Sabine Neches Navigation Improvement Project Integrated Section 203 Feasibility Report and Environmental Assessment

Appendix A Attachment 1

Ship Simulation Screening Report

February 2026

INTRODUCTION

1. The Sabine-Neches Navigation District (SNND) is conducting a study to evaluate the feasibility of widening three reaches of the Sabine-Neches Canal and Neches River (Figure 1) to allow deep draft ships to meet and allow night meeting of ship and tow traffic. The widening was evaluated by LOCUS LLC at the Maritime Pilots Institute (MPI) in Covington, LA.   The waterway includes the Veterans & Rainbow Bridges and the Martin Luther King (MLK) Bridge. The Pilots do not meet vessels near or under the bridges due to the proximity of bridge stanchions to the edge of the channel. The bridges will remain in place and the channel will not be widened under the bridges.

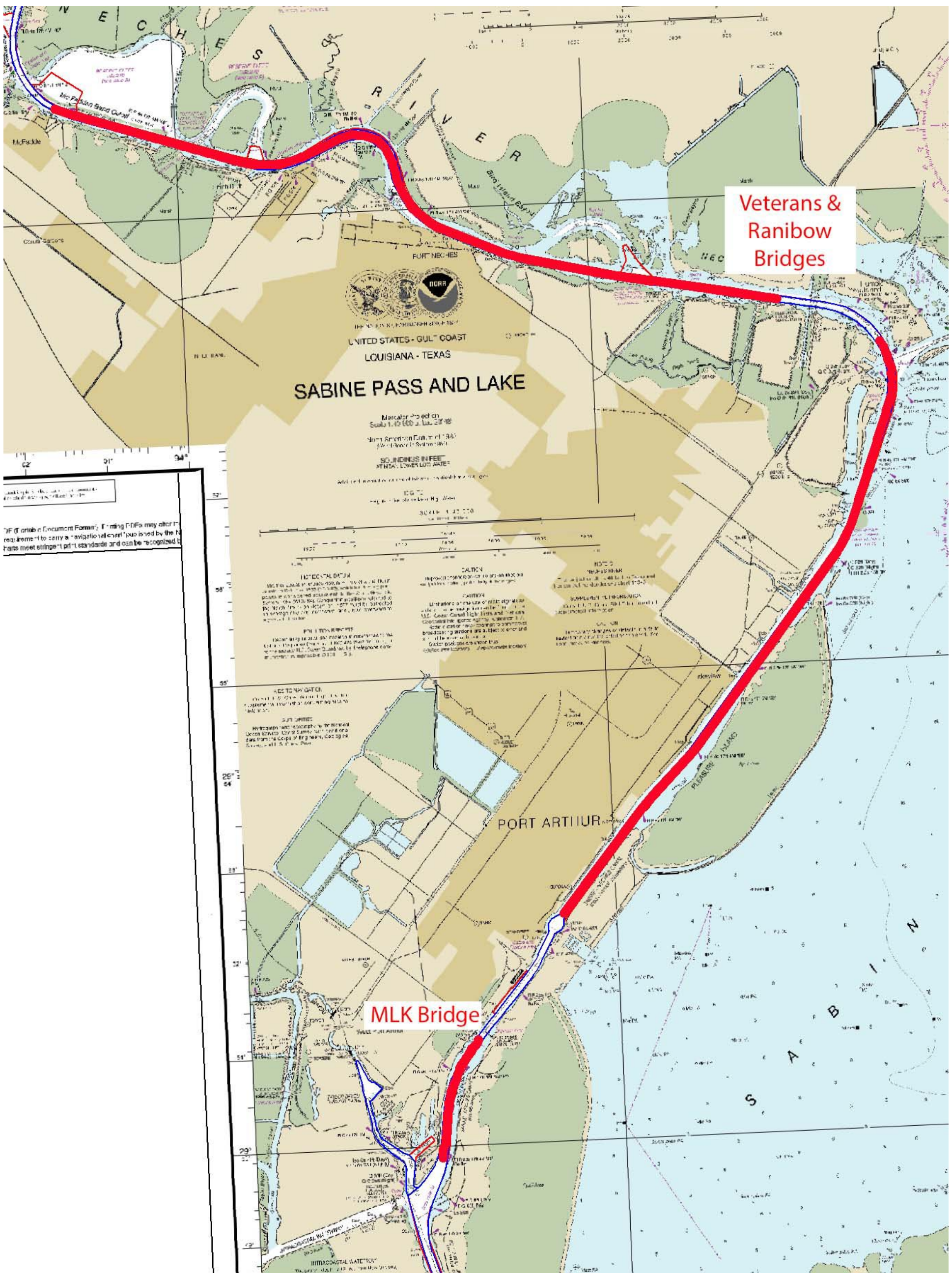


Figure 1. Sabine-Neches Canal and Neches River with proposed widening shown in red.

2. This report references three different channel layouts in the Sabine-Neches Waterway (SNWW). They are the as follows:

a. The **Existing Channel** is 40 ft mllw.
b. The **PED Channel** is the proposed channel currently approved to be dredged by the U.S. Army Corps of Engineers (USACE). The PED channel depth is 48 ft mllw. It follows a similar footprint to the Existing channel but does have some minor alignment changes. The PED channel footprint served as the basis for the widening proposed in this report.
c. The **Proposed Channel** is the PED Channel, widened.

3. The widening is proposed to be 100 ft on the "red side" of the PED channel. The "red side" is the side marked by red U.S. Coast Guard (USCG) markers and is on the right side of an inbound ship. The widening plan is described as follows:

a. The first widened reach is from channel marker "50" across from Taylors Bayou to the southern approach to the Martin Luther King (MLK) Bridge and is shown in Figure 2. The Proposed Channel shown in Figure 2 will be 500 ft wide north of Buoy 50A. The channel width varies south of Buoy 50A as it narrows from the wider channel at Buoy 50. Screening simulation exercises were not performed in this reach because the Pilots consider this area the least challenging, so it was decided to focus limited simulation time on the other reaches.
b. The second widened area is from north of the "eyeball" to the eastern approach to the Veterans and Rainbow Bridges and is shown in Figure 3. The Proposed Channel will be 500 ft wide in this area. The reach from the MLK Bridge to the "eyeball" is not proposed to be widened. Pilots have stated that they would not meet vessels in this reach, even if widened, due to the adjacent port's hard infrastructure and storm surge barrier.
c. The third widened reach is from west of the Veterans and Rainbow Bridges to McFadden Bend and is shown in Figure 4. The portion of the channel passing through the bridges was not widened. MAGPETCO bend is presently 600 ft wide. It will be widened 100 ft on the red side to 700 ft.

4. To determine the feasibility of the Proposed Channel, LOCUS LLC conducted a series of screening level simulations at MPI in Covington, LA. This simulation testing was conducted in a manner consistent with the USACE's Feasibility Level Screening Simulation (FLSS).[1] The FLSS uses real-time ship simulation to provide an iterative framework within which to examine ideas and possible solutions within the confines of a laboratory experiment. To reduce time and cost, lower resolution databases are used for FLSS and data processing is minimized. This is done knowing that a full simulation program with higher resolution databases will be conducted during ship simulations performed for the Pre-construction Engineering and Design (PED) portion of the study. FLSS studies make use of existing visual scenes, in-house vessel models that closely resemble design ships, and readily available current data.

The readily available current can include existing condition current data (that does not reflect the proposed changes to bathymetry), field data, or even vector fields provided by local ship pilots based upon their experience. The SNWW study did model currents for the widened channels (See Appendix A:

[1] Webb, Dennis W., Shelton, Timothy W. and Martin, S. Keith "SMART Planning Requires Smart Modeling: Getting the Most Value for Your Ship Simulation Dollar", Proceedings ASCE Ports 2019 Conference, Pittsburg, Pennsylvania, September 2019.

Hydrodynamic Modeling Report: Development of Numerical Current Model of Sabine Neches Waterway from Gulf of Mexico to Beaumont, TX Delivery of Current Databases for proposed Ship Simulation Study). This hydrodynamic modeling effort is beyond the typical effort expended for most FLSS studies and is discussed in paragraph 6.

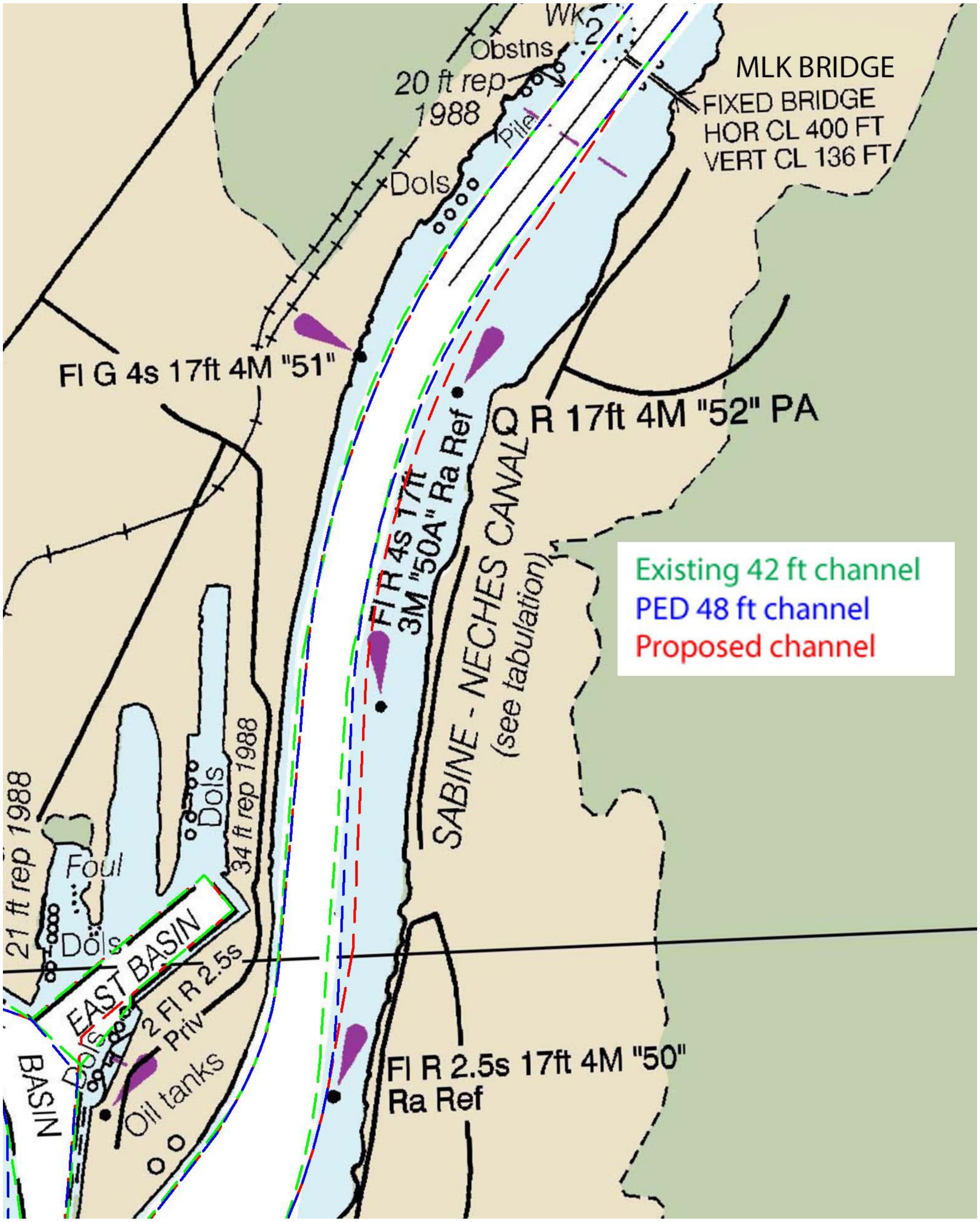


Figure 2 First widened reach

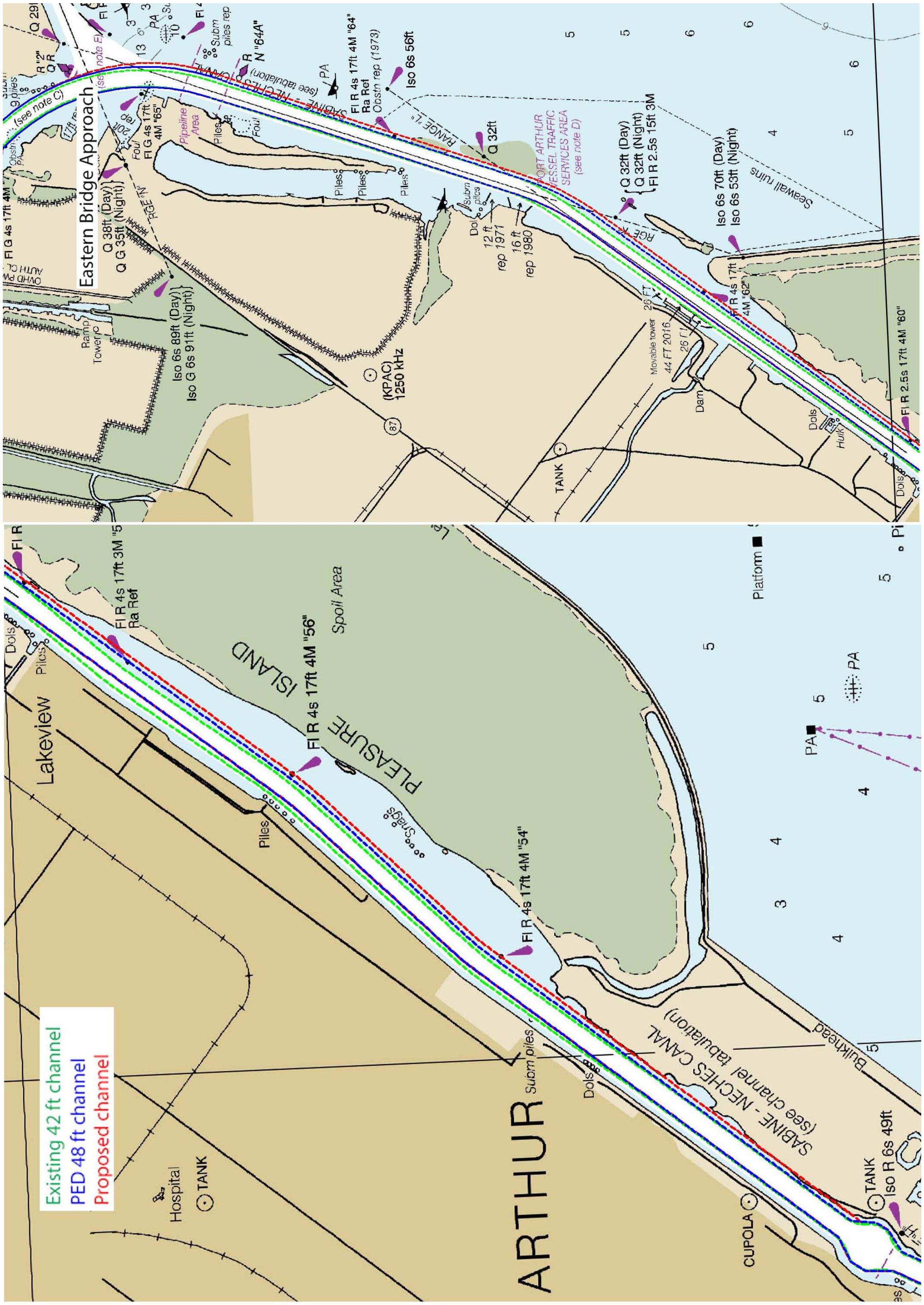


Figure 3 Second Widened Reach

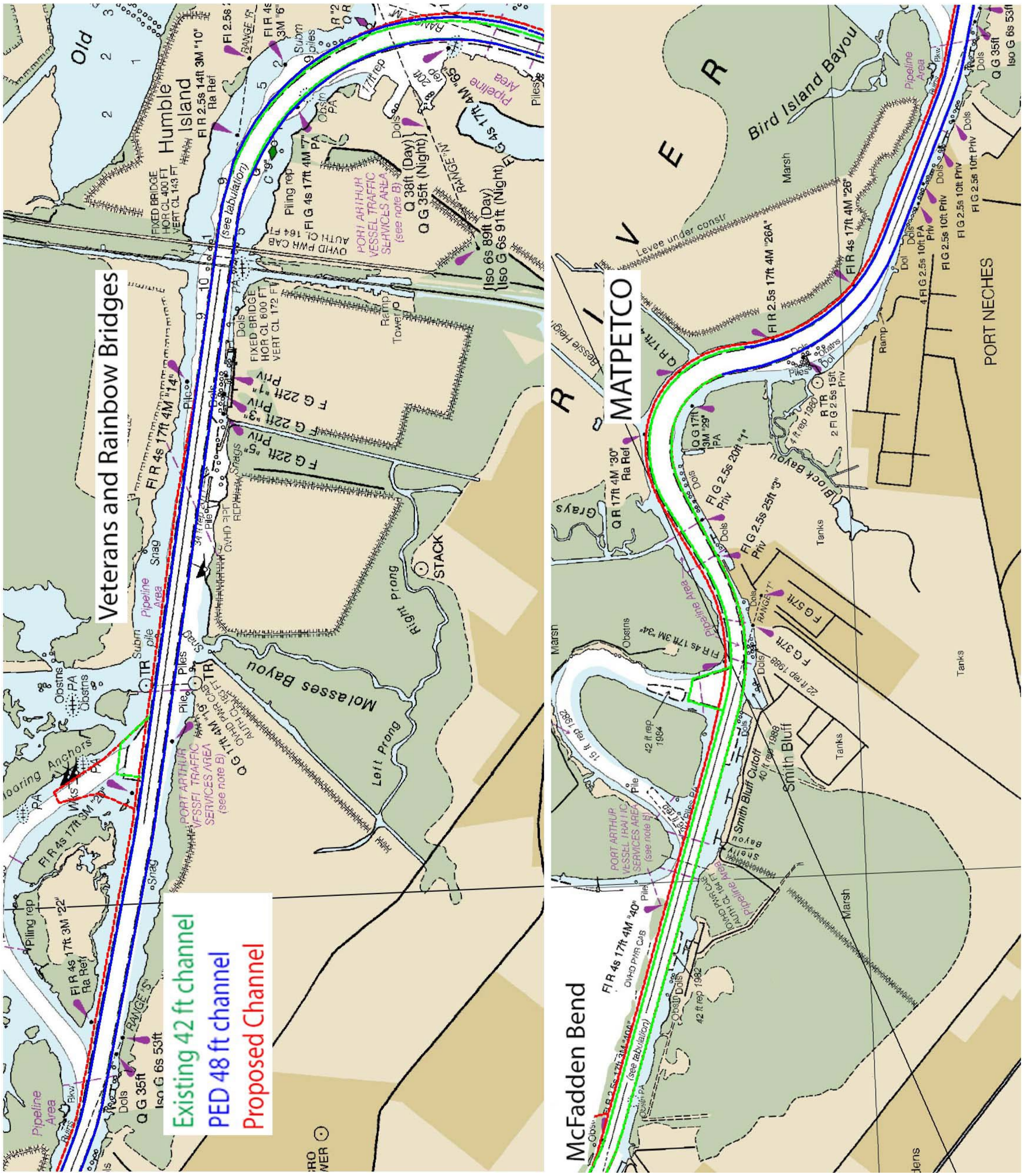


Figure 4 Third Widened Reach

Data processing is limited to a presentation of track plots and run-comment sheets to document what was done during the FLSS. The most important analysis is the group discussion at the conclusion of the FLSS. Recommendations should be agreed upon during the final meeting. The goal of the FLSS is to provide a “virtual world of the harbor of the future” realistic enough so that the Pilots can offer their expert opinion on whether the proposed channel improvements seem feasible.

5. **Database Development**. LOCUS LLC has provided training for the Sabine Pilots (Pilots) for many years at both facility in Covington and San Jacinto Community College (SJCC) in Le Porte TX. As such, LOCUS LLC maintains existing condition databases of the SNWW that have been extensively vetted by the Pilots. The bathymetry of the databases was modified to reflect the Proposed Channel and an additional channel layout which widened the Proposed Channel by another 50 ft. The additional layout was not used for any simulations and was developed in case it was determined the Proposed Channel was not wide enough. If necessary, channel markers were moved to the edge of the Proposed Channel. Currents for the Proposed Channel were modeled by J. Chris Hewlett of Waterways Simulation Technology (WST). The report for this effort is included as Appendix A. The footprint of the Proposed Channel was provided by HDR Engineering of Houston, TX.

6. Databases were also developed for a widened Port Arthur Channel. The widened Port Arthur Channel was included in the hydrodynamic model. These databases were developed to allow “what if” scenario simulation if additional time was available after the screening simulations of the Proposed Channel. There was not sufficient time for the “what if” simulations of the Port Arthur Channel.

7. Channel depth was set at 52 ft for simulations. This includes 48 ft authorized project, 2 ft advance maintenance and 2 ft over-depth. This allows the 48 ft draft ownships to transit the SNWW. A 48 ft draft ownship was used as the design vessel by the USACE for the year 2000 simulations of the SNWW deepening project.

8. Four different ownships were used during the screening simulations. They are shown in Table 1. Pilot cards for all ownships are included in Appendix B. Two-way ship traffic was accomplished by having two Panamax tankers meet each other and by having the Panamax tanker meet an Aframax tanker. The Panamax tanker ownships are 750 ft length-over-all (LOA) and are representative of the Long Range (LR) class that is common in the SNWW. The file containing Panamax ownship MBULK32X became corrupted about halfway through simulations and had to be renamed MBULK32Z. Two-way traffic between deep- and shallow-draft ships was accomplished by having the Suezmax Tanker meet the 4-barge tow. The Suezmax is the largest ship that currently uses the SNWW and represents the “worst case” ship scenario. The 4-barge tow was chosen to represent the “worst case” tow scenario. The four barges used to make up the tow are two 297 ft x 54 ft and two 195 ft x 35 ft. The barges drafted 10 ft and the pusher was 3900 horsepower (HP). The tow is identical to one chosen by the USACE, USCG, and the Gulf IntraCoastal Canal Association (GICA) as a design vessel during simulations of the Lake Borgne Floodgates by the USACE. It’s used for the SNWW FLSS was approved by both the USCG (Scott Whalen, Marine Safety Unit Port Arthur) and GICA (James Stark, President GICA).

Table 1. Ownships used during SNWW screening simulations.				
Description	Model	Length	Beam	Draft
Suezmax tanker	SUEZ156Q	899 ft	164 ft	48 ft
Aframax tanker	MTKM107N	799 ft	138 ft	40 ft
Panamax Tanker	MBULK32X and MBULK32Z	750 ft	106 ft	40 ft
4-barge tow	MTUG300	1069 ft	54 ft	10 ft
4-barge tow model is two 297 ft x 54 ft and two 195 ft x 35 ft and HP 3900				

9. Simulation Screening. Simulation screening was conducted May 20 and 21, 2021 at MPI in Covington, LA.   Simulation participants are shown in Table 2.

Table 2. Simulation participants		
Name	**Role**	**Organization**
Capt. W. Moore	Pilot	Sabine Pilots
Capt. K. Allen	Pilot	Sabine Pilots
Mr. M. Kanemand	Engineer	SNND
Mr. K. Reed	Engineer	SNND
Mr. C. McGarry	Ecologist	David Miller and Associates
Mr. V. Vannicola	Economist	David Miller and Associates
Mr. D. Webb	Engineer	Webb Sim
Mr. G. Burkley	Researcher	LOCUS LLC
Ms. A. Stauffer	Research Assistant	LOCUS LLC
Mr. F. Lagunes	Simulation Engineer	LOCUS LLC
Mr. A. Russel	Sim Operator	LOCUS LLC

10. The first 25 simulation runs were part of the vetting or validation process. Data collected during these runs will be included in this report. The first runs were conducted at slack tide and no wind. During these runs, modifications were made to the ship models until ship-to-ship and ship-to-bank forces felt reasonable.   Once this was achieved, currents (ebb and flood) and wind were added to the environmental conditions.

11. All production simulations (Runs 26 – 42) were two-way simulations and with one of the Pilots conning each ownship from a separate bridge. One bridge was the full mission simulator shown in Figure 5. The visual scene is displayed on the simulator screens. Other visual information is displayed on the radar, doppler display, Electronic Chart Display and Information System (ECDIS), and the Pilots own Personal Pilot Unit (PPU). The Pilots have their own PPU's that they use while handling ships in real life. The PPU's plug directly into the MPI simulator. Pilot commands were entered by a LOCUS employee acting as helmsman. The second ownship was conned via the simulator operator's station. This is shown in Figure 6. The operator's station also displayed the visual scene, radar, ECDIS and was able to accommodate the PPU. The operator entered the pilot's commands with a mouse and keyboard. The Pilots have used this method for two-way traffic at MPI before and were comfortable with the arrangement.

Figure 5. Sabine Pilot conning the MPI Full Mission Bridge Simulator

Figure 6. Sabine Pilot conning via the operator's station

12. Feasibility channel width was evaluated at four different locations; Old River, Fina Highline, Port Neches, and north of the "Eyeball." These are shown in Figure 7. The simulations increased in difficulty during the simulation program with the addition of nighttime runs, currents, and wind. The conditions conducted wind/no wind, currents/no currents, daytime/nighttime, were set based upon pilot requests. Docked ships were placed along the channel to represent a worse case. Ships that were placed at docks for simulation exercises were of realistic sizes to represent real life ships that might actually be docked. Docked ships were placed as per pilot requests.

Docked ships in the track plots are to scale. The pilots conned their vessels with knowledge that excessive speed could break a docked ships' mooring lines and used their judgement to set their speed.

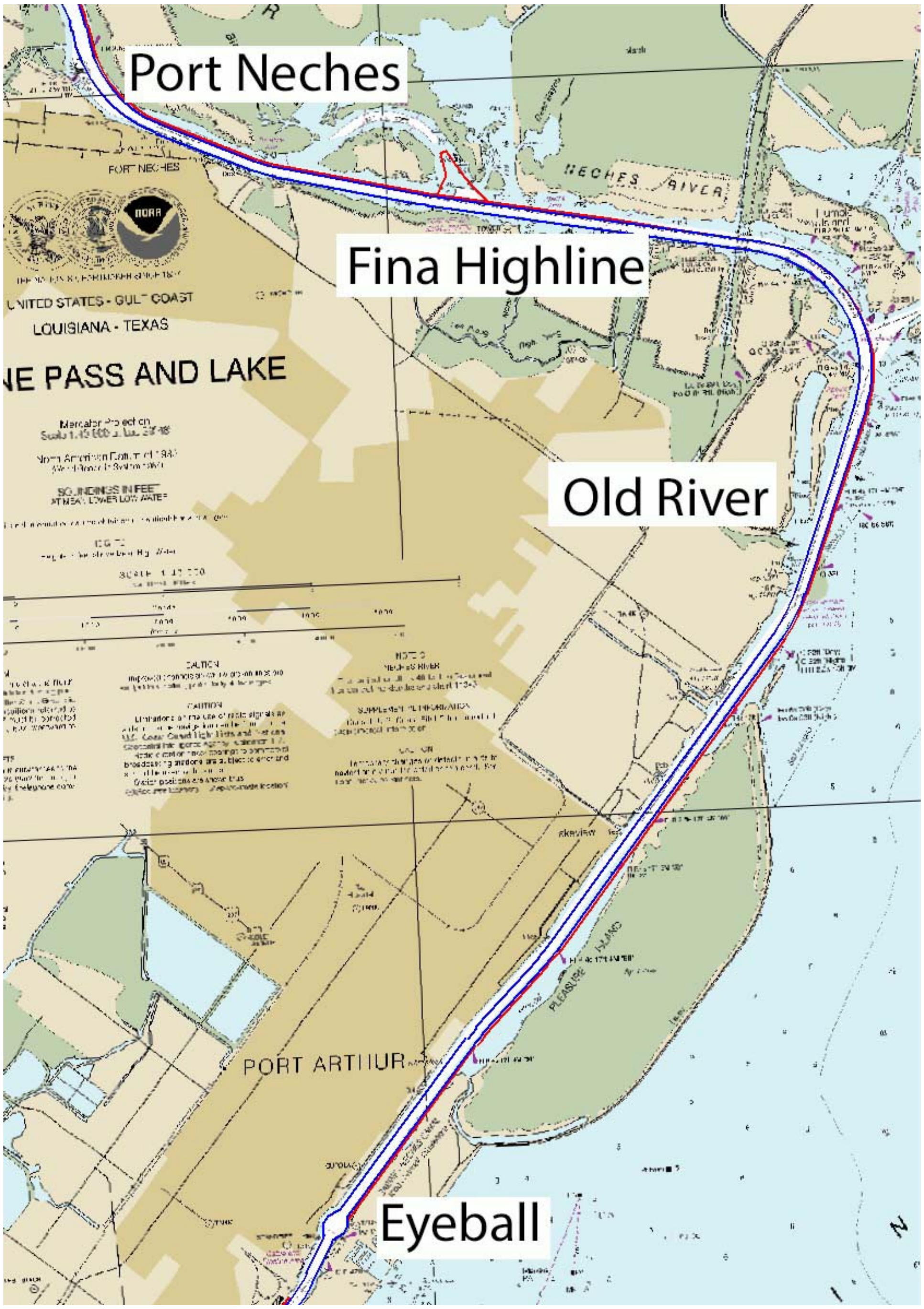


Figure 7. Two-way traffic locations

13. Results. Results are presented in the form of track plots which are included in Appendix C. Pilot comments and critical measurements were recorded for each exercise. The proposed channel is shown as the white area in the track plots. The blue dashed lines outside the channel are to be ignored.

