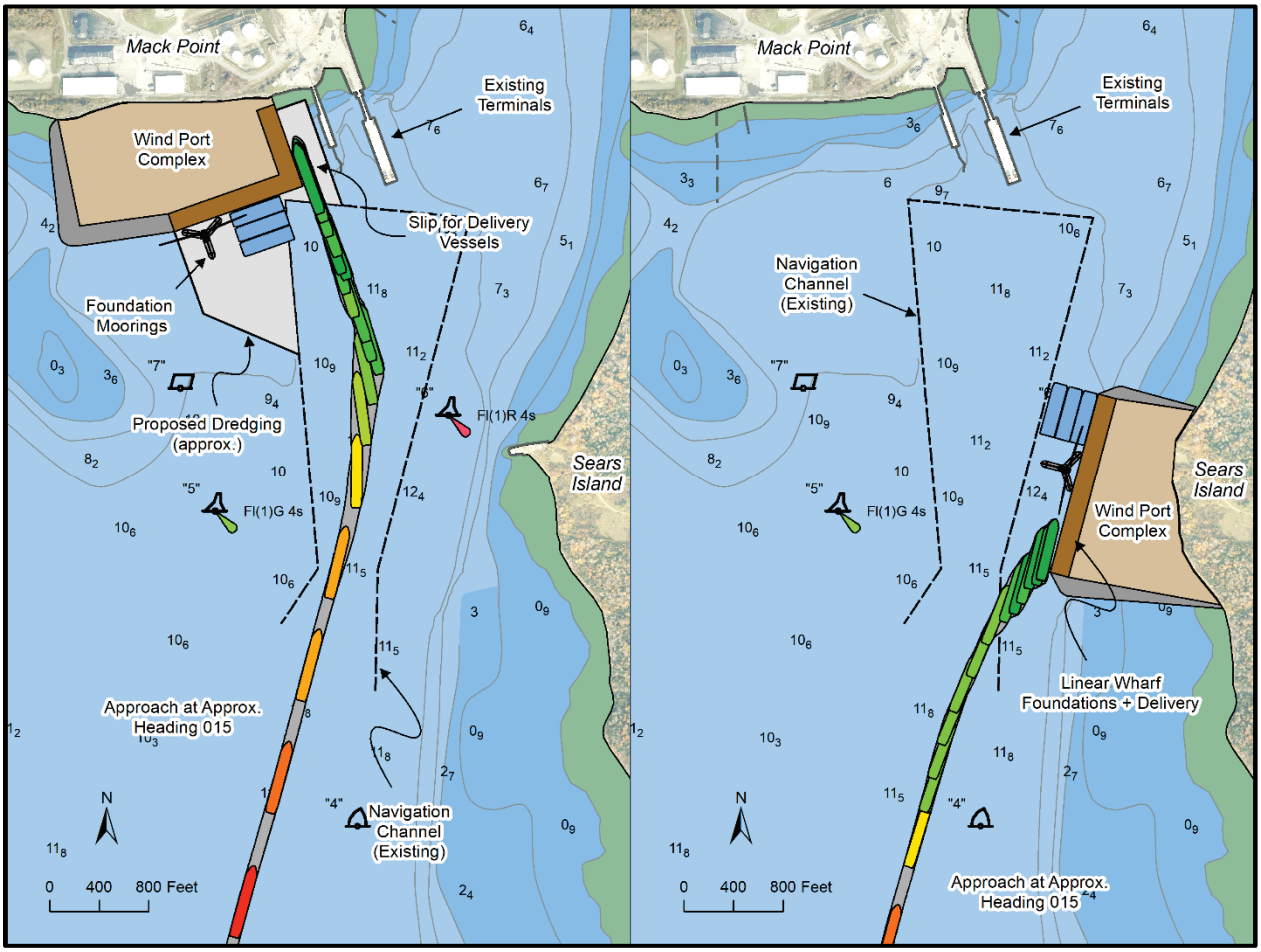

Figure ES-1: Typical Approaches for Mack Point (left) and Sears Island (right)

In total, 14 simulations were performed, including inbound and outbound maneuvers, and turning both to port and to starboard. Between the real-time simulations (averaging over 30 minutes each) and the intervening discussions, the pilots and project team spent two full days working collaboratively on this navigation study. The pilots provided feedback about the maneuvers, which is documented in the notes taken during the effort. In each simulation two tugs were used, based on the current fleet of tugs in Penobscot Bay. The following summaries outline the understanding that was developed through the simulation study:

Mack Point

The approach and departure maneuvers for the Mack Point terminal concept are similar to the comparable maneuvers at the existing liquid bulk and dry bulk terminals at Mack Point. Due to the nature of the cargo and crane configurations, vessels may need to berth port-side-to and starboard-side-to, which would dictate whether the vessel turns on arrival or departure. However, both maneuvers are feasible under favorable conditions.

With elevated wind conditions, the berth orientation at Mack Point is not ideal because the wind (often from SW or SSW) tends to catch the stern of the vessel just as it initiates the final turn and alignment with the berth. As noted above, this is a similar effect to what is experienced currently with vessels at the existing berths; however, with the larger sail-area of cargoes expected for the wind industry the effect is even more pronounced and would likely lead to some limitation in wind conditions for the operation (i.e., in the 20-25 knot range).

Sears Island

The alignment of the Sears Island terminal is parallel to the existing navigation channel and parallel to the shoreline of Sears Island. The following observations were made during the study about the terminal concept at Sears Island:

- There are no adjacent structures, resulting in larger navigation clearances, and associated safety when compared to Mack Point. The wind farm components moored to the Sears Island berth were the only navigation obstacles of concern for these maneuvers.

- The terminal is near open deep water to the south with nearly unrestricted turning area. This provides a safety margin for the turning maneuver and would allow the maneuver to be performed at higher wind speeds than comparable maneuvers at Mack Point. For the Mack Point terminal, there is sufficient space to turn the vessel, but maneuvering is confined to a defined area with hard structures adjacent.

- The terminal concept at Sears Island aligns reasonably well with the dominant wind direction (i.e., from SSW to SW). Wind conditions evaluated ranged from 15 knots steady to 25 knots gusting and directions from SSE to NW. While the exact wind limits may depend on the type and size of vessel, the pilots indicated clearly that for comparable vessels the wind speed limits for the Sears Island terminal would be higher than for the Mack Point terminal. This would result in increased berth availability for a terminal built at Sears Island.

- The terminal aligns with the shore, meaning the currents (though generally a minor effect) would tend to run parallel to the berth. In contrast, the currents at Mack Point tend to run across the berth, which is a more adverse condition.

Conclusions

In summary, the following conclusions were determined after two days of simulations under a wide variety of conditions:

- It is feasible to safely navigate to and from both terminals under typical environmental conditions. E.g., wind speeds less than 20 knots occur approximately 85% of the time and appear feasible for both terminals.

- The Sears Island terminal is in a definitively better location from a navigation perspective, providing for safer approach and departure maneuvers (increased clearances and better alignment with environmental conditions).

- Due to the lack of surrounding navigational obstacles, the Sears Island terminal concept allows for higher allowable wind speeds for vessel transit and would allow for less environmental restrictions for vessel maneuvering.

- The size of the tugs in the existing fleet are adequate for the vessels considered in this study. This study did not address the question of whether the number of tugs in the existing fleet will be sufficient to service the wind port or whether additional tugs may be required.

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1.0 INTRODUCTION

In support of future offshore wind energy projects, the Maine Department of Transportation is developing a port complex near Searsport, Maine. Searsport is located in Penobscot Bay, approximately 25 miles SSW of Bangor (Figure 1-1). Two specific locations were identified in the vicinity of Searsport. Both locations meet many of the basic project criteria and were selected for inclusion in the alternatives analysis for the project. The two proposed locations are:

- Mack Point: In this alternative, the port complex would be located on the mainland, in Searsport, adjacent to the existing port infrastructure.

- Sears Island: In this alternative, the port complex would be located on the west side of Sears Island, which is connected to the mainland by a causeway.

In support of the alternatives analysis, a full mission bridge ship simulation study was conducted as the United States Maritime Resource Center (USMRC) in Middletown, RI. All simulations were conducted by active Penobscot Bay & River pilots.

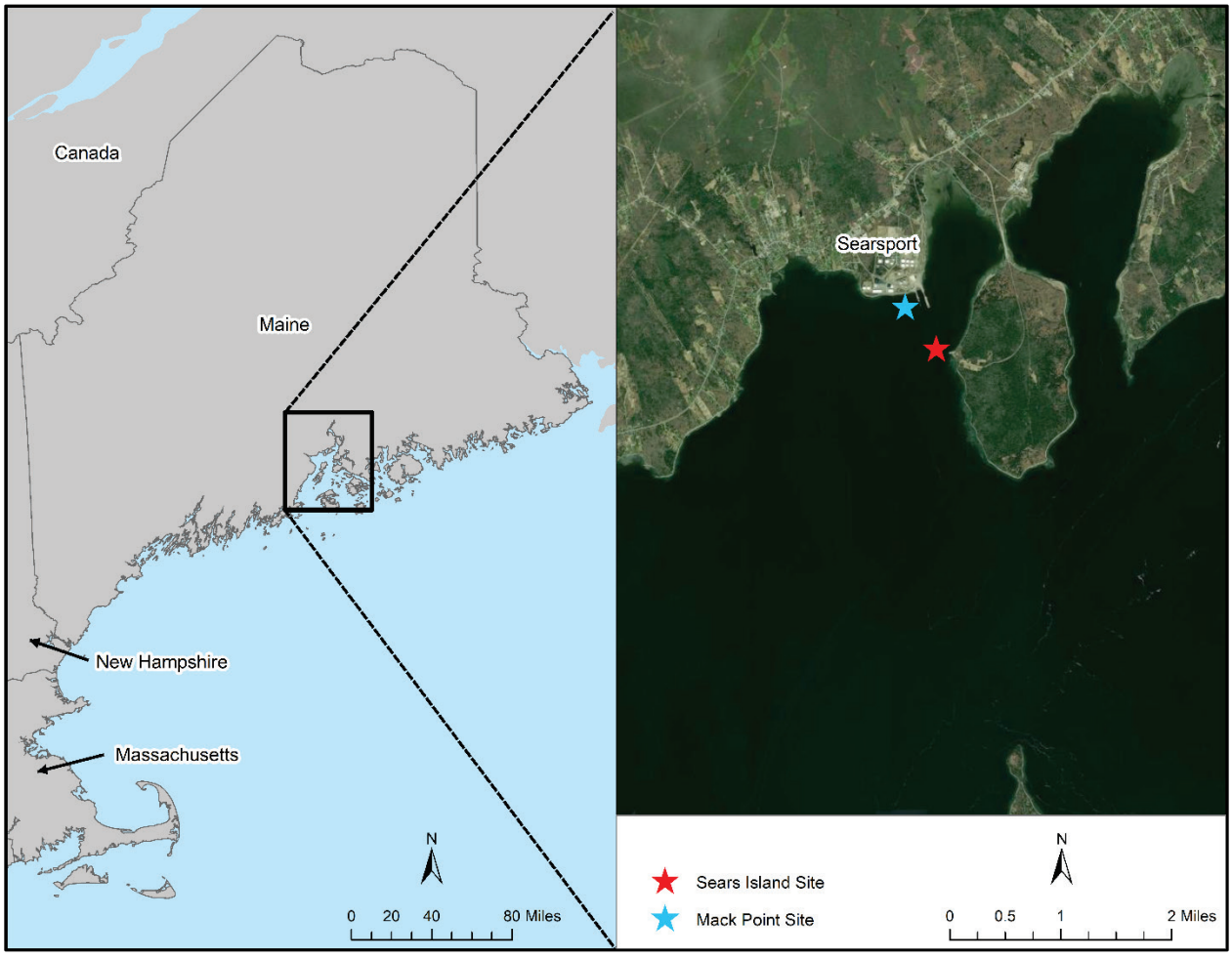


Figure 1-1: Project Location

1.1 Study Objectives

The selection of one site over the other depends on several factors. The purpose of this study was to compare the two locations from the perspective of navigation to/from the proposed terminals by the vessels that would be expected to call at the port.

Since the two terminals are located within 0.5 miles of each other, the navigation conditions only vary with respect to the final approach to the terminal; i.e., the transit from the ocean is the same for both terminals. This study was designed to provide insight into the differences between the two terminal locations with respect to navigation conditions and safety.

In particular, the study was looking to answer questions such as (but not limited to) the following:

- Does one terminal concept provide a higher degree of safety for navigation?
- Does one terminal concept provide better operability in terms of wind limits (i.e., less downtime)?
- Does one terminal provide more flexibility for future vessel operations that may not be envisioned currently (e.g., different or larger vessels, etc.)?
- Does one terminal provide for quicker arrival and departure maneuvers?
- Does one terminal concept provide a better opportunity for safe berthing for support vessels (e.g., tugs) under adverse conditions?

1.2 Stakeholders and Participants

Maine DOT commissioned the study and is the primary stakeholder. A complete list of the study participants who attended the simulations in person is included in Table 1-1.

Table 1-1: Navigation Study Participants

Name	Affiliation	June 11	June 12
Capt. David Gelinas	Penobscot Bay & River Pilots Association	✓	✓
Capt. Adam Philbrook	Penobscot Bay & River Pilots Association	✓	✓
Brian Holden	USMRC	✓	✓
Capt. Rick Comeau	USMRC	✓	✓
Josh Singer, PE	Moffatt & Nichol	✓	✓
Jeffrey Oskamp, PE	Moffatt & Nichol	✓	✓
Maryam Aboosaber, PE	Moffatt & Nichol	✓	
Alek Boving	Moffatt & Nichol	✓	
Thomas Hickey	Moffatt & Nichol		✓

2.0 SIMULATION BASIS

2.1 Design Vessels

The offshore wind industry in the US is rapidly evolving, so the precise vessels that will call at the terminal are not known for certain. However, based on the operating concept for the proposed port complex at Searsport, many of the large wind turbine components will be delivered by specialized heavy lift and/or roll-on/ roll-off (RoRo) vessels. These vessels would arrive loaded with components (elevated wind area) and depart with a lighter load.

The port facility would build the floating foundation units, launch the foundations, and then fit them with the wind turbine components, prior to towing out to sea. The navigation characteristics of the floating foundation units near the berth and towing out to sea are not considered in this study, which focuses on the vessels that would deliver components to the terminal. Table 2-1 summarizes the design vessels for this study. USMRC selected vessel models from their database which reasonably represent these design vessels for the purpose of this study (Table 2-2). The pilot cards for each vessel model are included in Appendix A. The tugs available to the pilots during the study closely matched the existing tug fleet in Penobscot Bay (Table 2-3; use of tugs was at the pilot's discretion; two tugs were used for each simulation).

Table 2-1: Proposed Vessels for Simulations

Parameter	Bigroll Biscay	Da Type 3
Length Overall [ft]	479	589
Beam [ft]	92	92
Draft (operating) [ft]	17.4	30
Propulsion	Azipods 1x bow thruster	Single screw, fixed pitch

Table 2-2: Vessel Models Used for Simulations

Parameter	Heavy Lift ECO LIFTER (carrying blades)	Chem Tanker #1	Bulk Carrier 24 (ballast)
Length Overall [ft]	492	600	509
Beam [ft]	84	90	85
Draft (at transit) [ft]	23.8	18.9 (bow) 25.6 (stern)	8.2 (bow) 17.2 (stern)
Propulsion	Single screw, fixed pitch Schilling rudder 1 bow thruster	Single screw, fixed pitch 1x bow thruster	Single screw, fixed pitch 1x bow thruster

Table 2-3: Tugs – Existing Fleet Operated by Fournier Tugs

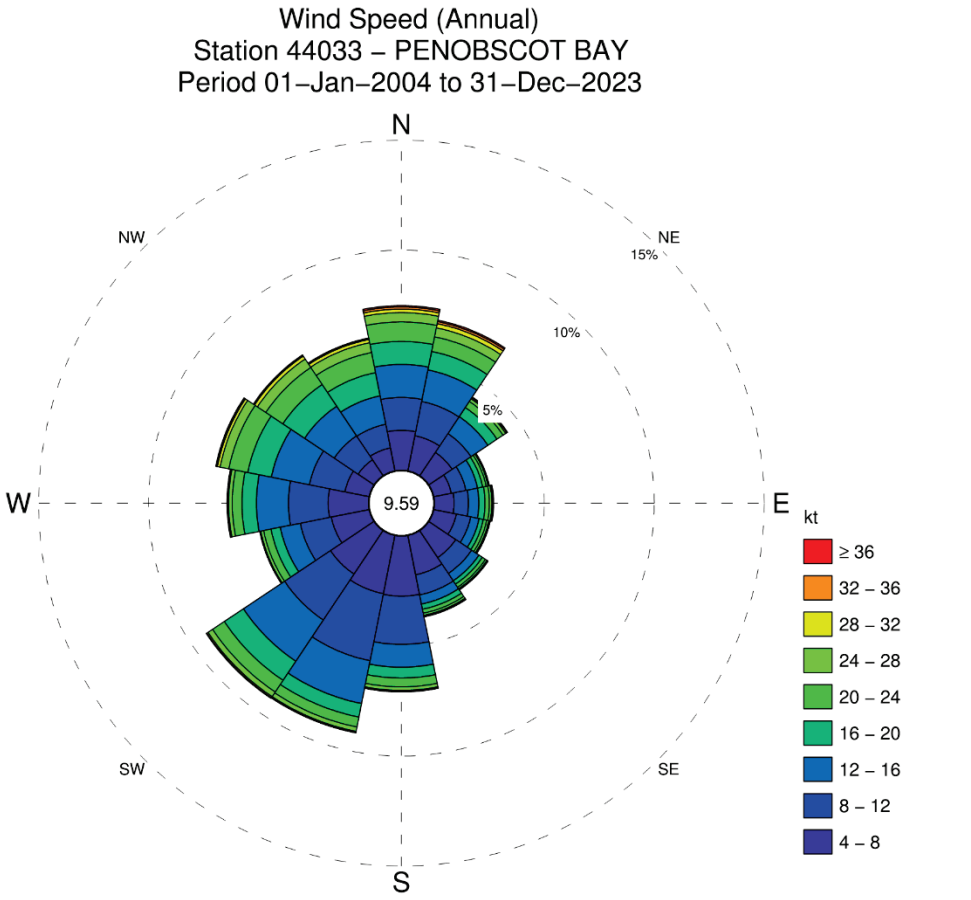
Parameter	Fournier Tractor	Fournier Boys	Capt. Arthur Fournier
Length Overall [ft]	85	90	101
Beam [ft]	33	50	32
Draft (operating) [ft]	12.5	17	13.5
Bollard Pull [t]	40	60	40
Propulsion Type	Azimuth Stern Drive (ASD)	Ship Docking Module (SDM) Z-drive	Twin Screw

2.2 Metocean Conditions

2.2.1 Wind

Wind data was obtained from the anemometer at NOAA Station 44033 *Penobscot Bay*. This station is maintained by the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) as station F01. This station records wave conditions, depth-varying current speed/direction, and wind conditions. While the waves and currents reported from this station are too far from the site to be applicable, the wind conditions recorded here are the most applicable for the project of available sources. Figure 2-1 shows an all-season wind rose and histogram for a 20-year period, from January 2004 through December 2023. Common wind directions are in the sectors WNW-N and SSW-SW. The wind speeds reported represent 30-second average wind speeds.

For reference, the 100-year wind speed reported by ASCE 7 for this area is 90 mph (3-second gust). This 3-second gust is approximately equivalent to a 78.9 mph (68.6 knots) as a 30-second average speed which is similar to the 95% confidence limit for wind speeds estimated in this study (67.1 knots; Table 2-4).



Percentage of Occurrence

Wind Speed, kt	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	7.48	6.98	4.30	2.57	2.70	2.62	3.24	3.77	7.08	9.14	9.17	5.07	6.43	7.11	6.60	6.15	90.41
36																	0.28
32																	0.55
28	0.16	0.20												0.13	0.16	0.15	1.26
24	0.42	0.41	0.14		0.11				0.16	0.20	0.25	0.13	0.17	0.41	0.46	0.45	3.67
20	0.88	0.68	0.33	0.16	0.20	0.16	0.17	0.18	0.40	0.46	0.64	0.34	0.44	0.87	0.93	0.93	7.77
16	1.05	0.86	0.50	0.24	0.28	0.20	0.19	0.24	0.49	0.63	1.05	0.43	0.66	1.10	1.19	1.08	10.18
12	1.50	1.46	0.93	0.54	0.48	0.39	0.40	0.43	1.04	1.98	2.25	0.93	1.46	1.77	1.62	1.32	18.49
8	1.50	1.58	1.03	0.68	0.65	0.66	0.87	0.93	2.19	3.11	2.51	1.43	1.81	1.64	1.30	1.09	22.97
4	1.81	1.63	1.28	0.81	0.90	1.05	1.48	1.82	2.73	2.70	2.38	1.75	1.83	1.12	0.87	1.06	25.24
Total	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total

Figure 2-1: Directional Wind Rose – NDBC Station 44033

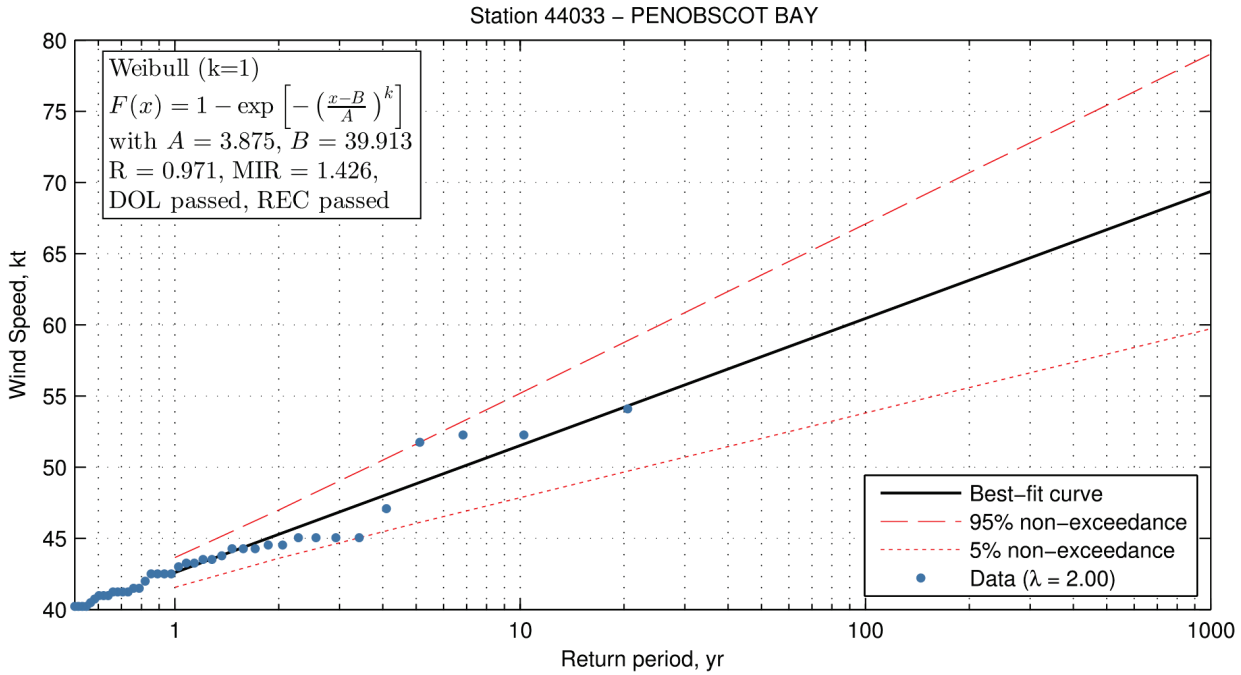


Figure 2-2: Extreme Value Analysis for Wind Speeds – NOAA Station 44033

Table 2-4: Wind Speed Return Periods – NOAA Station 44033

Return Period [years]	Wind Speed [knots] (30-second average)		
	5% Confidence	Best Fit	95% Confidence
5	46.1	48.8	51.6
10	47.9	51.5	55.2
25	50.2	55.1	59.9
50	52.0	57.8	63.5
100	53.8	60.4	67.1

2.2.2 Waves

In support of the simulation study, waves were considered as would be generated by the wind local to the site, based on the wind rose reported above. The calculations were performed using empirical wave growth equations presented in the US Army Corps of Engineers Coastal Engineering Manual (CEM) [1]. Figure 2-3 provides a wave rose for the project area. Based on this information, the waves exceed 1.0 ft significant wave height approximately 15 percent of the time. The waves included were calculated by the simulator software and coincide with the wind speed and direction.

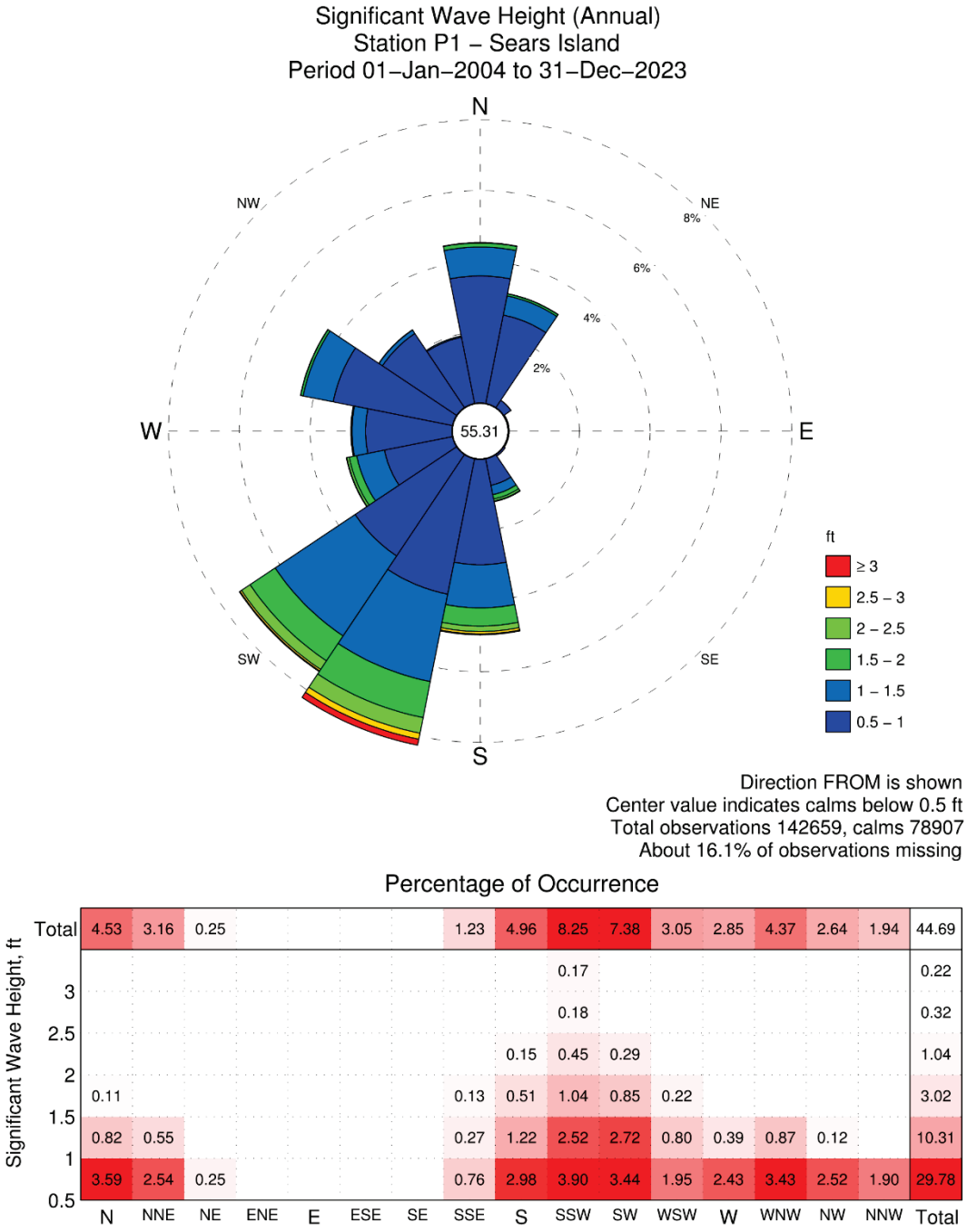


Figure 2-3: Wave Rose – Searsport Vicinity

2.2.3 Currents

Currents due to astronomical tides near Searsport are relatively weak and tend to run parallel to the shore. In support of the ongoing design and permitting efforts, M&N has prepared hydrodynamic models to simulate the tidal currents in Penobscot Bay. The details of the tidal

model will be presented in a separate study, but relevant results for the ship simulation effort are presented here at five (5) output points near the project (Figure 2-4). Current roses, illustrating the percent of the time that currents run in each direction and speed are shown in Figure 2-5 (output point No. 1, Sears Island) and Figure 2-6 (output points No. 2 through No. 5). Currents in the vicinity of each terminal tend to run up to a maximum of about 0.2 knots in either direction along the shore.

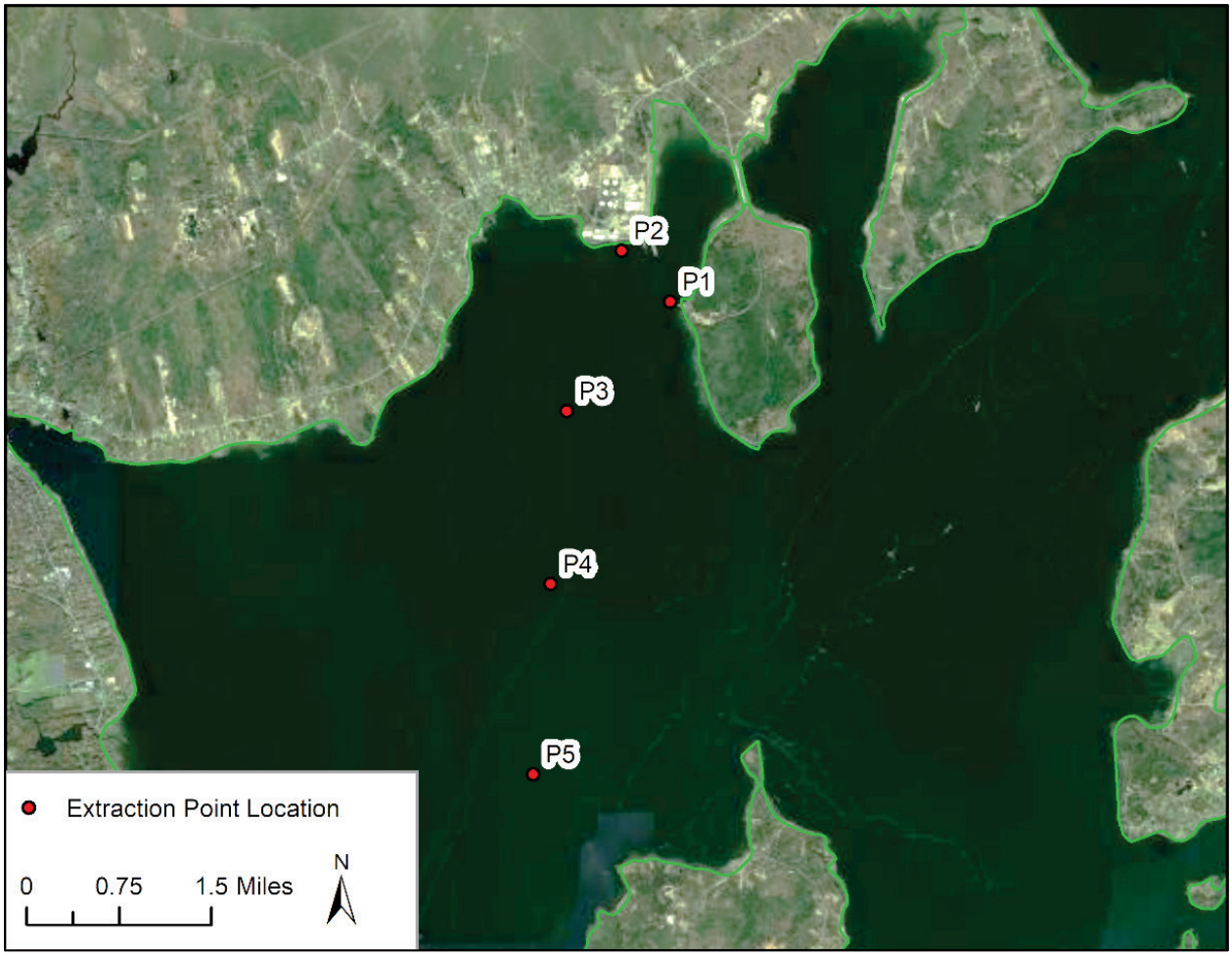


Figure 2-4: Current Model Output Point Locations

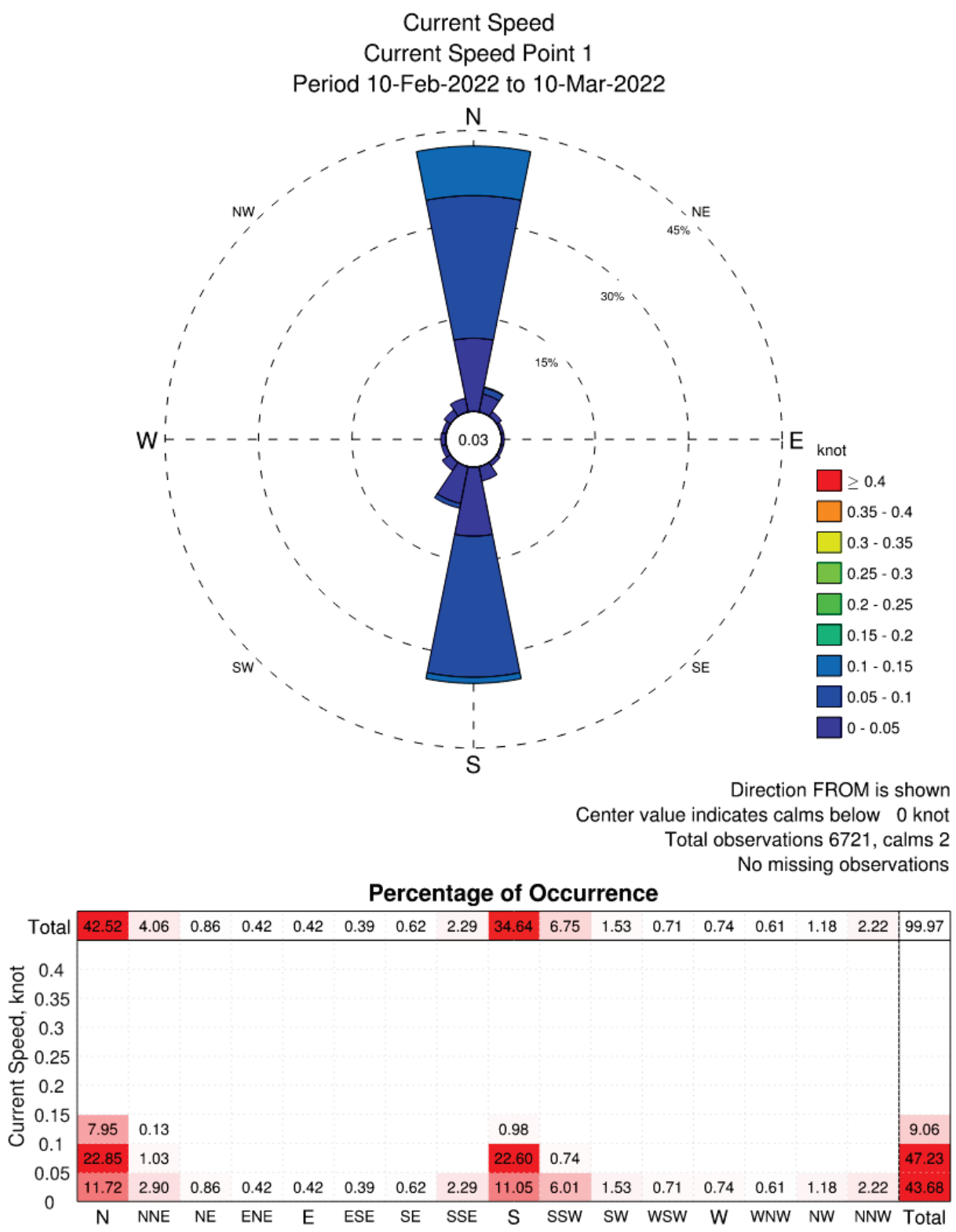


Figure 2-5: Current Data – Output Point No. 1 (Sears Island)

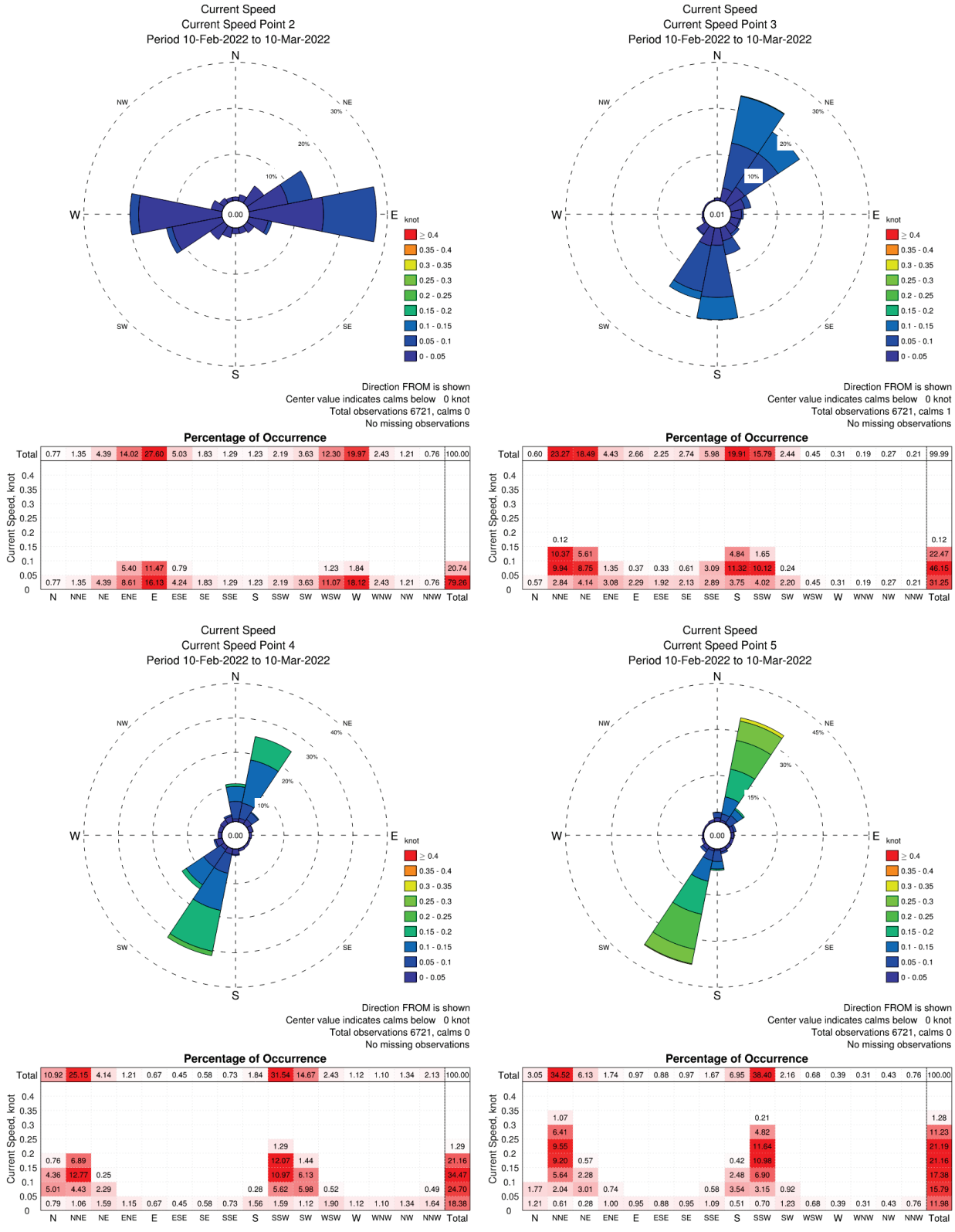


Figure 2-6: Current Data – Output Points No. 2 through No. 5

2.3 Port Geometry

The two port concepts evaluated are illustrated in Figure 2-7, summarized as follows:

- **Mack Point Concept (Figure 2-7, left side):** the proposed wharf configuration includes two wharf segments adjacent at a 90-degree angle. This includes one berth parallel to the existing liquid bulk and dry bulk terminals, which would be used for vessels delivering wind turbine components (e.g., blades, etc.). Additionally, the terminal provides an open south-facing wharf that could be used for delivery vessels but is primarily intended to support wind turbine foundations.

- **Sears Island Concept (Figure 2-7, right side):** The alignment of the Sears Island terminal is parallel to the existing navigation channel and parallel to the shoreline of Sears Island. The terminal provides +/-1,500 ft of continuous wharf space. Given the size of the delivery vessels anticipated, this would support two delivery vessels. Crane equipment would be installed toward the north end of the wharf, making this the preferred location for working with the floating foundation elements.

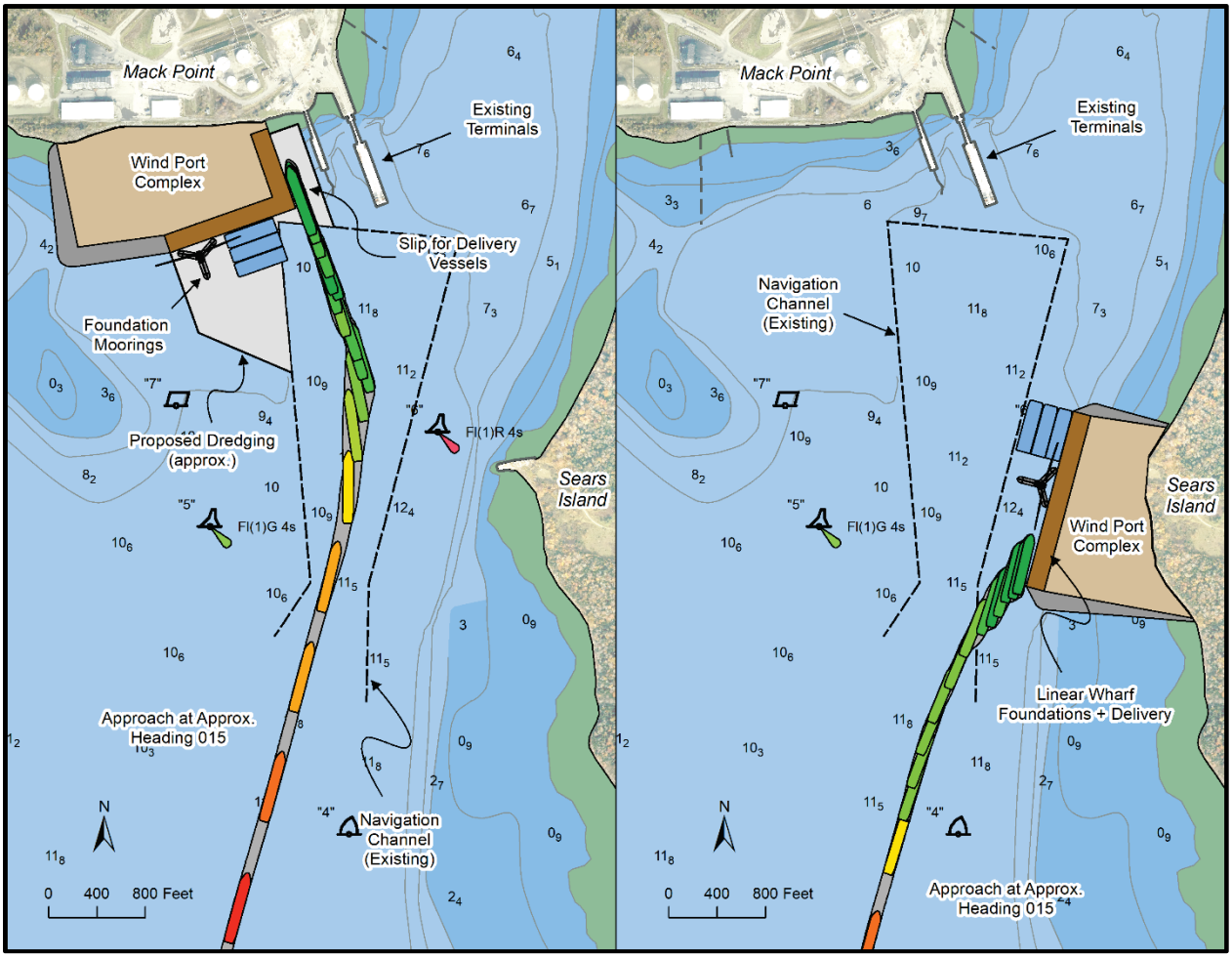


Figure 2-7: Terminal Geometry (Mack Point: Left Side; Sears Island: Right Side)

2.4 Description of Maneuvers

2.4.1 Mack Point

Approach Maneuver: The approach to the terminal area is similar to the approach for the existing Mack Point terminals. Transit past Sears Island is at approximately a heading of 015 degrees. For a port-side-to docking maneuver, the approach is as shown in Figure 2-7, with a turn of +/- 30 degrees to port to align with the berth while completing the final approach. For some vessels, the cranes may require berthing in a specific orientation to reach all the cargo on the vessel. If a starboard-side-to configuration is required at the berth, the vessel would turn on the inbound maneuver.

Departure Maneuver: Departure from the Mack Point terminal is different depending on the vessel orientation at the berth. For a starboard-side-to configuration at the berth, the vessel can pull straight out of the berth making a gentle turn to starboard as it approaches Sears Island. For a port-side-to configuration at the berth, the vessel would back out of the slip and turn (direction of turn dictated by wind direction and pilot's preference) prior to heading south away from the terminal.

2.4.2 Sears Island

Approach Maneuver: The approach to the terminal from open water is the same as for the Mack Point terminal, but the maneuver is shorter, ending adjacent to Sears Island. Compared to Mack Point, the terminal is on the opposite side of the channel, so the starboard-side-to berthing operation is simpler than port-side-to. However, as noted above, certain vessel-cargo-crane combinations may dictate the orientation for berthing.

Departure Maneuver: Departure from the Sears Island terminal is different depending on the vessel orientation at the berth. For port-side-to orientation, the departure maneuver involves pulling the vessel off the dock and then heading south (the wharf aligns closely with the departure heading). Departure from a starboard-side-to orientation requires turning the vessel. However, the area adjacent to the dock is all deep water relative to the vessel drafts expected, so there is minimal limitation on the area that the pilots can use for turning.

2.5 Aids to Navigation

Besides terminal lighting and electronic nautical chart aids, the existing aids to navigation (ATONs) in the vicinity of the terminals include one lit red buy immediately adjacent to Sears Island and one lit green buoy, across the channel from Sears Island (Figure 2-7).

This study did not evaluate ATONs in detail, but it is acknowledged that the red buoy would need to be re-located if the Sears Island concept is selected because it is located within the footprint of the proposed terminal. Once an alternative is selected, the location of existing ATONs should be evaluated and revised. If additional ATONs are required, they can be identified at that time.

3.0 SIMULATION METHODOLOGY

3.1 Simulator Facility and Software

The simulations were conducted at the United States Maritime Resource Center (USMRC) in Middletown, Rhode Island. USMRC runs the Wärtsilä NTPro 5000 simulation software, which is used in many ship simulation centers around the world, including M&N's in-house simulator in Baltimore, Maryland. The software is developed primarily for use in training for professional mariners; however, given the fidelity of the simulation experience, it is also well suited for engineering applications.

NTPro simulates real time vessel maneuvers through realistic 3D renderings of harbor geometry (Figure 3-1), accounting for vessel response to wind, waves, currents, bathymetry (shallow water effects), and vessel-structure interaction. The vessel hydrodynamics are incorporated with a full six degree-of-freedom model. Ship models used in the simulator are developed and verified with data from basin tests and real-world collection schemes. The vessel models used for this study are from the USMRC vessel library.

Figure 3-1: USMRC Simulator Bridge – Approach to Sears Island Terminal

Simulations in this study were conducted by two of the Penobscot Bay pilots (Table 1-1). For each simulation, one of the pilots conned the vessel, while the other acted as the helmsman.

USMRC has three different ship bridges at the center, with the capability of simulating multiple interacting vessels in the same real-time experience. This includes tugs, which could be included

as separate manned vessels in the simulation. However, this would require additional participation from tug masters and was beyond the scope of this study. Tugs were handled using the NTPro auto-tug feature, in which boat and line handling for the tugs is completed by the software itself based on commands by the simulator operator. The pilot conning each simulation gave tug orders through a radio to the simulator operator who carried out the orders in real-time.

3.2 Testing Matrix

The matrix of simulations completed for this study is shown in Table 3-1. The following considerations were used in selecting the scenarios and conditions:

- The focus of the study was to compare the two terminals with respect to navigation, so when possible similar vessels and conditions were used for both terminals.

- Both port-side-to and starboard-side-to maneuvers were simulated at each terminal.

- Inbound simulations generally were initiated southwest of Sears Island along the typical inbound route. The inbound vessel heading for approaching both terminals is 015 degrees.

- With one exception (Simulation 7) all simulations directly considered arrival or departure from one of the two proposed terminals. Simulation 7 considered transit of a vessel from one of the existing docks past the Sears Island terminal (to illustrate the clearance between the existing channel and the proposed terminal).

- Most of the simulations considered vessels arriving or departing the portion of berth that would be considered “typical” for receiving delivery vessels. However, a few simulations (e.g., Simulation 13) considered the possibility of a delivery vessel berthing along the portion of wharf that would typically be used for the floating foundations.

- Based on input from the pilots, wind speeds were considered as 15-25 knots for most simulations. The purpose of the simulations was not to identify the most extreme conditions that would be possible, but to use conditions that are elevated to the point where any differences between the terminals would be evident, in terms of how high winds would affect the maneuvers.

Table 3-1: Matrix of Completed Simulations

Simulation No.	Day	Pilot	Vessel Model	Description	Vessel Orientation at Berth	Wind Speed [kts]	Wind Direction [deg. Nautical]	Currents	Tug 1 (Bow)	Tug 2 (Stern)
1	1	Capt. David Gelinas	Bulk Carrier 24	Inbound to Sears Island	Starboard-side-to	15.0	202.5	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
2	1	Capt. Adam Philbrook	Chemical Tanker	Inbound to Sears Island	Starboard-side-to	10.0	315.0	Ebb	Fournier Boys (60t SDM)	Fournier Tractor (40t ASD)
3	1	Capt. David Gelinas	Heavy Lift ECO LIFTER	Inbound to Sears Island	Port-side-to	15.0	202.5	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
4	1	Capt. Adam Philbrook	Heavy Lift ECO LIFTER	Inbound to Sears Island	Port-side-to	22.0 (gusting)	220.0	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
5	1	Capt. David Gelinas	Chemical Tanker	Inbound to Sears Island	Starboard-side-to	15.0	315.0	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
6	1	Capt. Adam Philbrook	Chemical Tanker	Outbound from Sears Island	Starboard-side-to	15.0	315.0	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
7[a]	1	Capt. David Gelinas	Chemical Tanker	Outbound from Liquid Bulk Dock (existing)	Starboard-side-to	15.0	315.0	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
8	2	Capt. David Gelinas	Chemical Tanker	Inbound to Mack Point	Port-side-to	15.0	202.5	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
9	2	Capt. Adam Philbrook	Heavy Lift ECO LIFTER	Inbound to Mack Point	Starboard-side-to	15.0	202.5	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
10	2	Capt. David Gelinas	Heavy Lift ECO LIFTER	Inbound to Mack Point	Starboard-side-to	22.0 (gusting)	225.0	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
11	2	Capt. Adam Philbrook	Heavy Lift ECO LIFTER	Inbound to Mack Point	Starboard-side-to	22.0 (gusting)	225.0	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
12	2	Capt. David Gelinas	Heavy Lift ECO LIFTER	Inbound to Mack Point	Starboard-side-to	22.0 (gusting)	225.0	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
13	2	Capt. Adam Philbrook	Heavy Lift ECO LIFTER	Inbound to Mack Point	Port-side-to	22.0 (gusting)	225.0	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)
14	2	Capt. David Gelinas	Heavy Lift ECO LIFTER	Inbound to Sears Island	Port-side-to	25.0 (gusting)	225.0	Flood	Captain Arthur (40t Twin Screw)	Fournier Tractor (40t ASD)

[a] USMRC was unable to locate the log file for Simulation No. 7 after the simulations were complete.

4.0 OVERVIEW OF SIMULATION OUTPUT DATA TYPES

4.1 Feedback from Pilots & Notes

The notes taken by the USMRC staff and other observers during the simulations are one of the important ways of documenting the conversations and observations that took place during the study. The simulation participants gathered after each simulation to talk about how it went, what was learned, and if/how that would affect the conditions to be tested next. Appendix B includes the simulation summaries (including notes) prepared by USMRC, and Appendix C includes the simulation notes prepared by M&N. These notes will not be summarized directly here but are incorporated directly and/or indirectly into the discussion in Section 5.0.

4.2 Map Figures

One helpful way of understanding the simulation data is through plan-view (i.e., map) figures that illustrate the tracks taken by each vessel and the movements of the tugs relative to the deep-draft vessel. Appendix D includes a plan-view summary of each simulation in the study. In each figure, the speed of the vessel (speed over ground, knots) is shaded in color at snapshots (2-minute intervals) throughout each simulation. Typical figures are illustrated in Figure 4-1.

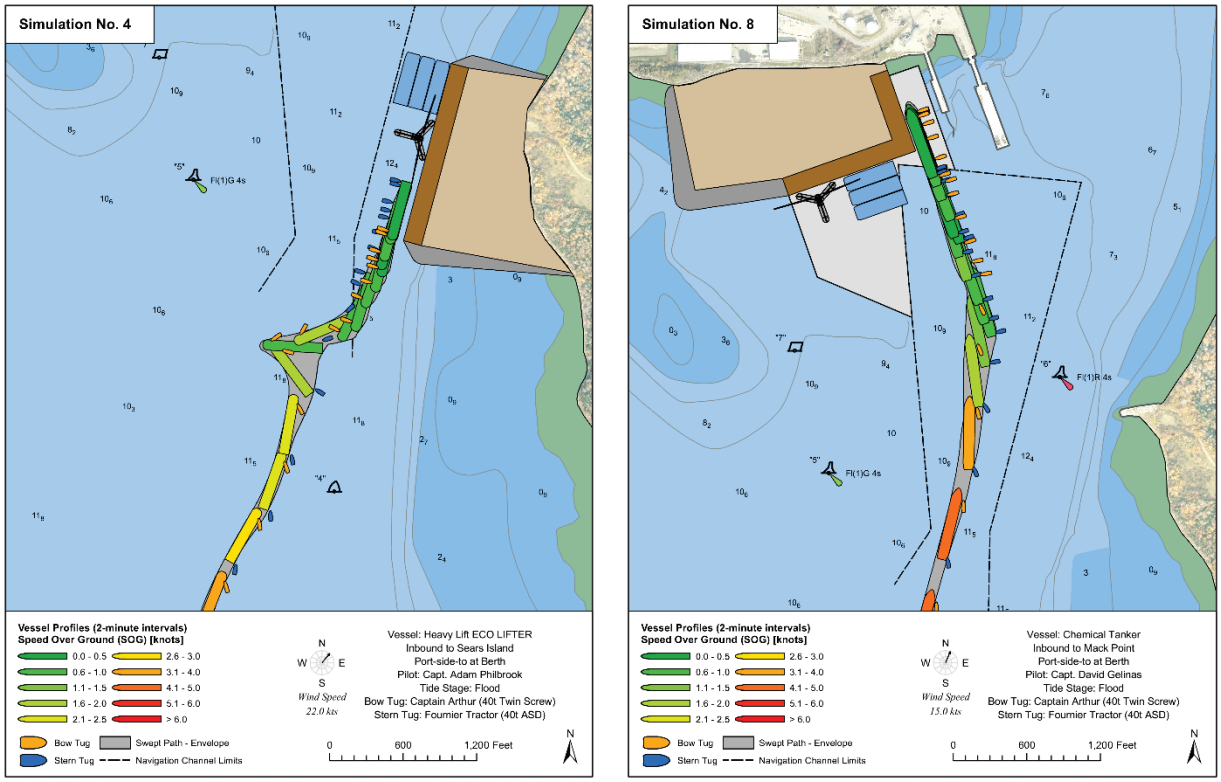


Figure 4-1: Typical Swept-path Figures

4.3 Time-history Figures for Vessel Parameters

The ship simulation software saves a log file to the server after each simulation that contains enough information to fully replay the simulation. Detailed reports of the simulation data can be exported for analysis and plotting. Figure 4-2 illustrates a typical time-series plot showing the parameters for one of the simulations. Appendix E includes time-series plots for each simulation.

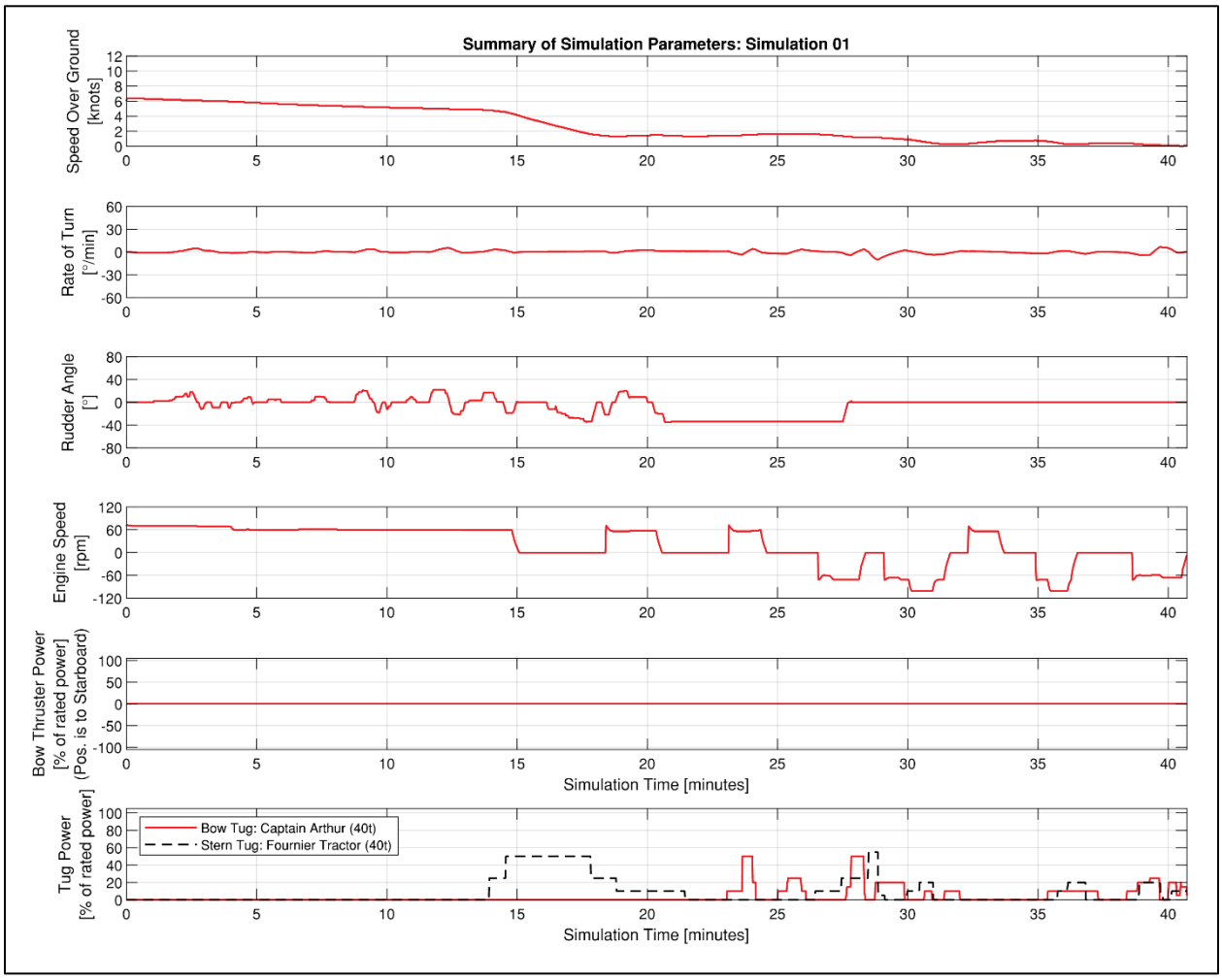


Figure 4-2: Typical Timeseries Figures for Vessel Parameters

5.0 DISCUSSION OF RESULTS

5.1 Mack Point

A total of six simulations were performed to evaluate the Mack Point terminal (Table 5-1). The following subsections discuss key points from the maneuvers. Note that the figures illustrating each maneuver in the text here are snapshots from the complete run summary figures in Appendix D, which contain the corresponding legend & scale information.