14. Overtaking at Old River. Four simulations were conducted with the Suezmax overtaking the 4-barge tow at Old River. These are listed in Table 3. Comments are listed in Table 4.

Table 3. Overtaking runs at Old River.							
Run	Vessel	Heading	Vessel	Heading	Current	Wind	Visibility
26	SuezMax	South (Outbound)	4-Barge	South	Slack	Calm	Daylight
27	SuezMax	South (Outbound)	4-Barge	South	Slack	Calm	Daylight
28	SuezMax	South (Outbound)	4-Barge	South	Slack	Calm	Nighttime
29	SuezMax	South (Outbound)	4-Barge	South	Slack	Calm	Nighttime

All runs were southbound. Note that ship transits are typically listed as inbound or outbound. However, tow traffic in this area is passing through heading north or south. Therefore, the ship heading is also listed as south for an outbound run to signify the ship and tow were heading in the same direction. Starting position and speed for each vessel was based upon pilot input. Currents and wind were not used in these simulations based on the pilot's request. Two runs (26 and 27) were conducted during daylight conditions and the third and fourth runs (28 and 29) were conducted at twilight. A photograph of MPI's full mission bridge operating during an Old River twilight run is shown in Figure 8. Run comments are shown in Table 3. The pilots gained knowledge from each run and the exercises concluded with the pilots feeling they would conduct the twilight maneuver in real life.

Figure 8. Twilight conditions at Old River

Table 4. Comments from Old River Simulations		
Run	Vessel	Comments
26	Ship	Moved over further than the pilot should have. Goal is to only move about 20 meters off centerline.
	Tow	Tow lost power during the overtaken and could feel the suction from the vessel.
27	Ship	Ship handled as expected. Still got over about 30 meters off centerline.
	Tow	Tow tug lost about 1.5 knots as the Suez was passing. Bow started to come off the bank and was hard to steer back.
28	Ship	This was a realistic maneuver; however the passing speed was a little too fast (about 9 knots).
	Tow	Was 15 meters off centerline while passing.
29	Ship	Tow had full ahead and was losing energy while being passed by the vessel. Stern is being sucked into the ship. Cut down speed to 4.5 knots and began picking up speed because the vessel started pulling the tow along with it.
	Tow	Run went as expected and pilots note for this location that this would be feasible to do in real life.

15. Meeting at Fina Highline. Three simulations (Runs 30, 31, and 32) were conducted with two Panamax tankers meeting at the Fina Highline. These are shown in Table 5. All runs were conducted during daylight with no current or wind. The pilots observed that slower speeds (less than 3 knots) were crucial to success and that a 70-ton assist would be required off the stern of both ships to maintain steerage at the lower speeds. This is accomplished by having the ship operate at a faster propeller RPM, this improving rudder response. The tug is required to keep the ship from going too fast. Pilots' comments are shown in Table 6.

Table 5. Meeting at Fina Highline							
Run	Vessel	Heading	Vessel	Heading	Current	Wind	Visibility
30	Panamax	Outbound	Panamax	Inbound	Slack	Calm	Daylight
31	Panamax	Outbound	Panamax	Inbound	Slack	Calm	Daylight
32	Panamax	Outbound	Panamax	Inbound	Slack	Calm	Daylight

Table 6. Comments from Fina Highline Simulations		
Run	Vessel	Comments
30	Operator	Skin to skin distance was 196 feet.
	Inbound	Model seems like it handles heavy and not as responsive as expected. The meet was in a good area but it needs to be done with slower speeds.
	Outbound	The vessel handled well. Inbound did not get over far enough and was easier to recover.
31	Operator	Skin to skin distance was 170 feet.
	Inbound	Meeting location was good. Ship to ship interaction seems realistic for these vessels.
	Outbound	Need a stern assist tug on the outbound tug. The difficult part is maintaining speed for meeting but need to keep a controlled speed while passing the moored vessels.
32	Operator	Adding a 70-ton stern assist tug on both vessels. Skin to skin distance was 217 feet.
	Inbound	Got speed down to 2.9 knots while passing the moored vessels to maintain control of the ship and move the meeting location past the berths. Having the assist tug, made the maneuver more controllable.
	Outbound	Easier going outbound because they do not have to worry about passing the moored vessels. Did not use the assist tug at all.

16. Ship/Tow Meeting at Port Neches. The runs are listed in Table 7. Runs 33 -38 were conducted with the Suezmax meeting the 4-barge tow at Port Neches. Runs 33-36 were conducted without current or wind. A low flood was added to Run 37 and a high ebb to Run 38. All runs were conducted at night, as shown in Figure 9. Pilots' comments are shown in Table 8. The pilots observed that a 90-ton assist tug would be required for the Suezmax and that the maneuver would have to be done at slow speeds.

Table 7 Meeting at Port Neches							
Run	Vessel	Heading	Vessel	Heading	Current	Wind	Visibility
33	SuezMax	East (Outbound)	4-Barge	West	Slack	Calm	Nighttime
34	SuezMax	East (Outbound)	4-Barge	West	Slack	Calm	Nighttime
35	SuezMax	East (Outbound)	4-Barge	West	Slack	Calm	Nighttime
36	SuezMax	East (Outbound)	4-Barge	West	Slack	Calm	Nighttime
37	SuezMax	East (Outbound)	4-Barge	West	Low Flood	Calm	Nighttime
38	SuezMax	East (Outbound)	4-Barge	West	High Ebb	Calm	Nighttime
39	AfraMax	Outbound	Panamax	Inbound	High Ebb	Calm	Daylight
40	AfraMax	Outbound	Panamax	Inbound	High Ebb	Calm	Nighttime

Figure 9. Night meeting at Port Neches

Table 8. Comments from Ship/Tow Port Neches Simulations		
Run	Vessel	Comments
33	Operator	Assist tug on the stern of the outbound vessel.
	Ship	A ship with this draft does not run in this area. With the 70-ton tug, it was not enough tug power to slow down the vessel to the desired speed so it may require a larger tug.
	Tow	The two tugs could have been further outside of the channel in this area to give more space for the ship.
34	Operator	Failure due to running aground in the bend. The simulation cannot be started with a rate of turn so the bend is not manageable at the starting location. The ship will be moved back for future runs so that they have time to get a rate of turn before meeting.
	Ship	
	Tow	
35	Operator	Skin to skin was 100 feet. There was 150 feet to the gas ship at the berth and the vessel was making 5 knots while meeting
	Ship	The meeting was successful but a 70-ton tug is not enough for a vessel this size in this area. The vessel will not slow down.
	Tow	No comment
36	Operator	Using a 90-ton tug on the stern and dropping the start speed to 6 knots. Skin to skin distance was 160 feet.
	Ship	The vessel is able to make the turn and slow down with the 90-ton tug. The meeting is doable and has plenty of space between the tow and the ship.
	Tow	No comment
37	Operator	Using a 90-ton tug on the stern.

Table 8. Comments from Ship/Tow Port Neches Simulations		
	Ship	The current was slightly noticeable and the model behaved consistently in the conditions.
	Tow	No comment
38	Operator	
	Ship	The current was noticeable, but it did not change the approach to the maneuver. Everything has to be slowed down with a vessel of this size to be able to make it work due to being near the moored vessels and passing the tow tug (about 3.5 knots).
	Tow	No comment

17. Ship/Ship Meeting at Port Neches. Runs 39 and 40 were conducted with the Aframax meeting the Panamax at Port Neches. Both runs were conducted with a high ebb and no wind. Run 39 was conducted during daylight and run 40 at night. These runs are listed in Table 9. The ships docked along the south edge of the channel increased the difficulty of this maneuver. It was extremely tight, but the track plots indicated that it was feasible and worth considering in future simulations. Pilots' comments are shown in Table 10.

Table 10. Comments from Ship/Ship Port Neches Simulations		
Run	Vessel	Comments
39	Operator	70-ton assist stern tug on both vessels. Skin to skin distance was 140 feet.
	Inbound	This is not a good meeting location, especially with ships this size. The inbound ship did not want to slow down, making steering more difficult. The inbound ship also got pushed towards the edge of the channel and did not want to come back after the meet.
	Outbound	No comment
40	Operator	70-ton assist stern tug on both vessels. Skin to skin distance was 100.
	Inbound	This is a very difficult to do due to the meeting location. Both tugs had to be used the entire time to steer the ship against the current.
	Outbound	No comment

18. Double Encounter Meetings North of the "Eyeball." Runs 41 and 42 were conducted with the Suezmax meeting two 4-barge tows north of the "eyeball" and are listed in Table 11. Both runs were conducted at night with 20 knots of wind from the southeast. Run 41 was conducted with high ebb and run 42 with low ebb. During Run 41 both meetings resulted in a vessel leaving the channel. The tow left the channel after the first meeting and the ship left the channel after the second meeting. Run 42 was regarded as safe. Pilots' comments are shown in Table 12. The pilots' success with the second exercise can probably be attributed to experience gained during the first exercise and keeping their speeds lower.

Table 11 Double Encounter Meetings North of the "Eyeball"							
Run	Vessel	Heading	Vessel	Heading	Current	Wind	Visibility
41	SuezMax	North (Inbound)	4-Barge	South	High Ebb	20K SE	Nighttime
42	SuezMax	North (Inbound)	4-Barge	South	Low Ebb	20K SE	Nighttime

Table 12. Comments from Double Encounter Meetings North of the "Eyeball"		
Run	Vessel	Comments
41	Ship	Vessel was going too fast. The wind and current together, made the maneuver much more difficult. Both the ships and tows were out of shape. It is possible but not something that would be preferred.
	Tow	No Comment
42	Ship	With these environmental conditions, this maneuver is safe and can be completely successfully.
	Tow	No Comment

19. **Conclusions From Final Debriefing.** The final debriefing was held after the last simulation on May 21, 2021. It was agreed that assist tugs and slow ships speeds of 3 to 4 knots are critical for successful meetings, especially when the maneuver is conducted in a reach with docked vessels. A 70 ton assist tug was necessary for the Panamax and Aframax ships and a 90 ton was required for the Suezmax. Given these requirements, it was feasible for meetings simulated to be conducted in a 500 ft wide channel. The widening will allow for the ships and tow traffic to share the SNWW for most situations and will increase the window of operation for ships to meet in the SNWW.

20. Demonstration of Night Simulations for Towing Industry. A demonstration of removing the nighttime restrictions upon the interaction between tow and ship traffic was demonstrated at SJCC on June 9, 2021. The purpose of the demonstration was to include towing industry in the preliminary evaluation of the effectiveness of the 100 ft widening for night time transits with both ships and tows occupying the SNWW. The demonstration was conducted in a more informal way than a typical simulation that allowed for open discussion during simulations between observers that included ship pilots and two operators. The demonstration was conducted with two of SJCC's three bridges configured for tow simulation. One of the tow bridges is shown in Figure 10. The other bridge was configured as a ship.

Figure 10. SJCC Tow Simulator

21. The morning began with a brief presentation describing the widening project and a short question and answer session. Towing industry raised concerns that the situation might arise where two ships were meeting while a tow was alongside. The Sabine Pilots stated that having three vessels abreast was not an objective for this widening and that care would be taken to avoid the situation. Towing industry requested that simulation of that scenario be included. The demo was unable to accommodate this request because two of the simulators were configured for tows and it would take too much time to reconfigure one of them as a ship. However, it was explained that additional simulations would be conducted as the project moved through the Corps of Engineers' process.

22. Towing industry observed that U.S. Coast Guard Vessel Traffic Service – Port Arthur was not present for the demo. It was explained that Mr. Scott Whalen was included in discussions of the simulation program. It was agreed that all meetings would be "two whistle" or port-to-port. It was also agreed that overtaking would be avoided.

23. Appendix D includes the sign in sheet for demonstration attendees. Care was taken to have all attendees sign in. However, it is likely that some of those who arrived late are not listed on the sheet. Most simulations were double encounters of a ship meeting two twos, one after the other. Most simulations were conducted with the ship being the 48-ft draft Suezmax, but a few were undertaken with an Aframax loaded to 40 ft. The tow configuration used for most simulations was the 1069 ft long inline four-barge tow used in Covington. Some runs were conducted with an empty six-pack. The six-pack was two barges wide and three barges long. The barges were 35 ft wide and 195 ft long and were empty. This increased the influence of wind upon the tow. The last run of the day was a "double wide" tow with two empty 297 ft x 54 ft barges side-by-side.

24. The runs were not conducted in a "laboratory environment" as is typical for formal simulator testing. This was a demonstration for industry with many observers moving between simulators and

asking questions of the mariner conning the simulator. Data from the runs will not be analyzed as part of any report.

25. Following the last simulation, the remaining attendees meet to discuss their observations. It was agreed that the simulations were successful other than warmup runs or runs, runs with unvetted vessel models, or one run that included an intentional embarrassment of navigation by the tow driver. It was agreed that tow drivers and ship pilots were able to maintain positive control of their vessels at all times and were able to control the vessel-to-vessel lateral distances. Concern was raised by towing industry that typically the licensed tow driver with the least experience runs the midnight to 0600 shift and they would be the ones to primarily deal with meeting ships. It was agreed that additional training, including ship simulation, could address this issue.

Appendix A

Hydrodynamic Modeling Report

Waterway Simulation Technology, Inc.

❖❖❖

Columbia Office
158 Hampton Crest Trail
Columbia, SC 29209
Phone: 601-506-8698

Email: jchwst@bellsouth.net
Attn: J. Christopher Hewlett

Vicksburg Office
2791 Burnt House Rd
Vicksburg, MS 39180
Phone: 601-638-4226
Fax: 601-630-9017
Email: lldaggett@wst.ms
Attn: Larry L. Daggett

DATA REPORT

Subject: Development of Numerical Current Model of Sabine-Neches Waterway from Gulf of Mexico to Beaumont, Texas. Delivery of Current Databases for Proposed Ship Simulation Study

Introduction and Purpose

As an interim measure in support of channel widening, a simulation study is proposed for deep-draft navigation on the Sabine-Neches waterway (SNWW) on the border of Texas and Louisiana. The scope of the proposed simulation study encompasses preliminary tests for the purpose of identifying and screening navigation issues related to the future channel widening. In support of the simulation study this report covers the development of an updated numerical model aimed at providing current vector databases to simulation engineers.

Background

Figure 1 to Figure 3 show general details of a previously used numerical grid covering the SNWW. This grid was developed in support of a 2-D depth-averaged finite element RMA2 computational model, which over the years provided current data for various ship navigation simulation studies. These studies included the original deepening tests by the US Army

Engineers (USAE) and several Waterway Simulation Technology (WST) studies[1] at various commercial sites along the waterway. The RMA2 model was adjusted and its output was pilot-validated several times.

---

[1] A: Analysis of Tanker Maneuvering at the Proposed Gulfgate Terminal 1, Port Arthur, TX, May 2011, WST
B: Ship Maneuvering Study of the Proposed Pleasure Island Dock Facility, Port Arthur, Texas, April 2012, WST & MITAGS
C: Golden Pass LNG Terminal Underkeel Clearance Analysis, February 2009, WST
D: Disabled LNG Tanker Simulation Study for Sabine Pass LNG Terminal, April 2006, WST

Figure 1: SNWW RMA2 Numerical Grid

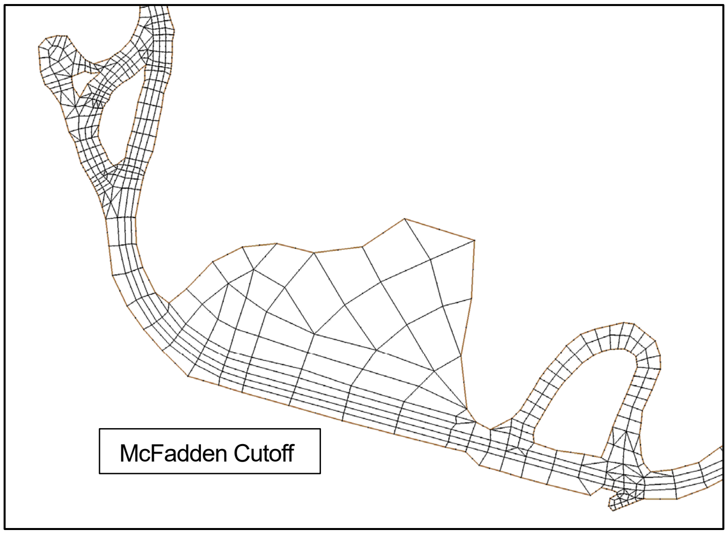


Figure 2: Section of RMA2 Model Grid in Upper Neches River

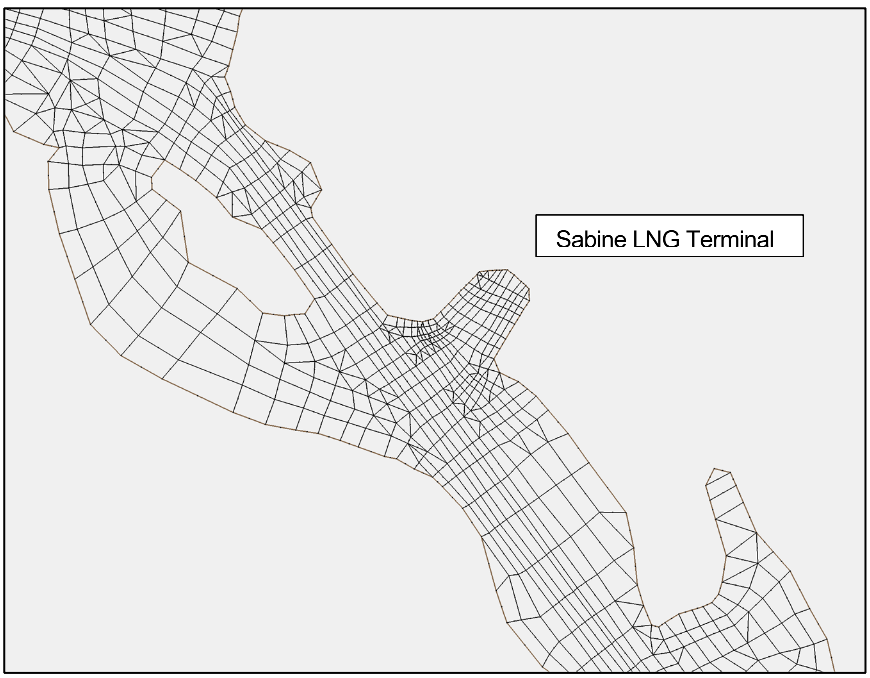


Figure 3: Section of RMA2 Model Grid in Sabine Pass

In the years since the referenced studies were conducted, the USAE has developed improved computational methods for a variety of applications. One of these applications was providing more accurate and efficient calculation of currents for computer simulation of vessel navigation. The hydrodynamic numerical model now preferred over RMA2 for simulation current data is the Adaptive Hydraulic (ADH) modeling system[2]. This system allows only triangular computational elements, is more numerically stable and is designed to

[2] Adaptive Hydraulics (AdH) Version 4.5 Hydrodynamic User Manual A TWO-DIMENSIONAL MODELING SYSTEM DEVELOPED BY THE COASTAL AND HYDRAULICS LABORATORY Guidelines for Solving Two-Dimensional Shallow Water Problems with the Adaptive Hydraulics Modeling System, ERDC, January 2015

dynamically adjust grid resolution in required areas for better approximation of wetting and drying conditions. The two-dimensional, depth-averaged version of ADH was used for the present current modeling effort.

Upgrade of SNWW Model for Existing Navigation Channel

For provision of current data for the proposed vessel navigation simulation study, WST modified the existing RMA2 numerical grid to meet the geometric requirements of the ADH model system and the computational grid was first set to existing channel bathymetry and layout. The latest USAE existing channel bathymetric surveys (Figure 4) were used for this grid adjustment. The bathymetric surveys were conducted in the general time span of August 2020 to January 2021 and predominantly covered only the authorized deep-draft channel (Figure 5 – shaded areas).

NR_01_SMC.xyz	NR_1A_TDB.xyz	NR_1B_TSB.xyz	NR_02_BTB.xyz
NR_2A_TBM.xyz	NR_2B_CEC.xyz	NR_03_MBB.xyz	NR_04_TBE.xyz
NR_05_BBS.xyz	PA_01_PAC.xyz	PA_02_JPA.xyz	PA_03_ETB.xyz
PA_3A_ETB.xyz	PA_04_WTB.xyz	PA_05_TTB.xyz	PA_06_TBT.xyz
SN_01_SRC.xyz	SN_02_SRC.xyz	SP_02_OBK.xyz	SP_03_OBR.xyz
SP_04_SJC.xyz	SP_05_SPC.xyz	SR_01_SOT.xyz	SR_02_OTB.xyz
SR_2A_OMS.xyz	SR_03_HWY.xyz	SR_3A_OHI.xyz	SR_04_CBY.xyz
SR_05_OFT.xyz	SR_06_ABC.xyz		

Figure 4: Survey Data Files from USAE Galveston District
(Website: https://www.swg.usace.army.mil/Missions/Navigation/Hydrographic-Surveys/Sabine-Neches-Waterway/)

Figure 6 to Figure 9 give examples of the developed SNWW computational grid. Bathymetry outside of the navigation channel was visually estimated using soundings noted on NOAA navigation charts. The vertical datum for the bathymetry was mean-lower-low-water (mllw). Channel bottom elevations were not converted to a fixed vertical datum, such as NAVD88, because differences in the area are approximately one foot or less – a shift not likely to result in significant current magnitude variations in the model results. Navigation channel alignment for existing conditions was obtained from NOAA electronic charts US5TX73M and US5TX72M. Figure 10 and Figure 11 show bathymetry contours for two areas of the SNWW model grid.

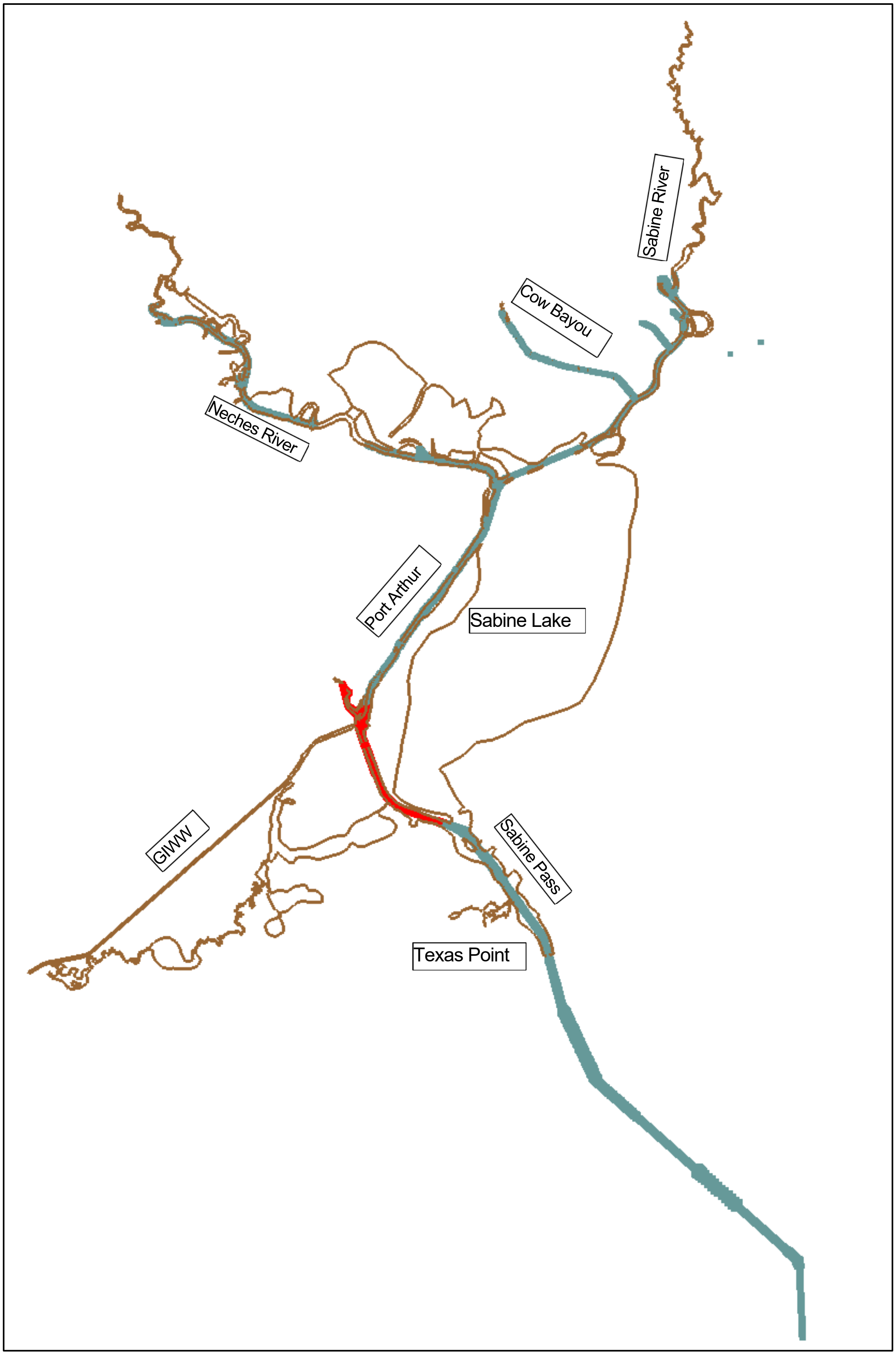


Figure 5: General Project Layout and Areal Coverage of USAE Bathymetric Surveys

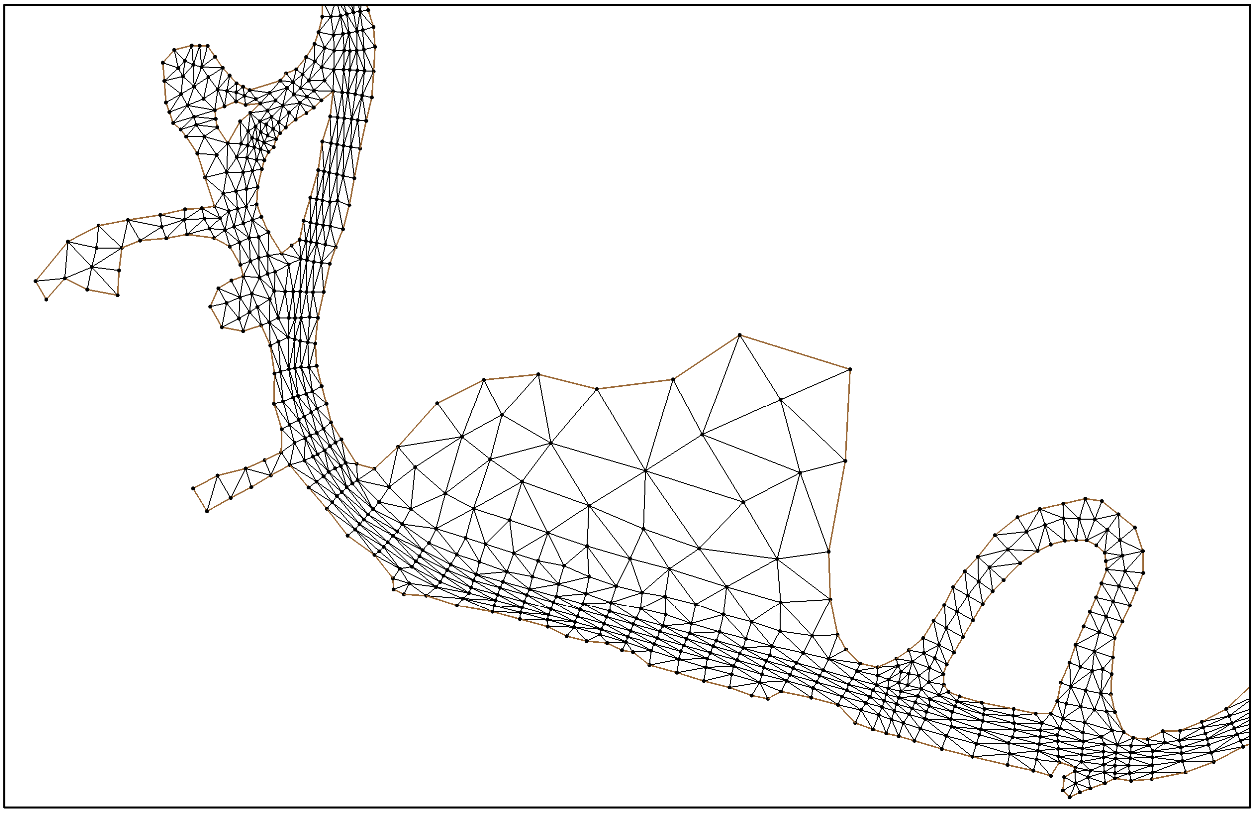


Figure 6: Section of ADH Grid in Upper Neches River

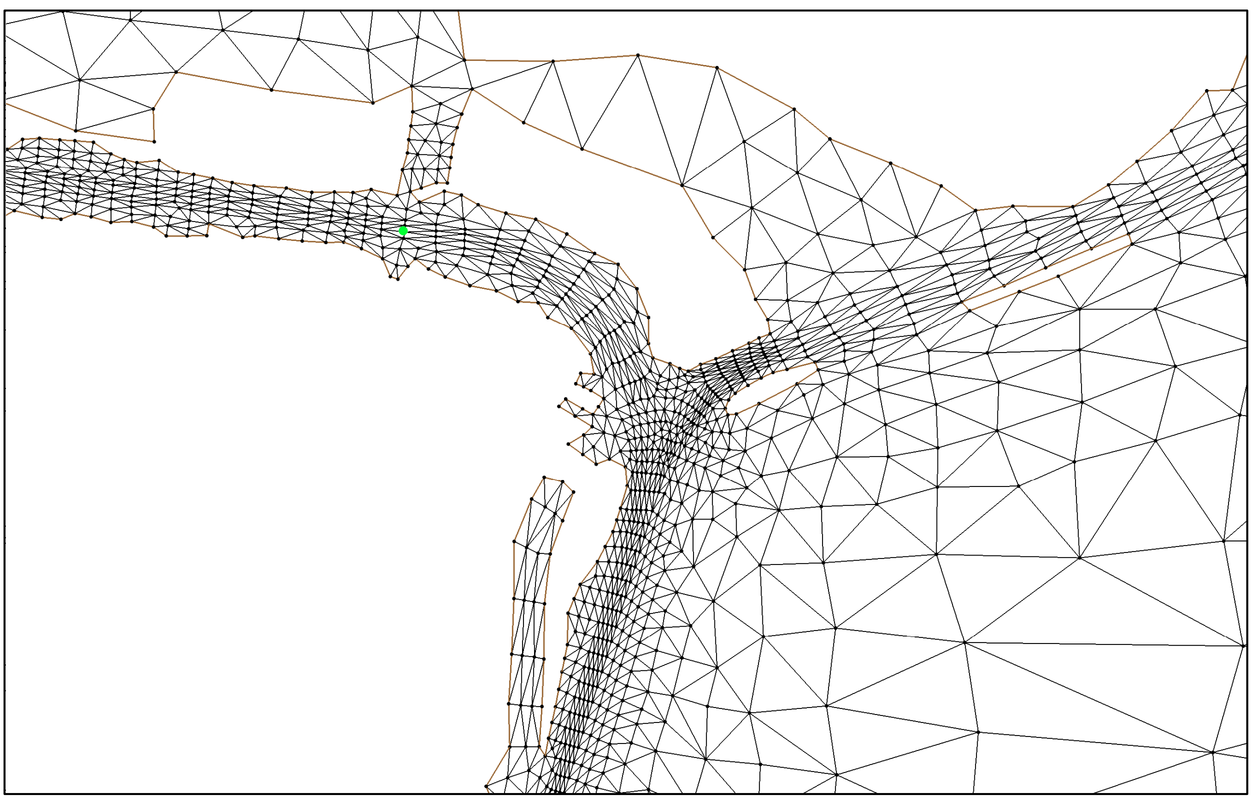


Figure 7: Section of ADH Grid at Split of Neches and Sabine Rivers

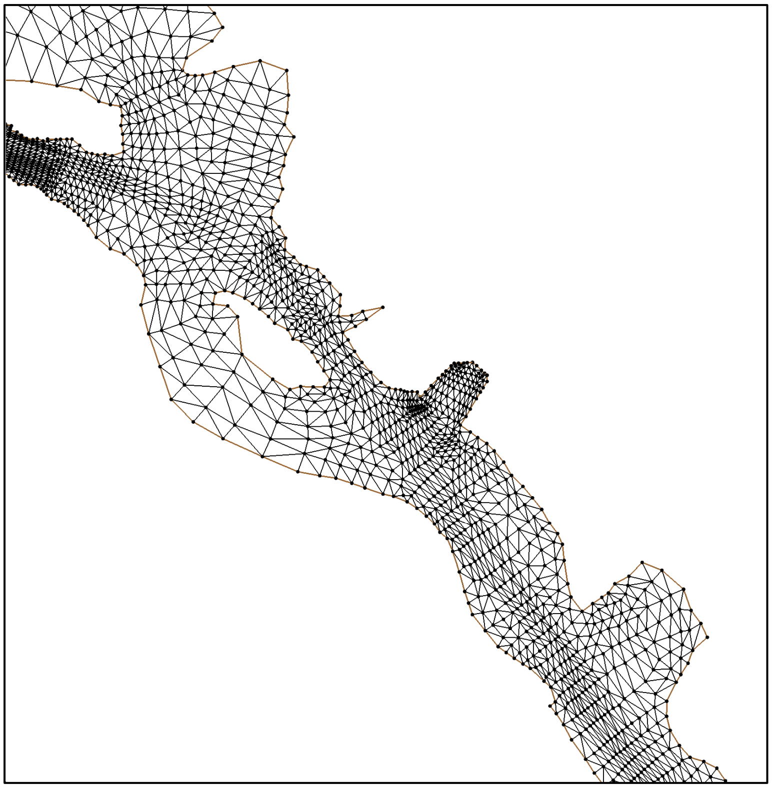


Figure 8: Section of ADH Grid in Sabine Pass

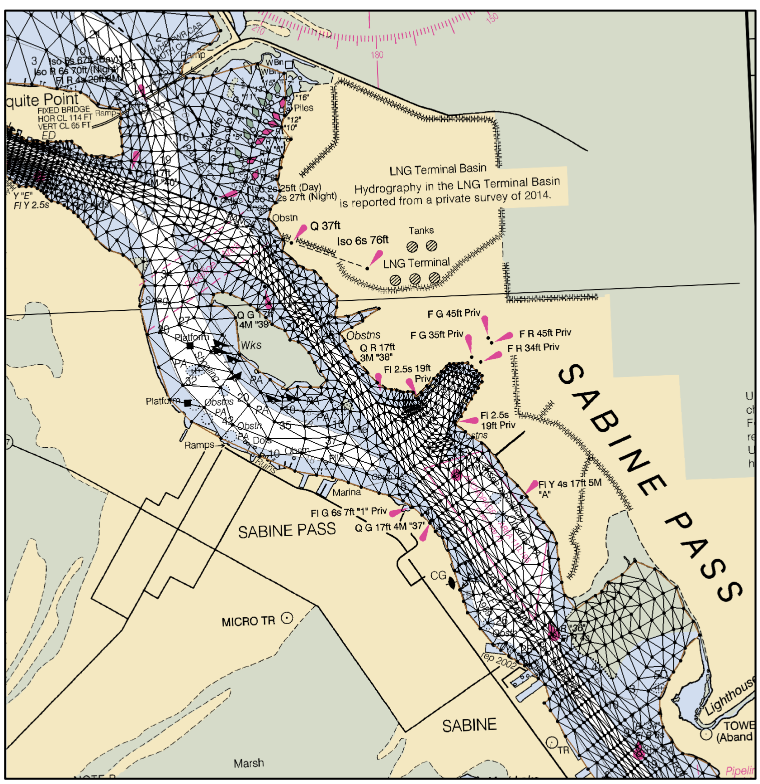


Figure 9: Computational Grid on NOAA Raster Navigation Chart (11342) – Sabine Pass

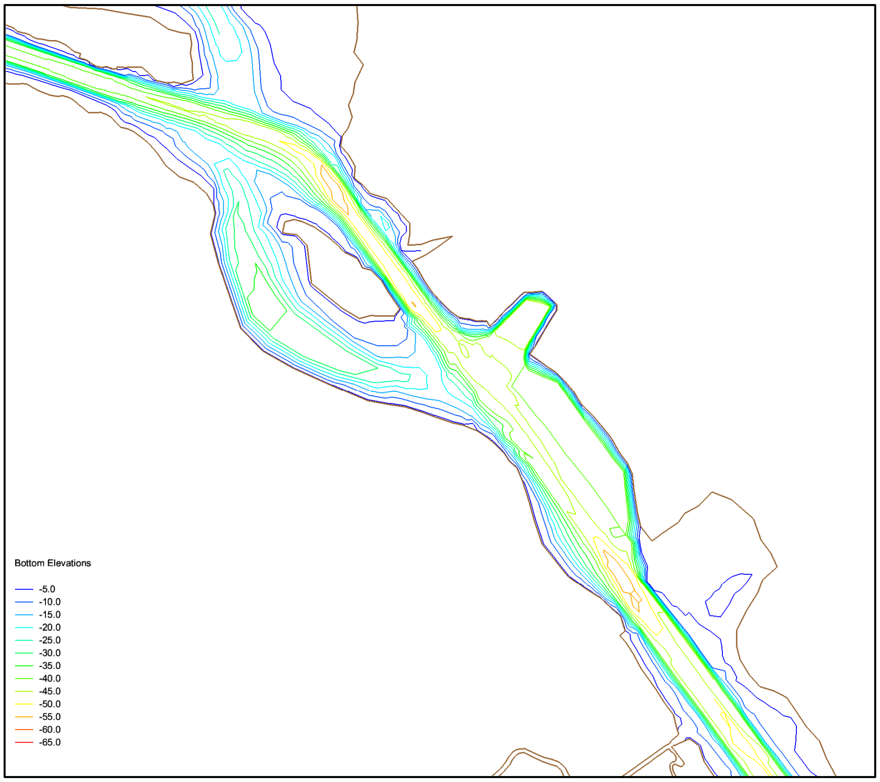


Figure 10: ADH Model Bottom Elevation Contours in Sabine Pass

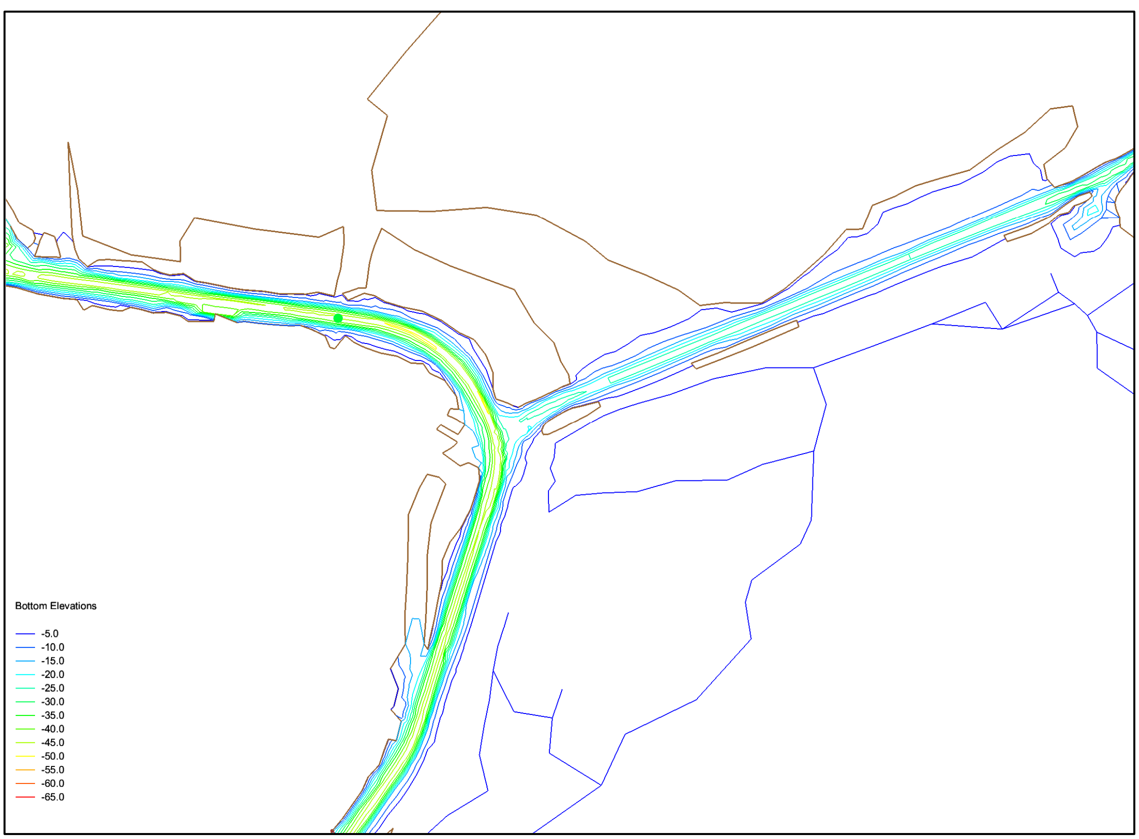


Figure 11: ADH Model Bottom Elevation Contours at Split of Neches and Sabine Rivers

Boundary Conditions and Model Run Timing

Model boundary conditions were applied at the grid limits of the Sabine and Neches Rivers, Cow Bayou and at Texas Point (see Figure 5). The rivers and bayou conditions were flow rates (cubic feet per second) obtained from archived data from USGS gauging stations and the Texas Point condition was water surface elevation relative to mllw. No measured record of conditions was available for the western end of the GIWW; therefore, since the boundary was distant from the navigation channel segments of interest, the boundary was left closed. Tests for the proposed ship simulation study were restricted to inland runs; therefore, the seaward boundary for the model was set at Texas Point because of the availability of a tidal record at the location.

Run timing was chosen from the tidal record for Texas Point (NOAA Tidal Station #8770822) during the period January 2020 through February 2021. Figure 12 shows the fourteen-month set of water surface elevation data extracted from the record for NOAA Tide Station #8770822 at Texas Point. This data set was analyzed for identification of a seven-day period with a large tidal variation which would result in reasonably high current magnitudes in various reaches of the SNWW navigation channel. The highest tidal variations resulting in the most extreme current magnitudes are normally not used for simulation testing of channel modifications.

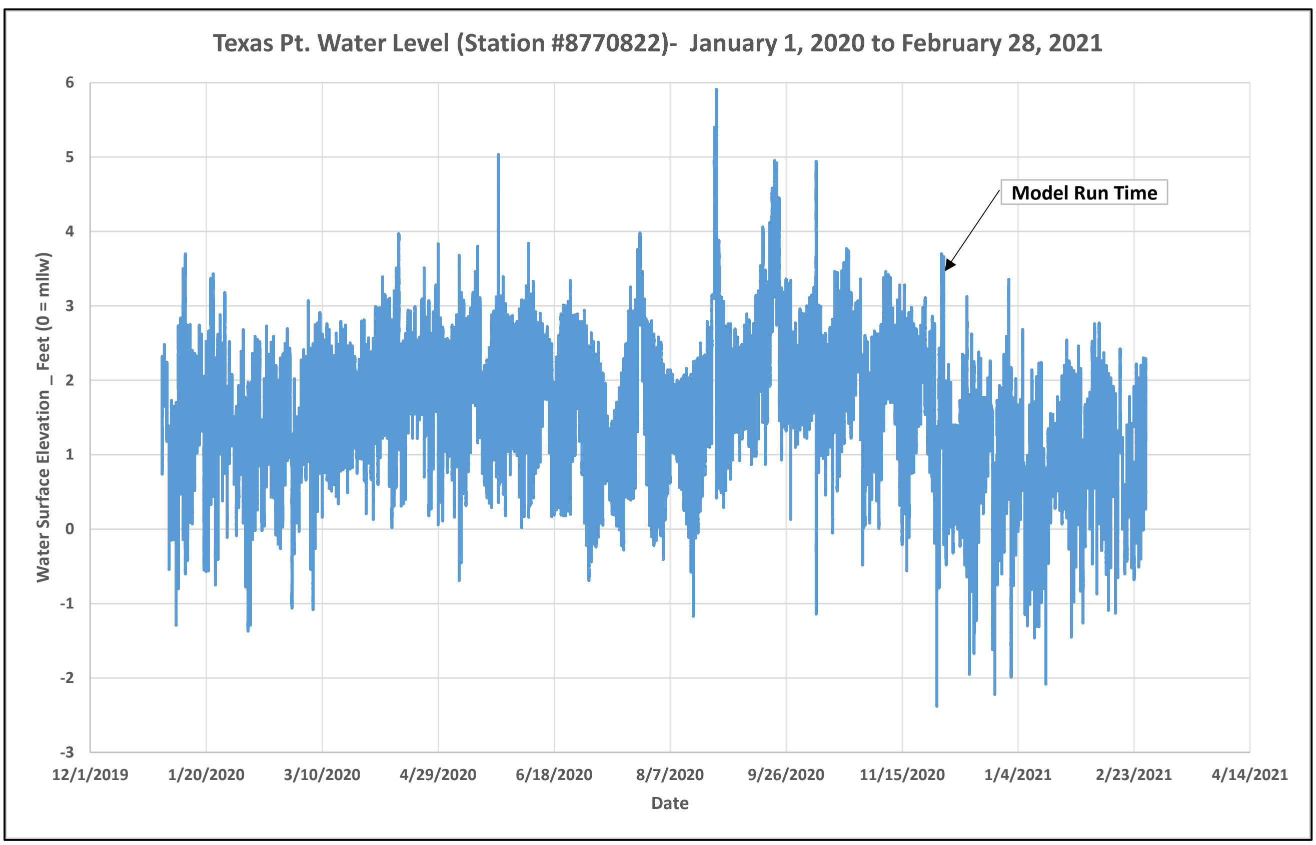


Figure 12: Water Surface Elevation (mllw) at Texas Pt.

Figure 13 & Figure 14 show the magnitude of absolute tidal variation for two discrete time intervals. The calculations for these plots were used to determine a numerical model time period for calculation of current data for the proposed simulation tests. A seven-day date interval of November 28, 2020 through December 4, 2020 was chosen. For the fourteen-month data set, the date period chosen for model runtime contains the 5th largest one-day tide variation at Texas Point and the largest seven-day tide variation. A seven-day period was chosen for model runtime to allow adequate numerical spin-up time in conjunction with a runtime length which could be completed in a reasonable amount of pc-processor time.

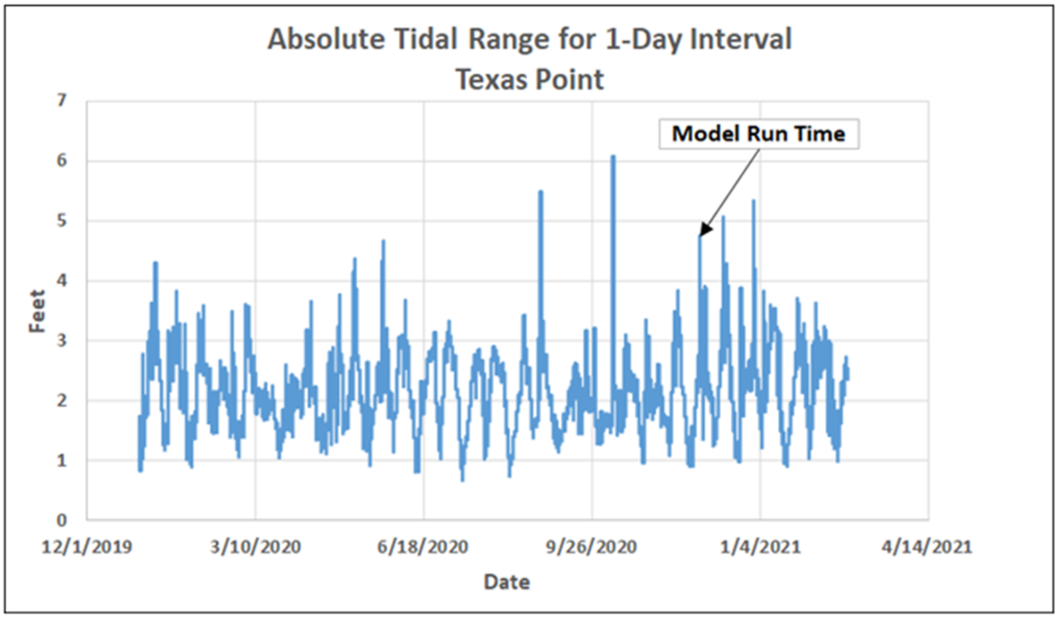


Figure 13: Tidal Variance for One-day Time Period

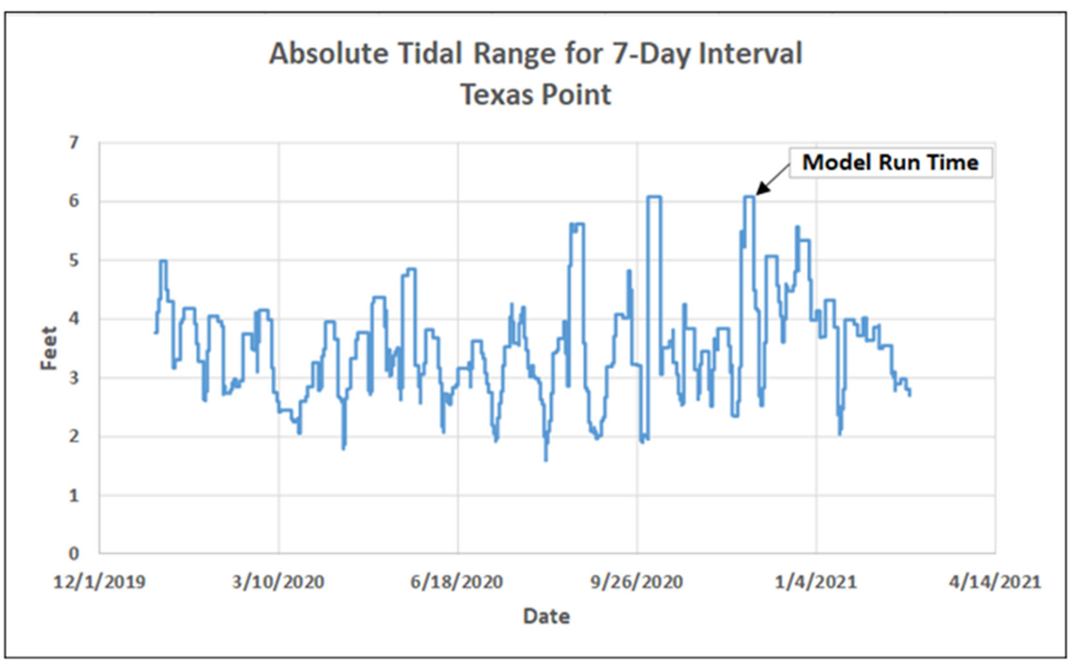


Figure 14: Tidal Variance for Seven-day Time Period

Figure 15 to Figure 17 show three data sets used for upstream SNWW model numerical boundary conditions. The figures show that for Cow Bayou and the Neches River the discharge during the seven-day run period was fairly high; however, the Sabine River discharge was low. It should be noted that the Neches River gauge at Beaumont remains in the tidal zone; therefore, at times the flow rate is negative, indcating an upstream flow with tide dominating fresh water inflow.

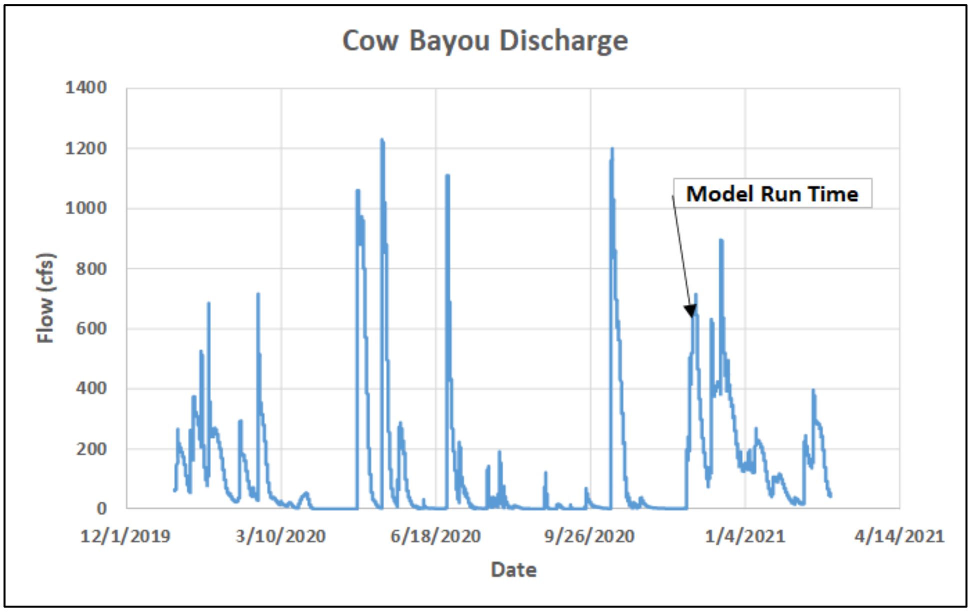


Figure 15: Cow Bayou Discharge – Fourteen Months

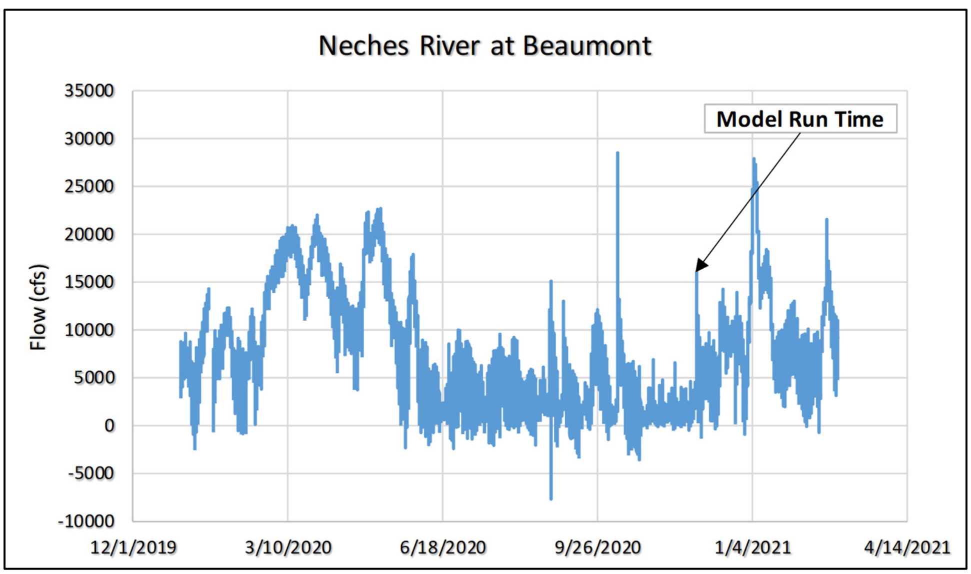


Figure 16: Neches River Discharge – Fourteen Months

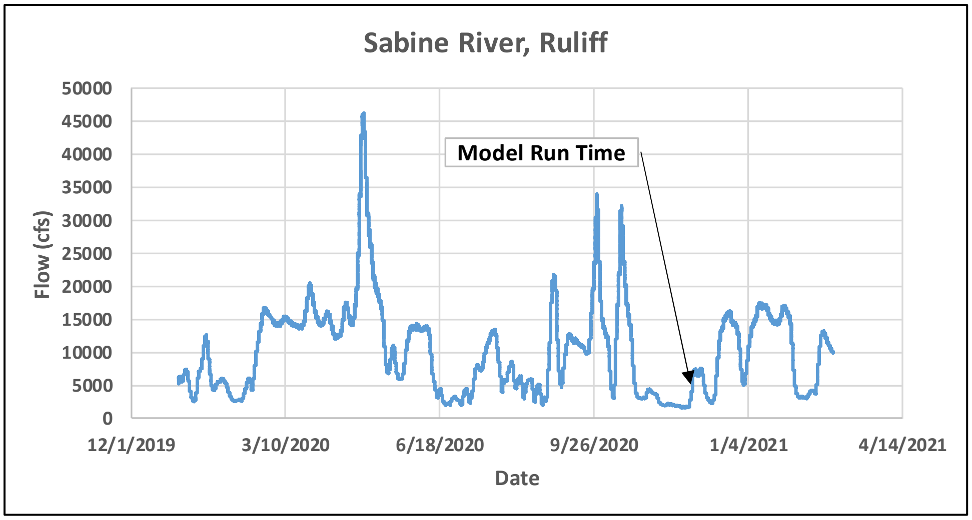


Figure 17: Sabine River Discharge – Fourteen Months

Existing Condition Model Calibration

Calibration of the SNWW numerical model to existing condition centered on two locations for which current data were recorded: Rainbow Bridge (Sta SN0501) and Port Arthur (Sta SN0701). Archived data for the two locations were accessed through the internet NOAA Ports website for the Sabine-Neches waterway. Figure 18 shows the relative locations of these stations.