Table 5-1: Ship Simulations for the Mack Point Terminal Concept

ID	Vessel Model	Description	Vessel Orientation at Berth	Wind Speed [kts]	Wind Direction [deg. Nautical]	Currents
8	Chemical Tanker	Inbound to Mack Point	Port-side-to	15.0	202.5	Flood
9	Heavy Lift ECO LIFTER	Inbound to Mack Point	Starboard-side-to	15.0	202.5	Flood
10	Heavy Lift ECO LIFTER	Inbound to Mack Point	Starboard-side-to	22.0 (gusting)	225.0	Flood
11	Heavy Lift ECO LIFTER	Inbound to Mack Point	Starboard-side-to	22.0 (gusting)	225.0	Flood
12	Heavy Lift ECO LIFTER	Inbound to Mack Point	Starboard-side-to	22.0 (gusting)	225.0	Flood
13	Heavy Lift ECO LIFTER	Inbound to Mack Point	Port-side-to	22.0 (gusting)	225.0	Flood

5.1.1 Inbound Maneuvers – Typical Conditions (Simulations 8 & 9)

Simulation 8 considered a direct approach into the slip (Figure 5-1, no turn). The maneuver is qualitatively similar to the comparable maneuvers for the existing terminals. The minimum clearance between the tugs and the existing terminal was 68ft, illustrating the relatively tight space in the berth area. The Chemical Tanker vessel model was used for this simulation to illustrate the longest and widest of the design vessels for the Mack Point delivery berth.

Simulation 9 includes the same environmental conditions as Simulation 8, but the vessel was switched to a heavy lift vessel with larger wind area (the ECO LIFTER). This vessel is smaller than the Chemical Tanker (Table 2-2) but includes a larger wind area. Simulation 9 illustrates a typical inbound maneuver to the starboard-side-to berth orientation.

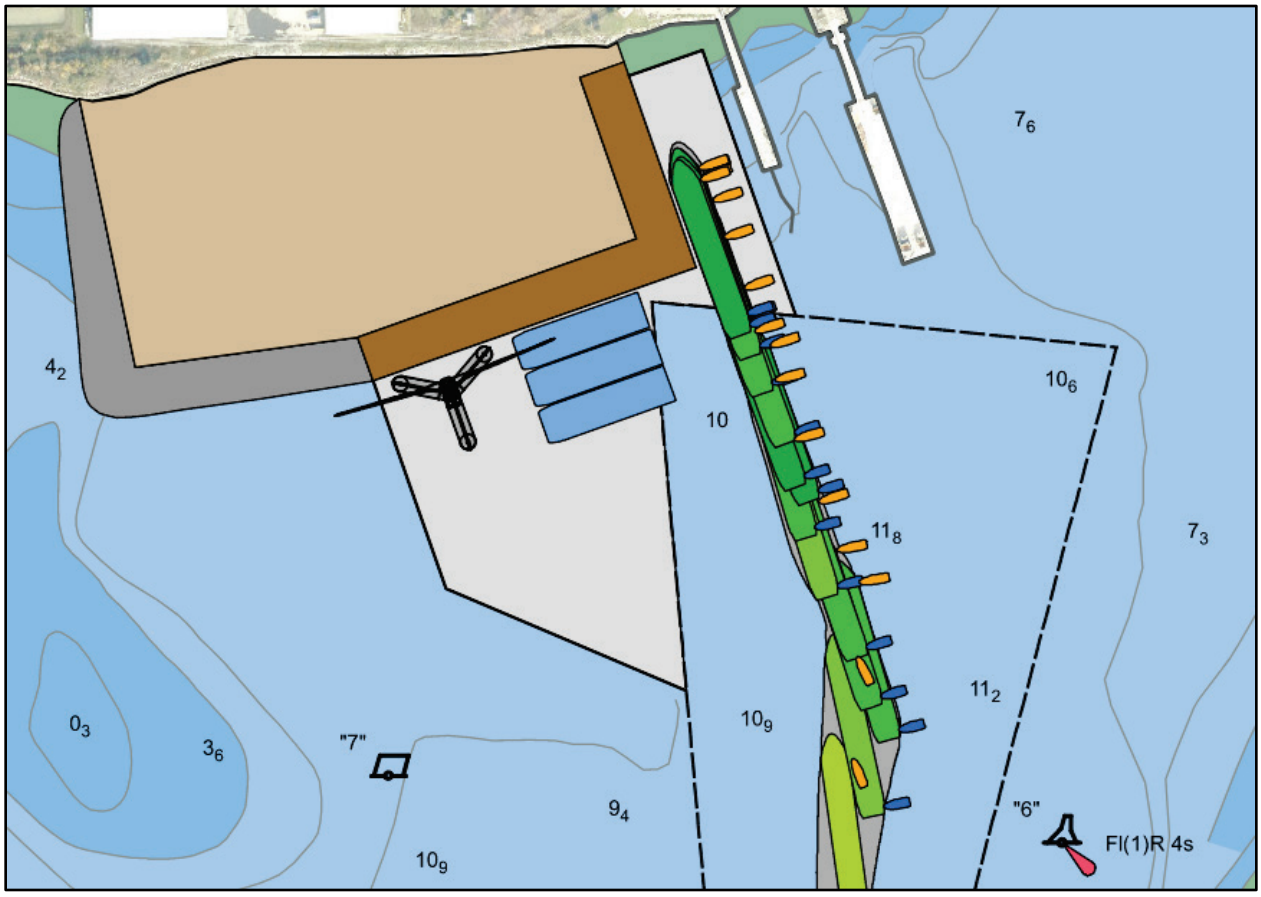


Figure 5-1: Simulation 8 – Approach to Mack Point – Typical Conditions

5.1.2 Inbound Maneuvers – Elevated Conditions (Simulations 10 & 11)

Both Simulations 10 & 11 considered the same conditions. Based on the wind effects felt in Simulations 8 and 9, the team was concerned that 25 knots of wind would not likely be feasible; however, the team wanted to explore what a reasonable upper limit might be for the approach. Simulations 10 & 11 considered 22 knots of wind (with gusts). This maneuver was performed twice, once by each of the pilots participating in the study.

The pilots executed the turn in opposite directions, reflecting their individual preference. In both cases the wind effect was strong; these two simulations used more tug power than any other simulations in the study. Simulation 10 (Figure 5-2) used full power on one of the tugs for a period of several minutes.

The project team concluded that 22 knots of wind is likely near the upper limit of wind speed for this vessel. Note that the wind effects on vessels carrying wind components could vary substantially depending on the type of components (blades, towers, etc.). The purpose of this study was to compare the maneuvers between the two proposed terminals, not to define a precise upper limit for wind.

One other item to consider regarding the Mack Point terminal is the orientation relative to the dominant wind directions. Strong wind frequently approaches from SW or SSW, which would tend to catch the stern of the vessel just as it initiates the final turn and alignment with the berth. This is a similar effect to what is experienced currently with vessels at the existing berths; however, with the larger sail-area of cargoes expected for the wind industry the effect is even more pronounced and would likely lead to some limitation in wind conditions.

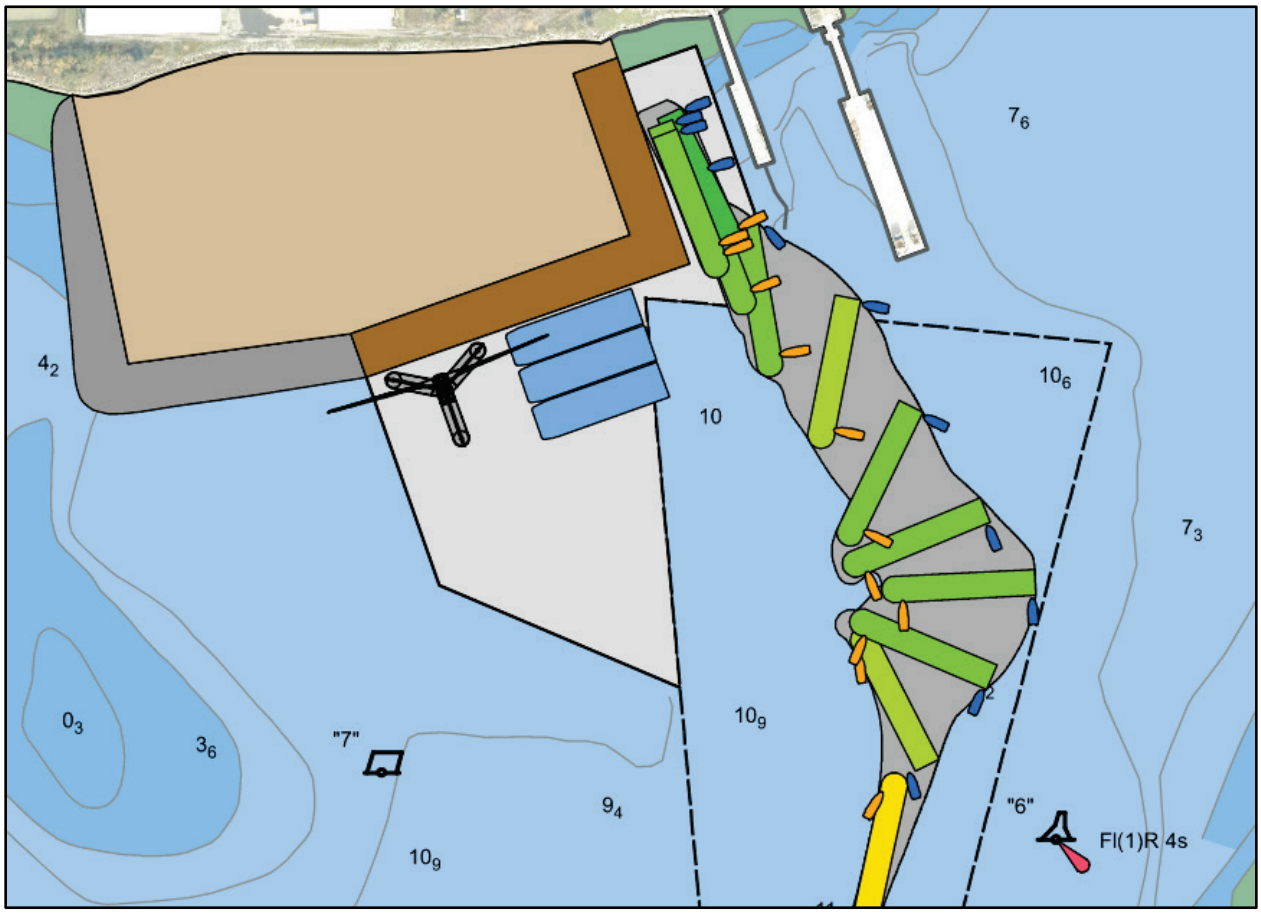


Figure 5-2: Simulation 10 – Approach to Mack Point – Elevated Wind

5.1.3 Maneuvers to the Open South Facing Wharf (Simulations 12 & 13)

These two simulations considered the same elevated environmental conditions as the previous simulations. However, the destination for the vessel was the south-facing portion of the wharf (Figure 5-3). Both simulations were completed successfully. The open face of the wharf provides increased clearances compared to berthing inside the slip. Neither simulation used more than 50% tug capacity, and 50% was only used for a brief period.

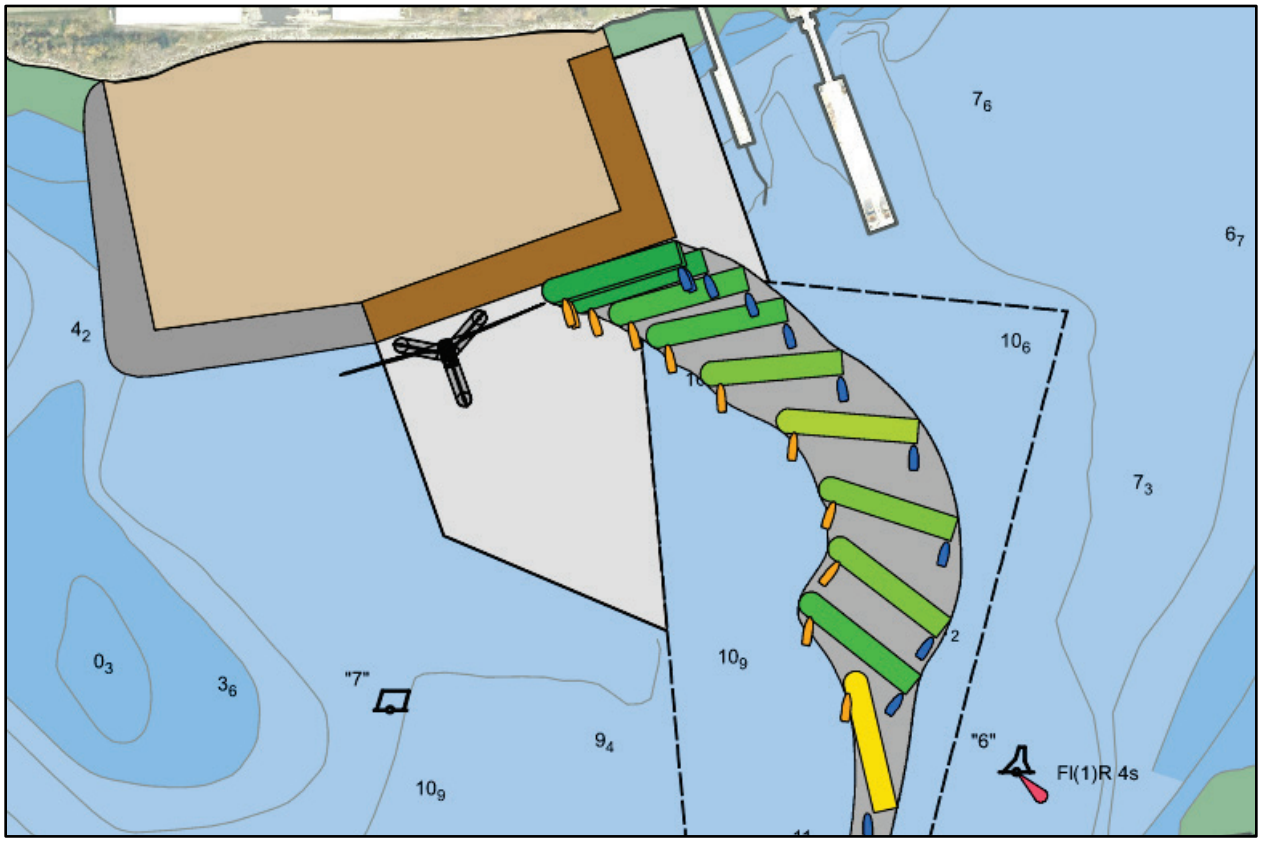


Figure 5-3: Simulation 12 – Mack Point (south-facing wharf)

5.2 Sears Island

A total of seven simulations were performed to evaluate maneuvers to/from the Sears Island Terminal (Table 5-2). Note that the figures illustrating each maneuver in the text here are snapshots from the complete run summary figures in Appendix D, which contain the corresponding legend & scale information.

Table 5-2: Ship Simulations for the Sears Island Terminal Concept

ID	Vessel Model	Description	Vessel Orientation at Berth	Wind Speed [kts]	Wind Direction [deg. Nautical]	Currents
1	Bulk Carrier 24	Inbound to Sears Island	Starboard-side-to	15.0	202.5	Flood
2	Chemical Tanker	Inbound to Sears Island	Starboard-side-to	10.0	315.0	Ebb
3	Heavy Lift ECO LIFTER	Inbound to Sears Island	Port-side-to	15.0	202.5	Flood
4	Heavy Lift ECO LIFTER	Inbound to Sears Island	Port-side-to	22.0 (gusting)	220.0	Flood
5	Chemical Tanker	Inbound to Sears Island	Starboard-side-to	15.0	315.0	Flood
6	Chemical Tanker	Outbound from Sears Island	Starboard-side-to	15.0	315.0	Flood
14	Heavy Lift ECO LIFTER	Inbound to Sears Island	Port-side-to	25.0 (gusting)	225.0	Flood

5.2.1 Starboard-side-to Berthing (Simulations 1 & 2)

The concept for the Sears Island terminal allocates the southern end of the berth as the typical berth for accepting delivery vessels. Simulations 1 & 2 evaluated typical approaches to this southern berth position under modest environmental conditions. Of all the simulations performed, these were the most straightforward maneuvers. The berthing control was noted as “very good”, and tug usage was minimal. The pilots pointed out that the berth orientation aligns better with the dominant wind direction (SW to SSW) than the Mack Point terminal, which improves the vessel control.

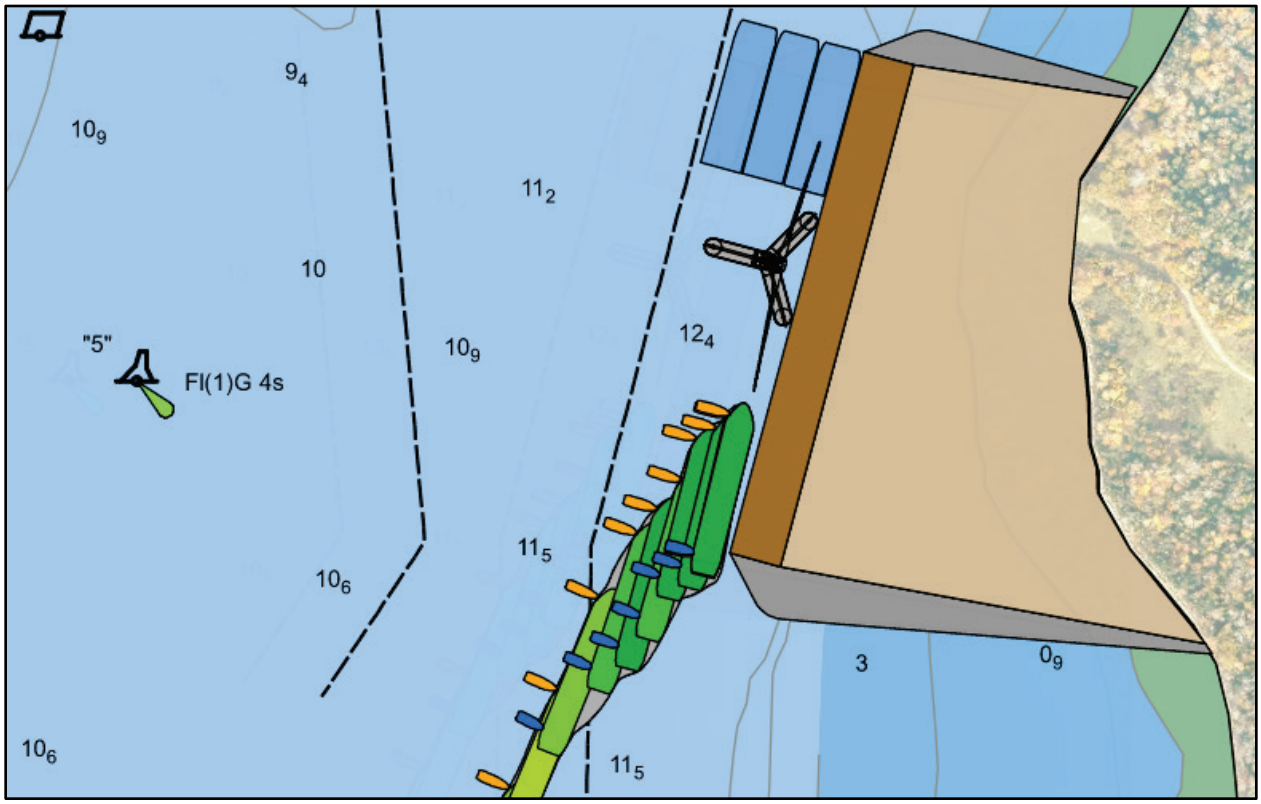


Figure 5-4: Starboard-side-to Berthing at Sears Island (Simulation 1)

5.2.2 Port-side-to Berthing (Simulations 3, 4 & 14)

Three simulations were considered for port-side-to berth orientation on the south berth (typical berth position) for Sears Island. For two of the simulations (3 & 14) the turn was executed toward starboard; Simulation 4 illustrated a turn to port (Figure 5-5). The simulations were performed with increasing wind speed: 15 knots, 22 knots with gusts, and 25 knots with gusts, for Simulations 3, 4, and 14, respectively.

All maneuvers were executed successfully. Simulation 14 considered the highest wind speed used in the study (25 knots). The pilot indicated that there was plenty of sea room to do the maneuver and that the vessel was brought alongside without difficulty. However, the margin of available power was reduced; tug usage on Simulation 14 was quite high (one tug was used for several minutes at full power).

Figure 5-5: Port-side-to Berthing at Sears Island (Simulation 4)

5.2.3 Alternate Berth Position – Approach & Departure (Simulations 5 & 6)

While the typical berth position for a delivery vessel at the Sears Island terminal would involve the vessel mooring alongside the southern end of the wharf, the team agreed that other berth positions would be possible, and a potentially challenging maneuver would be to berth a delivery vessel between equipment moored at either end of the wharf. Figure 5-6 illustrates an approach to the center part of the wharf, with a floating wind turbine moored to the south and barges (representing the launching barges / equipment) to the north.

In the final berth position, the vessel's bow was situated approximately 150 ft from the barges to the north and 50 ft to the wind turbine foundation at the south end. With clearances like this, the maneuver would likely only be performed in daylight with favorable wind conditions (e.g., 20 knots). However, the maneuver appears feasible. Simulation 6 illustrates the outbound maneuver from the same berth position, which was also performed successfully. The specific limits on maneuvers of this kind would depend on the exact size of the vessel in transit and the size of the turbine components and equipment moored adjacent.

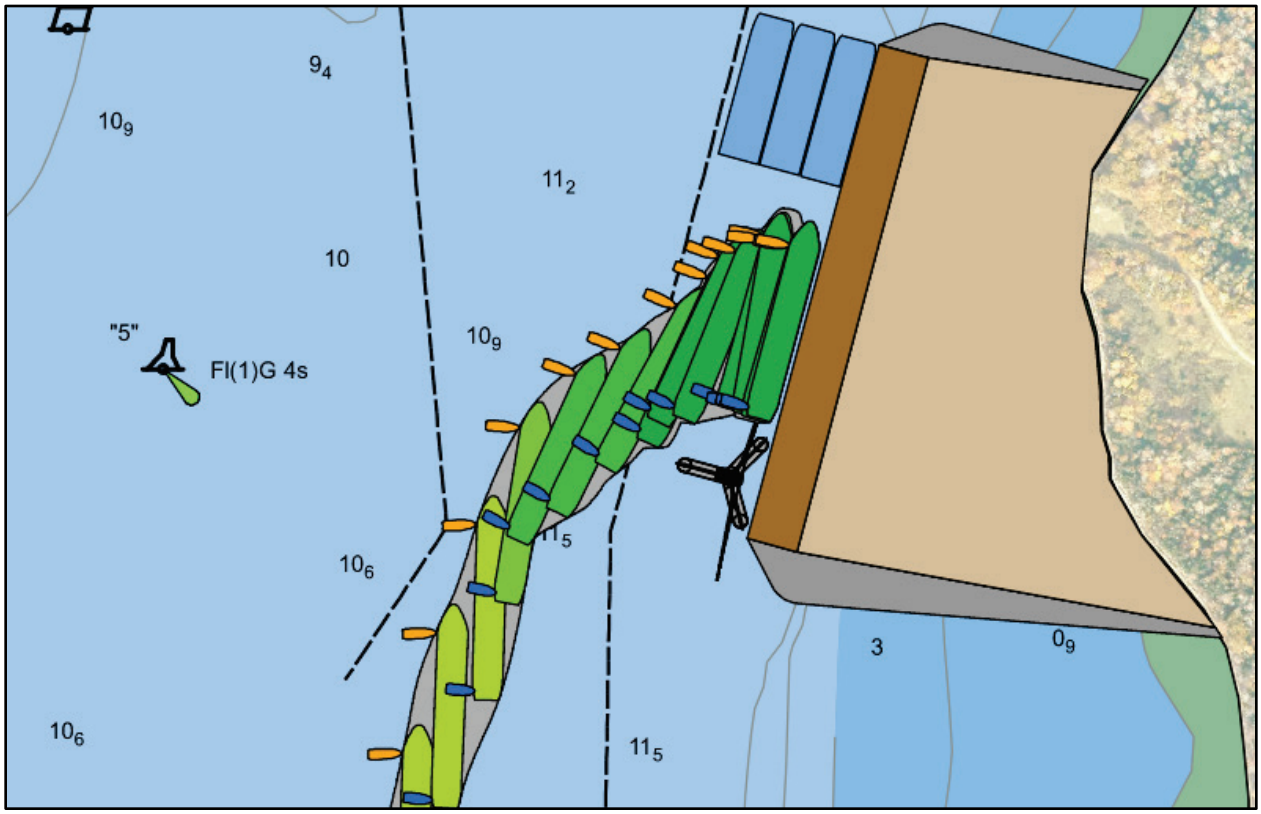


Figure 5-6: Alternate Berth Position – Sears Island (Simulation 5)

6.0 SUMMARY & CONCLUSIONS

A series of full mission bridge simulations were carried out at USMRC to evaluate maneuvering of offshore wind vessels transiting to and from two (2) potential locations, Mack point and Sears Island.

Mack Point

The approach and departure maneuvers for the Mack Point terminal concept are similar to the comparable maneuvers at the existing liquid bulk and dry bulk terminals at Mack Point. With elevated wind conditions (for the vessels considered in this study, this limit was around 22 knots) the berth orientation at Mack Point is not ideal because the wind (often from SW or SSW) tends to catch the stern of the vessel just as it initiates the final turn and alignment with the berth. This is a similar effect to what is experienced currently with vessels at the existing berths; however, with the larger sail-area of cargoes expected for the wind industry the effect is even more pronounced and would likely lead to some limitation in wind conditions for the operation (i.e., in the 20-25 knot range).

There is sufficient space to turn the largest vessel, but maneuvering is confined to a definite area with hard structures adjacent. Once the vessel enters the berth pocket, the navigation clearances are defined with hard structures/shoreline on three sides of the vessel. The simulations showed that clearances were adequate, and maneuvers can be successfully completed; however, the Sears Island terminal lacks the presence of hard structures near critical points in the maneuver.

Sears Island

The alignment of the Sears Island terminal is parallel to the existing navigation channel and parallel to the shoreline of Sears Island. The terminal aligns with the shore, meaning the currents (though generally a minor effect) would tend to run parallel to the berth. In contrast, the currents at Mack Point tend to run across the berth, which is a more adverse condition.

There are no adjacent structures, resulting in more navigation clearances, and associated safety. The wind farm components moored to the Sears Island berth were the only navigation obstacles of concern for these maneuvers. The terminal is near open deep water to the south with nearly unrestricted turning area. This provides a safety margin for the turning maneuver and would allow the maneuver to be performed at higher wind speeds than comparable maneuvers at Mack Point.

The terminal concept at Sears Island aligns reasonably well with the dominant wind direction (i.e., from SSW to SW). Wind conditions evaluated ranged from 15 knots steady to 25 knots gusting and directions from SSW to NW. While the exact wind limits may depend on the type and size of vessel, the pilots indicated clearly that for comparable vessels the wind speed limits for the Sears Island terminal would be higher than for the Mack Point terminal. This would result in increased berth availability for a terminal built at Sears Island.

Overall

In summary, the following conclusions were determined after two days of simulations under a wide variety of conditions:

- It is feasible to safely navigate to and from both terminals under typical environmental conditions.

- The Sears Island terminal is in a better location from a navigation perspective than Mack Point as it provides for safer approach and departure maneuvers with increased clearances and better alignment with environmental conditions.

- Due to the lack of surrounding navigational obstacles, the Sears Island terminal concept allows for higher allowable wind speeds for vessel transit and would allow for less environmental restrictions for vessel maneuvering.

- The size of the tugs in the existing fleet are adequate for the vessels considered in this study. This study did not address the question of whether the number of tugs in the existing fleet will be sufficient to service the wind port or whether additional tugs may be required.

- By providing shelter from prevailing southwest winds, the north side of a Sears Island port facility could provide safe berthing for tugs and other support vessels necessary for efficient port operations. The Mack Point location does not offer such an opportunity and may require support vessels to vacate the port when adverse conditions are forecast.

7.0 REFERENCES

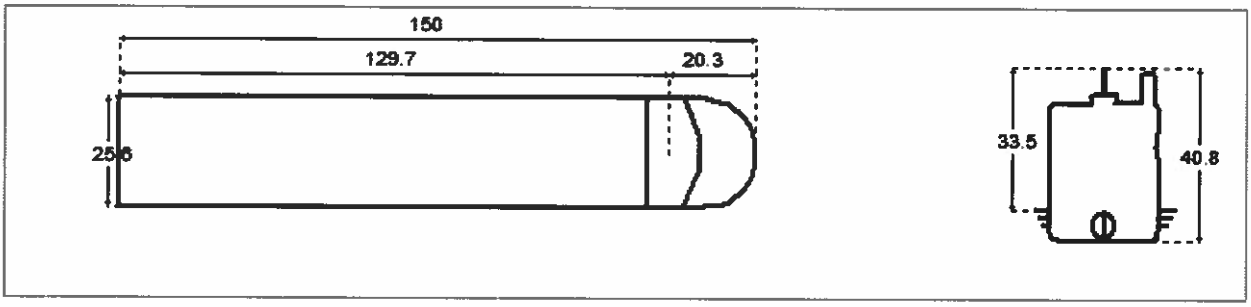
[1] United States Army Corps of Engineers (USACE), "EM 1110-2-1100, Coastal Engineering Manual," 2002.

APPENDIX A

PILOT CARDS

PILOT CARD					
Ship name	Heavy lift ship F900 ECO LIFTER 3.0.33.0 *			Date	21.03.2023
IMO Number	9785378	Call Sign	N/A	Year built	2017
Load Condition	9 blades				
Displacement	20503.62 tons		Draft forward	7.25 m / 23 ft 10 in	
Deadweight	10401.7 tons		Draft forward extreme	7.25 m / 23 ft 10 in	
Capacity			Draft after	7.25 m / 23 ft 10 in	
Air draft	33.53 m / 110 ft 3 in		Draft after extreme	7.25 m / 23 ft 10 in	

Ship's Particulars			
Length overall	150 m	Type of bow	-
Breadth	25.6 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	11 / 11		(1 shackle =27.5 m / 15 fathoms)
Max. rate of heaving, m/min	6 / 6		



Steering characteristics			
Steering device(s) (type/No.)	Schilling rudder / 1	Number of bow thrusters	1
Maximum angle	64	Power	900 kW
Rudder angle for neutral effect	0.28 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	15 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

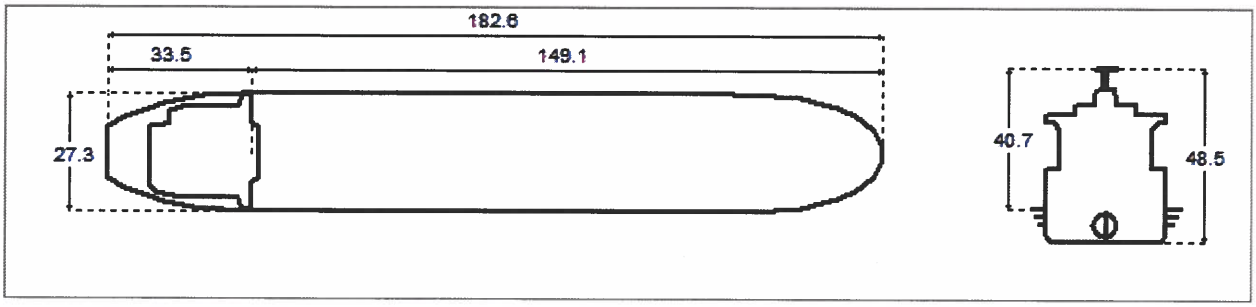
Stopping			Turning circle	
Description	Full Time	Head reach	Ordered Engine: 100%, Ordered rudder: 35 degrees	
FAH to FAS	430.6 s	7.85 cbls	Advance	1.56 cbls
HAH to HAS	414.6 s	6.09 cbls	Transfer	0.77 cbls
SAH to SAS	428.6 s	4.61 cbls	Tactical diameter	1.67 cbls

Main Engine(s)			
Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 5750 kW	Propeller type	FPP
Astern power	77.6 % ahead	Min. RPM	25
Time limit astern	N/A	Emergency FAH to FAS	135.7 seconds

Engine Telegraph Table				
Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	15.4	5726	111	0.81
"FAH"	12.6	2896	88	0.81
"HAH"	10.2	1489	70	0.81
"SAH"	7.6	638	52	0.81
"DSAH"	4.7	217	35	0.81
"DSAS"	-2.8	480	-35	0.81
"SAS"	-3.8	1557	-52	0.81
"HAS"	-4.7	2574	-62	0.81
"FAS"	-6.6	3276	-70	0.81
"FSAS"	-7.2	4366	-77	0.81

PILOT CARD					
Ship name	Chemical tanker 1 (Dis.25700t) bl. TRANSAS 2.31.5.0 *			Date	15.04.2020
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Ballast				
Displacement	25700 tons		Draft forward	5.7 m / 18 ft 9 in	
Deadweight	17600 tons		Draft forward extreme	5.7 m / 18 ft 9 in	
Capacity			Draft after	7.8 m / 25 ft 7 in	
Air draft	40.7 m / 133 ft 10 in		Draft after extreme	7.8 m / 25 ft 7 in	

Ship's Particulars			
Length overall	182.55 m	Type of bow	Bulbous
Breadth	27.34 m	Type of stern	U-shaped
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	15 / 15		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	9 / 9		



Steering characteristics			
Steering device(s) (type/No.)	Semisuspended / 1	Number of bow thrusters	1
Maximum angle	35	Power	800 kW
Rudder angle for neutral effect	0.29 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	15 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping			Turning circle	
Description	Full Time	Head reach	Ordered Engine: 100%, Ordered rudder: 35 degrees	
FAH to FAS	551.6 s	9.42 cbls	Advance	2.34 cbls
HAH to HAS	565.6 s	7 cbls	Transfer	1.04 cbls
SAH to SAS	660.6 s	5.2 cbls	Tactical diameter	2.65 cbls

Main Engine(s)			
Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 9466 kW	Propeller type	FPP
Astern power	60 % ahead	Min. RPM	24
Time limit astern	N/A	Emergency FAH to FAS	2.1 seconds

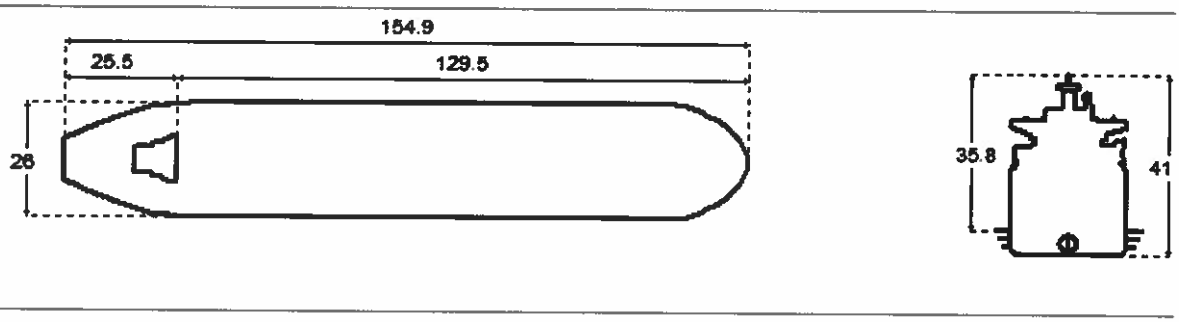
Engine Telegraph Table				
Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	15.5	7300	120.1	0.67
"FAH"	11	2728	86	0.67
"HAH"	8.2	1142	64	0.67
"SAH"	5.8	416	45.2	0.67
"DSAH"	3.9	128	30.1	0.67
"DSAS"	-1.8	155	-29.4	0.67
"SAS"	-2.4	489	-43.5	0.67
"HAS"	-3.4	1283	-60.4	0.67
"FAS"	-5.4	4953	-96.3	0.67

PILOT CARD

Ship name	Bulk carrier 24 3.0.5.0 *			Date	14.04.2020
IMO Number	9256444	Call Sign	H9NM	Year built	2001
Load Condition	Ballast				
Displacement	9969 tons		Draft forward	2.65 m / 8 ft 8 in	
Deadweight	21624 tons		Draft forward extreme	2.65 m / 8 ft 8 in	
Capacity			Draft after	5.24 m / 17 ft 2 in	
Air draft	35.76 m / 117 ft 7 in		Draft after extreme	5.24 m / 17 ft 2 in	

Ship's Particulars

Length overall	154.94 m	Type of bow	Bulbous
Breadth	26 m	Type of stern	Stern with thickened deadwood
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	24 / 24		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	18 / 18		



Steering characteristics

Steering device(s) (type/No.)	Normal balance rudder / 1	Number of bow thrusters	1
Maximum angle	35	Power	1350 kW
Rudder angle for neutral effect	0.18 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	25 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping

Description	Full Time	Head reach
FAH to FAS	259.6 s	4.45 cbls
HAH to HAS	320.6 s	4.02 cbls
SAH to SAS	444.6 s	3.84 cbls

Turning circle

Ordered Engine: 100%, Ordered rudder: 35 degrees

Advance	2.62 cbls
Transfer	1.26 cbls
Tactical diameter	2.91 cbls

Main Engine(s)

Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 4200 kW	Propeller type	FPP
Astern power	60 % ahead	Min. RPM	50
Time limit astern	N/A	Emergency FAH to FAS	35.2 seconds

Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	14.9	2826	161.1	0.66
"FAH"	12	1557	130	0.66
"HAH"	9.2	767	100	0.66
"SAH"	6.5	304	69.9	0.66
"DSAH"	5.5	214	60	0.66
"DSAS"	-3.3	261	-59.9	0.66
"SAS"	-3.9	392	-70	0.66
"HAS"	-5.5	995	-99.9	0.66
"FAS"	-7.2	2082	-130.1	0.66

APPENDIX B

SIMULATION NOTES - USMRC

USMRC
UNITED STATES MARITIME RESOURCE CENTER

August 26, 2024

Maine Port Authority
460 Commercial Street
Portland, ME 04101

Subject: **Observations from Full Mission Bridge Navigation and Vessel Maneuvering Simulations for Proposed Maine's Offshore Wind Port in Searsport**

To Whom it May Concern:

Under contract to the Maine Port Authority (MPA) and in cooperation with MPA's marine consultant, Moffatt & Nichol, the United States Maritime Resource Center (USMRC) conducted two days of real-time, mariner-in-the-loop navigation and vessel maneuvering simulations in support of the proposed Maine's Offshore Wind Port located in Searsport, Maine. The simulations were conducted at USMRC's facility located in Middletown, Rhode Island. The simulations were held on June 11 and 12, 2024, employing USMRC's full mission ship simulator. The purpose of these simulations was to evaluate the navigational safety aspects of and feasibility to conduct marine operations at two different proposed sites in Searsport using vessels that would be expected to deliver various floating offshore wind turbine components at the proposed sites in Searsport for assembly prior to transport to an offshore wind energy area.

In preparation for the simulations, USMRC built a high-fidelity geographic area model database of Penobscot Bay to include the seaward approaches as well as the area in the immediate vicinity of Searsport to include the Moffat & Nichol provided conceptual marine terminal infrastructure and associated bathymetric features at each of the two proposed sites (i.e., Sears Island and Mack Point). Two marine pilots from the Penobscot Bay & River Pilots Association performed an external validation of the area model prior to commencing the simulations to ensure any navigation references used by the pilots in performance of their duties were accurately depicted in the area model. Moffatt & Nichol provided the anticipated metocean conditions used during the simulations.

Three different ship models were used in the simulations to represent the expected size and windage area for offshore wind turbine component delivery vessels arriving to and departing from each of the proposed offshore wind port sites. These ship models have been used in other navigation studies for offshore wind marine terminals and the participating marine pilots found their maneuvering response to be realistic. Searsport currently has up to four ship assist tugs available at any given time. Primarily, ship assist tug models representing the two lower powered (in terms of bollard pull) of the four Searsport area tugs were used in the simulations to evaluate tug reserve power margins of safety. The ship assist tug models were operated by a USMRC simulation systems operator in a manner consistent with how the actual tugs are operated in Searsport.

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The real-time, mariner-in-the-loop simulations were conducted using two experienced Penobscot Bay & River Pilots. During the two days of simulations, a total of 14 runs were conducted (see Enclosure 1). The first day focused on the Sears Island proposed site and the second day focused on the Mack Point proposed site. During the simulations, the marine pilots used portable pilot unit (PPU) systems with SEAiq Pilot software installed. USMRC's simulation system provides position, timing, and Automatic Identification System (AIS) information to the PPU via a pilot plug similar to those found on the bridge of actual vessels. The SEAiq Pilot tool provides detailed, instantaneous maneuvering information to the pilot which enables the marine pilots to more precisely conn the vessel. SEAiq Pilot is the same PPU software used by the Penobscot Bay & River Pilots in their actual piloting work.

Of the 14 simulation runs conducted (all with daytime conditions), 12 were arrivals from various approach starting positions and two were departures. The remaining two simulation runs commenced in the turning basin areas adjacent to the conceptual marine terminal infrastructure at each of the proposed sites, midway through the ship's rotation maneuver.

Prior to each simulation run, the conning marine pilot was briefed as to the expected metocean conditions and the location of any vessels or floating offshore wind turbine structures already at the berth. The marine pilot was allowed to direct the placement of and utilize the ship assist tugs as they deemed most efficient. Simulation runs were often terminated when the ship was stable and oriented for berthing as pushing the vessel up against the berth fenders would only unnecessarily extend the length of time for each simulation. At the completion of each simulation run, the marine pilot conveyed his thoughts to the simulation facilitator who recorded them (see Enclosure 2). After completing the comments, the simulation team was provided with an opportunity to ask the marine pilot any questions to further clarify his observations.

After performing the 14 simulation runs for evaluation, USMRC hereby offers the following observations:

Observations:

1. Under typical environmental conditions, an expected offshore wind turbine component vessel could be navigated safely for arrivals and departures at both proposed sites.

2. Ship arrivals at the Mack Point site's east berth are similar to ship arrivals at the existing Searsport petroleum and bulk terminals being used today.

3. The Sears Island site provided more maneuvering area with fewer obstructions and a wider variety of options for bailout contingencies in the event of a shipboard or ship assist tug failure. In the event of an abort during berthing operations, the Sears Island site provided a navigable exit path both astern and ahead from the berth area. The Mack Point site is limited to astern movement only.

4. The notably larger and relatively unobstructed vessel maneuvering area adjacent to the Sears Island site provides a higher margin of safety during all berthing operations including unexpected pier side delays. Additionally, ship assist tug's propeller wash would not impact any adjacent structures at the Sears Island site whereas it likely would negatively impact the existing petroleum pier while docking at the east berth at the proposed Mack Point site.

5. The Sears Island site provided significantly fewer obstacles for the tugs to maneuver along side the ship during berthing. The Mack Point site, due to the existing petroleum pier required a closer initial approach distance for the ship as the ship assist tugs would be required to orient themselves perpendicular to the ship to facilitate pushing the ship onto or pulling the ship off the east berth at the Mack Point site with the petroleum pier in close proximity astern of the ship assist tugs. During three of the simulation runs the closest point the ship assist tugs got to the petroleum pier was 68, 50, and 60 feet which left little margin of safety in the event of a ship or assist tug casualty.

6. When maneuvering at the Mack Point site's east berth, the close proximity of the ship assist tug's propeller wash to the existing petroleum pier could be of some concern for erosion potentially impacting the structural integrity of the pier if the tugs were required to be used at half or full power due to weather conditions or other operational necessities.

7. The berth orientation of the Sears Island site provides less windage influence or impact on the vessel with the predominant south-southwesterly to southwesterly winds as the wind would impact the vessel almost directly ahead (on the bow) or astern (on the transom) which is optimal compared with a wind on the vessel's beam (i.e., the side of the ship). A wind direction more in line with the ship's heading would reduce any forces the wind would apply on the vessel and impacting the mooring/fendering structures. The expected deck cargo loads being delivered to either proposed site would typically present a relatively large windage area for the vessel during arrivals and alongside cargo operations.

8. Although only one departure simulation run was made from the existing petroleum pier, the closest point of approach of the departing ship to the Sears Island site was 600 feet and felt to be acceptable by the evaluation team. This simulation run was conducted with a northwesterly wind which has the effect of setting the departing ship towards the proposed Sears Island site while the ship maneuvers away from the petroleum pier. There was also both a ship as well as a floating offshore wind turbine alongside at the Sears Island site for this simulation.

As previously stated, under normal weather conditions, the navigation safety suitability is acceptable for both proposed sites. Based on these initial simulations, the Sears Island site appears to provide a larger margin of safety during all maneuvers while providing fewer navigation obstructions that could limit maneuvering. The Sears Island site also would provide

better sea and swell conditions when vessels or floating turbines are moored alongside particularly when exposed to strong southwesterly wind and waves.

USMRC appreciates the opportunity to provide navigation and vessel maneuvering simulations to the MPA in support of the development of Maine's Offshore Wind Port project. Our overall goal is to make a meaningful contribution to navigation safety and minimize financial and operational risk for our clients. If there are any further questions, please do not hesitate to contact us.

Sincerely,

Richard M. Comeau
Vice President, Simulation, Training, and Research

Enclosures:

1. Table of Simulation Runs – Searsport, Maine (Sears Island and Mack Point sites)
2. Simulation Run Forms (Runs 1-14)

Table of Simulation Runs

Searsport, Maine (Sears Island and Mack Point sites)

Dates: June 11-12, 2024										
Conditions						Maneuvers				
No	Ship Size	Tugs	Condition	Wind (knots)	Current (knots)	Start	Head	Speed	End	Comments
1	Bulk Carrier #24	2	Arrival Loaded	SSW 15	Flood	Oil Transfer Area	008	6.0	Sears Island	Starboard Side To
2	Chemical Tanker #1	2	Arrival Loaded	NW 10	Ebb	Oil Transfer Area	008	6.0	Sears Island	Starboard Side To
3	ECO LIFTER F900	2	Loaded Blades	SSW 15	Flood	Oil Transfer Area	008	6.0	Sears Island	Port Side To
4	ECO LIFTER F900	2	Arrival Loaded	SW 22 with gusts	Flood	Oil Transfer Area	008	6.0	Sears Island	Port Side To
5	Chemical Tanker #1	2	Arrival Loaded	NW 15	Flood	Oil Transfer Area	008	6.0	Sears Island	Starboard Side To
6	Chemical Tanker #1	2	Departure Ballast	NW 15	Flood	Sears Island	015	0.0	Sea	Starboard Side To
7	Chemical Tanker #1	2	Departure Ballast	NW 15	Flood	Sprague Terminal	340	0.0	Sea	Departure with Sears Island Terminal in place.
8	Chemical Tanker #1	2	Arrival Ballast	SSW 15	Flood	Oil Transfer Area	008	6.0	Mack Point	Port Side To East berth
9	ECO LIFTER F900	2	Arrival Blades	SSW 15	Flood	Sears Island Buoy #4	015	5.0	Mack Point	Stbd Side To East Berth
10	ECO LIFTER F900	2	Arrival Blades	SW 22 with gusts	Flood	Sears Island Buoy #4	015	5.0	Mack Point	Stbd Side To East Berth

Table of Simulation Runs

Searsport, Maine (Sears Island and Mack Point sites)

Dates: June 11-12, 2024										
Conditions						Maneuvers				
No	Ship Size	Tugs	Condition	Wind (knots)	Current (knots)	Start	Head	Speed	End	Comments
11	ECO LIFTER F900	2	Arrival Blades	SW 22 with gusts	Flood	Sears Island Buoy #4	015	5.0	Mack Point	Stbd Side To East Berth Turn is made to starboard
12	ECO LIFTER F900	2	Arrival Blades	SW 22 with gusts	Flood	Sears Island Buoy #4	015	5.0	Mack Point	Stbd Side To South Berth
13	ECO LIFTER F900	2	Arrival Blades	SW 22 with gusts	Flood	Sears Island Buoy #4	015	5.0	Mack Point	Port Side To South Berth
14	ECO LIFTER F900	2	Arrival Blades	SW 25 with gusts	Flood	North of Bouy #2	015	5.0	Sears Island	Port Side To

Project Name		Date	
Searsport		June 11, 2024	
Project Run	USMRC Exercise #	Initial Condition	
01	MDOT-S-01		
Run Description	Arrival Sears Island	Heading	Speed
Ship Type/Condition	Bulk Carrier 24	008	6.0
Pilot: Capt Gelinas	Wind Dir/Spd: SSW 15	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t twin screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Half	Half Astern Briefly	300 turbine at berth.

Run Description:

Familiarization arrival. Arthur F port bow, F Tractor C/L aft.

Comments

Familiarization Run. Started from Oil Transfer area on Slow Ahead. Tugs made up. Dead Slow ahead shortly thereafter. ME All Stop approaching the berth. C/L tug used to slow ship's speed. One ship length from berth both tugs at a 90° to push. ME used Half Astern briefly to slow speed. Once lined up and parallel, Tugs used to push vessel towards berth under control. Sim completed when stable off berth.

Pilot noted the heading of the berth is advantageous with the predominant SSW wind direction. Mack Pt berth orientation puts the winds on the port quarter.

Project Name		Date	
Searsport		June 11, 2024	
Project Run	USMRC Exercise #	Initial Condition	
02	MDOT-S-02		
Run Description	Arrival Sears Island	Heading	Speed
Ship Type/Condition	Chem Tanker #1 Ballast	008	6.0
Pilot: Capt Philbrook	Wind Dir/Spd: NW 15	Current Dir/Spd: Ebb 0.3 kts	
Tugs: 2 F Boys (60t SDM) F Tractor (40t ASD)			
Max Tug Power:	**Max Engine Power:**	**Closest Hazard**	
Half	Slow Ahead	Not recorded	

Run Description:

Familiarization arrival. Used ballasted version of vessel to relate more to windage and draft of vessels arriving.

Comments

Start NE of Oil Transfer Area. F Boys on port bow, F Tractor C/L aft. ME Dead Slow Ahead. Shift F Tractor to port quarter. Slows vessel by backing F Boys and F Tractor Quarter Astern along side. Tugs used to orient ship for berthing along with occasional use of the bow thruster. ME Slow Astern approaching the berth. Simulation completed when ship alongside berth.

Berthing control was very good. Used after tug to control COG. During debrief pilot noted that if the wind had been higher he would have swapped the positions of the tugs so there would be more power aft. No difficulties noted.

Project Name			Date	
Searsport			June 11, 2024	
Project Run		USMRC Exercise #	Initial Condition	
03		MDOT-S-03		
Run Description	Arrival Sears Island		Heading	Speed
Ship Type/Condition	ECO LIFTER Blades		008	7.5
Pilot: Capt Gelinas		Wind Dir/Spd: SSW 15	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Half	Slow Ahead	Not recorded

Run Description:

Bridge forward ship being moored Port Side To.

Comments

Started off at Slow Ahead (7.5kts). Arthur F stbd bow, F Tractor stbd quarter. ME All Stop and Arthur F slow alongside. Ship is turned (to starboard) well south of berth area. Vessel rotated with minimum effort. No difficulty pushing vessel towards berth without gaining headway or sternway. Simulation completed when stable off berth.

Pilot noted during debrief that out of an abundance of caution he turned earlier and approached slower due the turbines near the berth.

Project Name		Date	
Searsport		June 11, 2024	
Project Run	USMRC Exercise #	Initial Condition	
04	MDOT-S-04		
Run Description	Arrival Sears Island	Heading	Speed
Ship Type/Condition	ECO LIFTER Blades	008	7.5
Pilot: Capt Gelinas	Wind Dir/Spd: SW 22 w/gusts	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Quarter	Slow Ahead	

Run Description:

Bridge forward ship being moored Port Side To higher SW winds.

Comments

Started off at Slow Ahead (7.5kts). Arthur F stbd bow, F Tractor stbd quarter. ME All Stop and Arthur F slow alongside. Vessel slowed well before SI buoy #4. One ship length after SI #4, vessel turned to port. Turn made with no more than using a quarter power on tugs. Most of the maneuver was done using the ship's engine/rudder/bow thruster.

Project Name			Date	
Searsport			June 11, 2024	
Project Run		USMRC Exercise #	Initial Condition	
05		MDOT-S-05		
Run Description	Arrival Sears Island		Heading	Speed
Ship Type/Condition	Chem Tanker #1		008	6.0
Pilot: Capt Gelinas		Wind Dir/Spd: SW 22 w/gusts	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Half	Slow Ahead	56 feet turbine Leg

Run Description:

Chem Tanker #1 starboard side to between obstructions

Comments

Started off at Slow Ahead 6.0kts). Arthur F stbd bow, F Tractor stbd quarter. ME All Stop and Arthur F slow alongside. Vessel slowed prior to arrival with a 16 deg crab angle. Was not able to put a tug C/L aft due to clearance at berth. Cleared outer turbine leg by 80 ft. Once stable, vessel allowed to slide in. Final distances 148 from the bow to barges, 56 ft to turbine leg.

Would probably require restrictions (daylight, wind 20kts less).

Project Name			Date	
Searsport			June 11, 2024	
Project Run		USMRC Exercise #	Initial Condition	
06		MDOT-S-06		
Run Description	Departure Sears Island		Heading	Speed
Ship Type/Condition	Chem Tanker #1		015	0.0
Pilot: Capt Philbrook		Wind Dir/Spd: SW 22 w/gusts	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Quarter	Slow Ahead	85 ft

Run Description:

Chem Tanker #1 starboard side to between obstructions departure

Comments

Started with tugs away easy and allowed the current to get between the hull and the berth and allowed the stern to work its way out. When clear, turned ship to port, shifted port bow boat to starboard bow. During turn, turbine leg CPA was 300ft and bow CPA with buoy #5 430 ft.

Project Name		Date	
Searsport		June 11, 2024	
Project Run	USMRC Exercise #	Initial Condition	
07	MDOT-S-07		
Run Description	Departure Sprague Terminal	Heading	Speed
Ship Type/Condition	Chem Tanker #1	340	0.0
Pilot: Capt Gelinas	Wind Dir/Spd: NW 15	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Quarter	Slow Ahead	601 ft Sears Island Terminal

Run Description:

Chem Tanker #1 departure from Sprague Terminal with the proposed Sears Island wind terminal in place.

Tractor tug on stbd bow, Arthur F on stbd qtr.

Comments

Started with tugs towards Easy. While backing out, after tug used at various forces towards to keep the stern up into the current. When bow was clear of terminal, bow tug used towards Quarter to swing bow to port. Shortly after, the after tug was released. When turn completed, fwd tug released. Closest Point of Approach while passing the Sears Island wind terminal was 601 ft. Simulation completed shortly thereafter.

Pilot noted during debrief the when departing the Sprague terminal and turning, the ship model used did not seem to have the rudder power/a\effect he would have expected from an actual ship, thus his turn took longer.

Project Name		Date	
Searsport		June 12, 2024	
Project Run	USMRC Exercise #	Initial Condition	
08	MDOT-S-08		
Run Description	Arrival Mack Point Wind Term.	Heading	Speed
Ship Type/Condition	Chem Tanker #1	008	6.0
Pilot: Capt Gelinas	Wind Dir/Spd: SSW 15	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Full (bow)	Half Astern	Sprague

Run Description:

Chem Tanker #1 arriving Port Side To at proposed Mack Point Wind Terminal.

Tractor tug on stbd quarter, Arthur F on stbd bow.

Comments

During approach (since a Center Lead tug line was not used (ship design at this draft)) the pilot cycled the rudder to assist in slowing the vessel. Once vessel below 5 kts, astern engine order (Dead Slow/Slow/Half) was used to slow the vessel (pilot notes the minimal propeller walk). Approaching berth tugs out to 90° and push at Easy and Minimum push to line up. Piot did use the bow thruster occasionally to assist. As the relative wind got on the port quarter, more tug power was needed with the bow tug up to Full.

With tugs at a 90° the closest the stern of the bow tug got to Sprague pier was 68ft during docking.

Pilot commented that this would not be done at 25kts SSW wind.

During debrief, a discussion was held about tug wash impacting the vessel and pier under water structure.

Project Name		Date	
Searsport		June 12, 2024	
Project Run	USMRC Exercise #	Initial Condition	
09	MDOT-S-09		
Run Description	Arrival Mack Point Wind Term.	Heading	Speed
Ship Type/Condition	ECO LIFTER F900 Blades	015	5.0
Pilot: Capt Philbrook	Wind Dir/Spd: SSW 15	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Half	Slow	Pier Corner 18ft

Run Description:

ECO LIFTER F900 arriving Starboard Side To at proposed Mack Point Wind Terminal.

Tractor tug on Port quarter, Arthur F on Port bow.

Comments

Started simulation at Sears Island Buoy #4. Vessel slowed prior to entering turning basin. Tugs and bow thruster used to rotate vessel in the southern part of the turning basin. SSW wind pushes vessel to the North during this maneuver. Pilot used tugs and bow thruster to complete turn and develop sternway. Vessel backed into pier.

Pilot stated during debrief he would have gone further into the turning basin next time before starting turn.

Project Name		Date	
Searsport		June 12, 2024	
Project Run	USMRC Exercise #	Initial Condition	
10	MDOT-S-10		
Run Description	Arrival Mack Point Wind Term.	Heading	Speed
Ship Type/Condition	ECO LIFTER F900 Blades	015	5.0
Pilot: Capt Gelinas	Wind Dir/Spd: SW 22 w/ gusts	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Full (both)	Half	53 ft Sprague Caissons

Run Description:

ECO LIFTER F900 arriving Starboard Side To at proposed Mack Point Wind Terminal.

Tractor tug on Port quarter, Arthur F on Port bow.

Comments

Started simulation at Sears Island Buoy #4. Vessel slowed prior to entering turning basin. Pilot allows vessel to go further into turning basin before starting turn. To assist with the turn, Full port rudder (65°) was used with the Main Engine Half Ahead. Vessel, during turn, gets set down near Sprague Terminal.

Once clear of outer caisson, vessel maneuvered into berth.

Pilot noted during debrief that the aft tug may have given more communication to the pilot about closure distance to the caissons.

Pilot felt this is a doable in the future, but this would be the upper limit of wind speed/direction.

Project Name			Date
Searsport			June 12, 2024
Project Run	USMRC Exercise #		Initial Condition
11	MDOT-S-11		
Run Description	Arrival Mack Point Wind Term.	Heading	Speed
Ship Type/Condition	ECO LIFTER F900 Blades	015	5.0
Pilot: Capt Philbrook	Wind Dir/Spd: SW 22 w/ gusts	Current Dir/Spd: Flood 0.3 kts	

Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)

Max Tug Power:	**Max Engine Power:**	**Closest Hazard**
Half	Slow	Sprague Caisson 60 ft

Run Description:

ECO LIFTER F900 arriving Starboard Side To at proposed Mack Point Wind Terminal. Turn in the basin to be made to starboard

Tractor tug on Port quarter, Arthur F on Port bow.