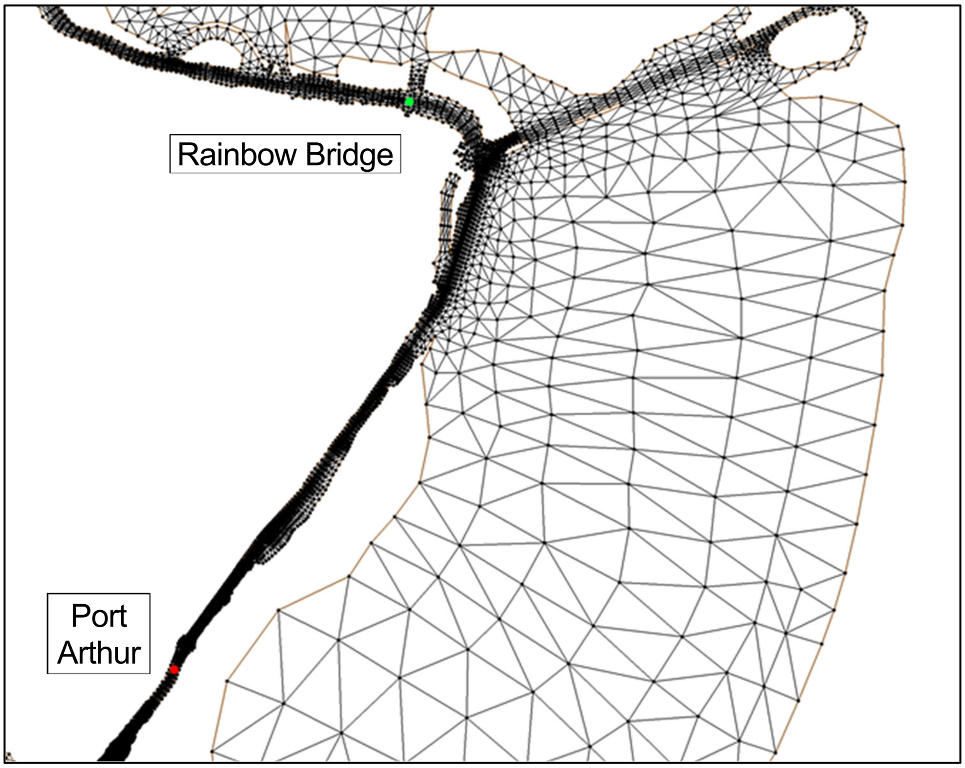


Figure 18: Model Calibration Stations

Figure 19 and Figure 20 show model results compared to recorded current magnitude for the model test period of 11/28/2020 through 12/04/2020. Model results were extracted only for the last five days to allow for model stabilization at the beginning of the run period. For Rainbow Bridge, Figure 19, the model results show the highest magnitude combined with the best agreement with measured data for the flood and ebb cycle near the December 3 timeframe. Since the model values are depth-averaged and the measured values are point measurements near the surface, this level of agreement is considered adequate. Visual inspection indicates approximately a 10% difference in the measured and model magnitude. Also, the variability of the measured values is higher than the model results, as would be expected. For Port Arthur, Figure 20, visual inspection for the December 3 flow cycle indicates approximately a 20% peak magnitude difference between measured and model values. The results also show a good comparison between the peak magnitude phasing of the measured and calculated values; therefore, the results are considered adequate for generation of ship simulation current data. Figure 21 to Figure 23 show a sampling of the existing channel current pattern from model results.

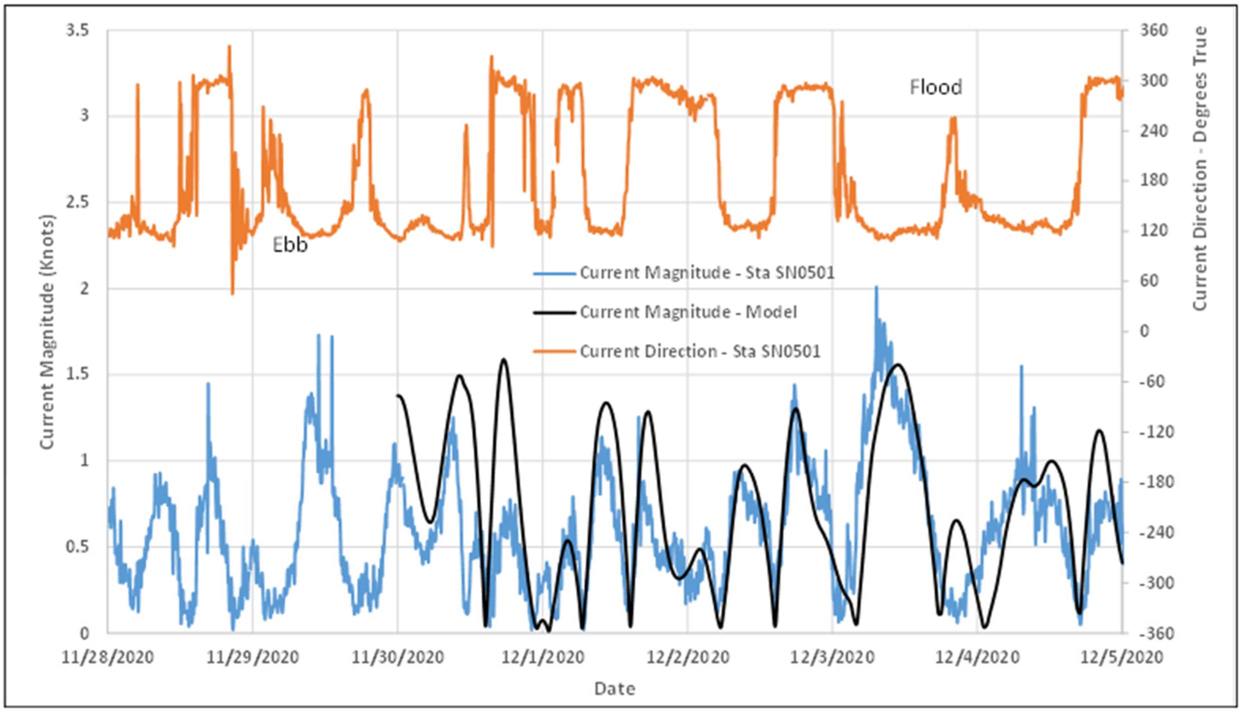


Figure 19: Current Magnitude Model Results for Existing Conditions – Rainbow Bridge

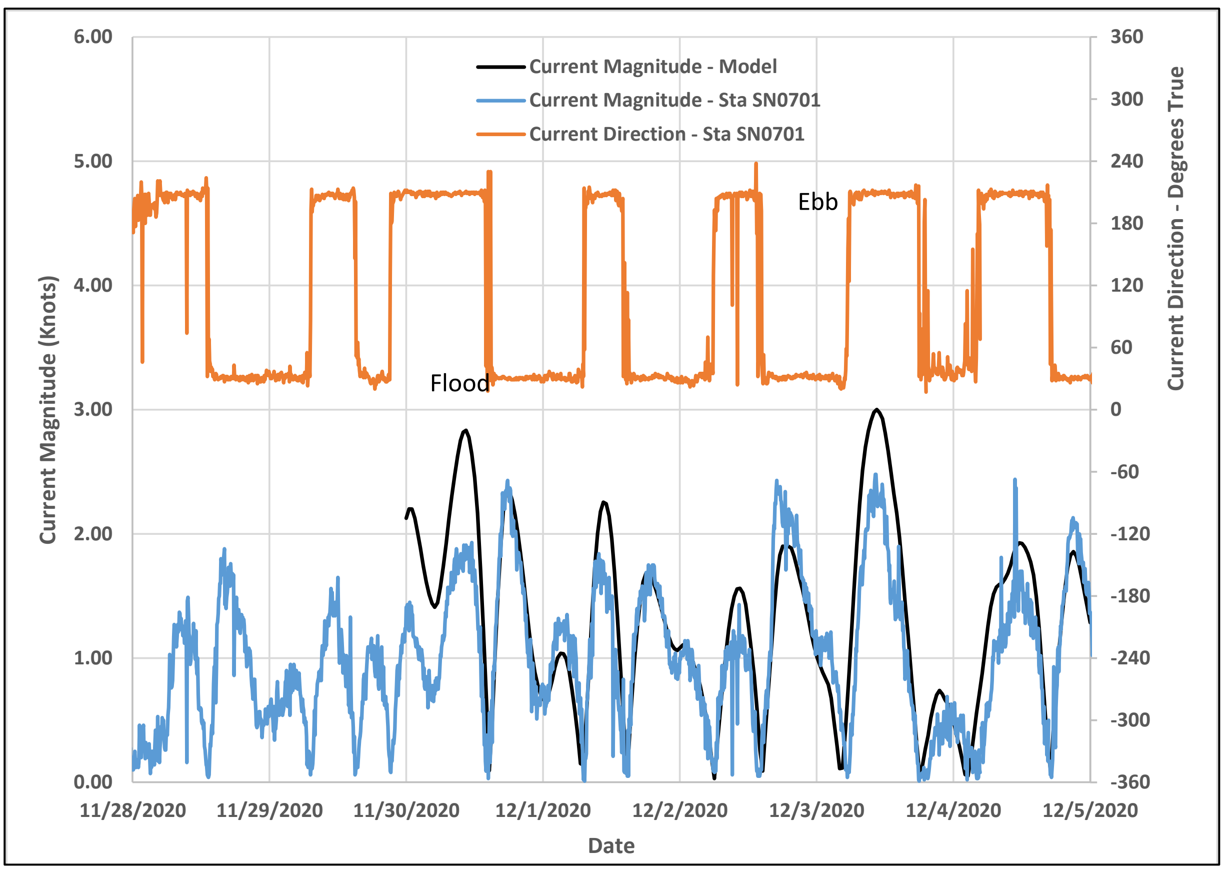


Figure 20: Current Magnitude Model Results for Existing Conditions – Port Arthur

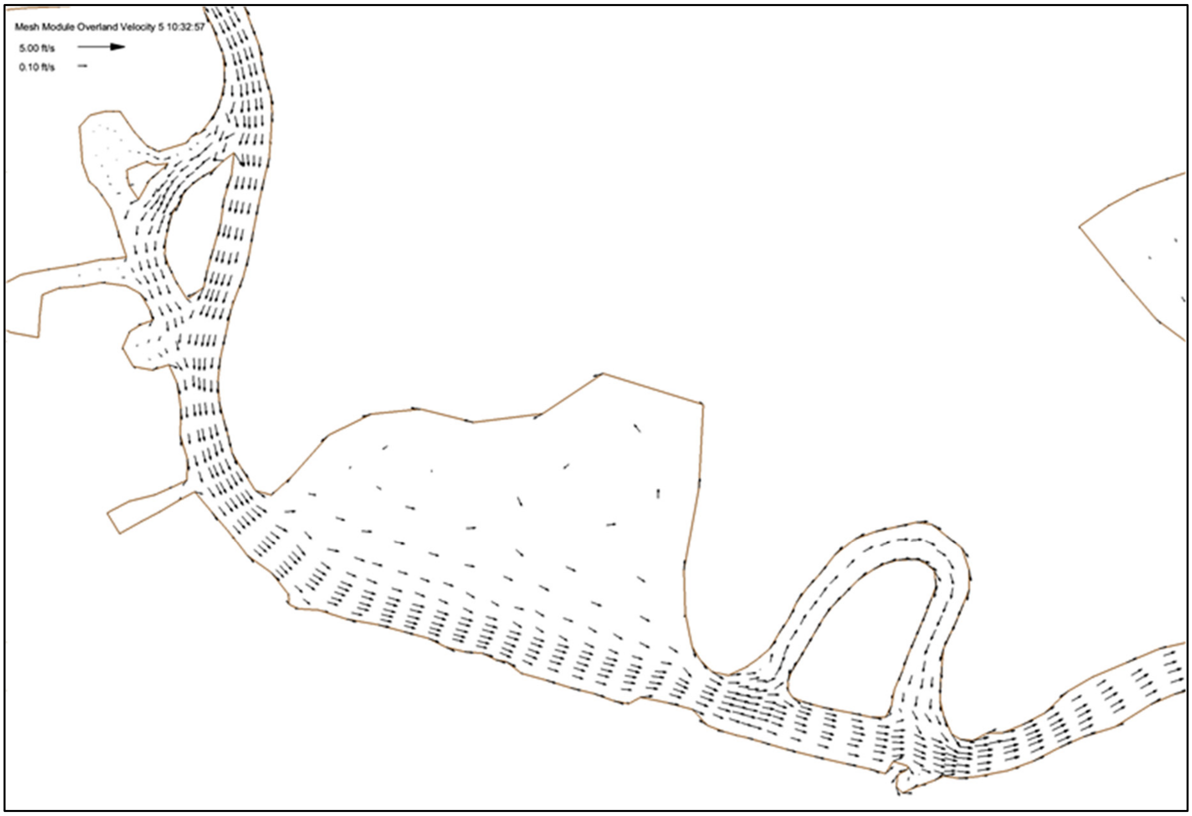


Figure 21: Existing SNWW Channel Ebb Current – Upper Neches River

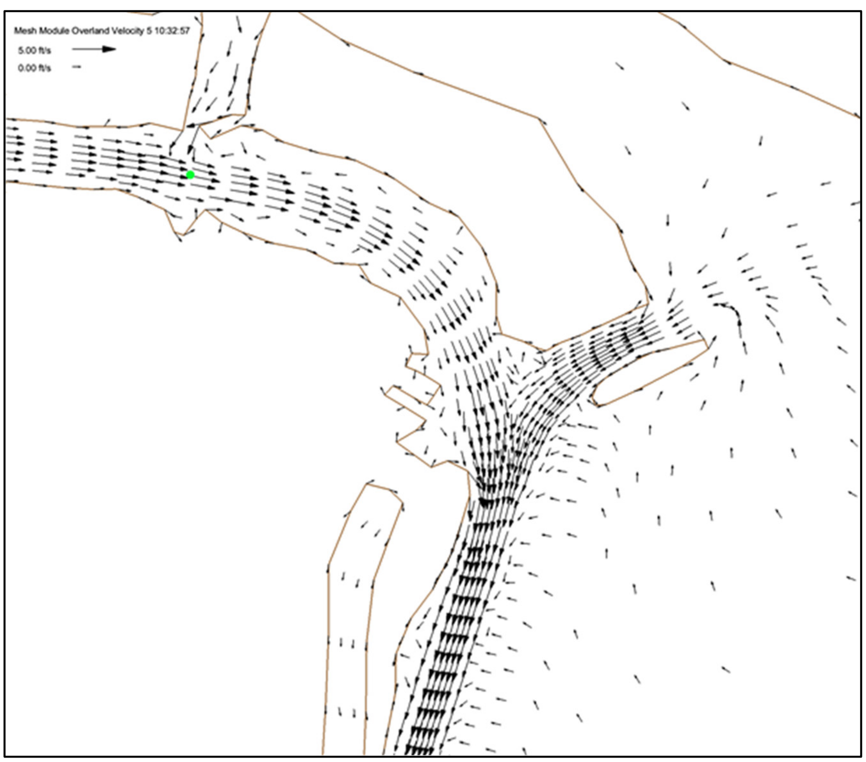


Figure 22: Existing SNWW Channel Ebb Current – Neches/Sabine Split

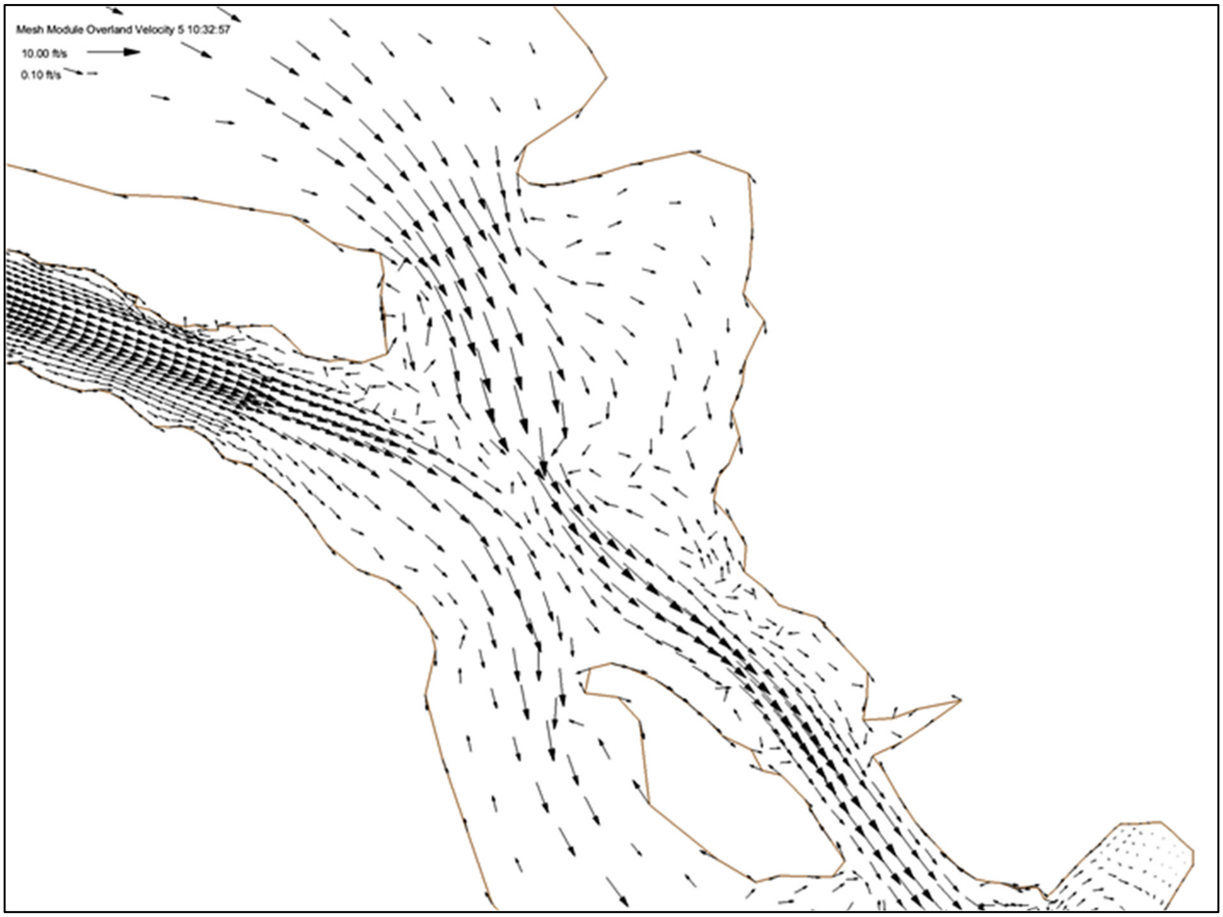


Figure 23: Existing SNWW Channel Ebb Current – Sabine Lake Outlet

Proposed Channel

Following the existing channel calibration, the grid was modified to a deepening project depth of 48 ft and modified to the proposed widening configuration. The widening consisted of a 500-ft section and a 700-ft section. Widening to 700 ft (500 ft existing) is proposed for the SNWW channel between the jetty channel and Port Arthur and widening in parts of the channel to 500 ft (400 ft existing) in the Port Arthur Canal up to McFadden Bend Cutoff near Beaumont. Furthermore, bend widenings added extra width in sections of the channel. Figure 24 to Figure 27 show the layout of the widened channel for a sampling of channel segments. The bottom elevation of the proposed widened channel was set at -48 ft and contours for a portion of the channel are shown in Figure 28.

In several sections of the waterway the alignment of the proposed widened channel required shifting of the shoreline. Without design guidance the position of the shoreline was estimated for the widened channel.   For these areas the shoreline was relocated approximately the same distance from the edge of the proposed channel as it was for the existing channel edge.

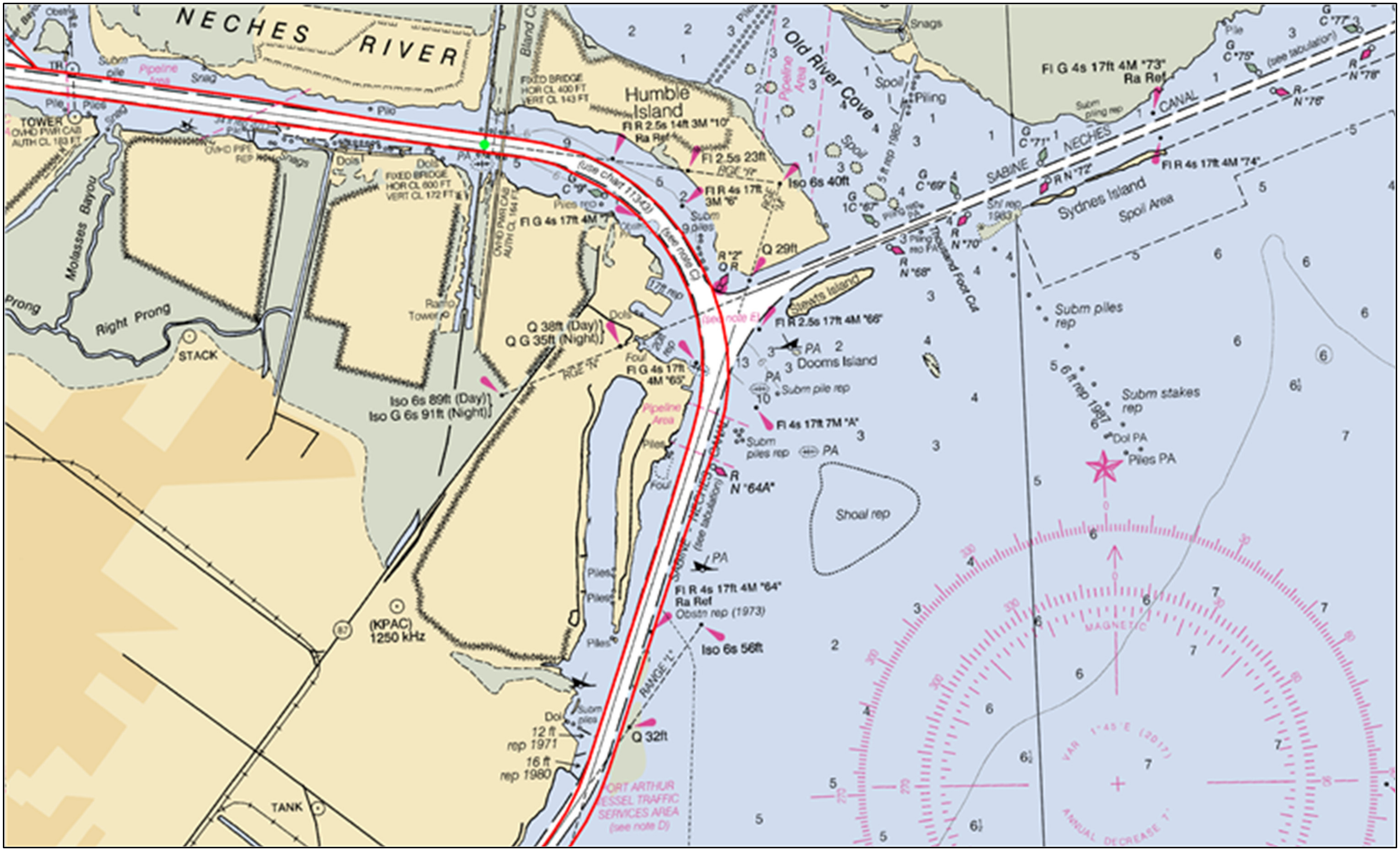


Figure 24: Widened Channel Compared to Existing – Neches/Sabine Split

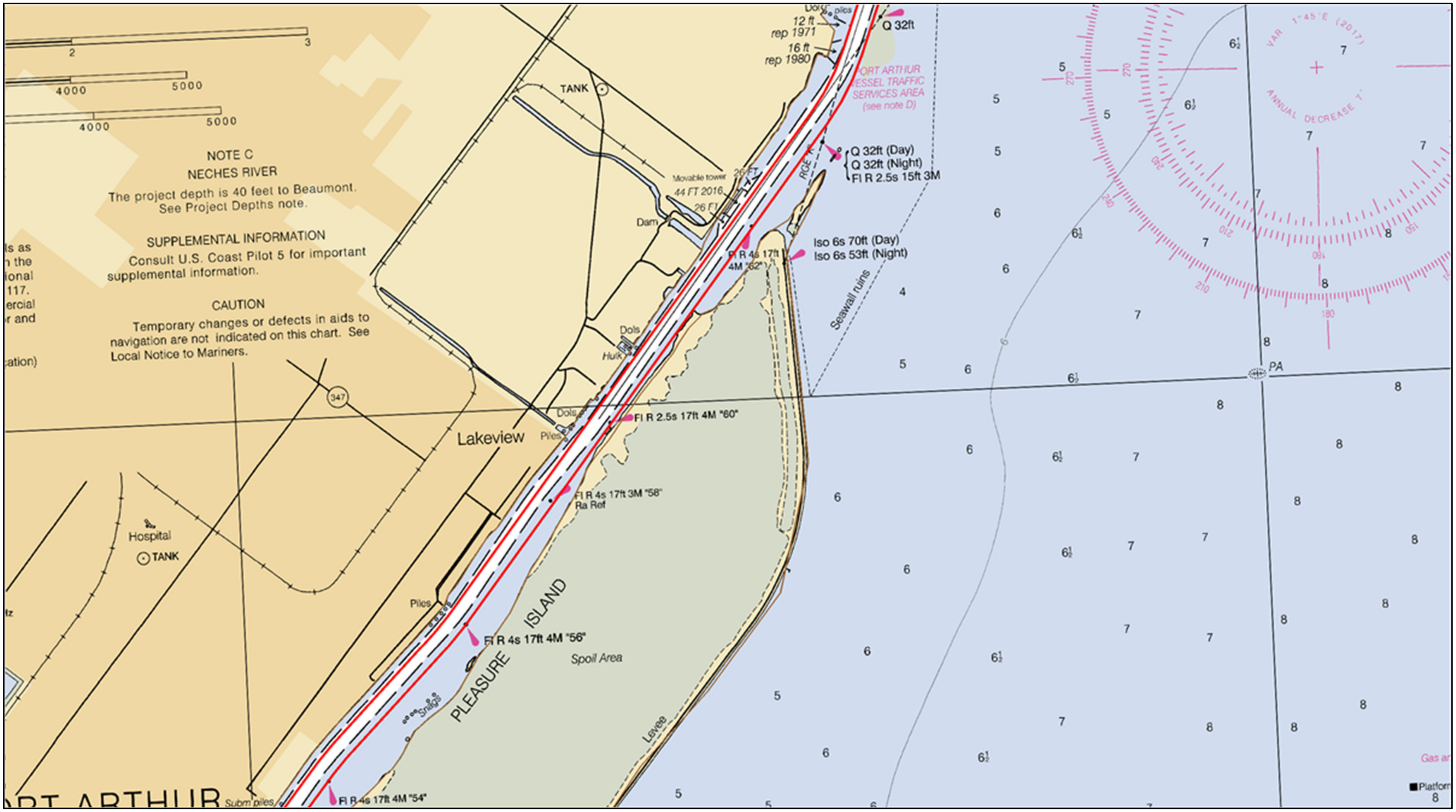


Figure 25: Widened Channel Compared to Existing – Part of Port Arthur Canal – Proposed Channel Shifted East