Comments

Started simulation at Sears Island Buoy #4. Pilot brought the ship in deeper and a little bit further to the west. Turn made using no more than Half Power on the tugs. After turn complete, vessel was further to the west in the basin for berth line up. Allowed the wind to push vessel towards line up. Once inside of berth, aft tug CPA with Sprague berth 60ft. Once in berth, maneuvered vessel along side.

Turn to stbd proved difficult with wind.

Project Name			Date	
Searsport			June 12, 2024	
Project Run		USMRC Exercise #	Initial Condition	
12		MDOT-S-12		
Run Description	Arrival Mack Point Wind Term.		Heading	Speed
Ship Type/Condition	ECO LIFTER F900 Blades		015	5.0
Pilot: Capt Gelinas		Wind Dir/Spd: SW 22 w/ gusts	Current Dir/Spd: Flood 0.3 kts	
Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)				
Max Tug Power:		**Max Engine Power:**	**Closest Hazard**	
Quarter		Half Ahead	Not recorded	

Run Description:

ECO LIFTER F900 arriving Starboard Side To at proposed Mack Point Wind Terminal. Vessel to moor to the south side of the proposed Mack Point Wind Terminal

Tractor tug on Port quarter, Arthur F on Port bow.

Comments

Started simulation at Sears Island Buoy #4. Pilot brought ship into the turning basin on the eastern side. Turns vessel parallel to berth in the basin and allows the vessel to set down onto the berth with the elements.

Project Name			Date	
Searsport			June 12, 2024	
Project Run		USMRC Exercise #	Initial Condition	
13		MDOT-S-13		
Run Description	Arrival Mack Point Wind Term.		Heading	Speed
Ship Type/Condition	ECO LIFTER F900 Blades		015	5.0
Pilot: Capt Philbrook		Wind Dir/Spd: SSW 15kts	Current Dir/Spd: Flood 0.3 kts	
Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)				
Max Tug Power:		**Max Engine Power:**	**Closest Hazard**	
Quarter		Half Ahead/Astern	Barge 100ft	

Run Description:

ECO LIFTER F900 arriving Port Side To at proposed Mack Point Wind Terminal. Vessel to moor to the south side of the proposed Mack Point Wind Terminal

Tractor tug on Stbd quarter, Arthur F on Stbd bow.

Comments

Started simulation at Sears Island Buoy #4. Pilot brought ship into the turning basin on the western side. Turns vessel parallel to berth in the basin approximately and allows the vessel to set down onto the berth with the elements and minimal use of tugs.

Project Name		Date	
Searsport		June 12, 2024	
Project Run	USMRC Exercise #	Initial Condition	
14	MDOT-S-14		
Run Description	Arrival Sears Island Wind Term.	Heading	Speed
Ship Type/Condition	ECO LIFTER F900 Blades	015	5.0
Pilot: Capt Gelinas	Wind Dir/Spd: SSW 25kts	Current Dir/Spd: Flood 0.3 kts	
Tugs: 2 Arthur F (40t Twin Screw) F Tractor (40t ASD)			
Max Tug Power:	**Max Engine Power:**	**Closest Hazard**	
Full (Both	Half Ahead	Buoy #5 570ft	

Run Description:

ECO LIFTER F900 arriving Port Side To at proposed Sears Island Wind Terminal.

Tractor tug on Stbd quarter, Arthur F on Stbd bow.

Comments

Started simulation North of Sears Island Bouy#2. Pilot brings ship south of berth area and turns ship to stbd. At completion of turn the bow of the vessel is even with the south part of the Sears Island Berth. Ship parallel to berth 350 ft off. Vessel brought alongside without difficulty.

Pilot noted that there was plenty of sea room to make this maneuver.

APPENDIX C

SIMULATION NOTES – M&N

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 11, 2024
Simulation #: 1
Pilot: D. Gelinas

Simulation Summary:

Time: *(Start)* 10:00 *(End)* 10:40 Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound): Oil Transfer Area

Tugboats (number and size available): 2 Tugs Port Facility: Mack Point / (Sears Island)

Ship Model (circle one): (*Bulk Carrier 24*) / *Heavy Lift ECO LIFTER*

Load Conditions / Cargo: *Ballast* / *Loaded* / *Blades* / *Towers* 28'10" "Loaded"

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts SSW Current *(stage / start time)*: Flood 0.3 knots

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Approach is similar to Bucksport. Vessel is approaching to starboard-side-to. Fourier Tractor is center lead aft – 40 t. Captain Arthur (twin screw) tug is port bow.
15:00	Tractor pulling aft with line-quarter, then half power. Several instances of hard rudder.
40:00	Alongside. The ship felt good. Rudder & steering generally felt good. Pilot stated it was low difficulty and was getting used to the simulation. Buoy 4 is fine and is in a nice location. Buoy 6 flashing red would have to move. Green buoy No. 5 is in an odd spot. The pilots don't know why. The dock heading at Sears Island is better because the wind is dead astern. At Mack Point, you have to make the turn at the last minute as you enter the berth. The heading of Sears Island is nice.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 11, 2024
Simulation #: 2
Pilot: A. Philbrook

Simulation Summary:

Time: *(Start)* 11:15 *(End)* 11:51 Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: Mack Point / (Sears Island)

Ship Model (circle one): *Bulk Carrier 24* / *Heavy Lift ECO LIFTER* Chemical Tanker

Load Conditions / Cargo: (*Ballast*) / *Loaded* / *Blades* / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts NW Current *(stage / start time)*: Ebb

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Purpose of the tanker is to include maximum draft.
00:00	Tractor center lead aft. Boys on the port bow.
09:00	Shift stern tug to port quarter.
36:00	Alongside.
	Pilot stated it was more difficult with wind from the northwest.
	Aft tug was used almost the whole time.
	Ideal track would have been further out and let the wind set down onto the dock.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 11, 2024
Simulation #: 3
Pilot: D. Gelinas

Simulation Summary:

Time: *(Start)* 12:56 *(End)* 13:33 Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: Mack Point / (Sears Island)

Ship Model (circle one): *Bulk Carrier 24* / (*Heavy Lift ECO LIFTER*)

Load Conditions / Cargo: *Ballast* / *Loaded* / (*Blades*) / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: 10 kts SSW Current *(stage / start time)*: Flood 0.3 knots

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Inbound to port-side-to. 2 Tugs. Captain Arthur on starboard bow. Tractor on starboard quarter. Turn toward starboard. Plenty of room to turn between the berth and the green buoy, but he turned south of the berth. Pilot stated went slower than normally but he wanted to maintain good clearances.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 11, 2024
Simulation #: 4
Pilot: A. Philbrook

Simulation Summary:

Time: *(Start)* 1:59 *(End)* 2:36 Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: Mack Point / (Sears Island)

Ship Model (circle one): *Bulk Carrier 24* / (*Heavy Lift ECO LIFTER*)

Load Conditions / Cargo: *Ballast* / *Loaded* / (*Blades*) / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: 25 kts SSW Current *(stage / start time)*: Flood 0.3 knots

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Turning direction is to port. Not as hard as expected. At the start, it was a little squirrely.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 11, 2024
Simulation #: 5
Pilot: D. Gelinas

Simulation Summary:

Time: *(Start)* 3:02 *(End)* 3:46 Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: Mack Point / (Sears Island)

Ship Model (circle one): *Bulk Carrier 24* / *Heavy Lift ECO LIFTER* Chemical Tanker

Load Conditions / Cargo: (*Ballast*) / *Loaded* / *Blades* / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts NW Current *(stage / start time)*: Flood 0.3 knots

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Captain Arthur on bow. Tractor on stern.
42:00	Inside the berth pocket but it seems challenging to lay the vessel onto the berth. Lots of moving around, rotating, etc. Pilot said "I don't like that". Pilot stated the crab angle was 16-18 degrees at some times. The tolerances are tight. Daylight only. Would be easier with a smaller ship.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 11, 2024
Simulation #: 6
Pilot: A. Philbrook

Simulation Summary:

Time: *(Start)* 4:18 *(End)* 4:30 Direction of Transit: Inbound / (Outbound)

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: Mack Point / (Sears Island)

Ship Model (circle one): *Bulk Carrier 24* / *Heavy Lift ECO LIFTER* Chemical Tanker

Load Conditions / Cargo: (*Ballast*) / *Loaded* / *Blades* / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts NW Current *(stage / start time)*: Flood 0.3 knots

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	First two minutes of the simulation involved some problems with the tugs. The vessel ran into the docks. Piloted stated the model did not react exactly as expected. Had to use more stern RPMs than expected. If they will turn off the dock like this, the green buoy across the channel needs to stay. Pilot stated it was doable. Looked easer than the docking.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 11, 2024
Simulation #: 7
Pilot: D. Gelinas

Simulation Summary:

Time: *(Start)* ____ *(End)* ___ Direction of Transit: Inbound / (Outbound)

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: (Mack Point) / Sears Island

Ship Model (circle one): *Bulk Carrier 24* / *Heavy Lift ECO LIFTER* Chemical Tanker

Load Conditions / Cargo: (*Ballast*) / *Loaded* / *Blades* / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts NW Current *(stage / start time)*: Flood 0.3 knots

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Tractor on starboard quarter. Arthur on starboard bow. Pilot stated the model seemed squirrely at first (current added to the initial speed). The ship didn't respond as expected to the rudder.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 12, 2024
Simulation #: 8
Pilot: D. Gelinas

Simulation Summary:

Time: *(Start)* 8:34 *(End)* ___ Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: (Mack Point) / Sears Island

Ship Model (circle one): *Bulk Carrier 24* / *Heavy Lift ECO LIFTER* Chemical Tanker

Load Conditions / Cargo: (*Ballast*) / *Loaded* / *Blades* / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts SSW Current *(stage / start time)*: Flood at 13:18

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
00:00	Tractor on starboard quarter. Captain Arthur on starboard bow.
10:00	Working the rudder back and forth as a way to slow the vessel.
20:00	Making the turn. Half astern to slow, using bow thruster half and full to starboard to slow rotation.
22:00	Half astern for a couple minutes took the speed down to 1.8 knots …. Rotation arrested.
33:00	Engine has been stopped for a while with very slow speed ~0.3 knots. Dead slow ahead. Pilot stated the model was very squirrely. Used bow thruster a lot. The bow was light and very sensitive to the thruster. Similar maneuver to present day.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 12, 2024
Simulation #: 9
Pilot: A. Philbrook

Simulation Summary:

Time: *(Start)* 9:50 *(End)* 10:24 Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: (Mack Point) / Sears Island

Ship Model (circle one): *Bulk Carrier 24* / (*Heavy Lift ECO LIFTER*)

Load Conditions / Cargo: *Ballast* / *Loaded* / (*Blades*) / *Towers* Starboard-side-to

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts SSW Current *(stage / start time)*: Flood

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Tractor on port quarter. Captain Arthur on port bow.
	Turning to port.
	The vessel does not seem to respond strongly to the wind.
	Pilot stated maneuvering area was sufficient for intended track.
	Pilot stated it was the same approach and considerations as the existing oil docks.
	Used stern tug a lot because of the wind.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 12, 2024
Simulation #: 10
Pilot: D. Gelinas

Simulation Summary:

Time: *(Start)* 10:50 *(End)* ____ Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound): By Sears Island

Tugboats (number and size available): 2 Tugs Port Facility: (Mack Point) / Sears Island

Ship Model (circle one): *Bulk Carrier 24* / (*Heavy Lift ECO LIFTER*)

Load Conditions / Cargo: *Ballast* / *Loaded* / (*Blades*) / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: SW – 22 kts gusting Current *(stage / start time)*: Flood

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Captain Arthur on bow. Tractor on stern. Very low clearance to the oil terminal dolphin. The wind pushed him farther into the berth pocket. ~w kt stern way, then half ahead in the berth area. Pilot stated the safety was passing, but not great. In regards to difficulty, pilot stated that compared to Sears Island, there are hard structures on both sides, so there are more navigation hazards. Pilot stated initially considered that maneuver a failure, or at least tighter than desired. Could have taken some more action earlier to get the stern turned around sooner. After discussion he said it wasn't so bad.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 12, 2024
Simulation #: 11
Pilot: A. Philbrook

Simulation Summary:

Time: *(Start)* _____ *(End)* 12:05 Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound): By Sears Island

Tugboats (number and size available): 2 Tugs Port Facility: (Mack Point) / Sears Island

Ship Model (circle one): *Bulk Carrier 24* / (*Heavy Lift ECO LIFTER*)

Load Conditions / Cargo: *Ballast* / *Loaded* / (*Blades*) / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: SW – 22 kts gusting Current *(stage / start time)*: Flood

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Same tugs. It was difficult to turn toward starboard – might have turned to port in real life. Not really a good maneuver. Pilot stated it was a challenging maneuver. Pilot stated it was not a fun maneuver. Wouldn't do it again in the same way. He would turn to port. Seems like the wind limit is somewhere near this speed.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 12, 2024
Simulation #: 12
Pilot: D. Gelinas

Simulation Summary:

Time: *(Start)* _____ *(End)* _____ Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: (Mack Point) / Sears Island

Ship Model (circle one): *Bulk Carrier 24* / *Heavy Lift ECO LIFTER*

Load Conditions / Cargo: *Ballast* / *Loaded* / (*Blades*) / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: SW – 22 kts gusting Current *(stage / start time)*: Flood

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Approach to starboard-side-to. Was expecting more lateral wind force. The tugs would not like the position, being exposed. Pilot said it was safe maneuvering, just fine. Stated it was better maneuver than the finger pier.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 12, 2024
Simulation #: 13
Pilot: A. Philbrook

Simulation Summary:

Time: *(Start)* _____ *(End)* 2:28 Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: (Mack Point) / Sears Island

Ship Model (circle one): *Bulk Carrier 24* / (*Heavy Lift ECO LIFTER*)

Load Conditions / Cargo: *Ballast* / *Loaded* / (*Blades*) / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts SSW Current *(stage / start time)*: Flood

Waves: _____ Water Level: _____

Notes During Simulation:

Time	Observations/Notes
	Mack Point shore parallel. Port-side-to.
	Similar maneuver, but going port-side-to.
	Pulling bow straight in at about 00:15 and then turned the stern around with the tug.
	Pilot stated the rudder didn't create as much rate of turn as expected.
	Pilot stated it was fine and totally a doable maneuver. Would be more challenging with higher winds.

Summary Ratings for Safety and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

240271 Navigation Study for Searsport Offshore Wind
Simulation Summary, Notes, & Pilot Evaluation

Date: June 12, 2024
Simulation #: 14
Pilot: D. Gelinas

Simulation Summary:

Time: *(Start)* _____ *(End)* _____ Direction of Transit: (Inbound) / Outbound

Distance from Berth (Starting Point for Inbound or Ending Point for Outbound):

Tugboats (number and size available): 2 Tugs Port Facility: Mack Point / (Sears Island)

Ship Model (circle one): *Bulk Carrier 24* / (*Heavy Lift ECO LIFTER*)

Load Conditions / Cargo: *Ballast* / *Loaded* / (*Blades*) / *Towers*

Environmental Conditions:

Wind *(Speed / Direction)*: 25 kts SW Current *(stage / start time)*: Flood

Waves: _____ Water Level: _____

Notes During Simulation:

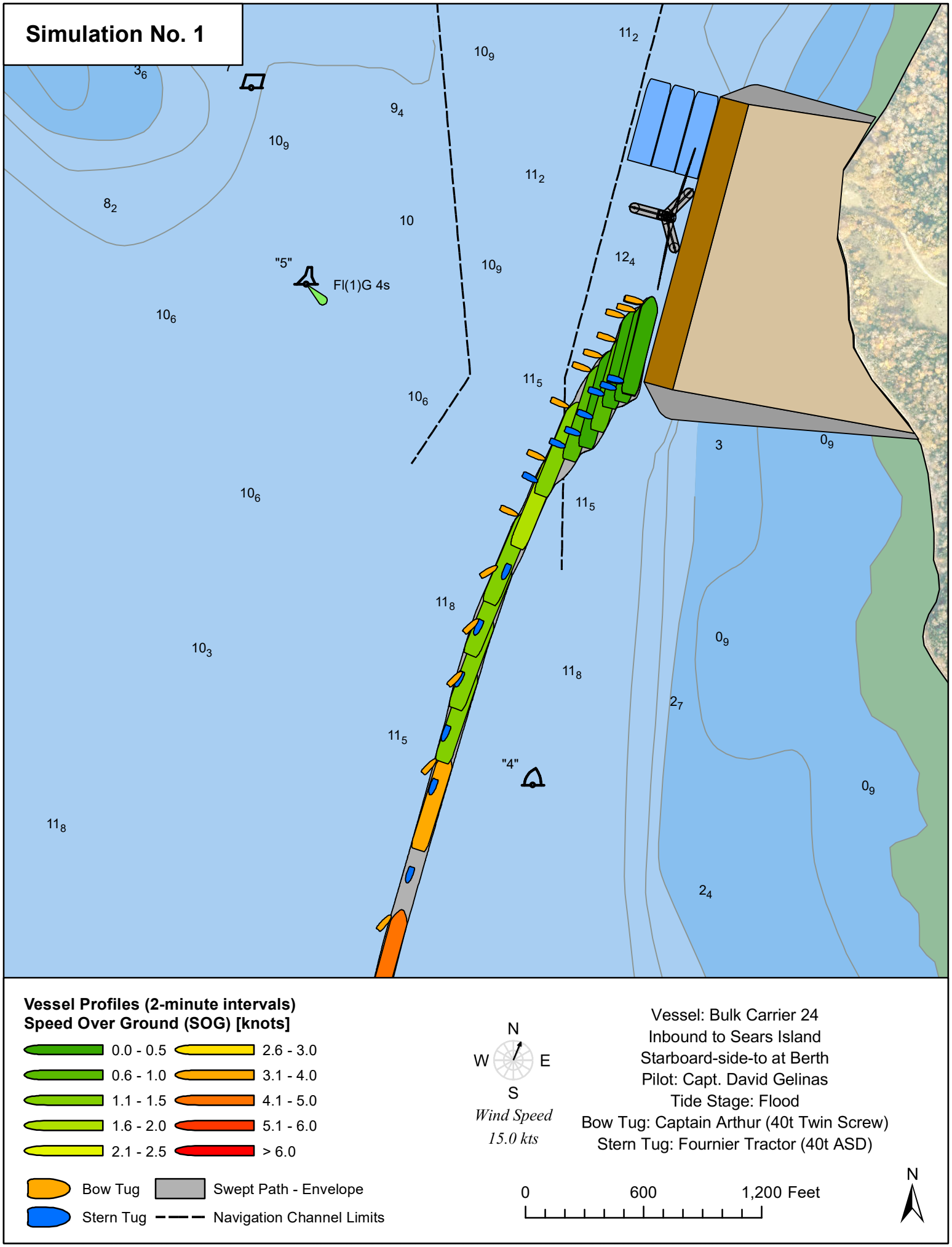
Time	Observations/Notes
	Turn to starboard. Pilot stated the wind made it difficult, but there was plenty of space to react to the conditions and make the turn. Overall, there was no problem.

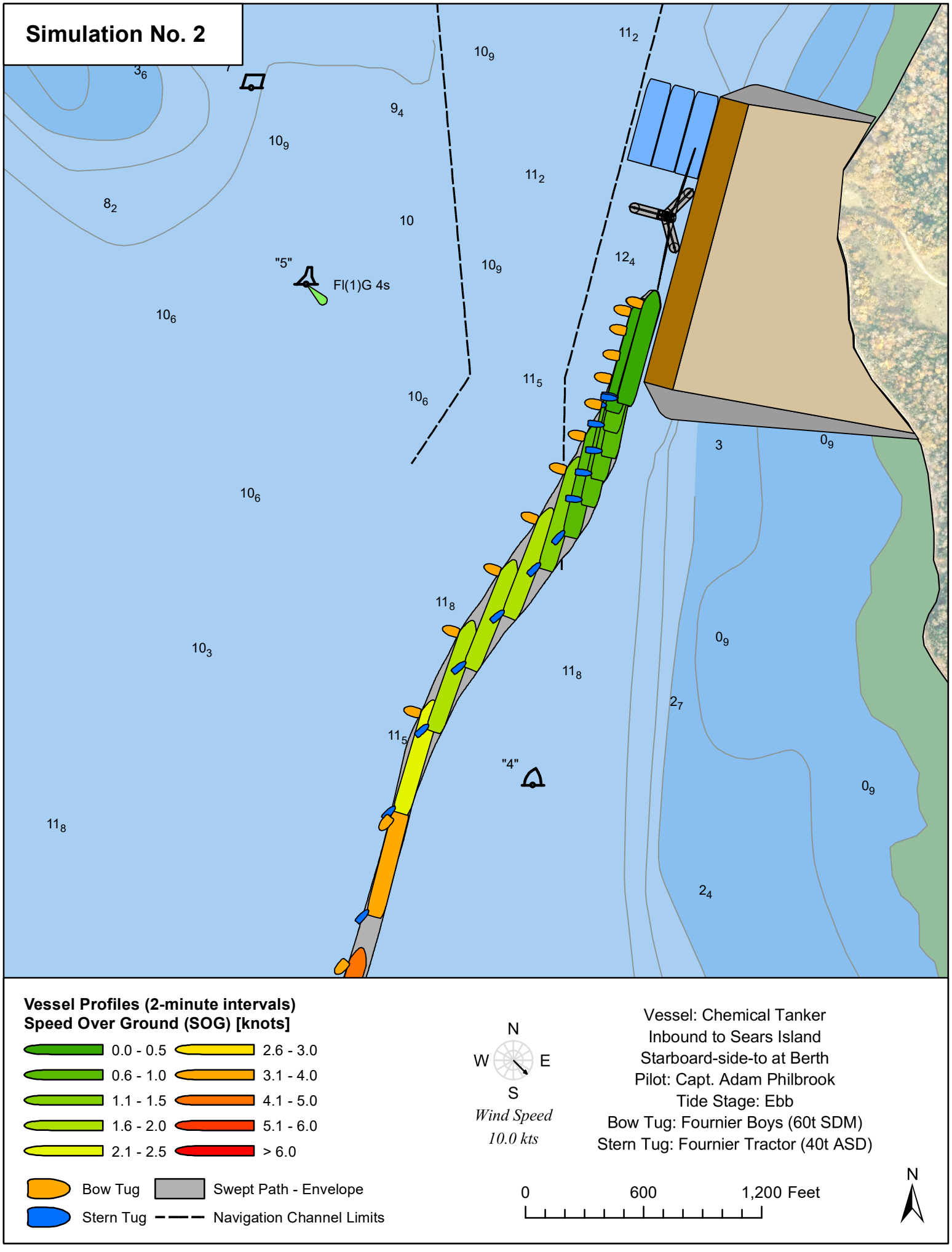
Summary Ratings for Safety and Difficulty:

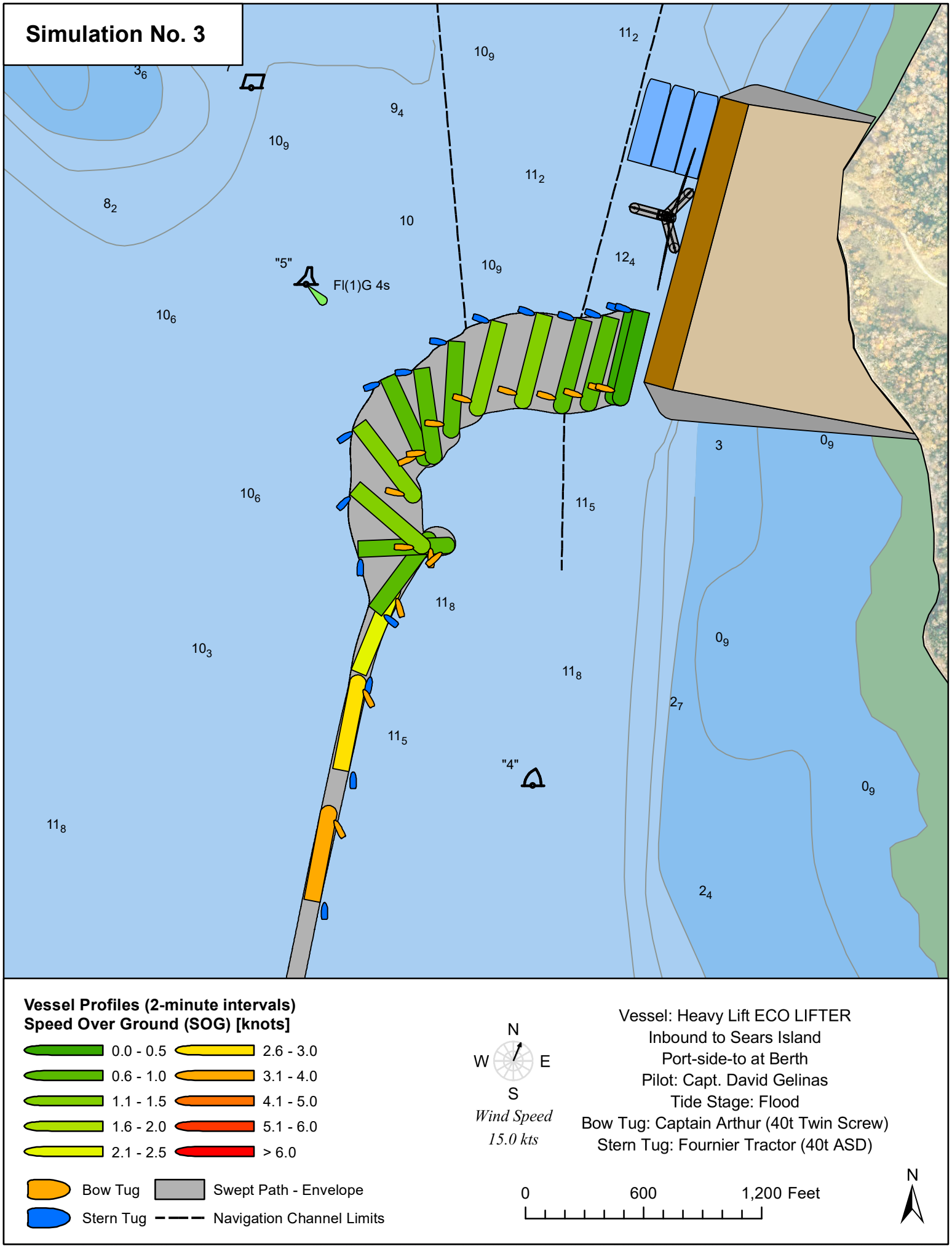
Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

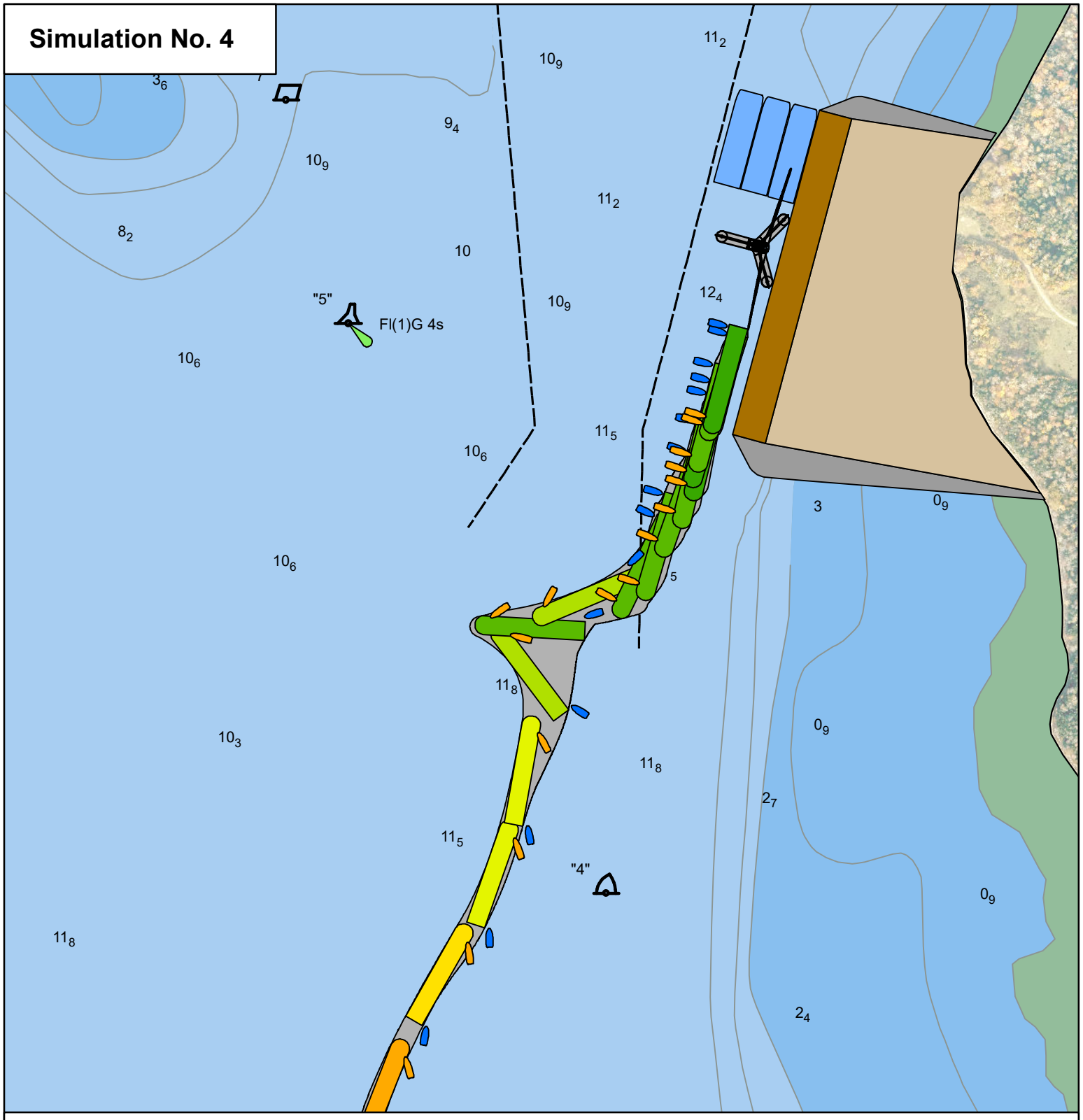
APPENDIX D

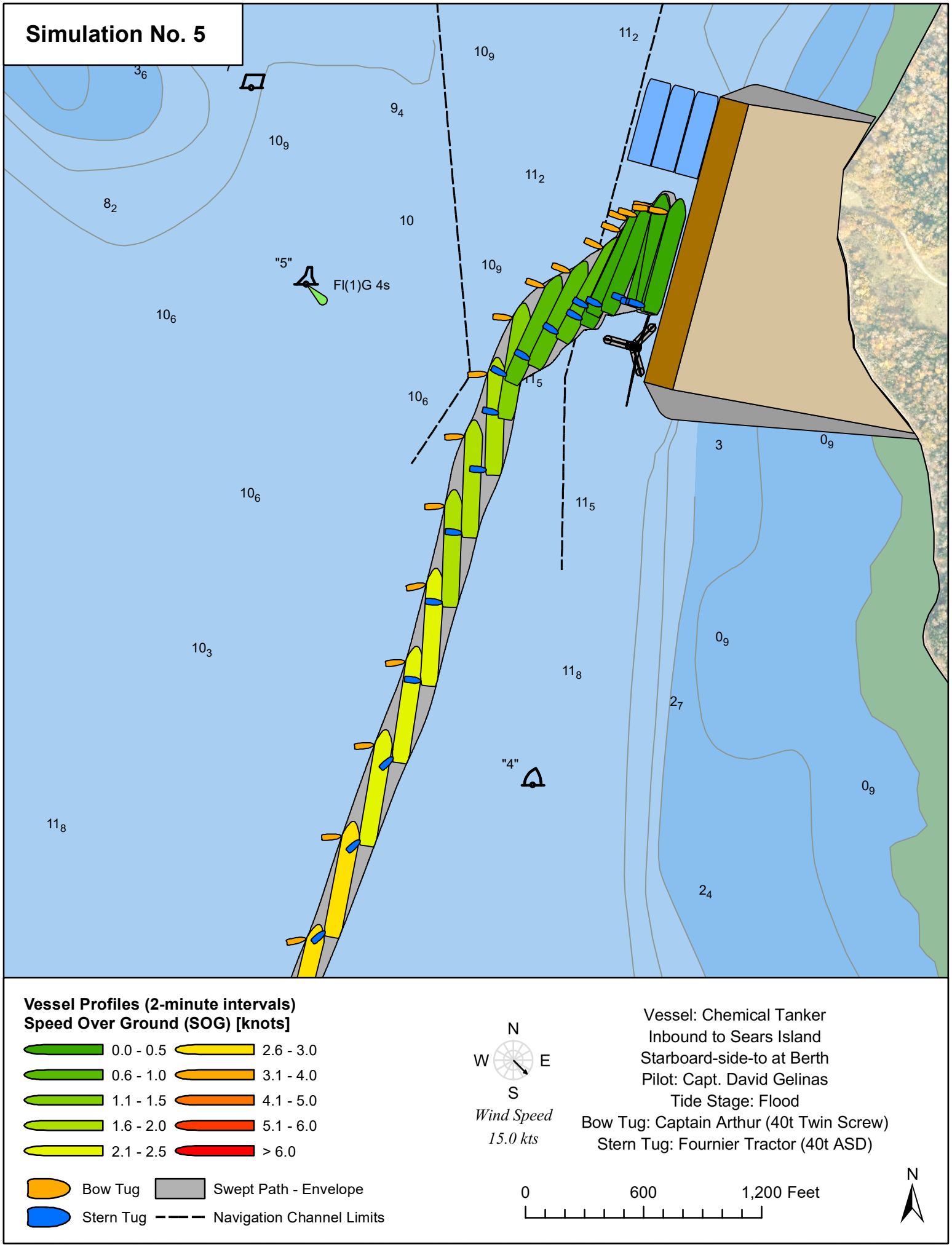
SIMULATION SUMMARIES – MAP VIEW

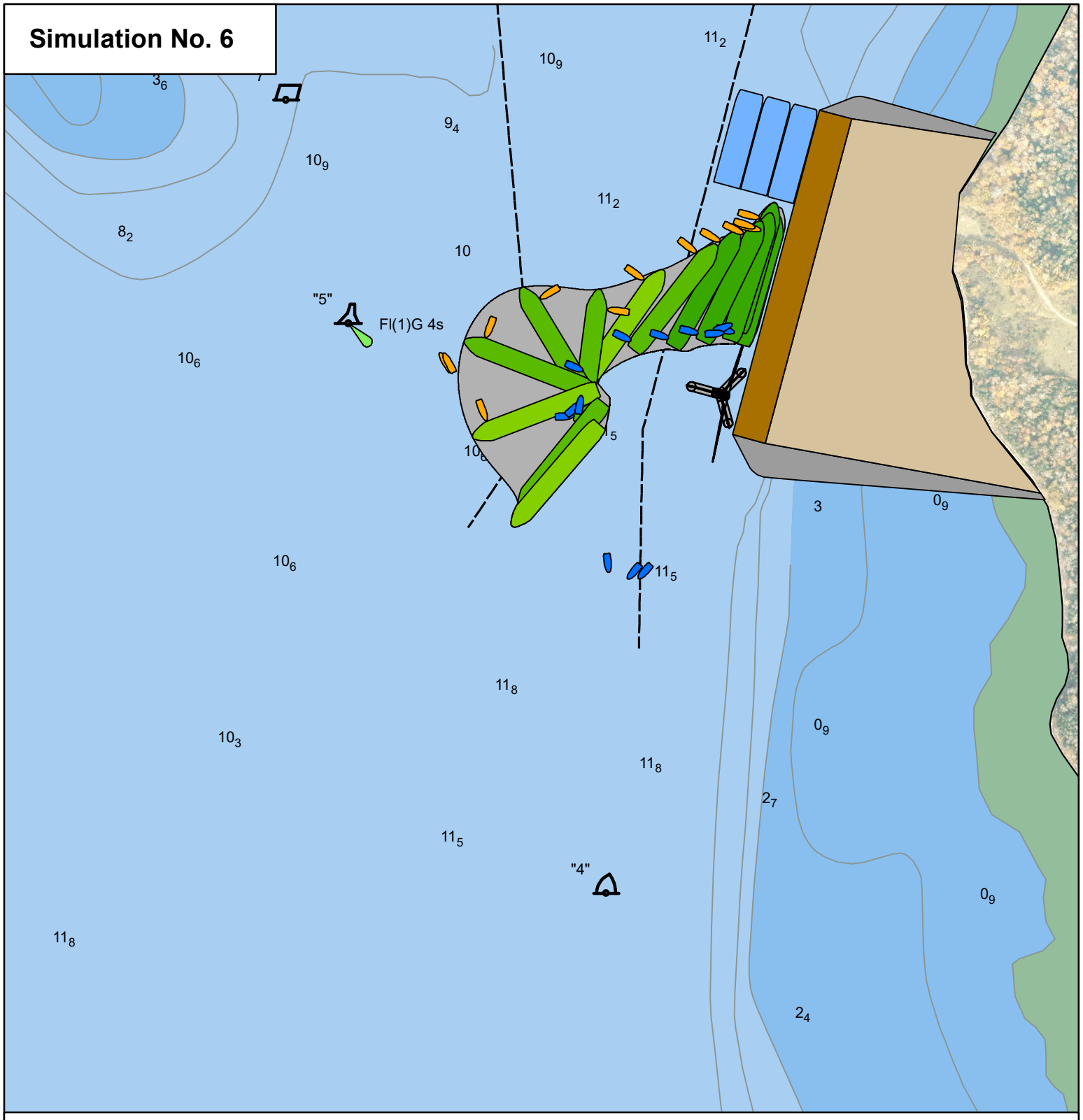

Simulation No. 1
"5"
Fl(1)G 4s
"4"
Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]
0.0 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.0
2.1 - 2.5
2.6 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
> 6.0
Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits
N
W
E
S
Wind Speed
15.0 kts
Vessel: Bulk Carrier 24
Inbound to Sears Island
Starboard-side-to at Berth
Pilot: Capt. David Gelinas
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)
0
600
1,200 Feet
N


Simulation No. 2
"5"
Fl(1)G 4s
"4"
Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]
0.0 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.0
2.1 - 2.5
2.6 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
> 6.0
Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits
N
W
E
S
Wind Speed
10.0 kts
Vessel: Chemical Tanker
Inbound to Sears Island
Starboard-side-to at Berth
Pilot: Capt. Adam Philbrook
Tide Stage: Ebb
Bow Tug: Fournier Boys (60t SDM)
Stern Tug: Fournier Tractor (40t ASD)
0
600
1,200 Feet
N


Simulation No. 3
"5"
Fl(1)G 4s
"4"
Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]
0.0 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.0
2.1 - 2.5
2.6 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
> 6.0
Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits
N
W
E
S
Wind Speed
15.0 kts
Vessel: Heavy Lift ECO LIFTER
Inbound to Sears Island
Port-side-to at Berth
Pilot: Capt. David Gelinas
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)
0
600
1,200 Feet
N


Simulation No. 4
"5"
Fl(1)G 4s
"4"
Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]
0.0 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.0
2.1 - 2.5
2.6 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
> 6.0
Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits
N
W
E
S
Wind Speed
22.0 kts
Vessel: Heavy Lift ECO LIFTER
Inbound to Sears Island
Port-side-to at Berth
Pilot: Capt. Adam Philbrook
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)
0
600
1,200 Feet
N


Simulation No. 5
"5"
Fl(1)G 4s
"4"
Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]
0.0 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.0
2.1 - 2.5
2.6 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
> 6.0
Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits
N
W
E
S
Wind Speed
15.0 kts
Vessel: Chemical Tanker
Inbound to Sears Island
Starboard-side-to at Berth
Pilot: Capt. David Gelinas
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)
0
600
1,200 Feet
N



Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]

0.0 - 0.5	2.6 - 3.0
0.6 - 1.0	3.1 - 4.0
1.1 - 1.5	4.1 - 5.0
1.6 - 2.0	5.1 - 6.0
2.1 - 2.5	> 6.0

Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits

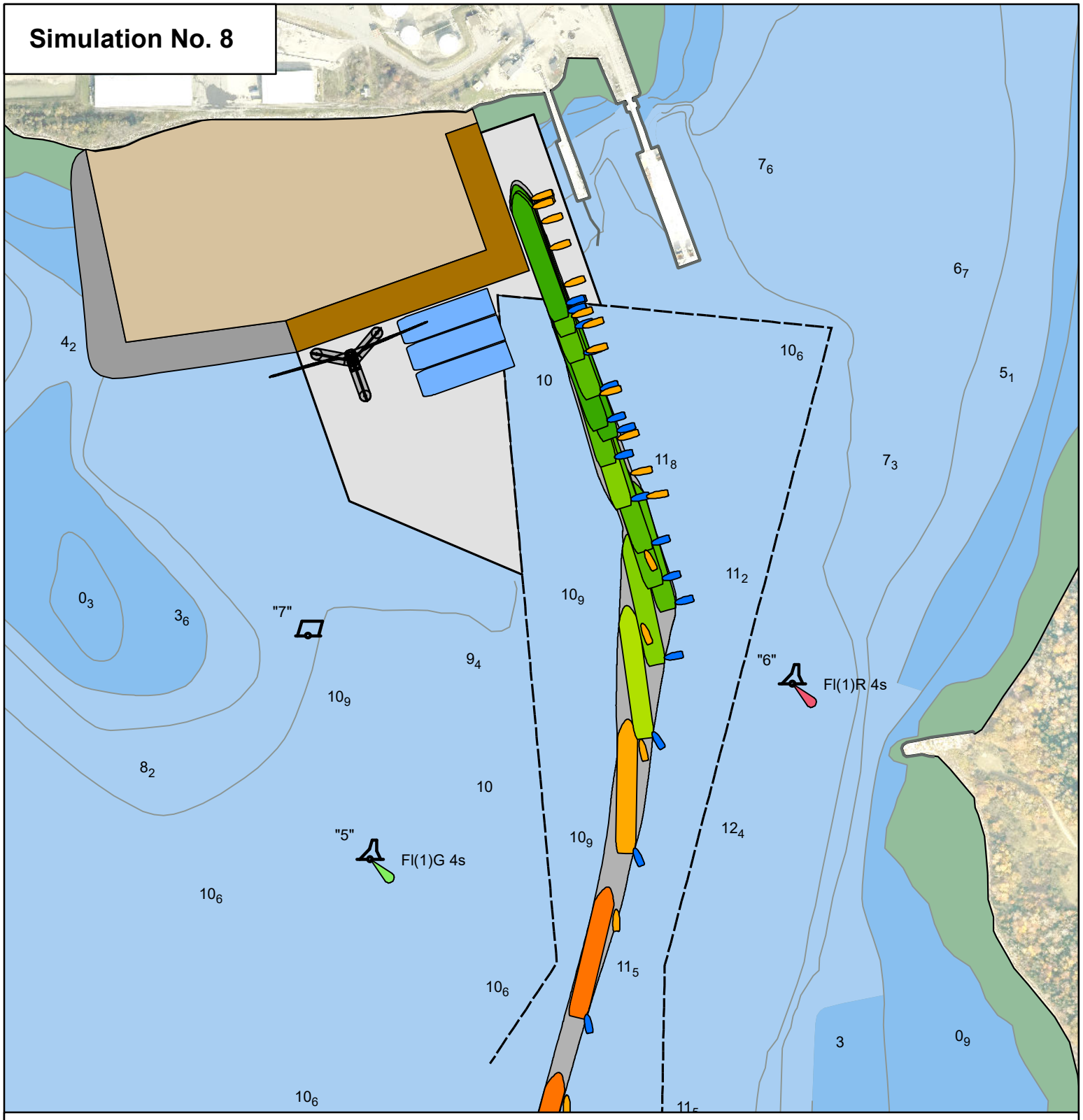
N
W E
S

Wind Speed
15.0 kts

Vessel: Chemical Tanker
Outbound from Sears Island
Starboard-side-to at Berth
Pilot: Capt. Adam Philbrook
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)

0 600 1,200 Feet

N



Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]

0.0 - 0.5	2.6 - 3.0
0.6 - 1.0	3.1 - 4.0
1.1 - 1.5	4.1 - 5.0
1.6 - 2.0	5.1 - 6.0
2.1 - 2.5	> 6.0

Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits

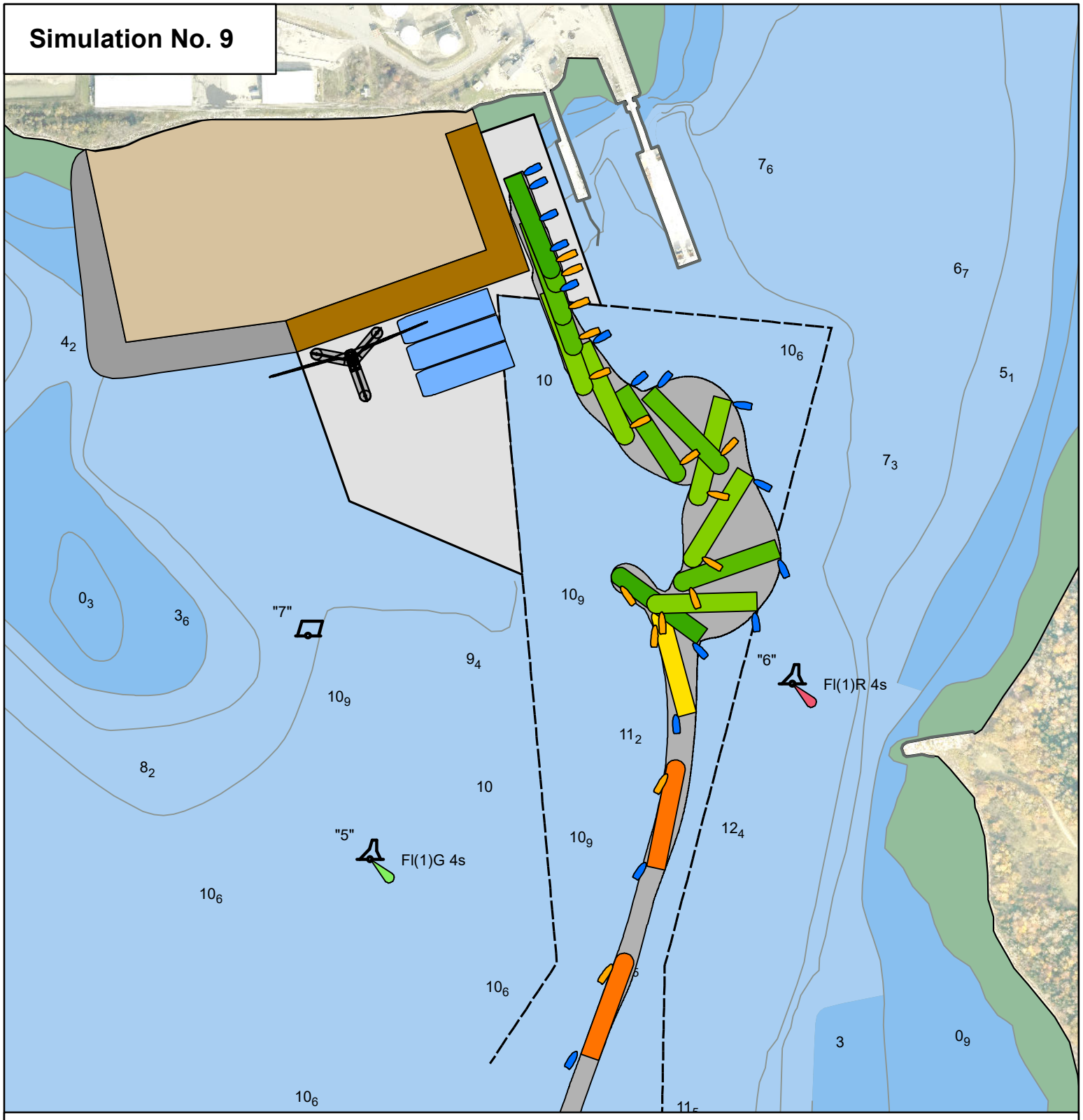
N
W E
S

Wind Speed
15.0 kts

Vessel: Chemical Tanker
Inbound to Mack Point
Port-side-to at Berth
Pilot: Capt. David Gelinas
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)

0 600 1,200 Feet

N



Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]

0.0 - 0.5	2.6 - 3.0
0.6 - 1.0	3.1 - 4.0
1.1 - 1.5	4.1 - 5.0
1.6 - 2.0	5.1 - 6.0
2.1 - 2.5	> 6.0

Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits

N
W E
S

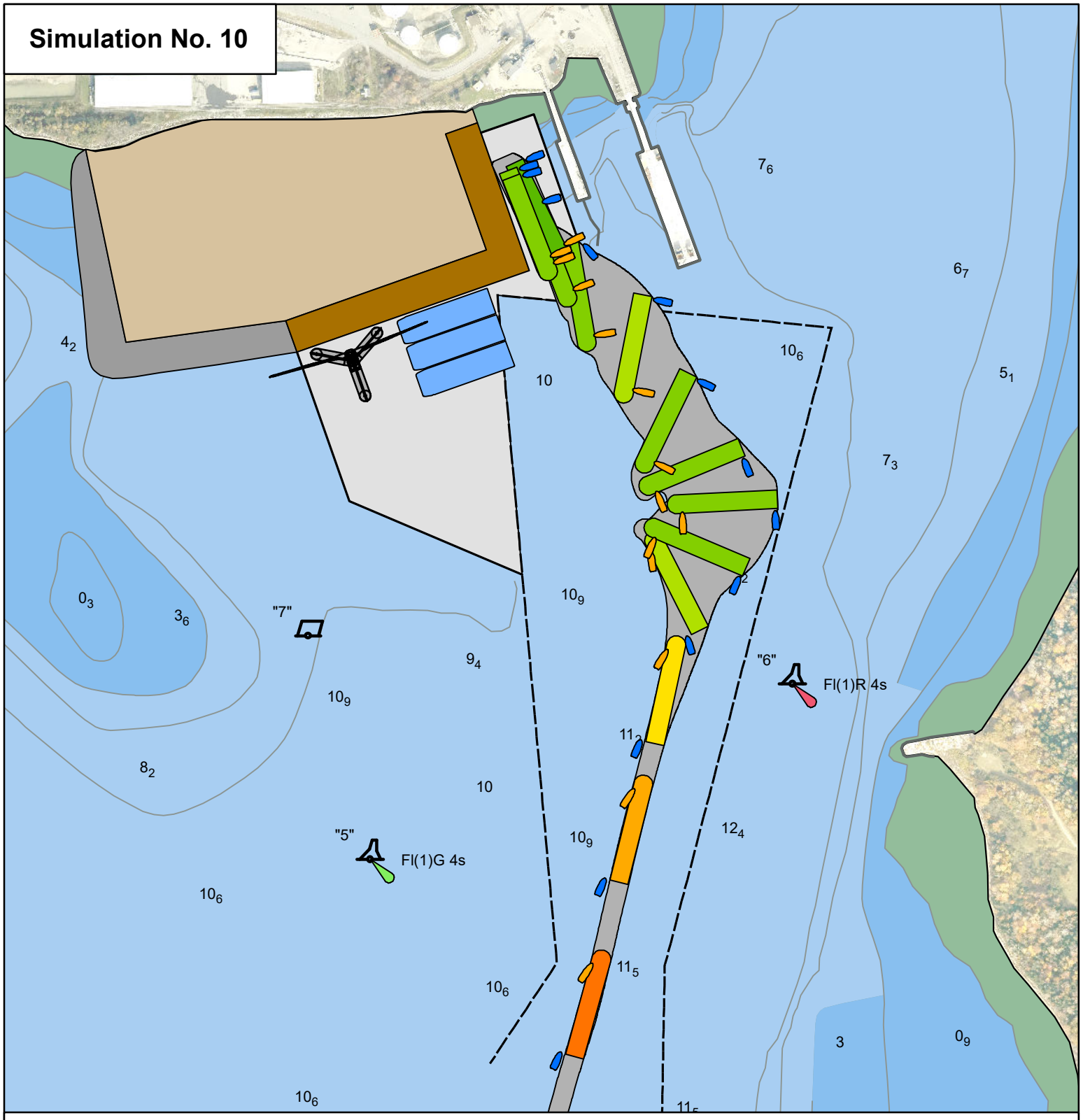
Wind Speed
15.0 kts

Vessel: Heavy Lift ECO LIFTER
Inbound to Mack Point
Starboard-side-to at Berth
Pilot: Capt. Adam Philbrook
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)

0 600 1,200 Feet

N

Simulation No. 10



Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]

0.0 - 0.5	2.6 - 3.0
0.6 - 1.0	3.1 - 4.0
1.1 - 1.5	4.1 - 5.0
1.6 - 2.0	5.1 - 6.0
2.1 - 2.5	> 6.0

Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits

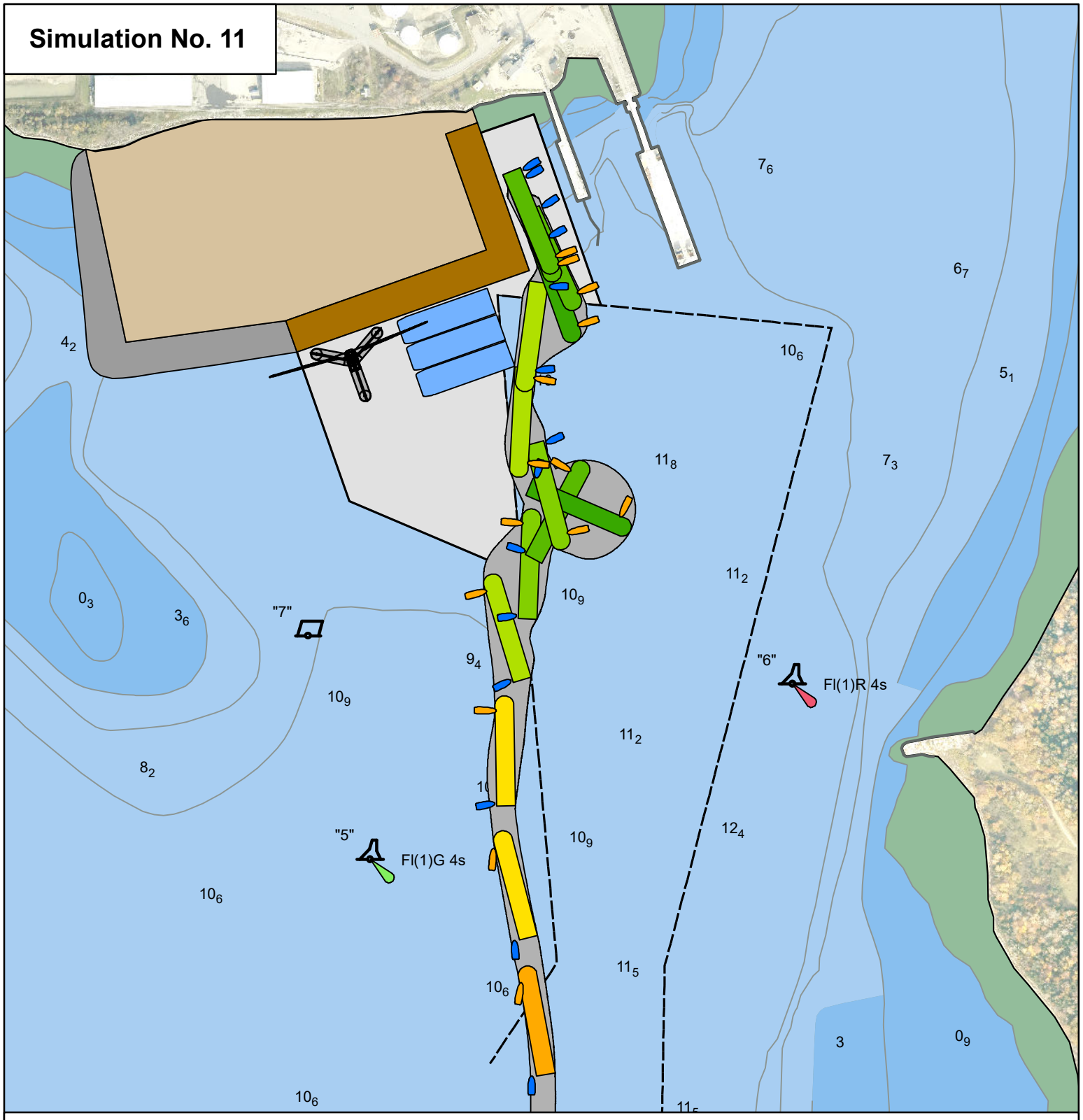
N
W E
S

Wind Speed
22.0 kts

Vessel: Heavy Lift ECO LIFTER
Inbound to Mack Point
Starboard-side-to at Berth
Pilot: Capt. David Gelinas
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)

0 600 1,200 Feet

N



Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]

0.0 - 0.5	2.6 - 3.0
0.6 - 1.0	3.1 - 4.0
1.1 - 1.5	4.1 - 5.0
1.6 - 2.0	5.1 - 6.0
2.1 - 2.5	> 6.0

Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits

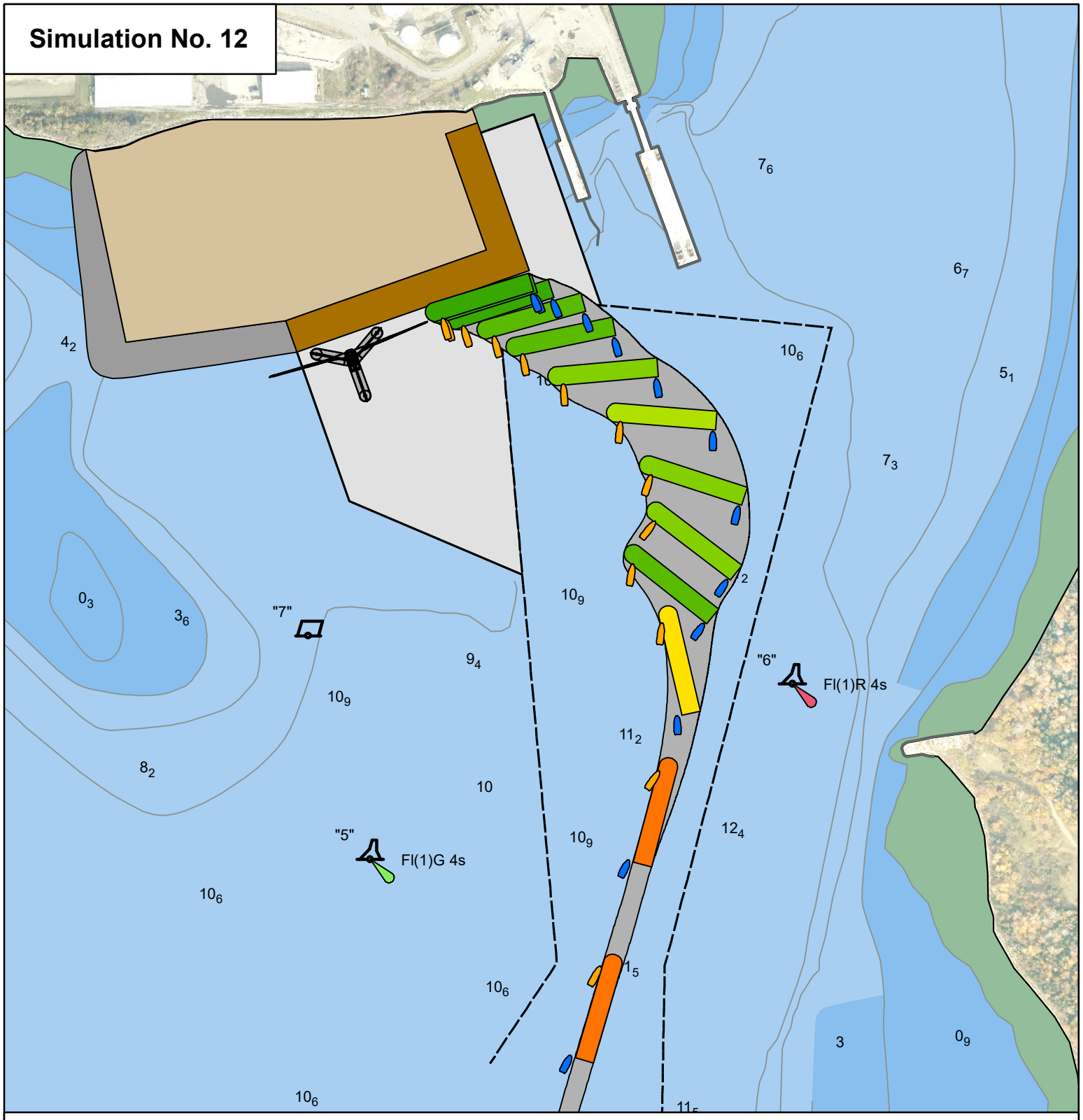
N
W E
S

Wind Speed
22.0 kts

Vessel: Heavy Lift ECO LIFTER
Inbound to Mack Point
Starboard-side-to at Berth
Pilot: Capt. Adam Philbrook
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)