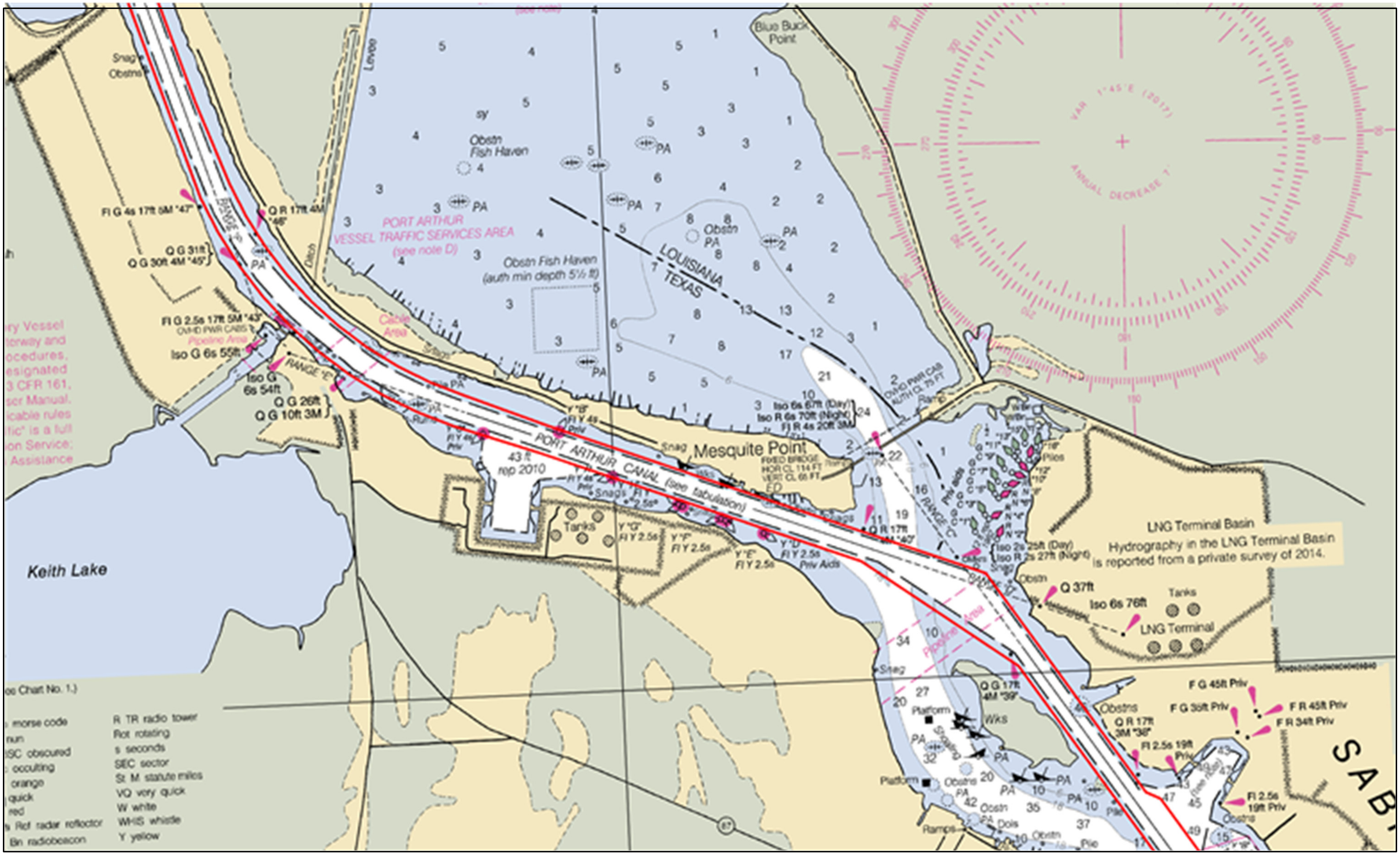


Figure 26: Widened Channel Compared to Existing – Sabine Lake Outlet Vicinity

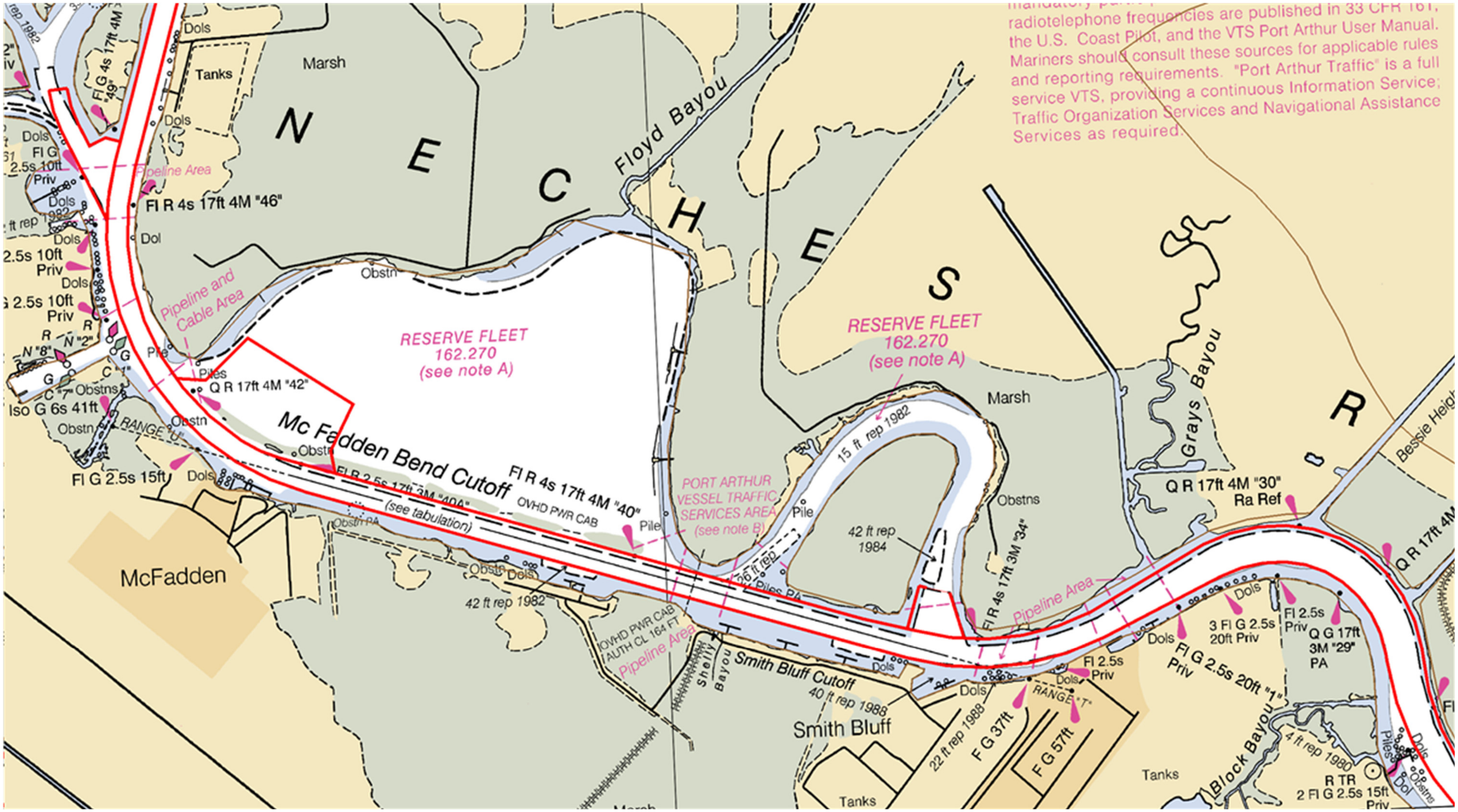


Figure 27: Widened Channel Compared to Existing – McFadden Bend, Neches River

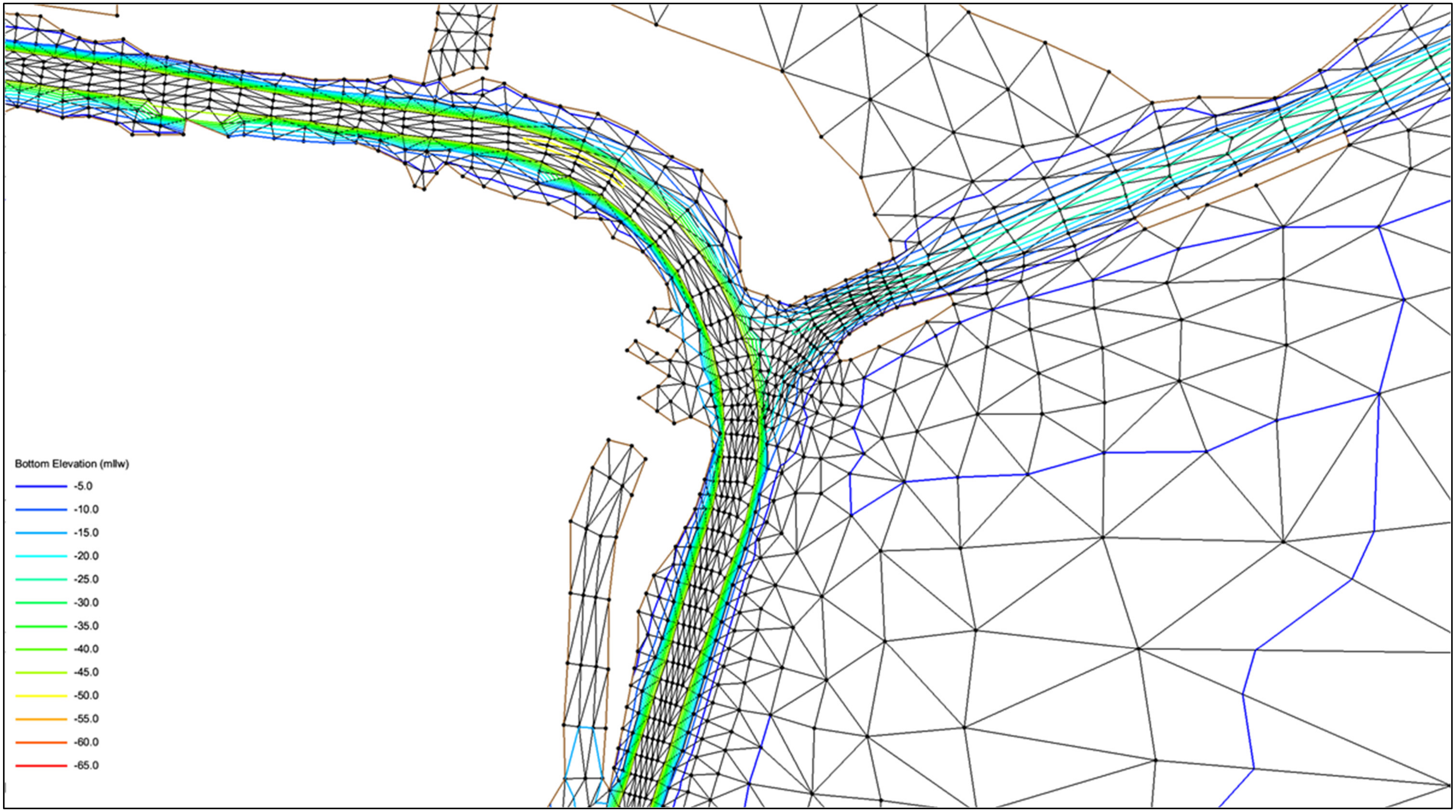


Figure 28: Widened Channel Grid with Bottom Elevation Contours - Sabine/Neches Split

Proposed Channel Model Results

The proposed channel grid was run for the same period of time and boundary conditions as was run for the existing channel. Figure 29 to Figure 32 show a sampling of current vector model results for the proposed channel. In general, the SNWW model was calibrated using data from two current measurement stations. However, in such a long, complicated, channel there are numerous locations in which the current magnitude model results were unverified. For example, the intersection of the Sabine Lake outlet with the navigation channel. There was a current measurement station in the vicinity; however, it was located well outside of the channel itself. Verification of currents for this location is necessarily dependent on pilot experience and opinion. SNWW current data transferred to the simulation development team is comprised of maximum ebb and flood current along the Port Arthur Canal for the time period tested. The current data bases represent snapshots in time; if needed, data can be extracted for other times in the modeled tidal cycle.

John Christopher Hewlett

Chris Hewlett, P.E.
Waterway Simulation Technology

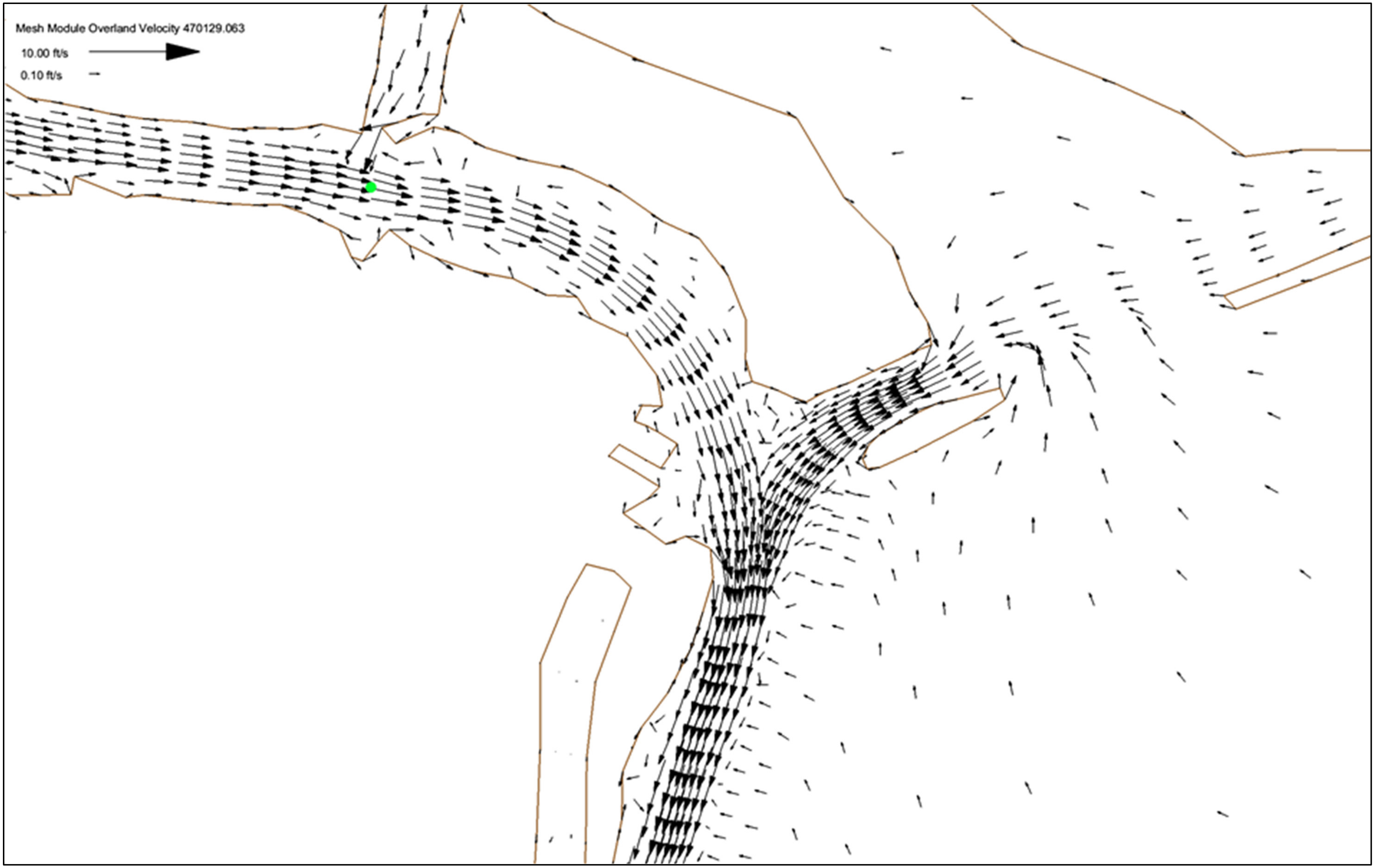


Figure 29: Proposed Channel Model Results, Ebb Tide, Rainbow Bridge Vicinity

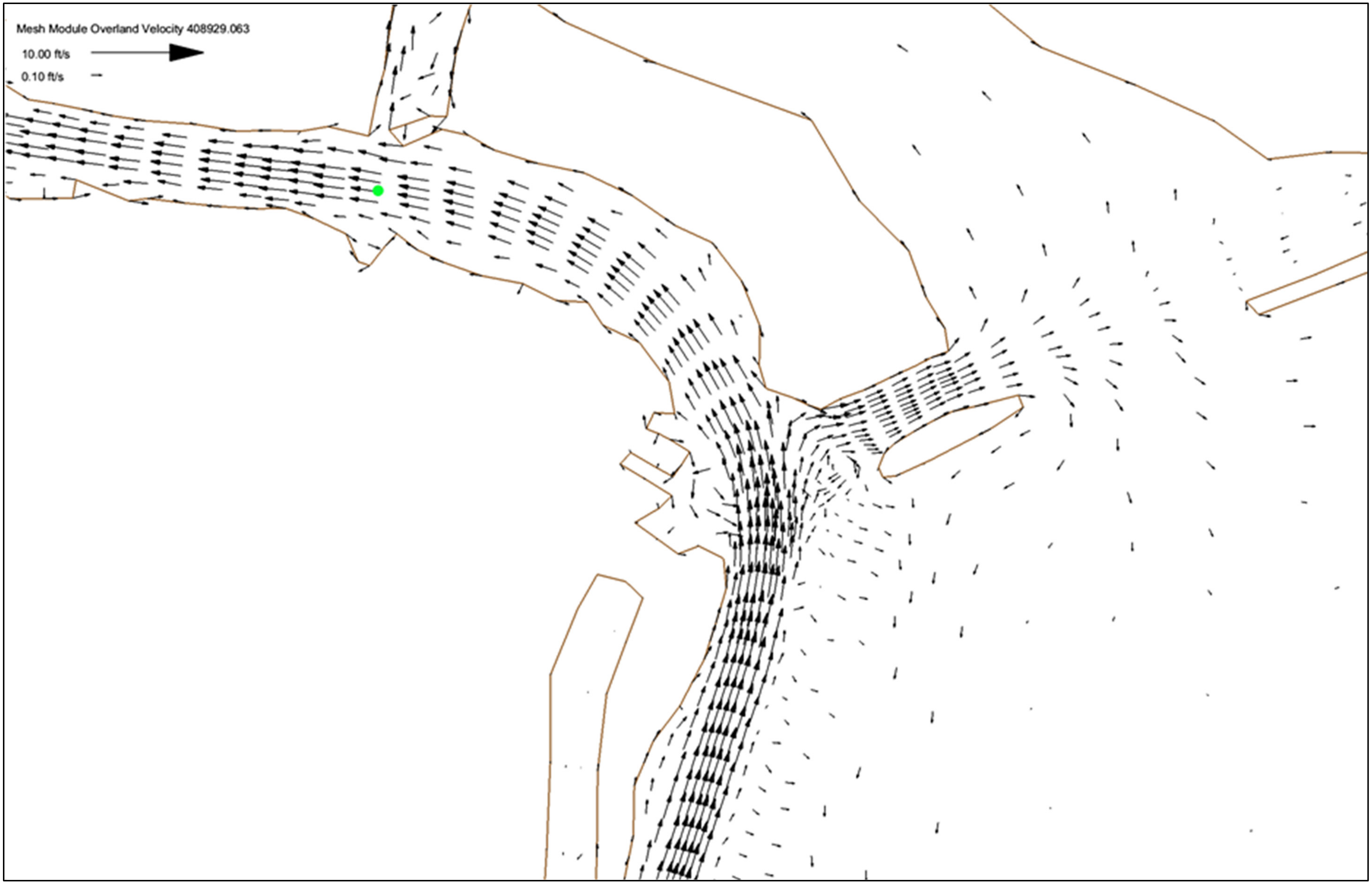


Figure 30: Proposed Channel Model Results, Flood Tide, Rainbow Bridge Vicinity

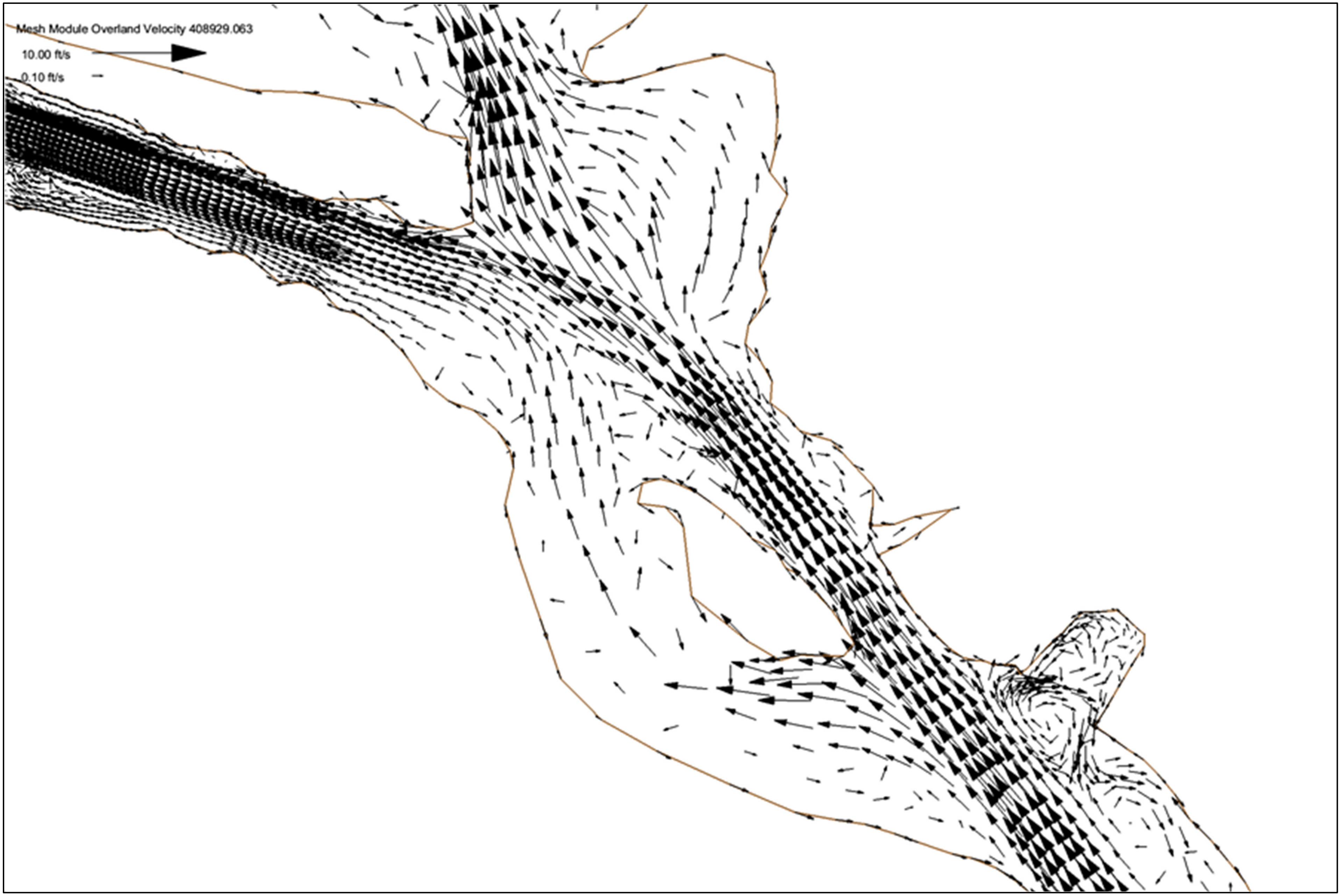


Figure 31: Proposed Channel Model Results, Flood Tide, Sabine Lake Outlet

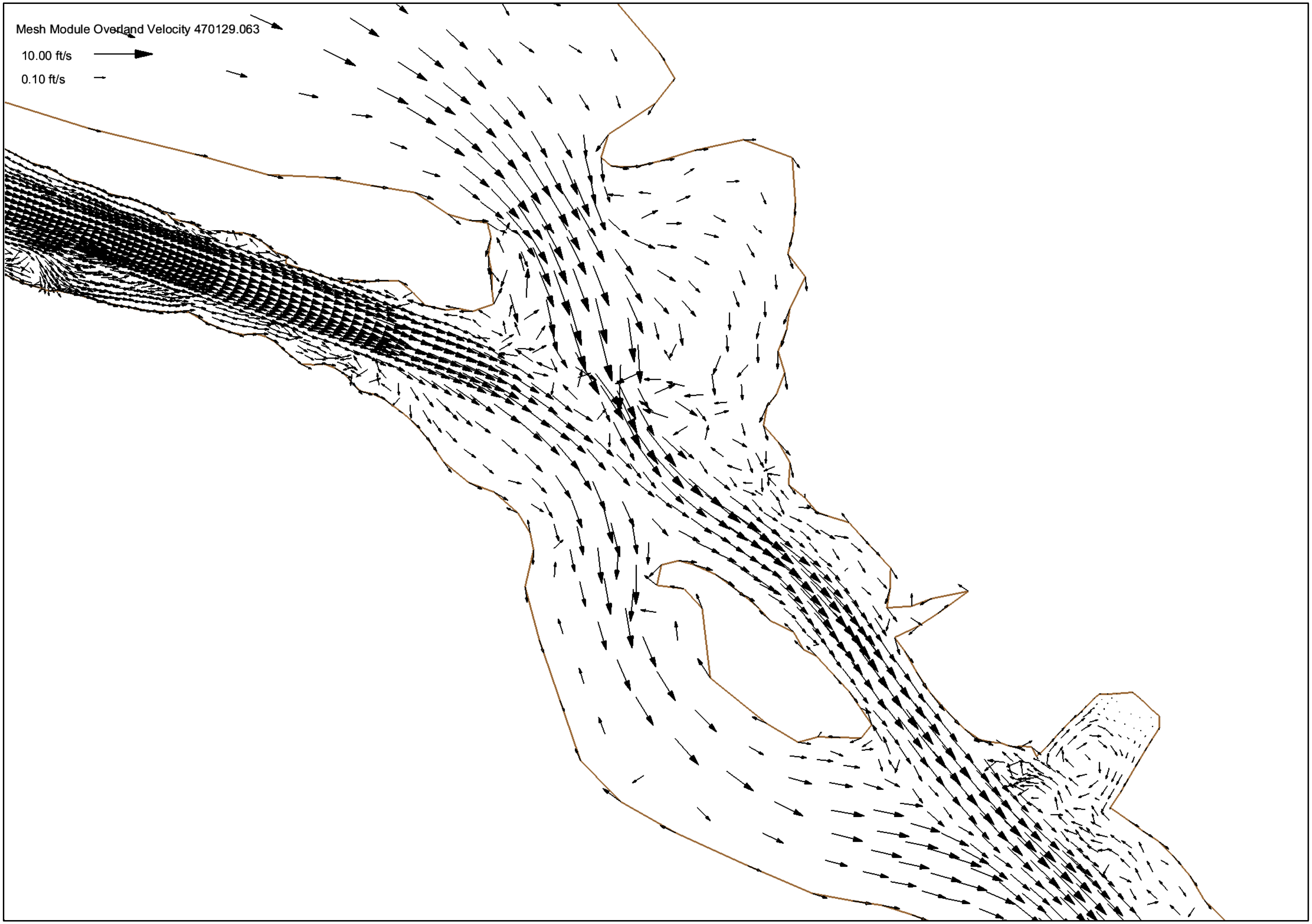


Figure 32: Proposed Channel Model Results, Ebb Tide, Sabine Lake Outlet

Appendix B

Pilot Cards

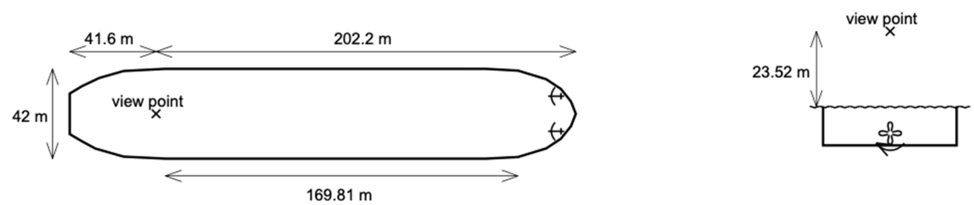
PILOT CARD

MTKM107N
Version 5

Ship's name 107 K **Date**
Call Sign **Deadweight** 107481 tonnes **Year built**
Draught aft 12.2 m / 40 ft 0 in **Forward** 12.2 m / 40 ft 0 in **Displacement** 99250 tonnes

SHIP'S PARTICULARS

Length overall 243.8 m **Anchor chain:** **Port** 13.0 shackles **Starboard** 13.0 shackles
Breadth 42 m **Stern** shackles
Bulbous bow Yes **(1 shackle = 27.432 m = 15 fathoms)**



PROPULSION PARTICULARS

Type of engine Diesel **Maximum power** 13557 kW (18432 hp)

Manoeuvring engine order		RPM	Pitch	Speed (knots) Loaded	Speed (knots) Ballast
Full sea speed	**1**	101.0		15.0	
Full Ahead	**0.8**	75.0		11.2	
Half Ahead	**0.5**	62.0		9.2	
Slow Ahead	**0.25**	42.0		6.2	
Dead Slow Ahead	**0.125**	35.0		5.1	
Dead Slow Astern	**-0.125**	-35.0			
Slow Astern	**-0.25**	-42.0			
Half Astern	**-0.5**	-62.0			
Full Astern	**-1**	-75.0			

Time limit astern min:sec
Full ahead to full astern min:sec
Max. No. of consecutive starts
Minimum RPM knots
Astern power % ahead

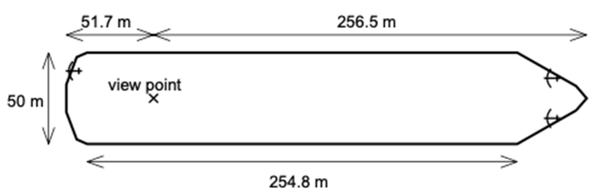
PILOT CARD

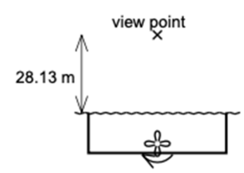
SUEZ156Q
Version 0

Ship's name: Suez 156 | Date: ______
Call Sign: ______ | Deadweight: 210157 tonnes | Year built: ______
Draught aft: 14.63 m / 47 ft 12 in | Forward: 14.63 m / 47 ft 12 in | Displacement: 191980 tonnes

SHIP'S PARTICULARS

Length overall 274 m **Anchor chain:** **Port** 13.5 shackles **Starboard** 13.5 shackles
Breadth 50 m **Stern** 13.5 shackles
Bulbous bow Yes **(1 shackle = 27.432 m = 15 fathoms)**





PROPULSION PARTICULARS

Type of engine Diesel **Maximum power** 25460 kW (34617 hp)

Manoeuvring engine order		RPM	Pitch	Speed (knots) Loaded	Speed (knots) Ballast
Full sea speed	1	86.4			16.5
Full Ahead	0.8	64.1			12.4
Half Ahead	0.5	49.0			9.4
Slow Ahead	0.25	33.0			6.2
Dead Slow Ahead	0.125	26.4			4.9
Dead Slow Astern	-0.125	-26.4			
Slow Astern	-0.25	-33.0			
Half Astern	-0.5	-49.0			
Full Astern	-1	-64.1			

Time limit astern ______ min:sec
Full ahead to full astern ______ min:sec
Max. No. of consecutive starts ______
Minimum RPM ______ ______ knots
Astern power ______ % ahead

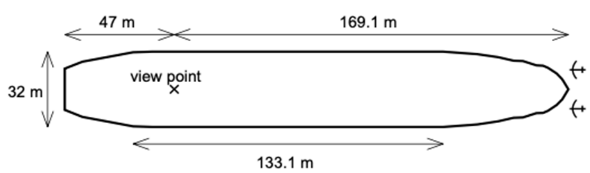
PILOT CARD

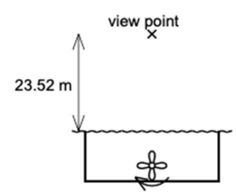
MBULK32X
Version 1

Ship's name Bulk Profit **Date** ______
Call Sign ______ **Deadweight** 0 tonnes **Year built** ______
Draught aft 12.2 m / 40 ft 0 in **Forward** 12.2 m / 40 ft 0 in **Displacement** 60920 tonnes

SHIP'S PARTICULARS

Length overall 215 m **Anchor chain:** **Port** 13.0 shackles **Starboard** 13.0 shackles
Breadth 32 m **Stern** ______ shackles
Bulbous bow Yes **(1 shackle = 27.432 m = 15 fathoms)**





PROPULSION PARTICULARS

Type of engine Diesel **Maximum power** 13557 kW (18432 hp)

Manoeuvring engine order		RPM	Pitch	Speed (knots) Loaded	Ballast
Full sea speed	**1**	101.0		14.9	
Full Ahead	**0.8**	75.0		11.2	
Half Ahead	**0.5**	62.0		9.2	
Slow Ahead	**0.25**	42.0		6.2	
Dead Slow Ahead	**0.125**	35.0		5.1	
Dead Slow Astern	**-0.125**	-35.0			
Slow Astern	**-0.25**	-42.0			
Half Astern	**-0.5**	-62.0			
Full Astern	**-1**	-75.0			

Time limit astern ______ min:sec
Full ahead to full astern ______ min:sec
Max. No. of consecutive starts ______
Minimum RPM ______ ______ knots
Astern power ______ % ahead

*MBULK32Z has the same pilot card but was renamed halfway through simulations due to a file corruption

PILOT CARD

MTUG300
Version 0

Ship's name MTowTug Date

Call Sign Deadweight 0 tonnes Year built

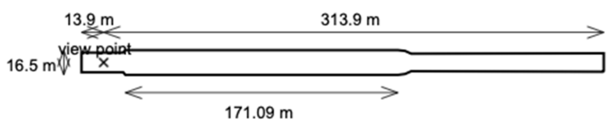
Draught aft 3.05 m / 10 ft 0 in Forward 3.05 m / 10 ft 0 in Displacement 12908 tonnes

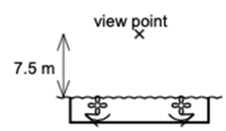
SHIP'S PARTICULARS

Length overall 325.8 m **Anchor chain:** **Port** shackles **Starboard** shackles

Breadth 16.5 m **Stern** shackles

Bulbous bow No **(1 shackle = 27.432 m = 15 fathoms)**





PROPULSION PARTICULARS

Type of engine Diesel **Maximum power** 2838 kW (3859 hp)

Manoeuvring engine order		RPM	Pitch	Speed (knots) Loaded	Speed (knots) Ballast
Full sea speed	**1**	249.0		8.1	
Full Ahead	**0.8**	177.8		5.7	
Half Ahead	**0.5**	130.0		4.1	
Slow Ahead	**0.25**	50.4		1.5	
Dead Slow Ahead	**0.125**	12.0		0.4	
Dead Slow Astern	**-0.125**	-12.0			
Slow Astern	**-0.25**	-50.4			
Half Astern	**-0.5**	-130.0			
Full Astern	**-1**	-190.9			

Time limit astern min:sec

Full ahead to full astern min:sec

Max. No. of consecutive starts

Minimum RPM knots

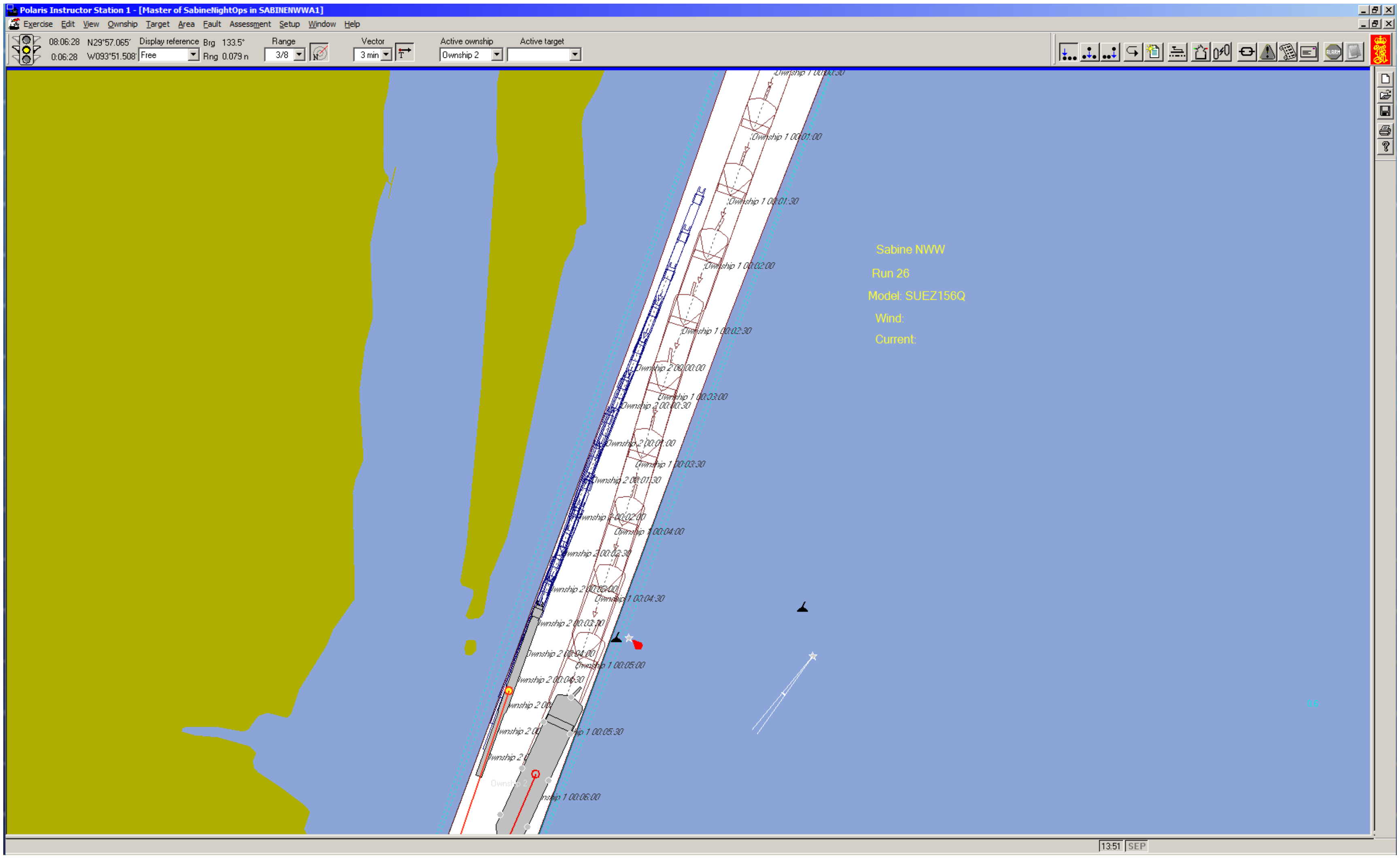
Astern power % ahead

Appendix C

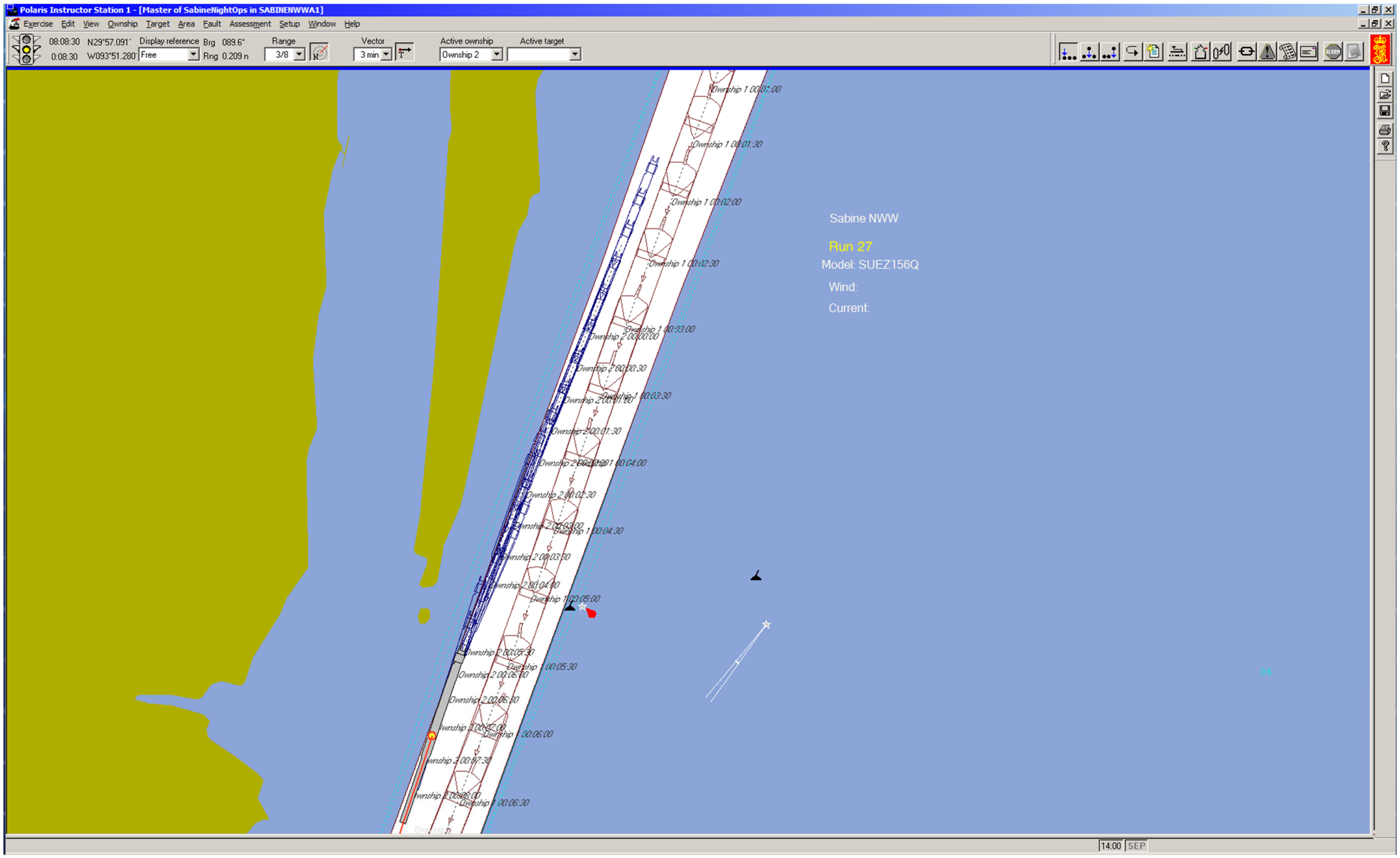
Track Plots

Overtaking runs at Old River.							
Run	Vessel	Heading	Vessel	Heading	Current	Wind	Visibility
26	SuezMax	South (Outbound)	4-Barge	South	Slack		Daylight
27	SuezMax	South (Outbound)	4-Barge	South	Slack	Calm	Daylight
28	SuezMax	South (Outbound)	4-Barge	South	Slack	Calm	Nighttime
29	SuezMax	South (Outbound)	4-Barge	South	Slack	Calm	Nighttime
Meeting at Fina Highline							
Run	Vessel	Heading	Vessel	Heading	Current	Wind	Visibility
30	Panamax	Outbound	Panamax	Inbound	Slack	Calm	Daylight
31	Panamax	Outbound	Panamax	Inbound	Slack	Calm	Daylight
32	Panamax	Outbound	Panamax	Inbound	Slack	Calm	Daylight
Meeting at Port Neches							
Run	Vessel	Heading	Vessel	Heading	Current	Wind	Visibility
33	SuezMax	East (Outbound)	4-Barge	West	Slack	Calm	Nighttime
34	SuezMax	East (Outbound)	4-Barge	West	Slack	Calm	Nighttime
35	SuezMax	East (Outbound)	4-Barge	West	Slack	Calm	Nighttime
36	SuezMax	East (Outbound)	4-Barge	West	Slack	Calm	Nighttime
37	SuezMax	East (Outbound)	4-Barge	West	Low Flood	Calm	Nighttime
38	SuezMax	East (Outbound)	4-Barge	West	High Ebb	Calm	Nighttime
39	AfraMax	Outbound	Panamax	Inbound	High Ebb	Calm	Daylight
40	AfraMax	Outbound	Panamax	Inbound	High Ebb	Calm	Nighttime
Double Encounter Meetings North of the "Eyeball"							
Run	Vessel	Heading	Vessel	Heading	Current	Wind	Visibility
41	SuezMax	North (Inbound)	4-Barge	South	High Ebb	20K SE	Nighttime
42	SuezMax	North (Inbound)	4-Barge	South	Low Ebb	20K SE	Nighttime

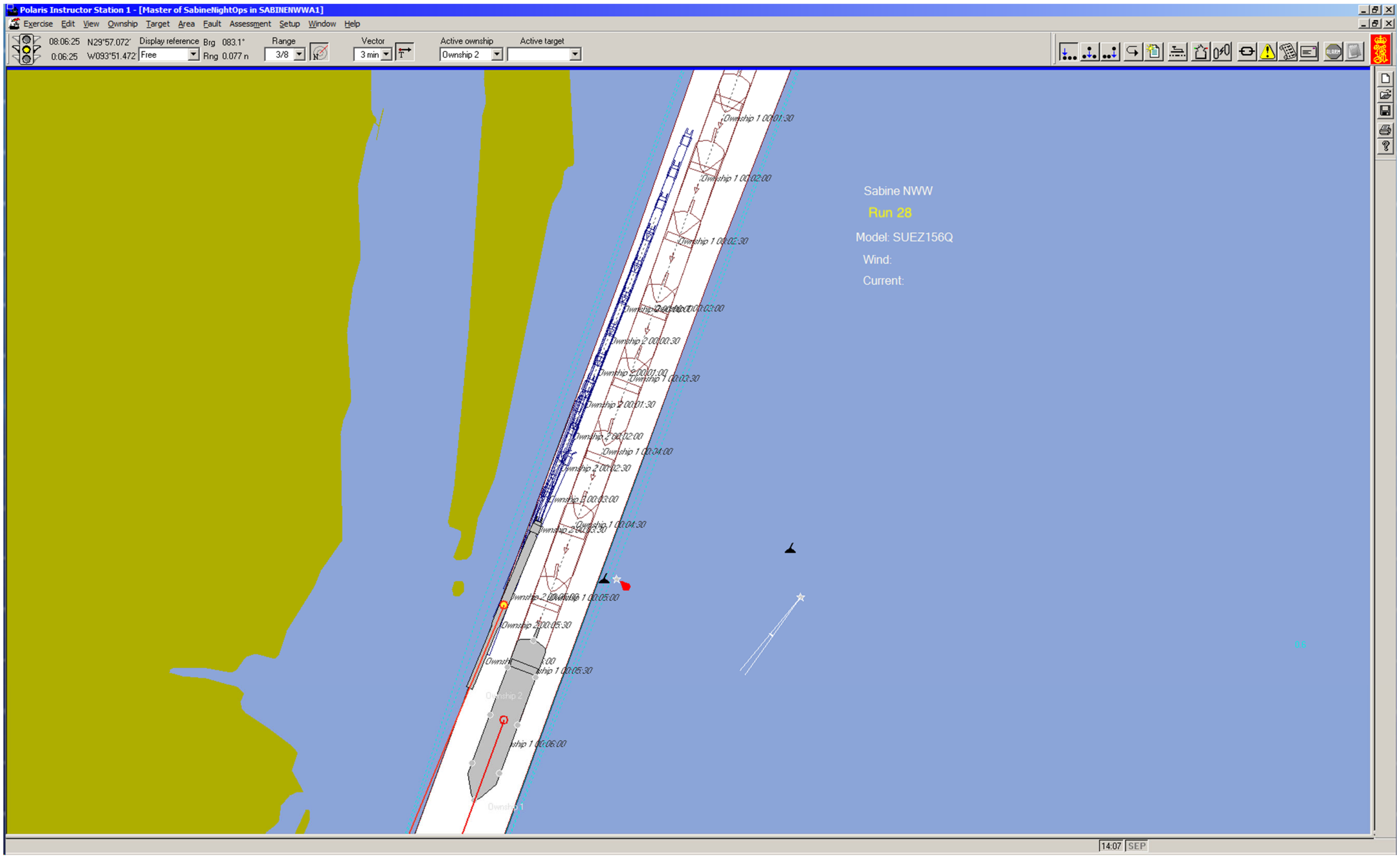
Run 26: Overtaking at Old River, Day Time, No Wind, No Current



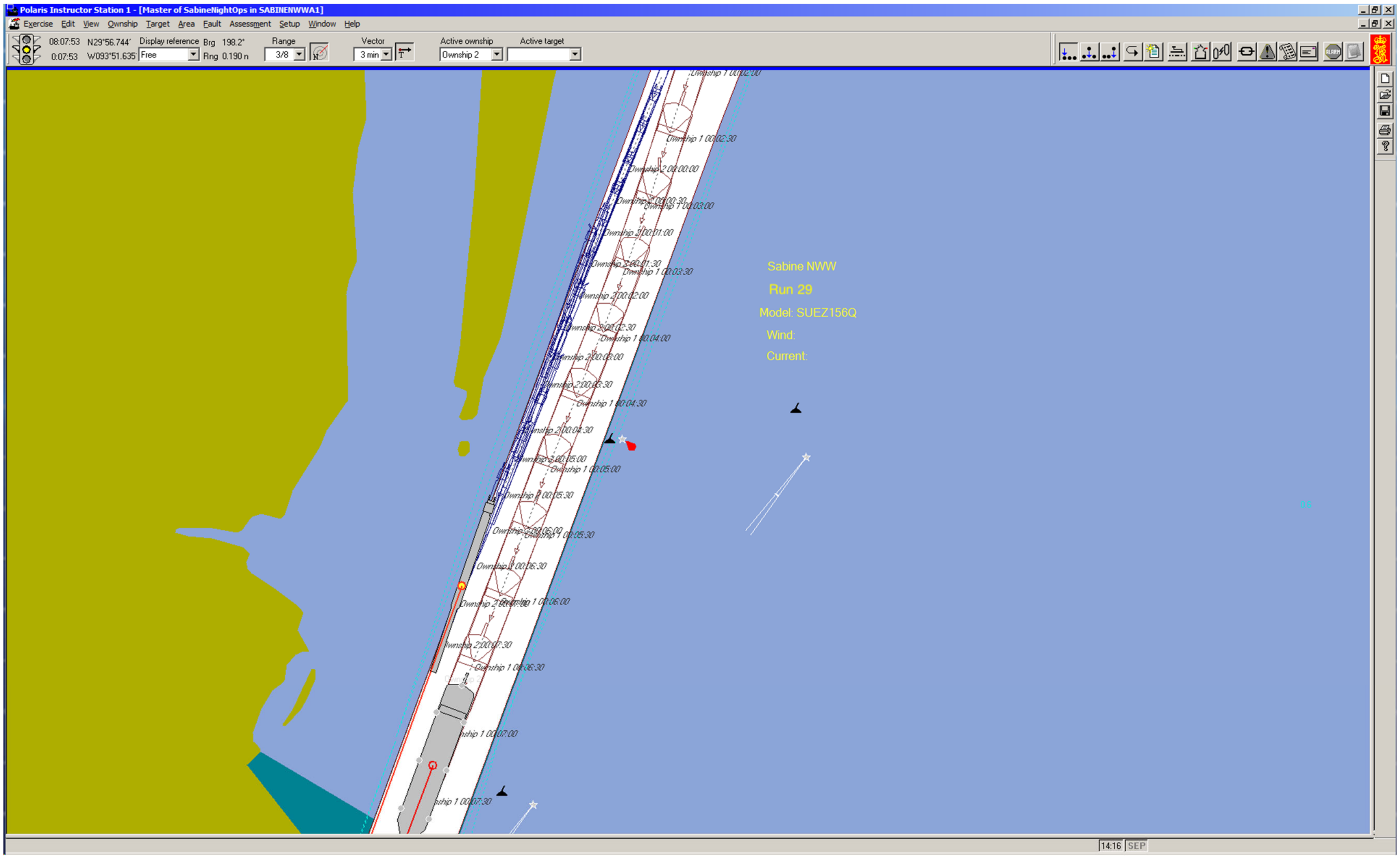
Run 27: Overtaking at Old River, Day Time, No Wind, No Current



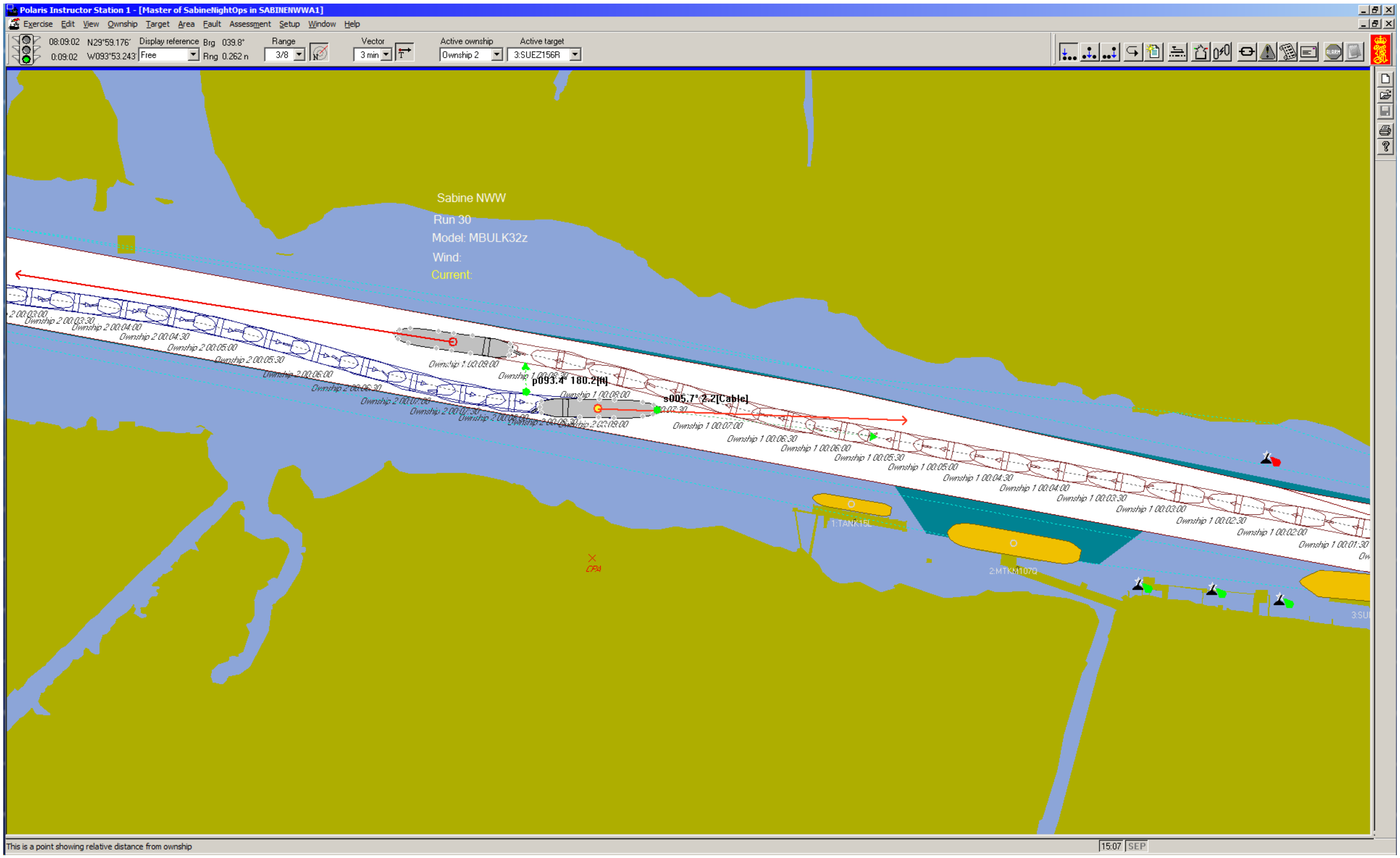
Run 28: Overtaking at Old River, Twilight, No Wind, No Current