0 600 1,200 Feet

N



Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]

0.0 - 0.5	2.6 - 3.0
0.6 - 1.0	3.1 - 4.0
1.1 - 1.5	4.1 - 5.0
1.6 - 2.0	5.1 - 6.0
2.1 - 2.5	> 6.0

Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits

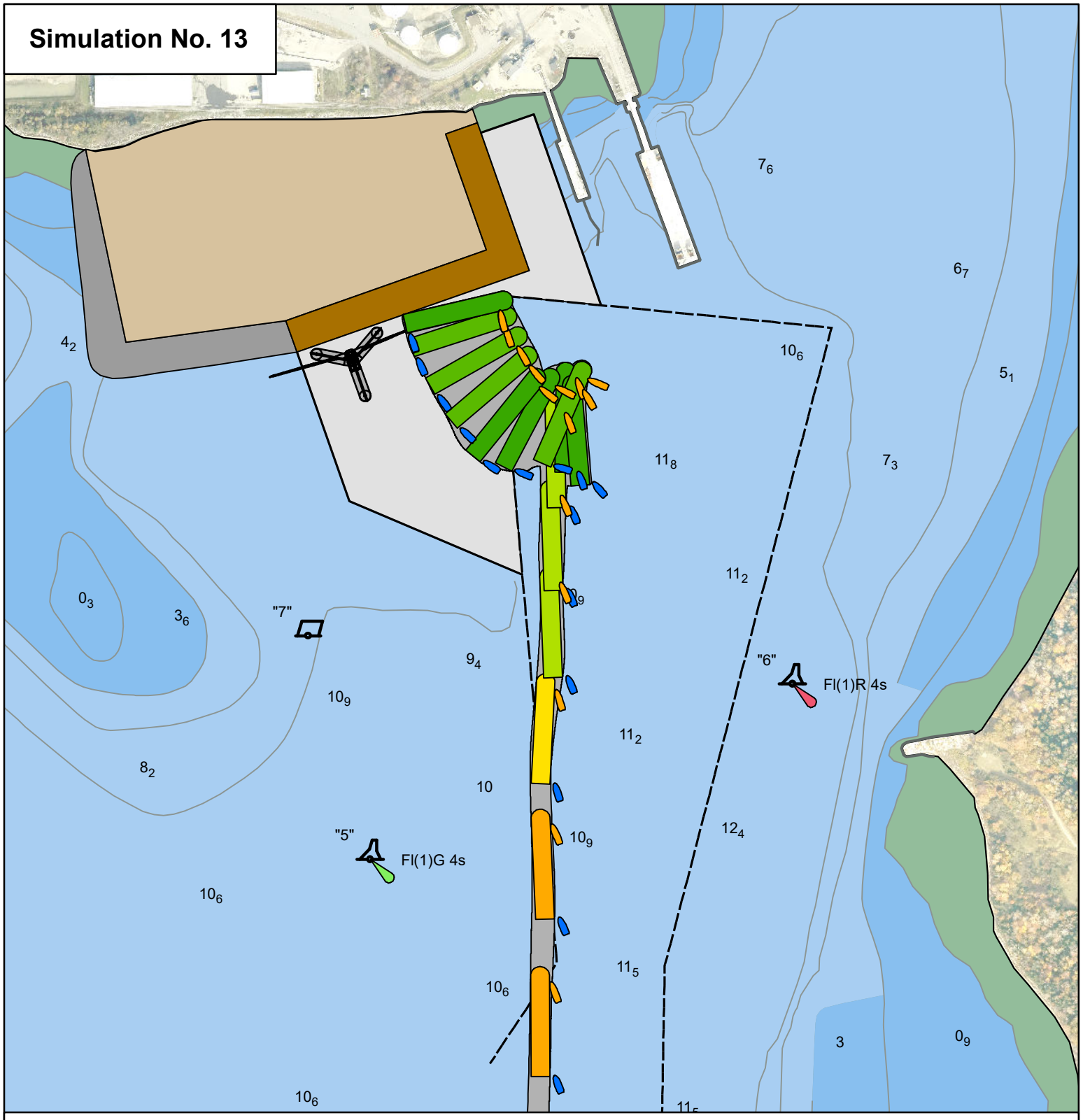
N
W E
S

Wind Speed
22.0 kts

Vessel: Heavy Lift ECO LIFTER
Inbound to Mack Point
Starboard-side-to at Berth
Pilot: Capt. David Gelinas
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)

0 600 1,200 Feet

N



Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]

0.0 - 0.5	2.6 - 3.0
0.6 - 1.0	3.1 - 4.0
1.1 - 1.5	4.1 - 5.0
1.6 - 2.0	5.1 - 6.0
2.1 - 2.5	> 6.0

Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits

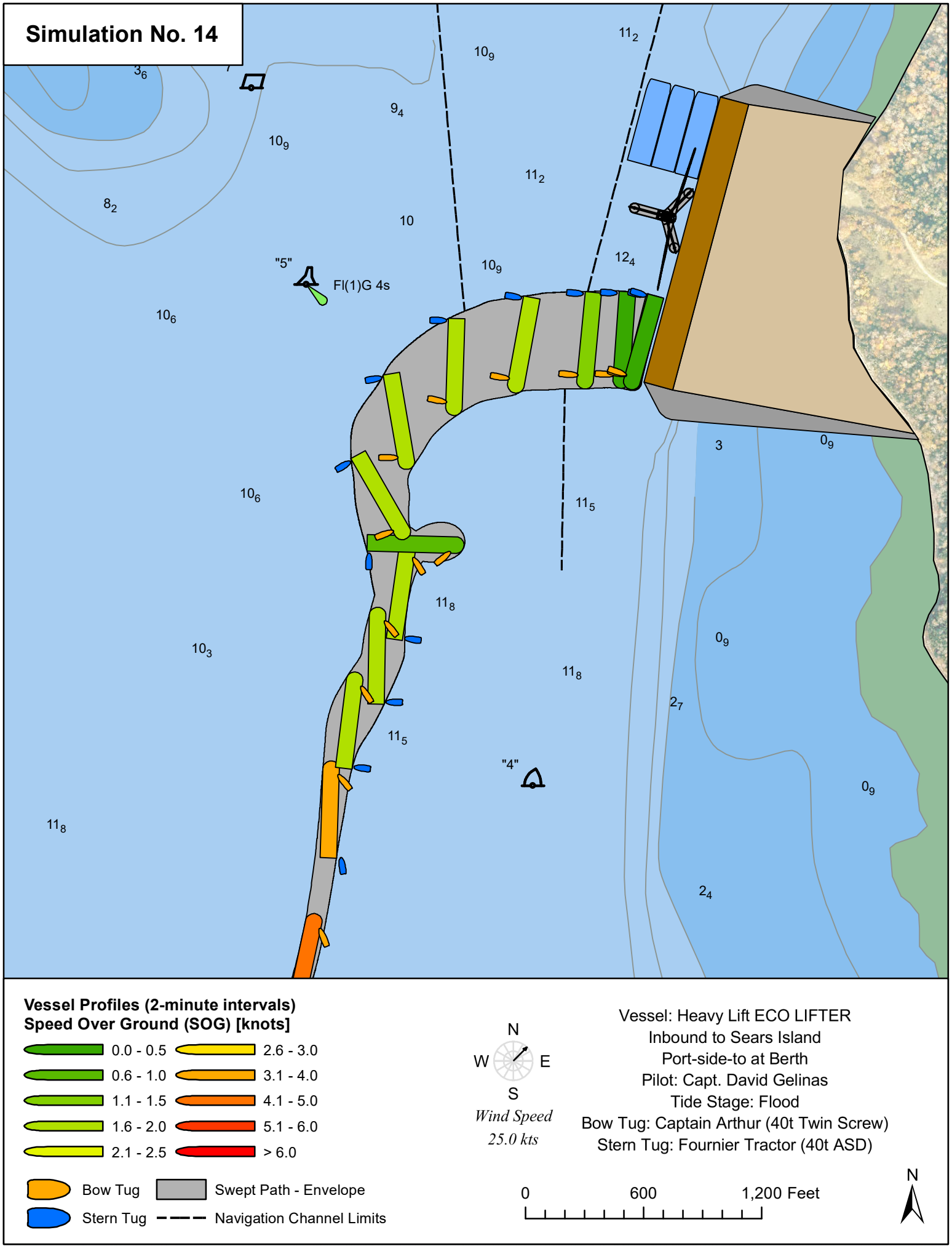
N
W E
S

Wind Speed
22.0 kts

Vessel: Heavy Lift ECO LIFTER
Inbound to Mack Point
Port-side-to at Berth
Pilot: Capt. Adam Philbrook
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)

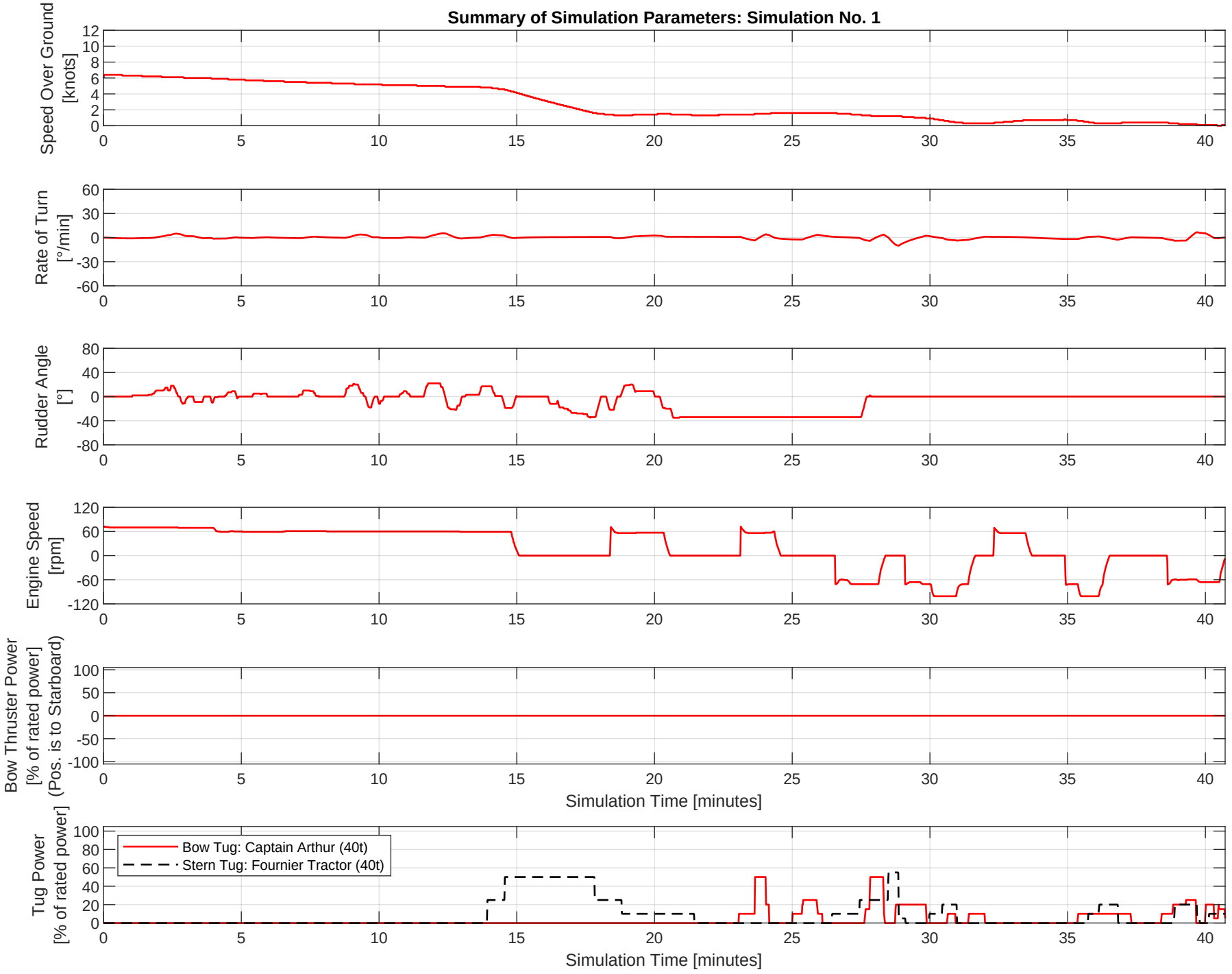
0 600 1,200 Feet

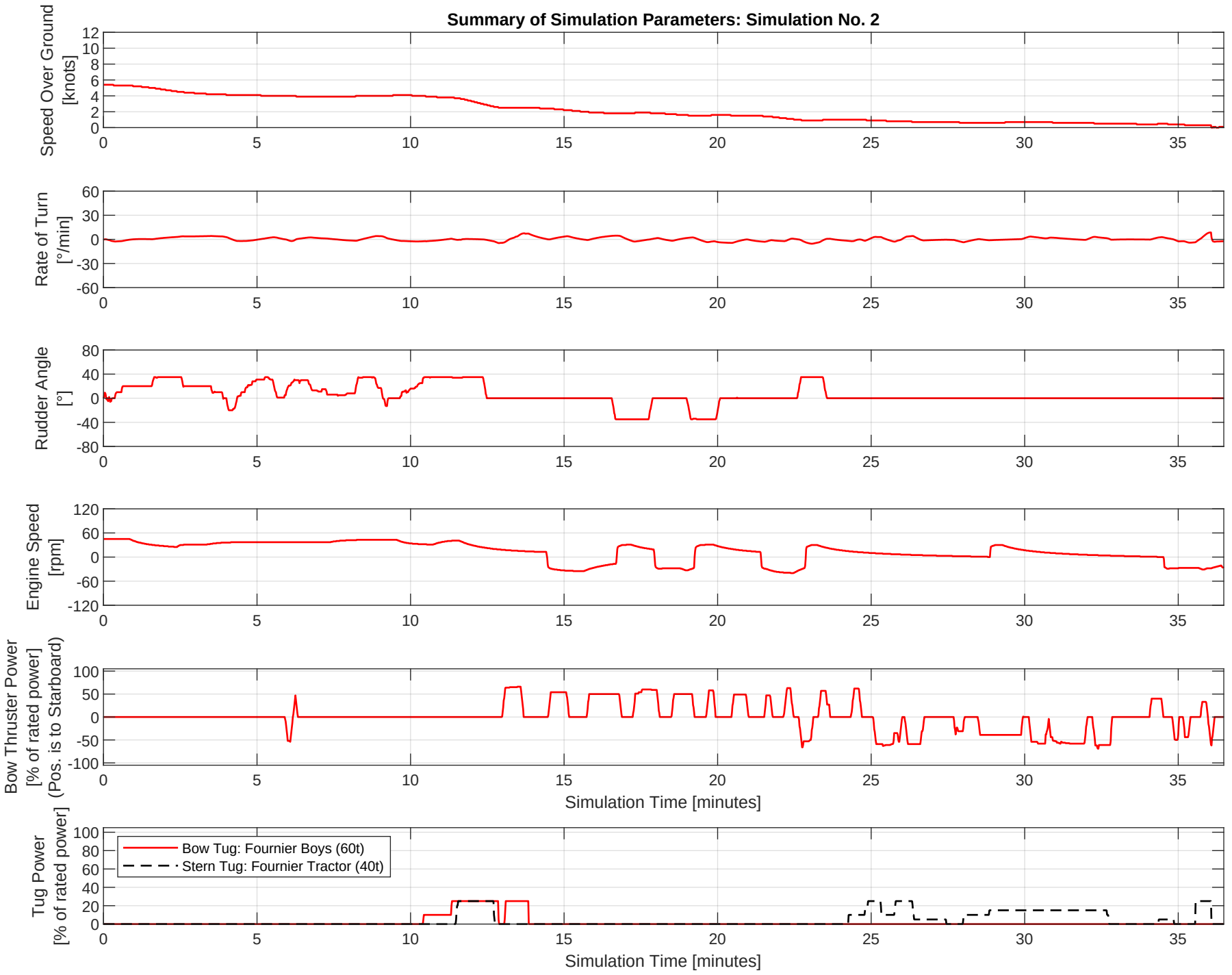
N

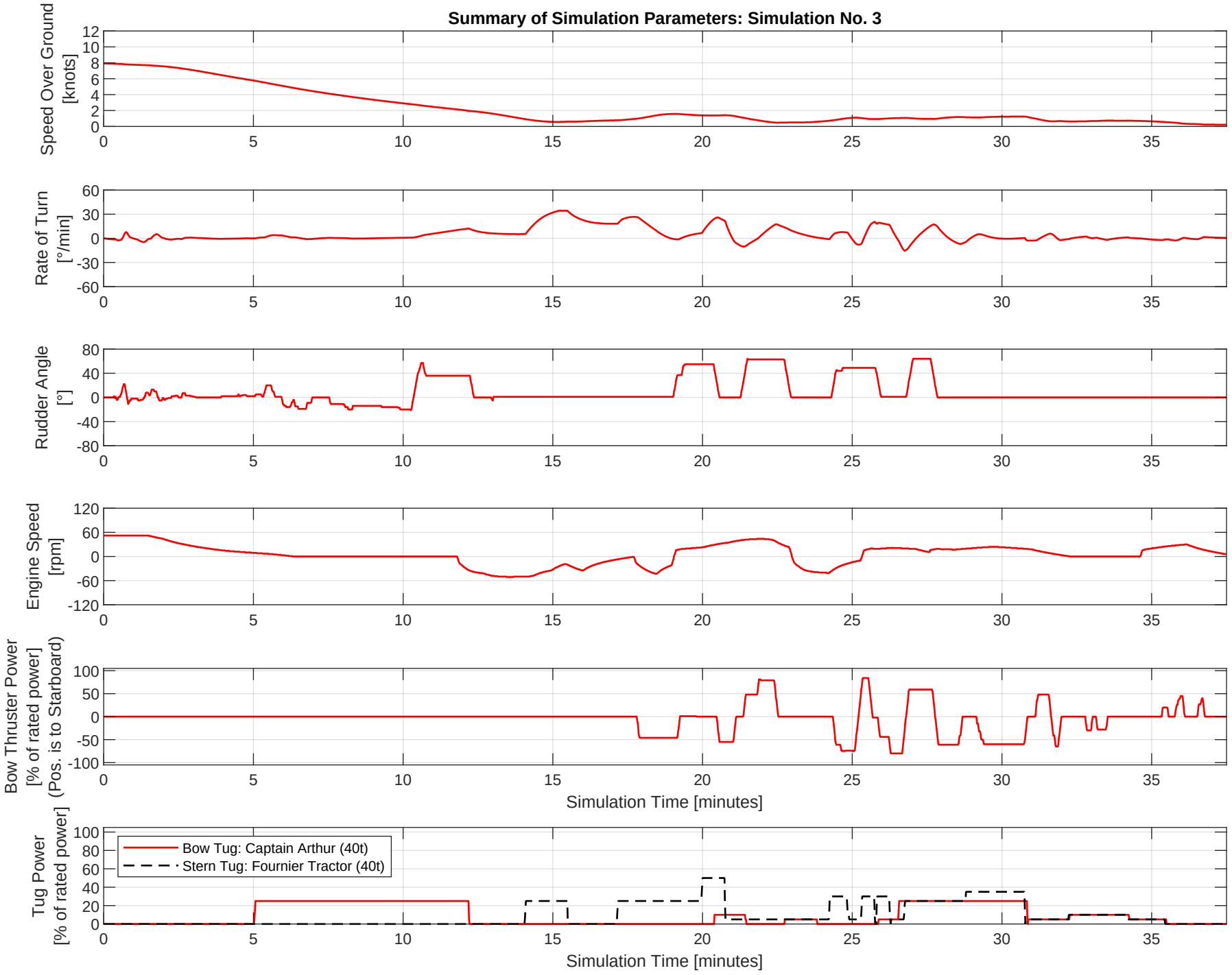

Simulation No. 14
"5"
Fl(1)G 4s
"4"
Vessel Profiles (2-minute intervals)
Speed Over Ground (SOG) [knots]
0.0 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.0
2.1 - 2.5
2.6 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
> 6.0
Bow Tug
Stern Tug
Swept Path - Envelope
Navigation Channel Limits
N
W
E
S
Wind Speed
25.0 kts
Vessel: Heavy Lift ECO LIFTER
Inbound to Sears Island
Port-side-to at Berth
Pilot: Capt. David Gelinas
Tide Stage: Flood
Bow Tug: Captain Arthur (40t Twin Screw)
Stern Tug: Fournier Tractor (40t ASD)
0
600
1,200 Feet
N

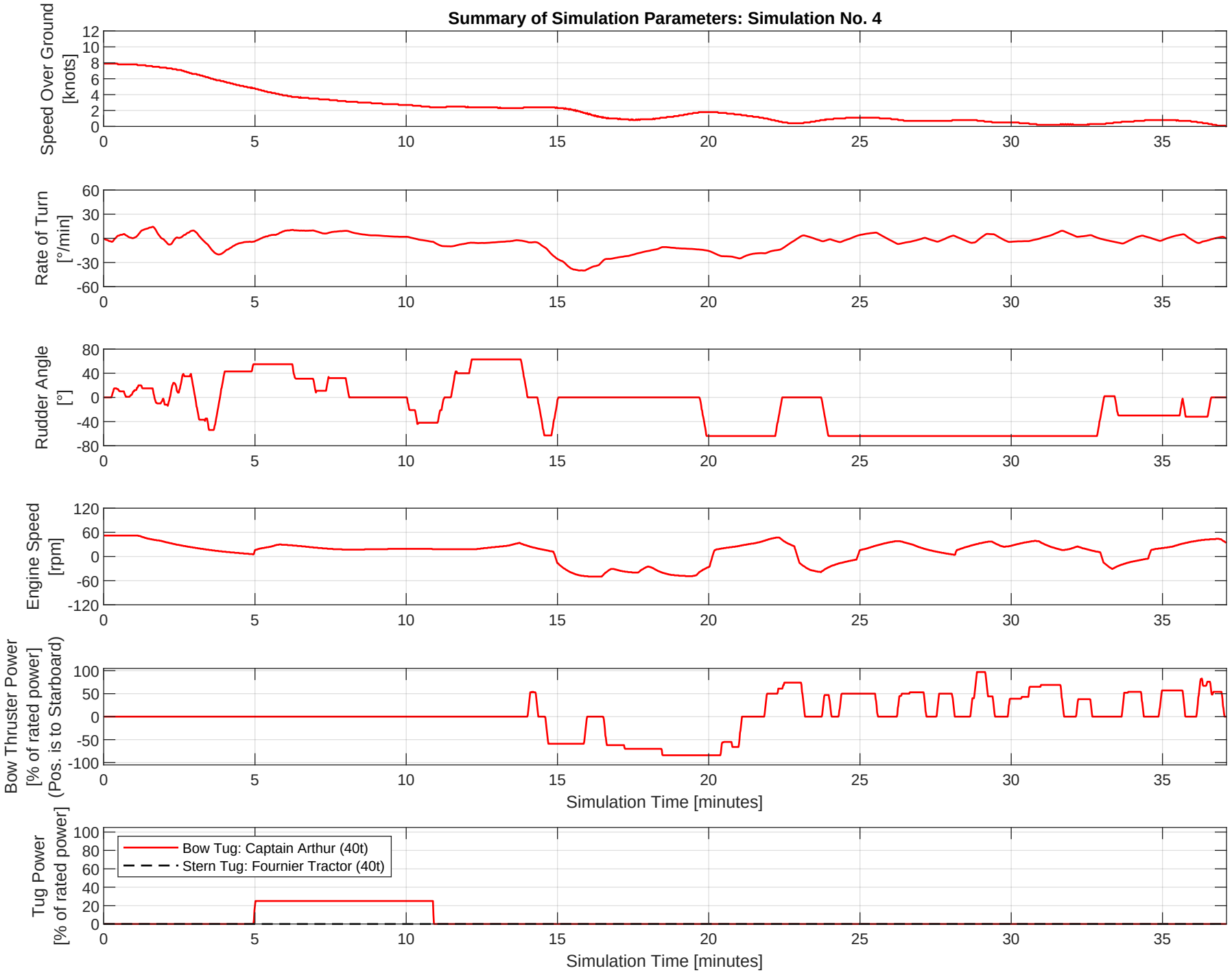
APPENDIX E

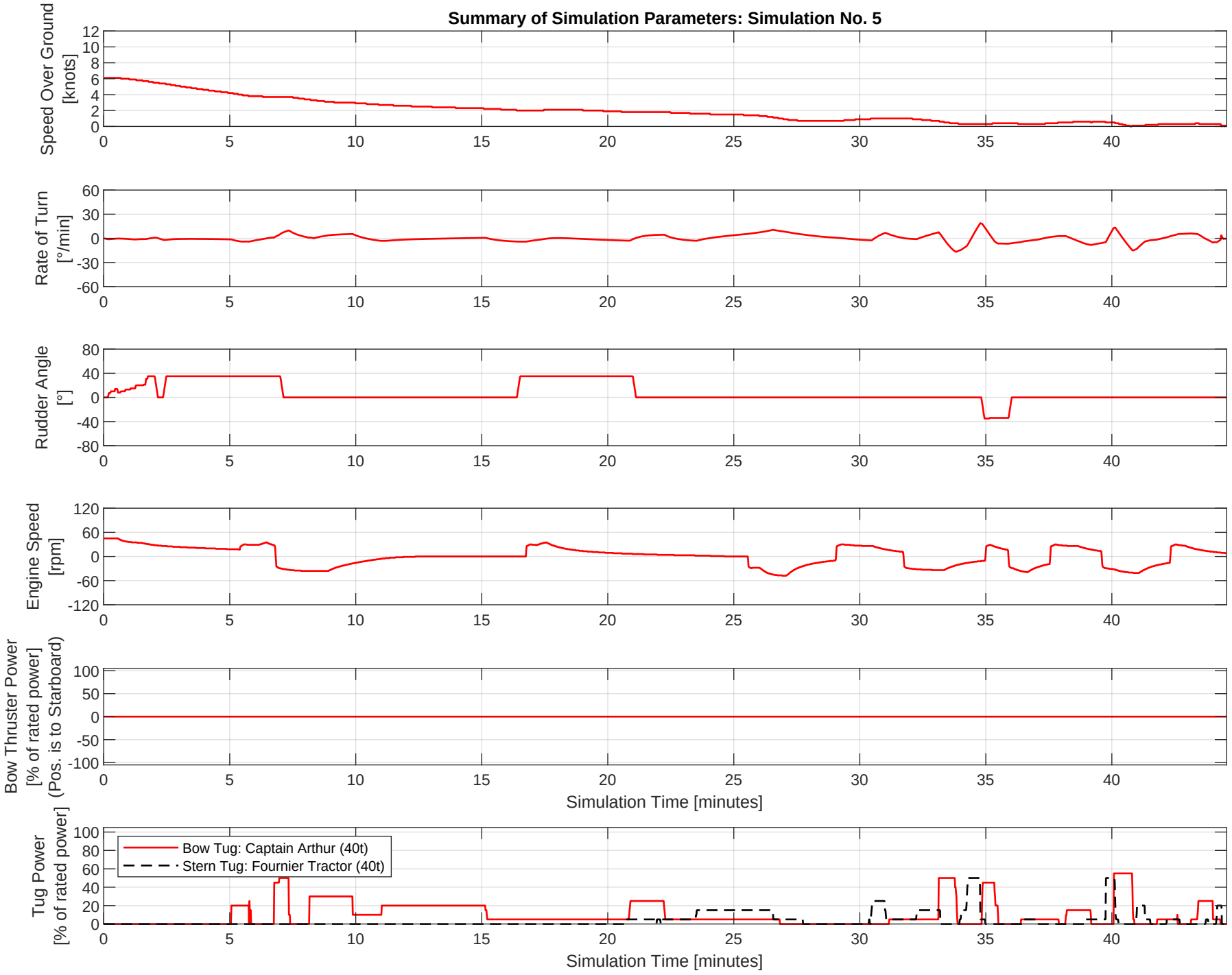
TIMESERIES FIGURES OF SIMULATION PARAMETERS

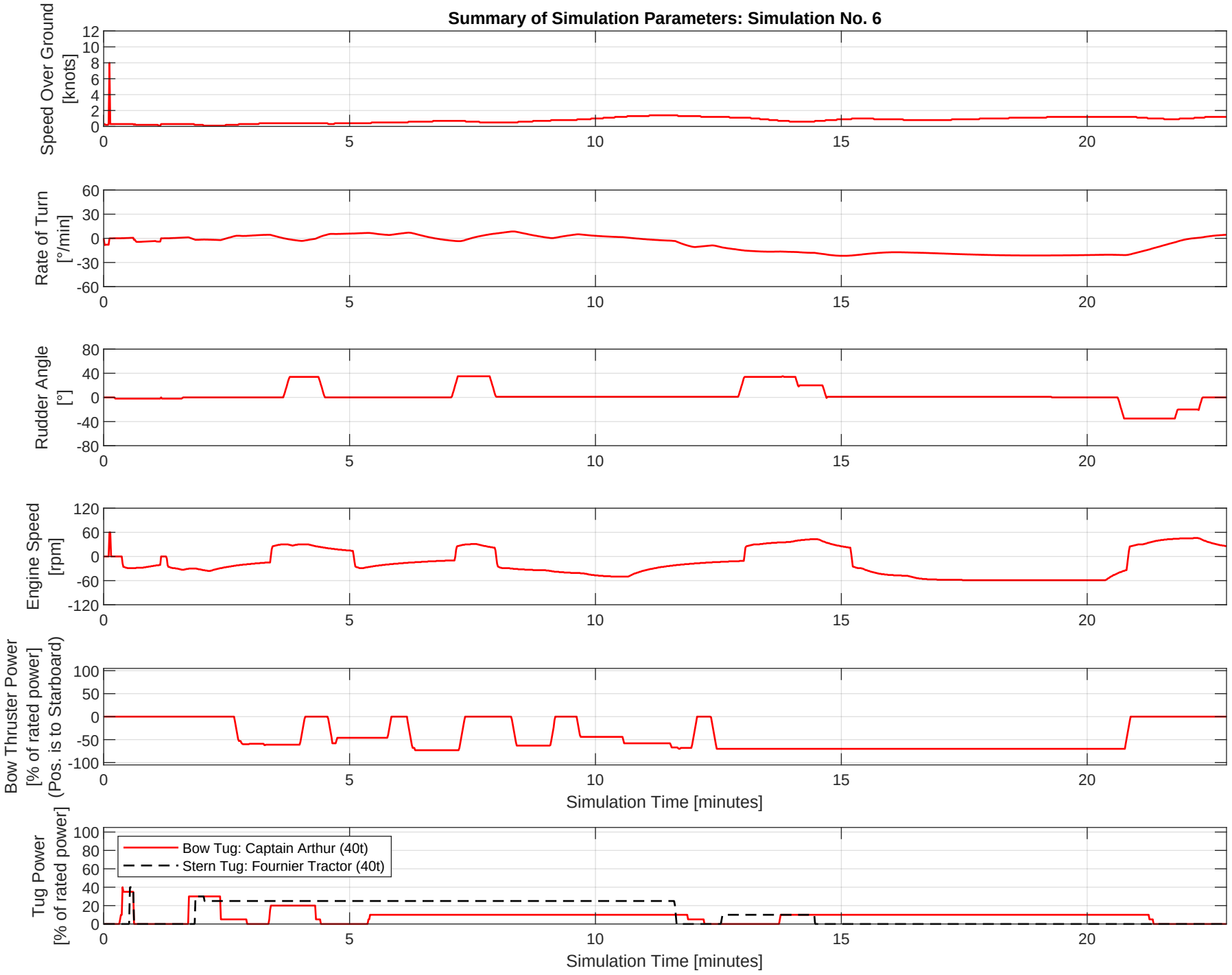

Summary of Simulation Parameters: Simulation No. 1
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]