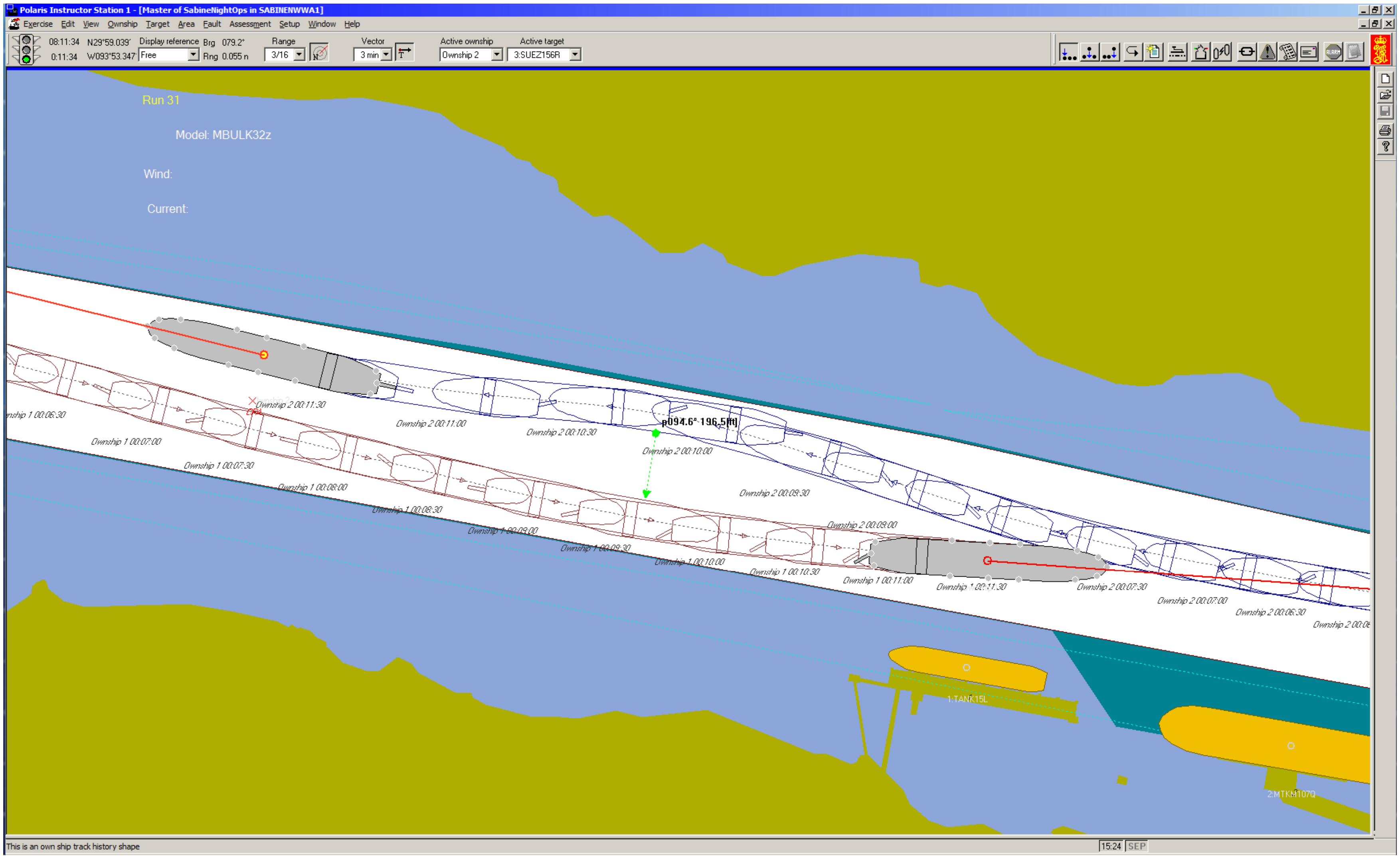
Run 29: Overtaking at Old River, Twilight, No Wind, No Current



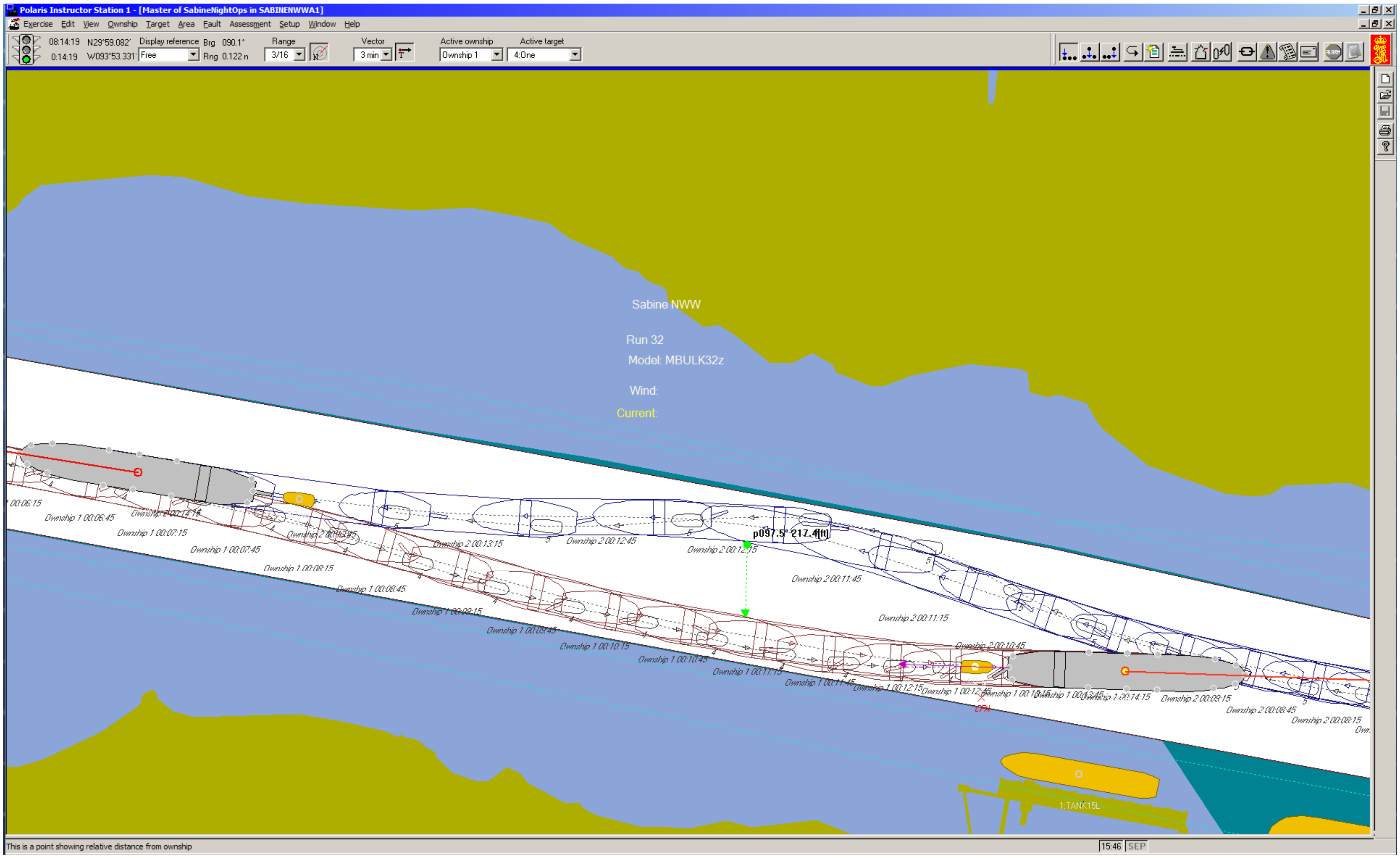
Run 30: Meeting at Fina Highline, Day Time, No Wind, No Current



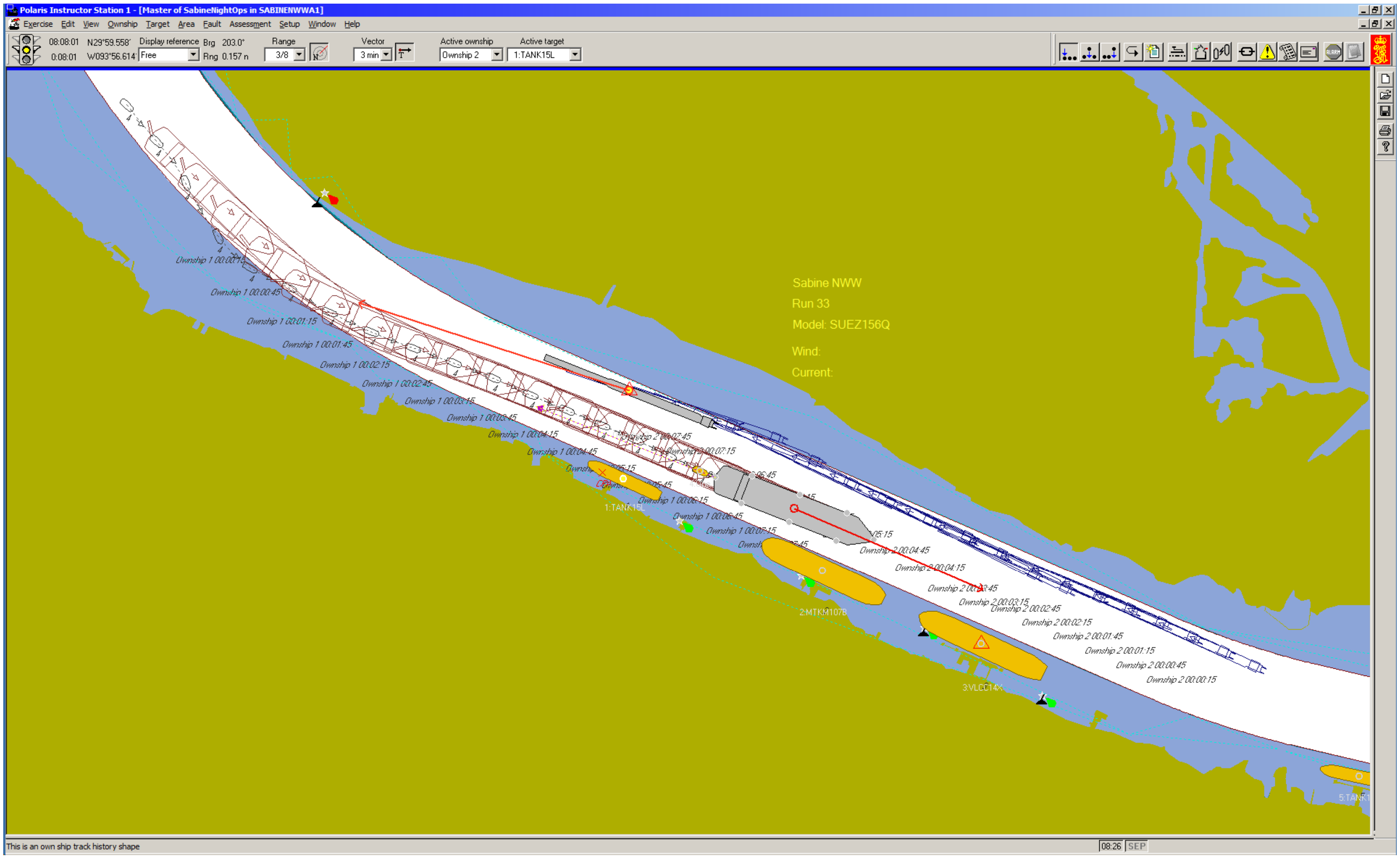
Run 31: Meeting at Fina Highline, Day Time, No Wind, No Current



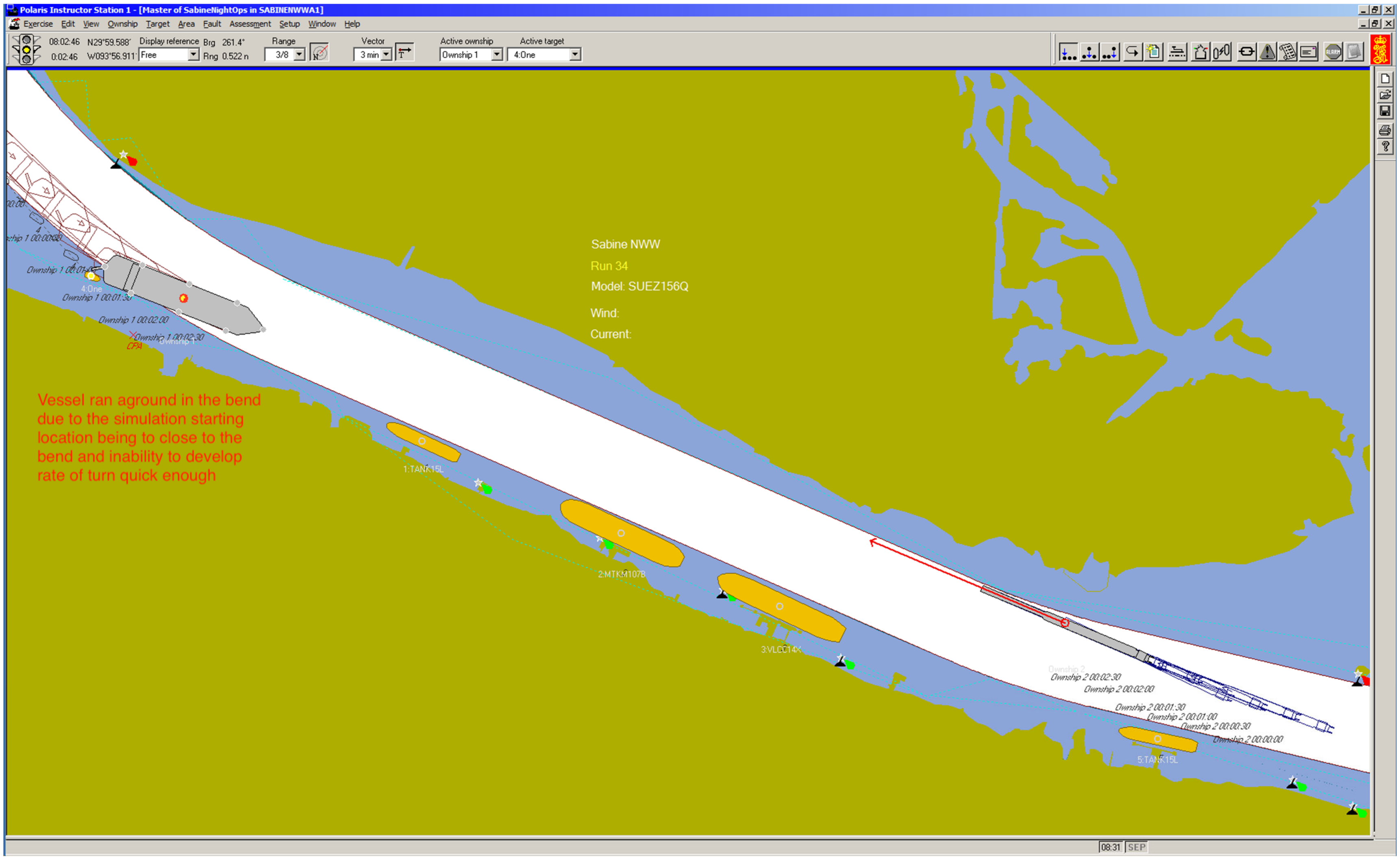
Run 32: Meeting at Fina Highline, Day Time, No Wind, No Current



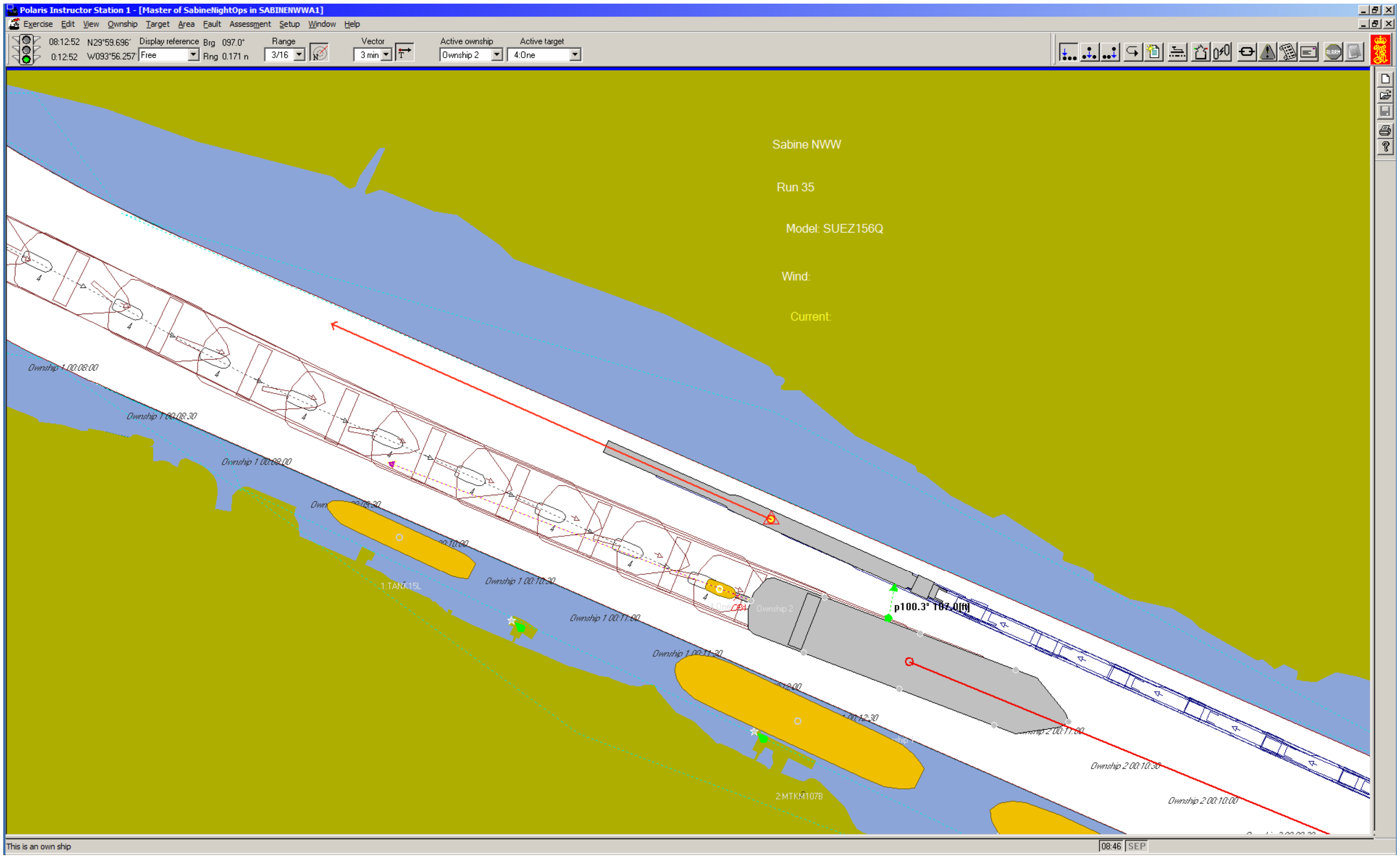
Run 33: Meeting at Port Neches, Night Time, No Wind, No Current



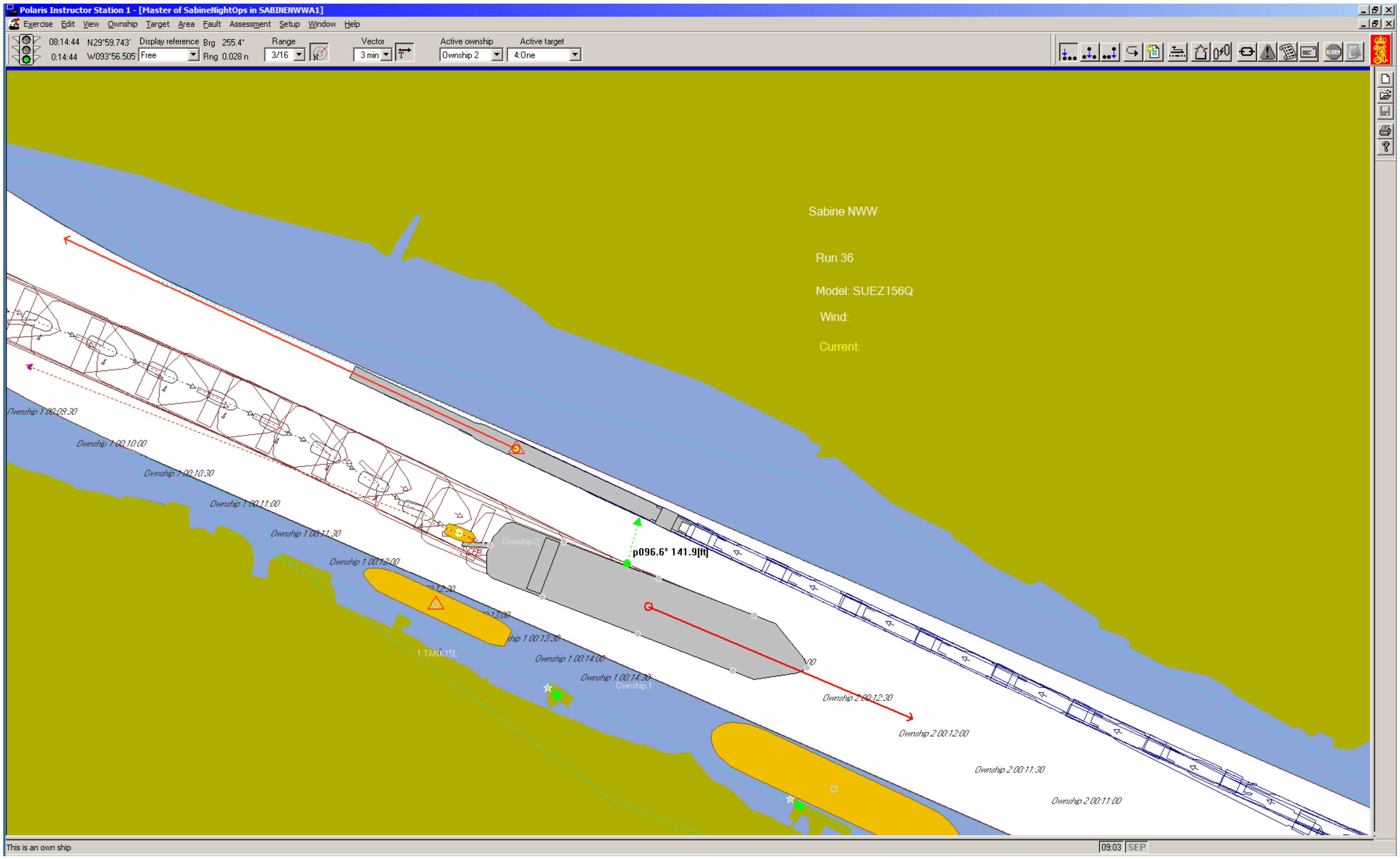
Run 34: Meeting at Port Neches, Night Time, No Wind, No Current



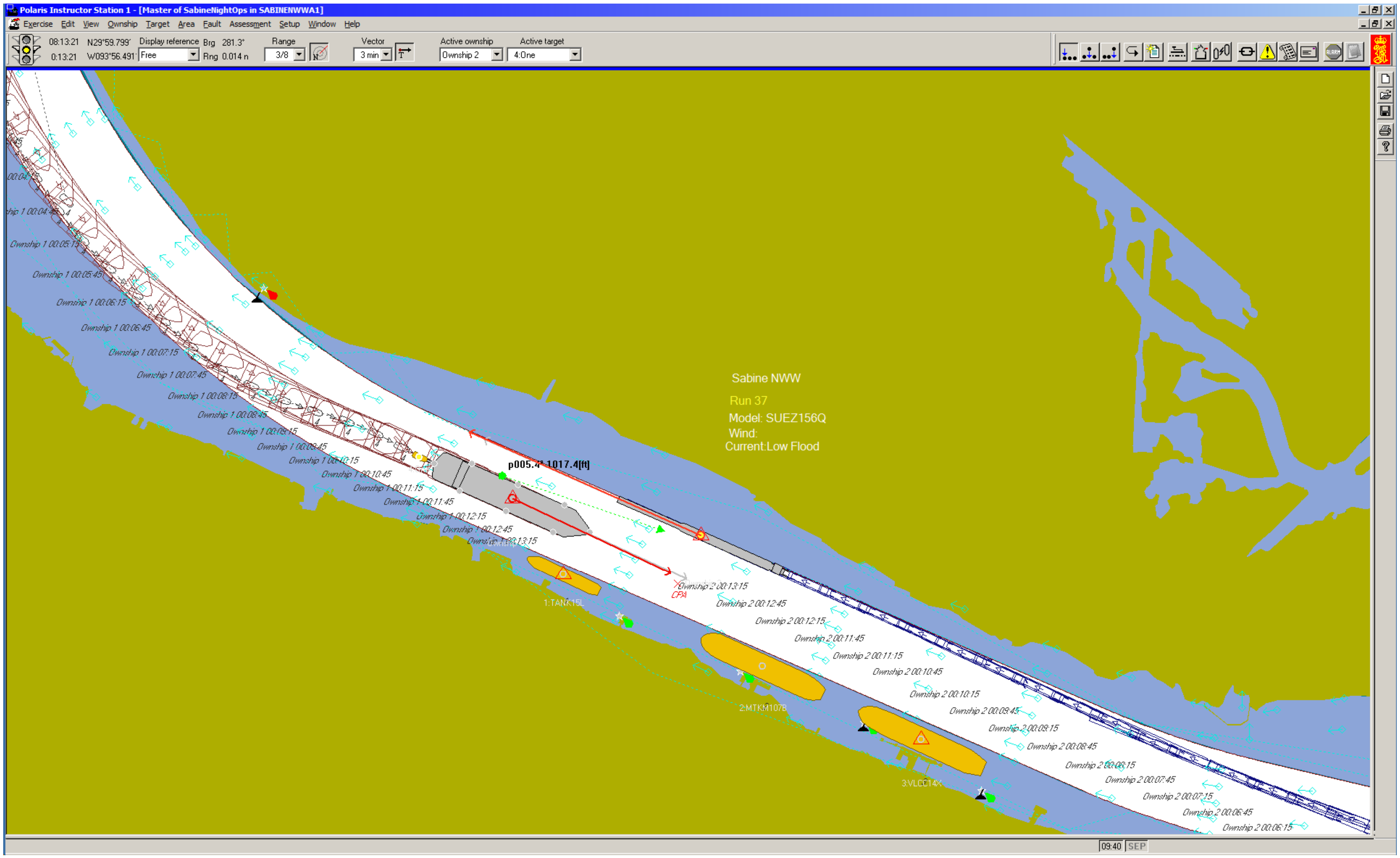
Run 35: Meeting at Port Neches, Night Time, No Wind, No Current



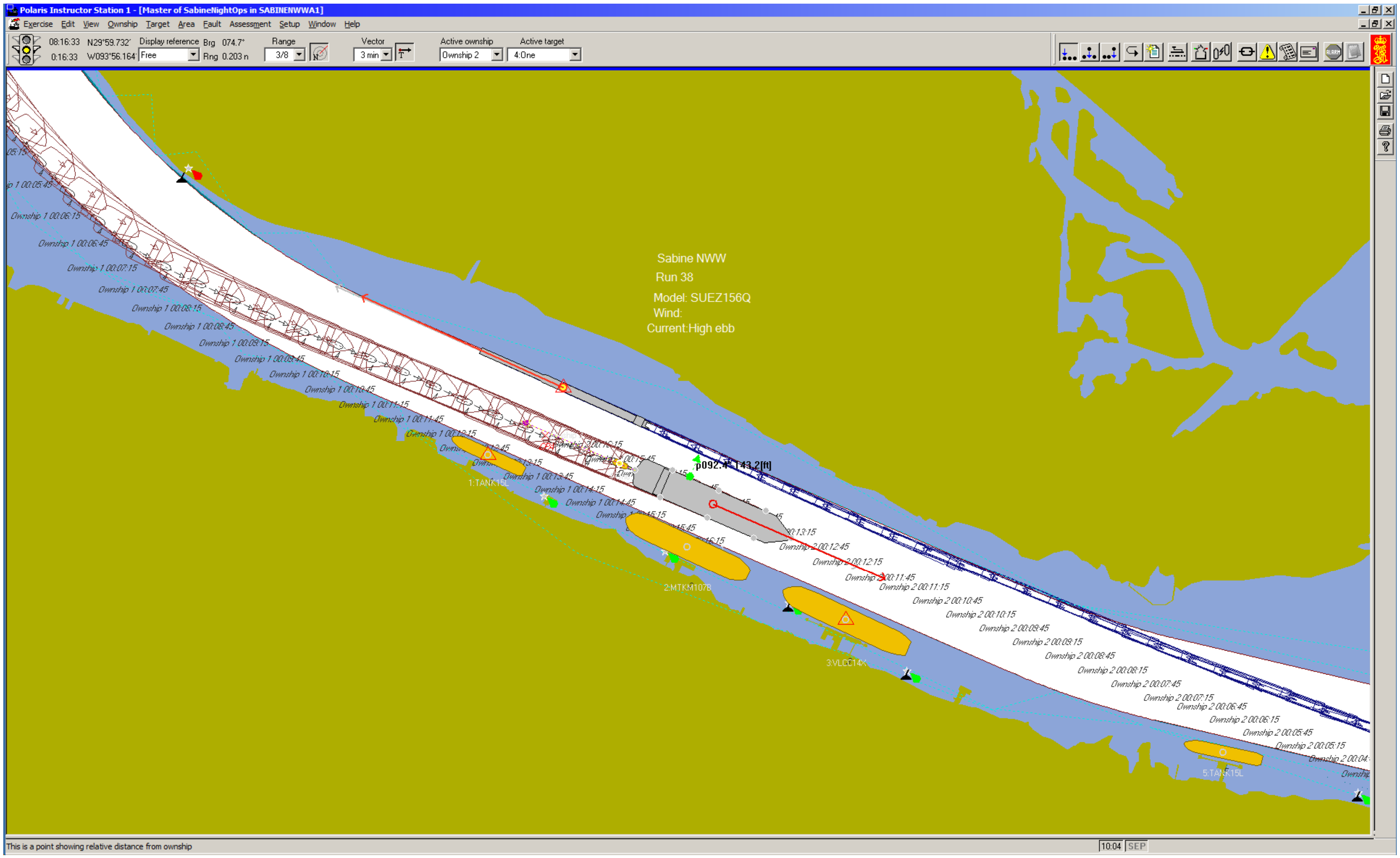
Run 36: Meeting at Port Neches, Night Time, No Wind, No Current



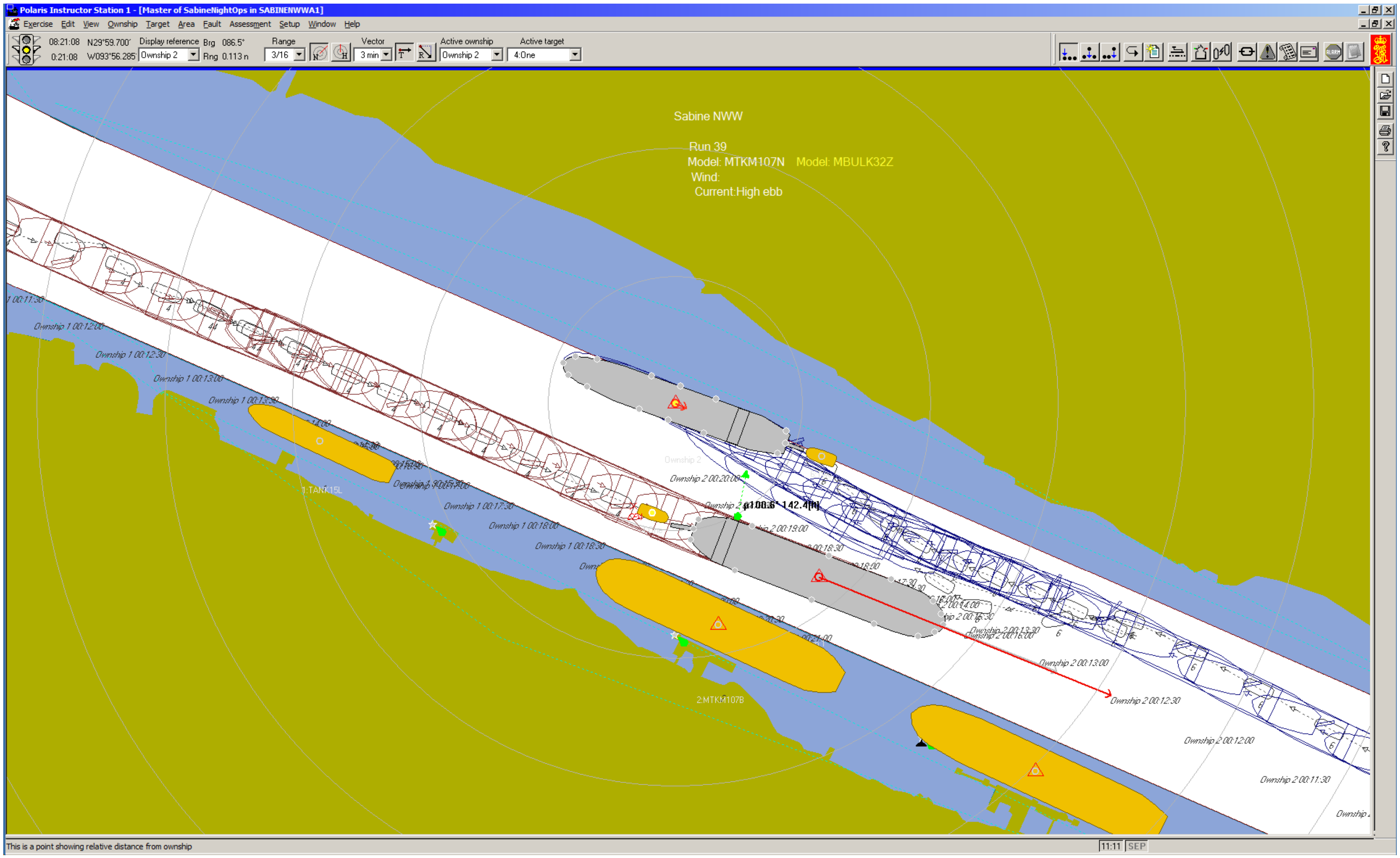
Run 37: Meeting at Port Neches, Night Time, No Wind, Low Flood



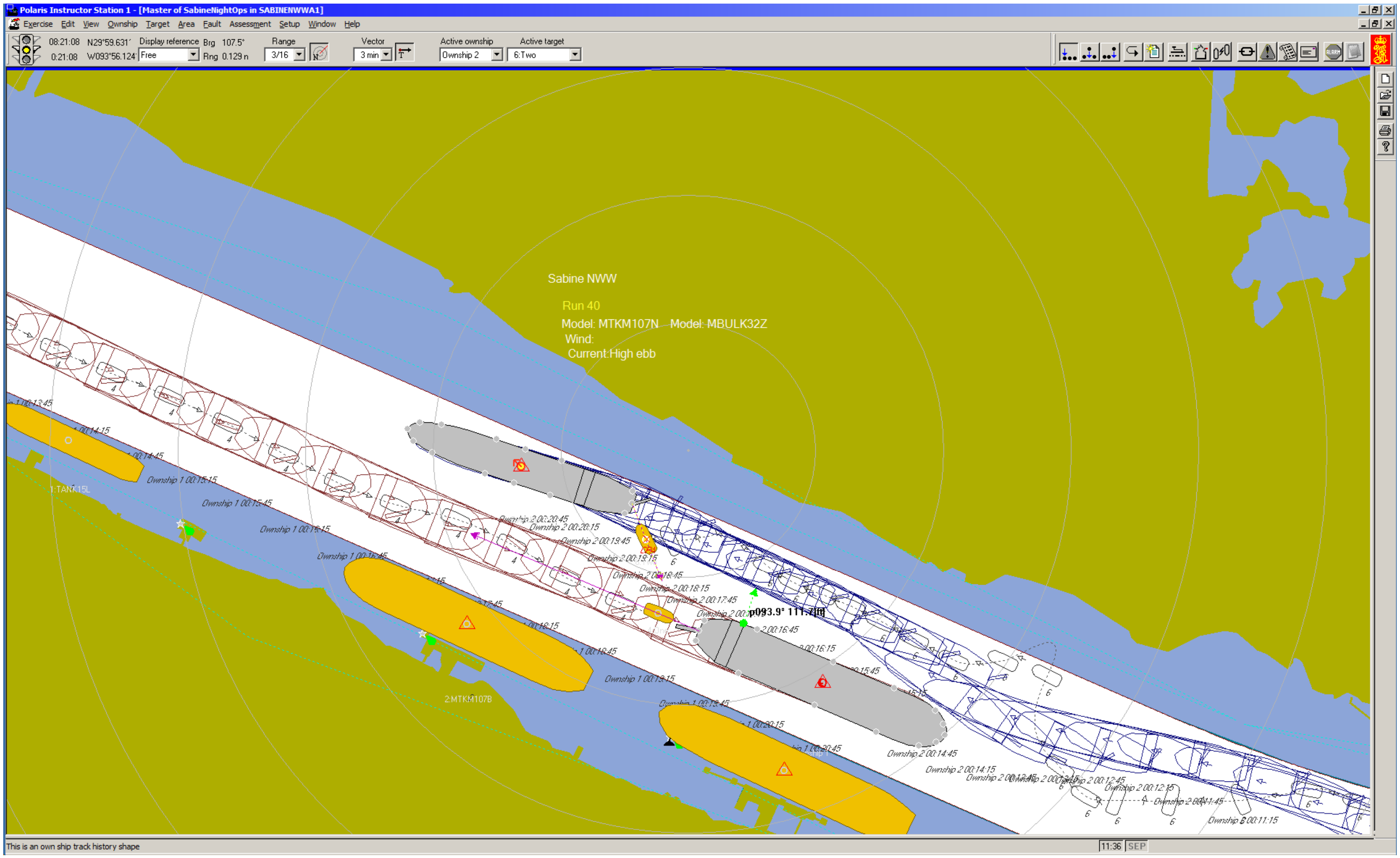
Run 38: Meeting at Port Neches, Night Time, No Wind, High Ebb



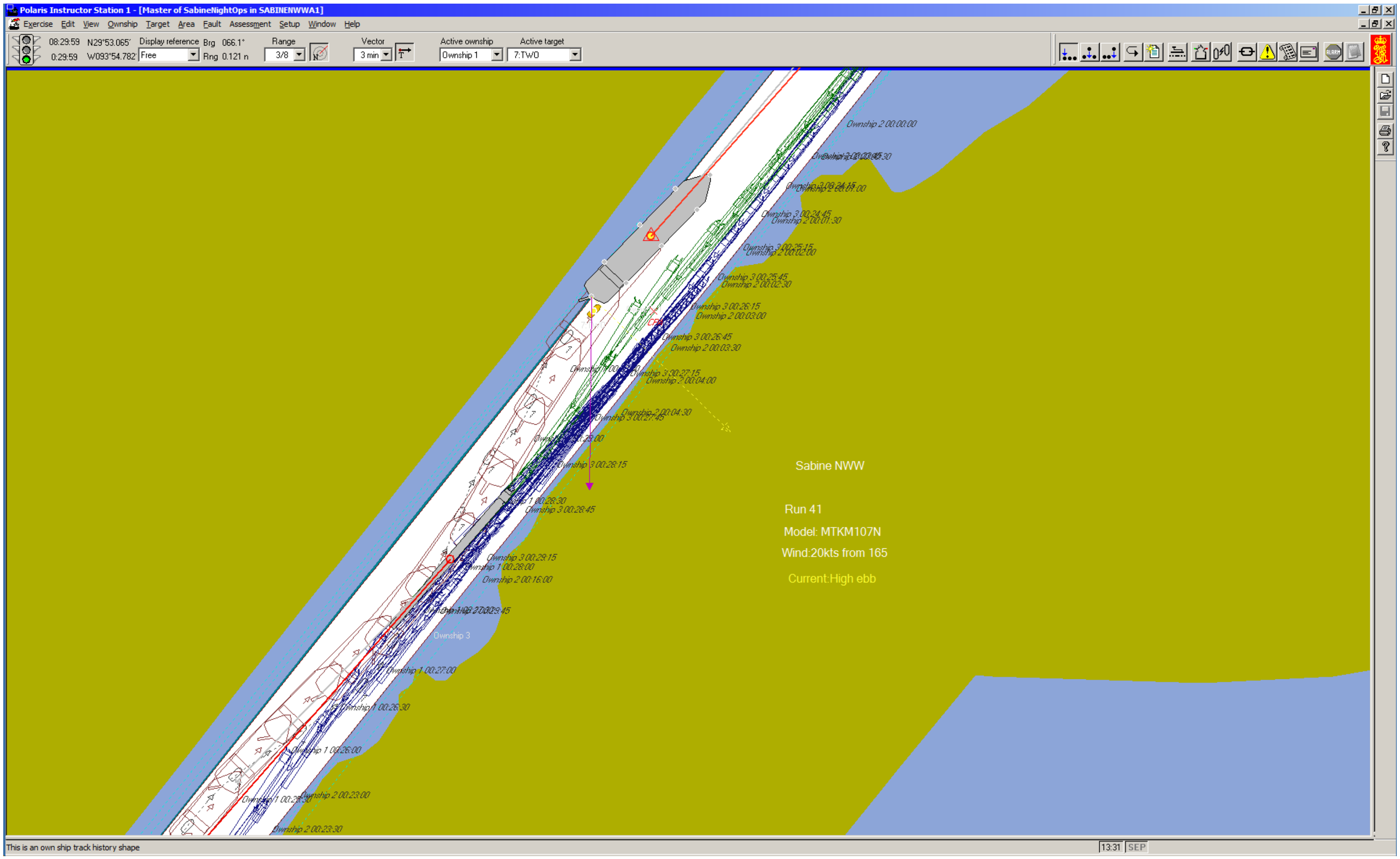
Run 39: Meeting at Port Neches, Day Time, No Wind, High Ebb



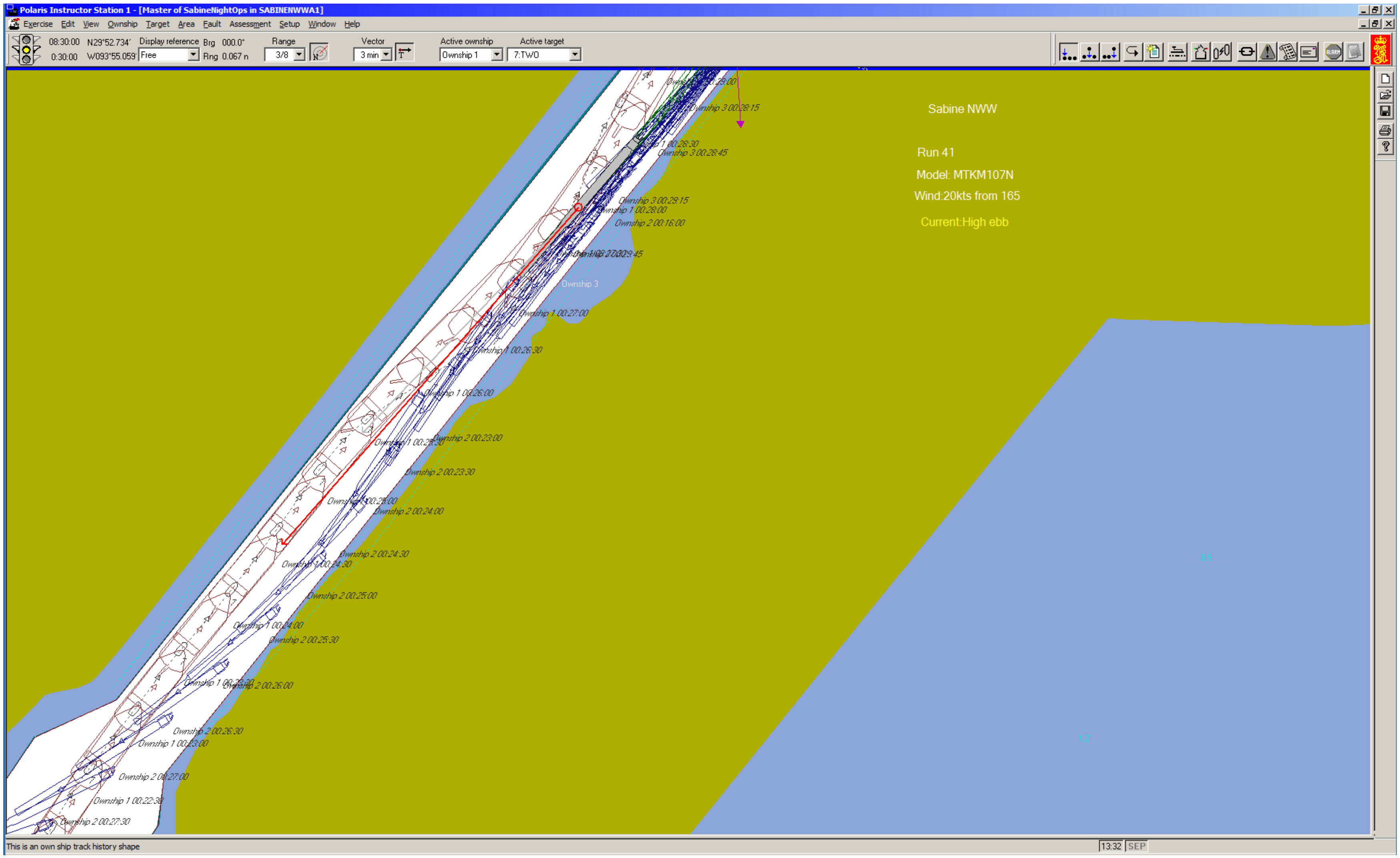
Run 40: Meeting at Port Neches, Night Time, No Wind, High Ebb



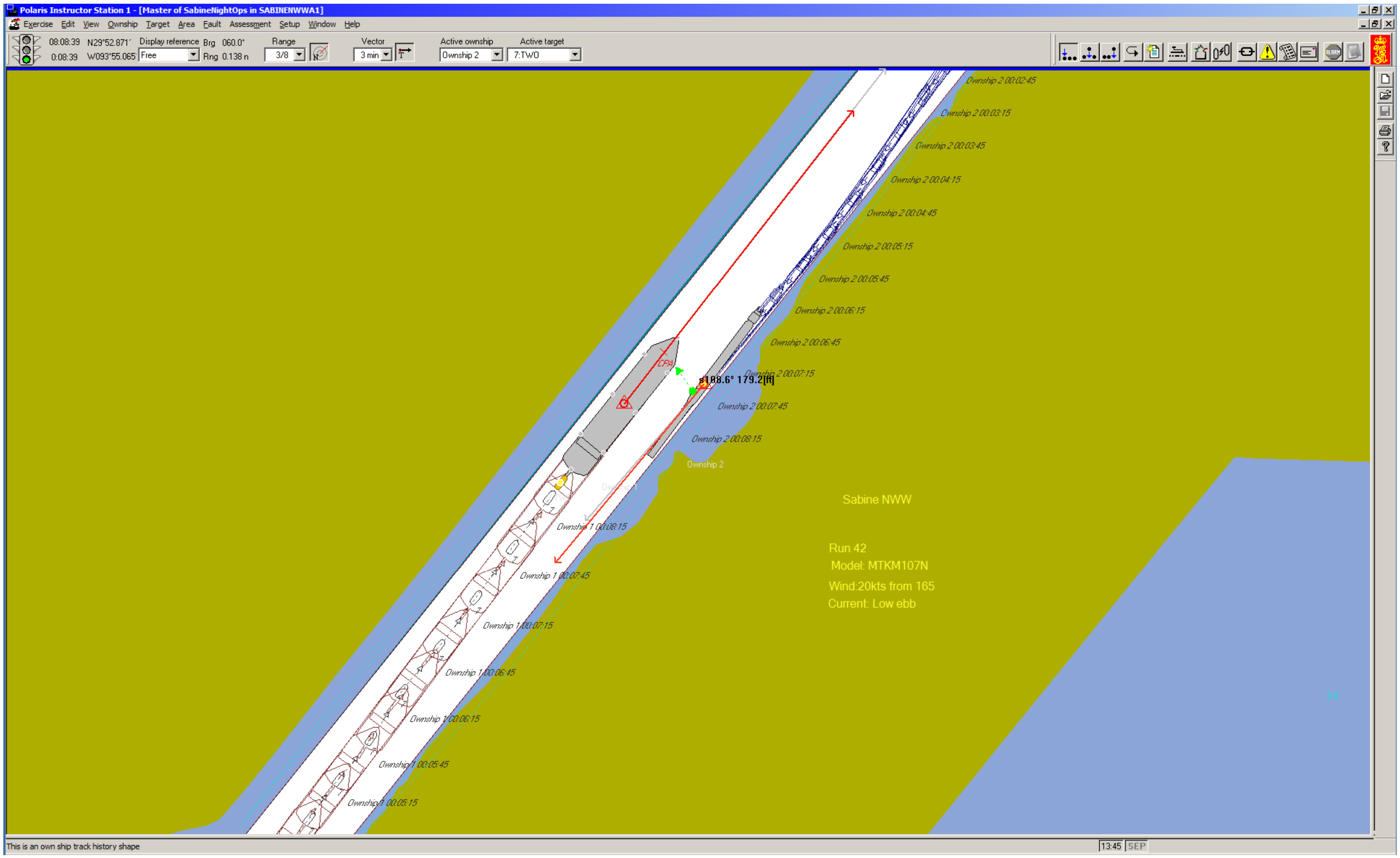
Run 41a: Double Encounter north of the “eyeball”, Night Time, 165/20 Knots, High Ebb



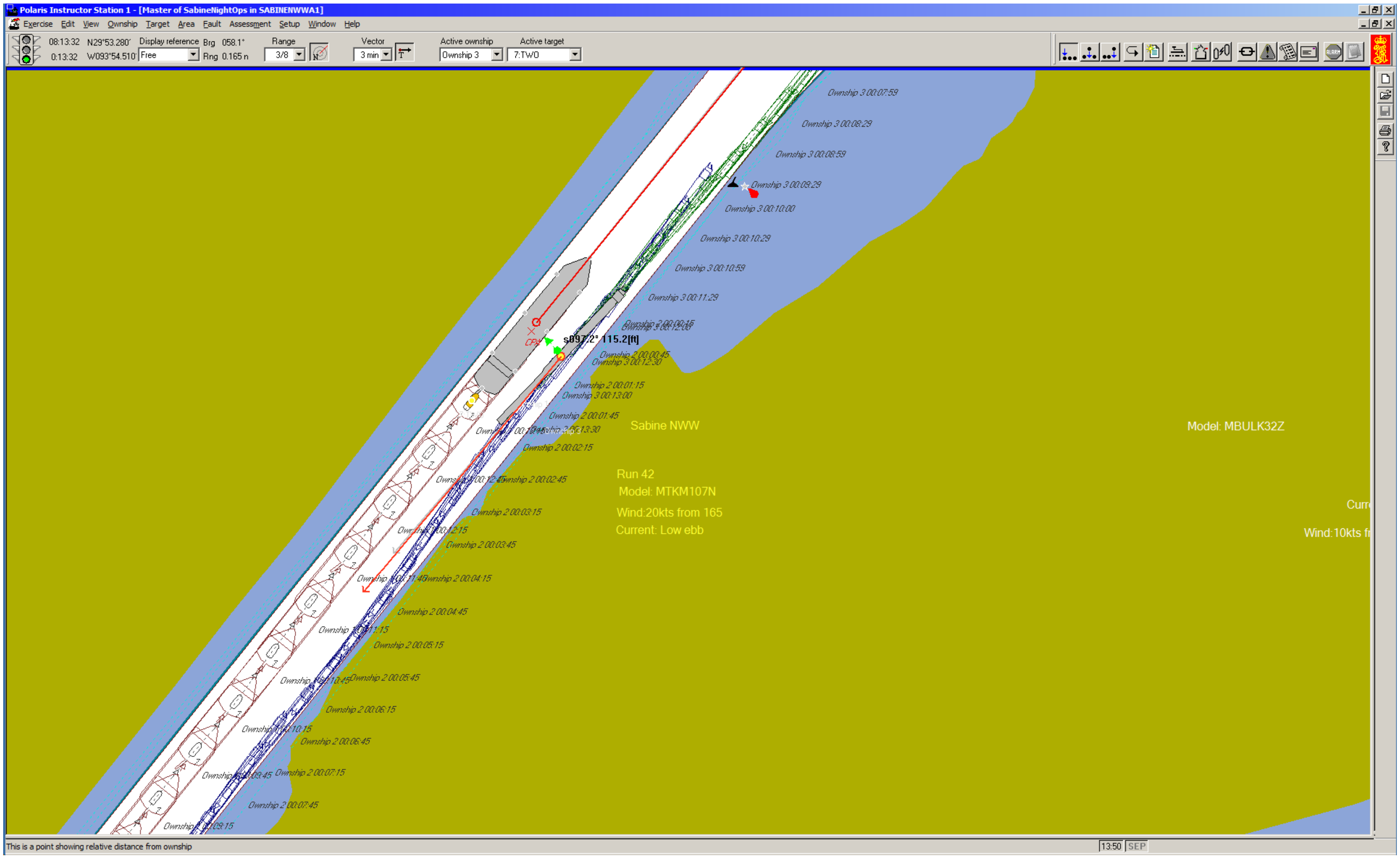
Run 41b: Double Encounter north of the “eyeball”, Night Time, 165/20 Knots, High Ebb



Run 42a: Double Encounter north of the “eyeball”, Night Time, 165/20 Knots, Low Ebb



Run 42b: Double Encounter north of the “eyeball”, Night Time, 165/20 Knots, Low Ebb



Appendix D

Sign in sheet for Towing Industry Demonstration

MPI

Project:	Sabine Waterway Widening	**Meeting Date:**	6/9/2021
Facilitator:	George Burkely	**Place/Room:**	SJC Maritime Simulator

Name	Company	Phone	E-Mail
Roy Peña	Genesis	281-389-5891	roy.pena@genlp.com
James Leonard	Enterprise	985-791-1206	Jeleonard@eprod.com
Dennis Webb	Webb Sim	601-415-8080	Denniswebb1984@gmail.com
Brent Goodridge	Sabine Pilots	409-960-1066	b.goodridge@hotmail.com
Stephen Kucharski	Sabine Pilots		
Wesley Moore	Sabine Pilots	4099639873	wmoore@sabinepilots.com
Jerry Diamantides	DMA/SNND	703 314 1643	jerry@dma-us.com
Matthew Kaufman	SNND	409 729 4588	MKAUFMAN@NAVIGATI--
Kyle Reed	SNND	409-550-2763	Kreed@navigationdistrict.org
Rob Clarkson	Kirby	346-321-6412	[illegible]
Eric Shankle	Kirby	9366358452	EricShankle@Rocketmail.com
Dane Morgan	Blessey	504-810-9352	dMorgan@Blessey.com
Michael Berry	Blessey	504-738-8522	mBerry@blessey.com
George Jernigan	Blessey	504-920-4089	gjernigan@blessey.com
Randy Moore	Golding Barge	601-630-7369	RandyMoore@goldingBarge.com
Joe Graham	Campbell Trans	724-825-8410	Graham.j@barges.us
Neil McLellan	HDR	7132566362	neil.mclellan@HDRINC.com
Nate Hough	Campbell Trans.	412-995-0773	Hough.n@barges.us