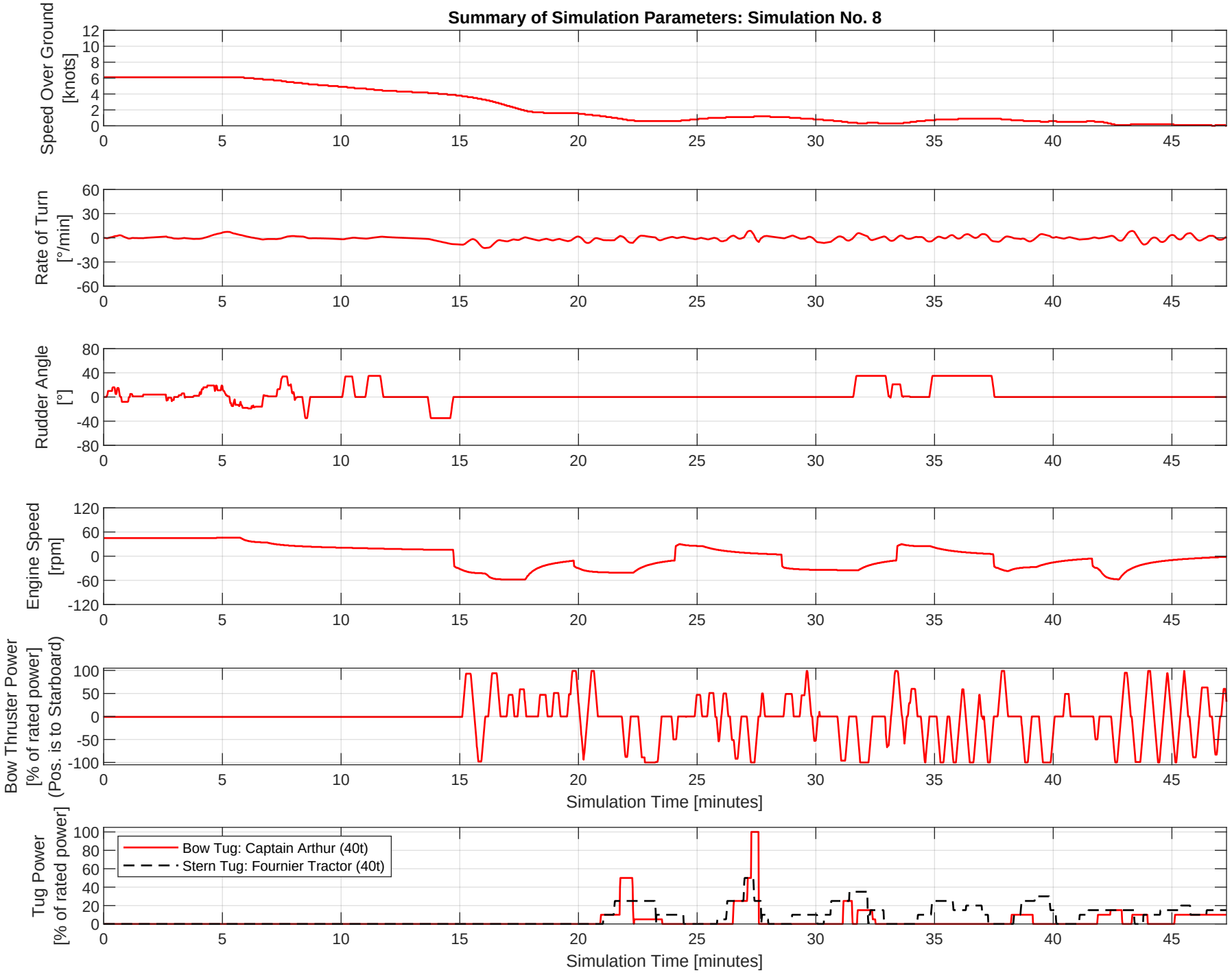

Summary of Simulation Parameters: Simulation No. 2
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Fournier Boys (60t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]

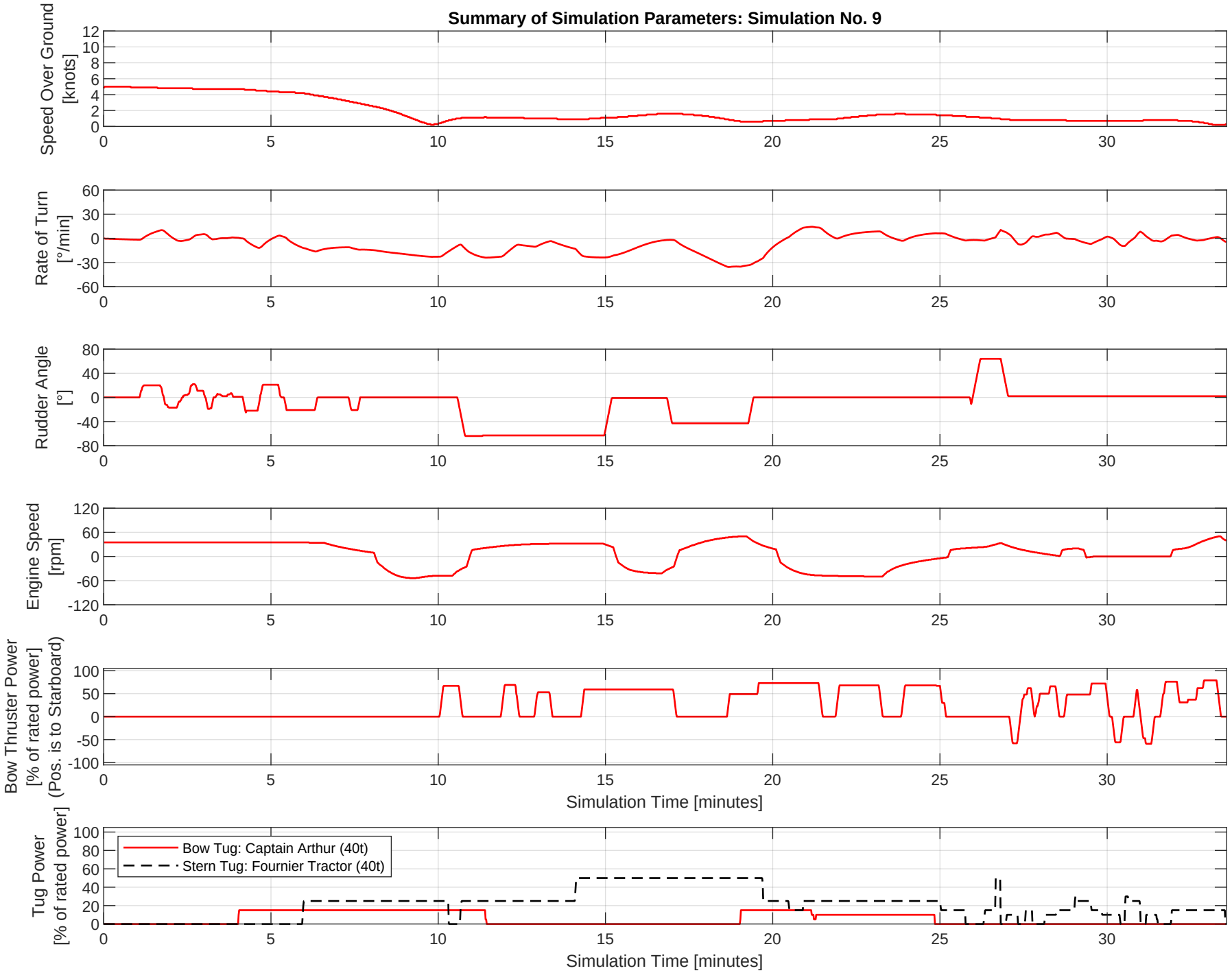

Summary of Simulation Parameters: Simulation No. 3
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]

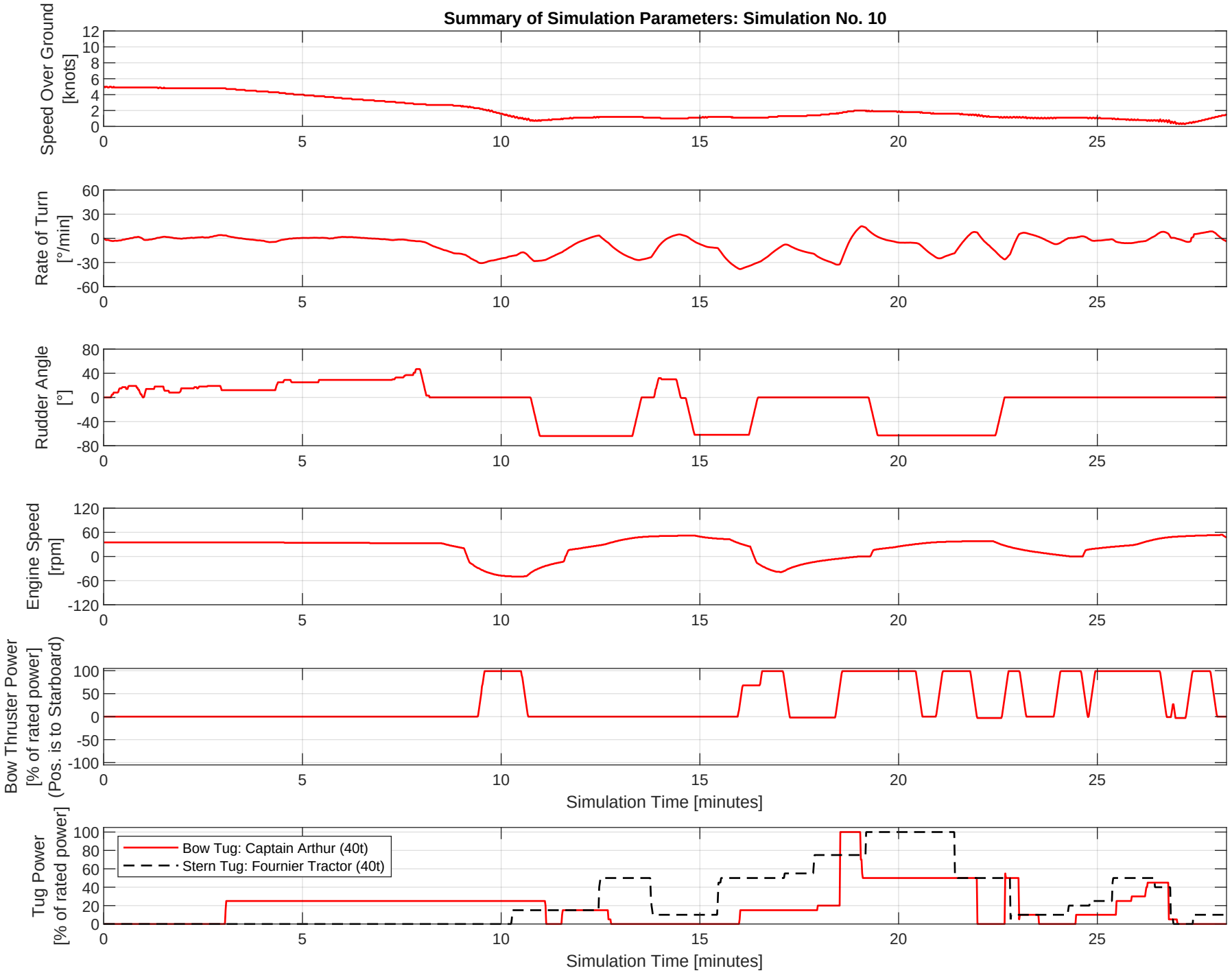

Summary of Simulation Parameters: Simulation No. 4
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]

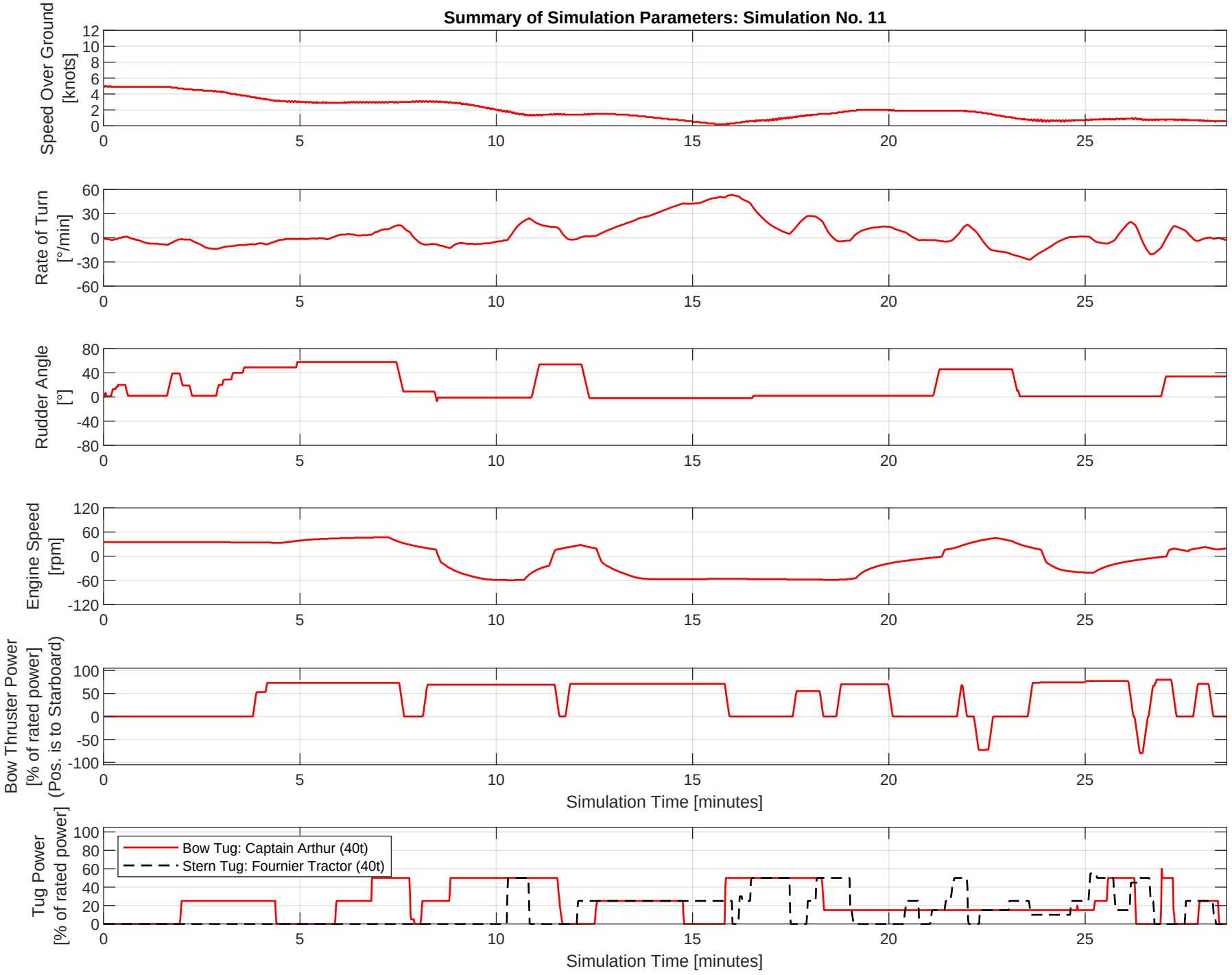

Summary of Simulation Parameters: Simulation No. 5
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]

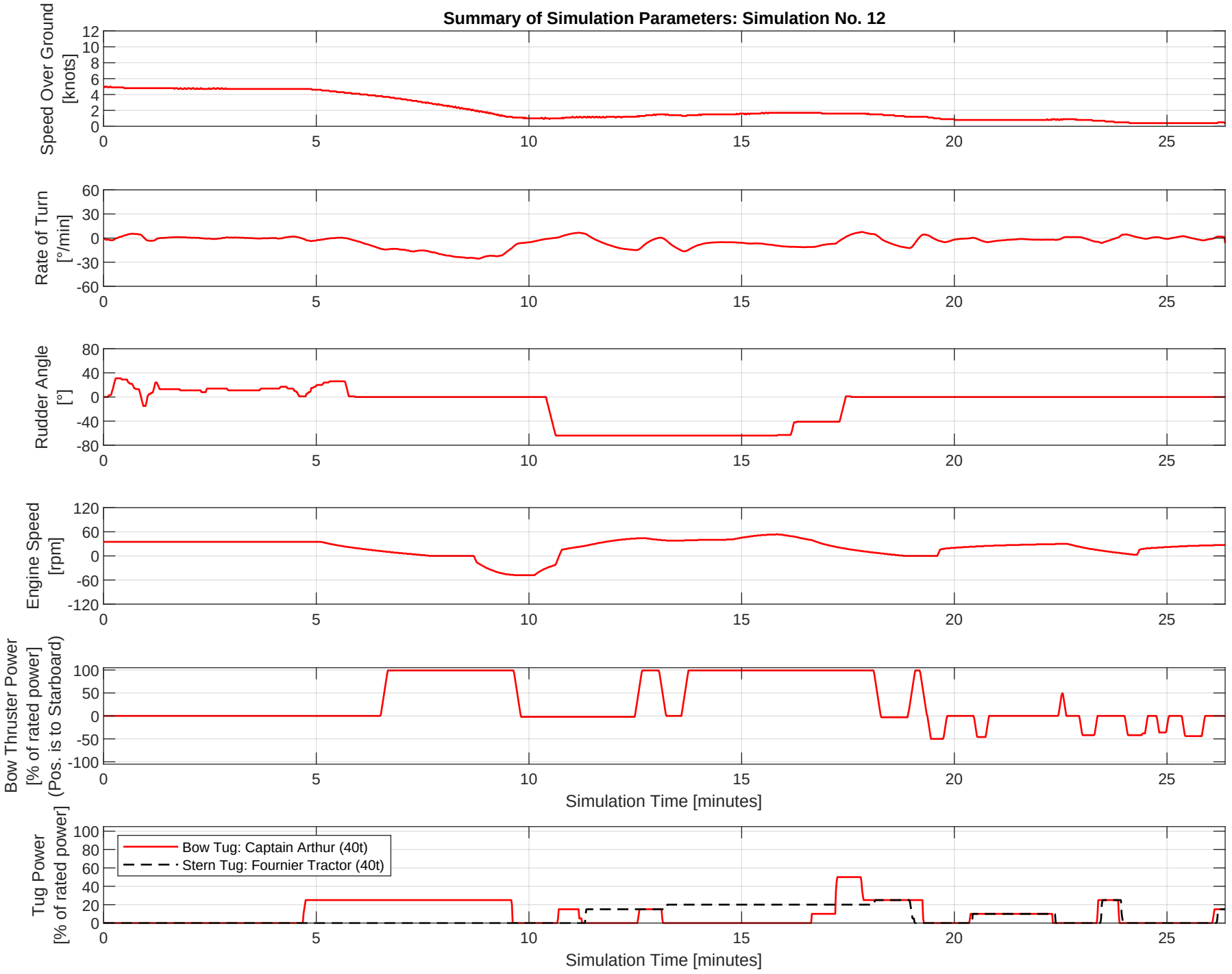

Summary of Simulation Parameters: Simulation No. 6
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]

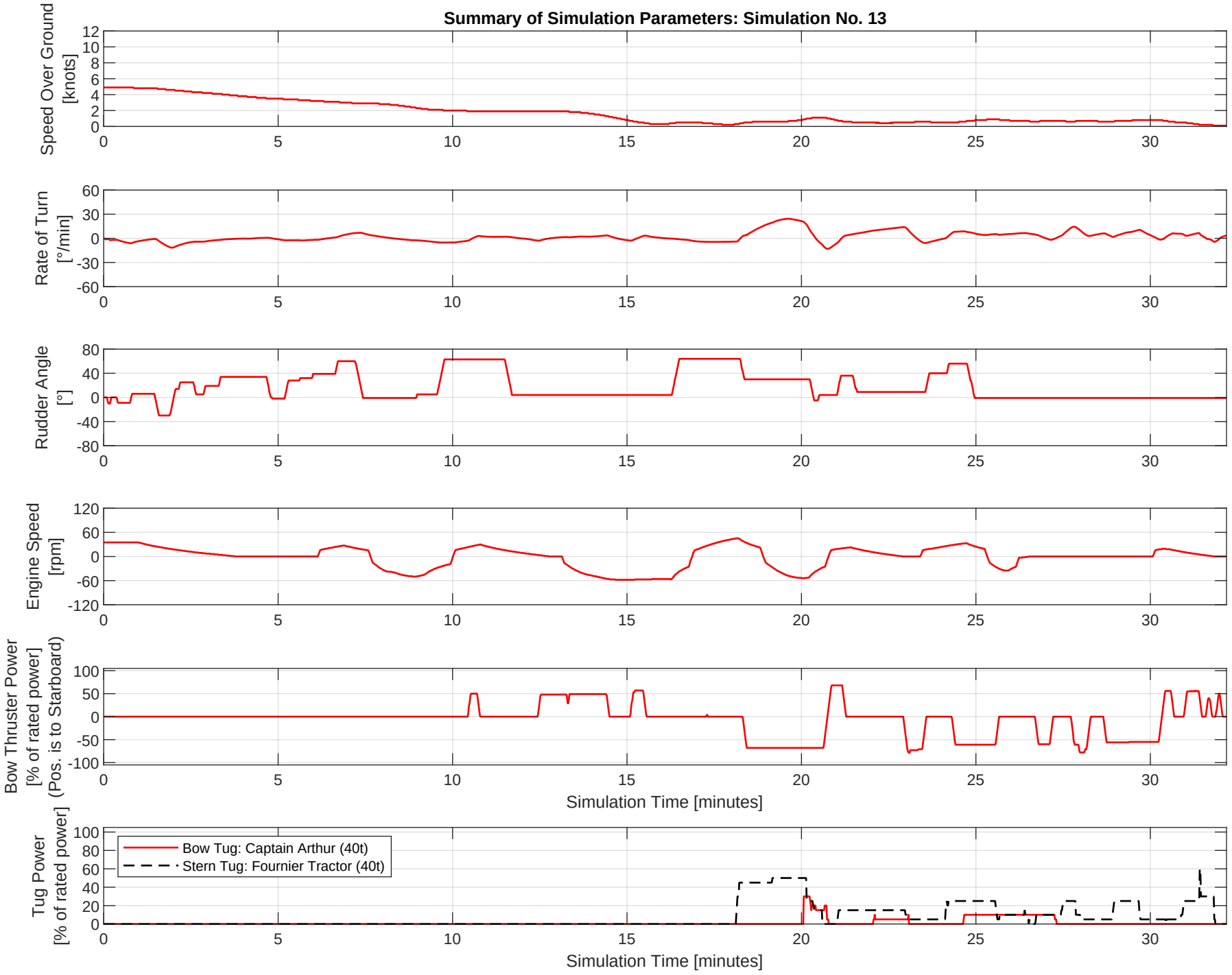

Summary of Simulation Parameters: Simulation No. 8
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]

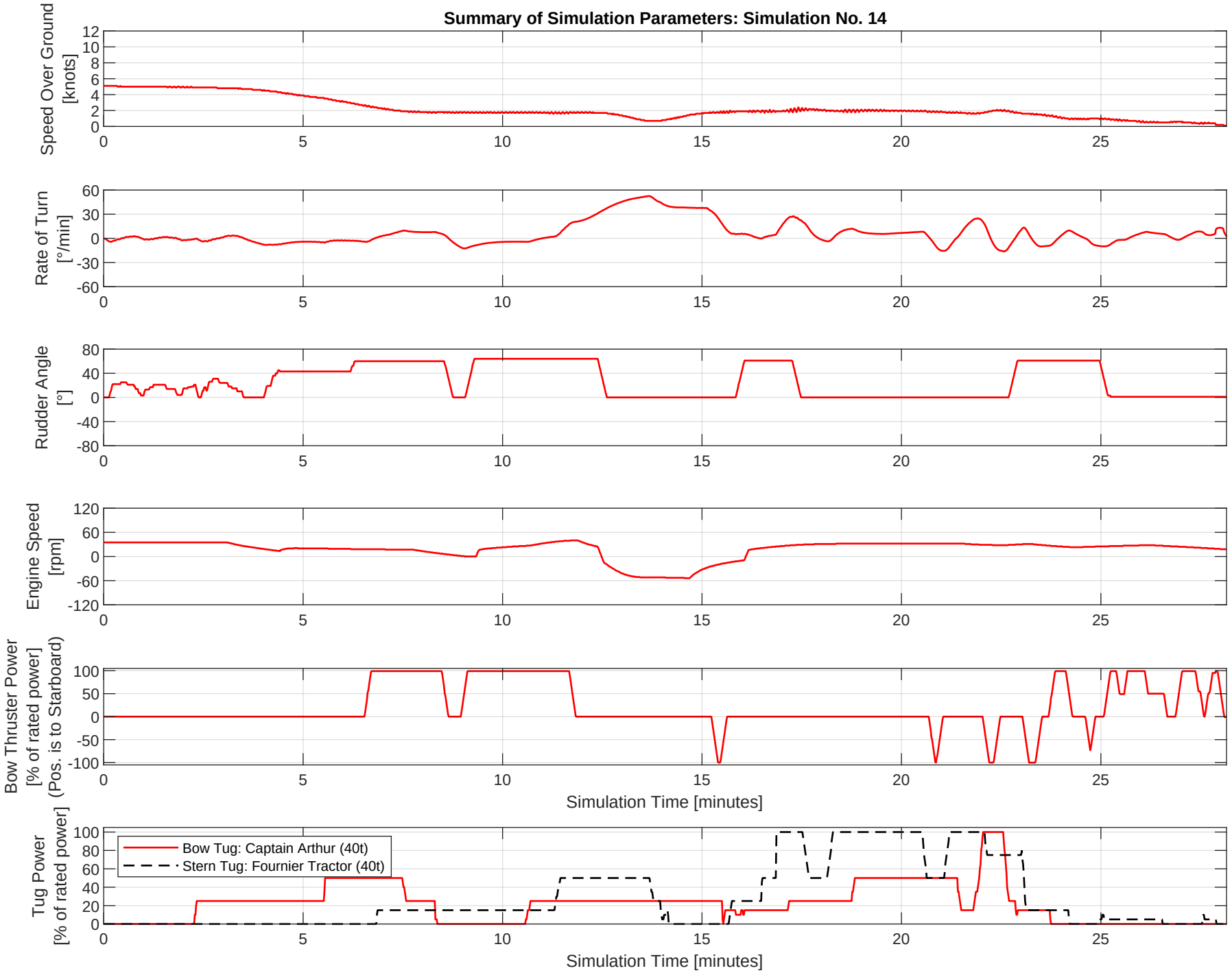

Summary of Simulation Parameters: Simulation No. 9
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]


Summary of Simulation Parameters: Simulation No. 10
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]


Summary of Simulation Parameters: Simulation No. 11
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]


Summary of Simulation Parameters: Simulation No. 12
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]


Summary of Simulation Parameters: Simulation No. 13
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]


Summary of Simulation Parameters: Simulation No. 14
Speed Over Ground [knots]
Rate of Turn [°/min]
Rudder Angle [°]
Engine Speed [rpm]
Bow Thruster Power [% of rated power] (Pos. is to Starboard)
Simulation Time [minutes]
Tug Power [% of rated power]
Bow Tug: Captain Arthur (40t)
Stern Tug: Fournier Tractor (40t)
Simulation Time [minutes]