MITAGS-PMI
MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES
PACIFIC MARITIME INSTITUTE

THE LEADER IN MARITIME TRAINING

Full Mission Ship Simulation Study Report
Part A (Phase I)
14,000 TEU (Kalina Class)
For The
Port of New York / New Jersey Shipping Association

By The Maritime Institute of Technology and Graduate Studies (MITAGS)

And

Towing Solutions, Inc. (TSI)

MITAGS 692 MARITIME BOULEVARD
LINTHICUM HEIGHTS, MARYLAND 21090
TOLL-FREE: 866-656-5569
WEBSITE: WWW.MITAGS.ORG

PMI 1729 ALASKAN WAY SOUTH
SEATTLE, WASHINGTON 98134
TOLL-FREE: 888-893-7829
WEBSITE: WWW.MATES.ORG

MITAGS is internationally certified as a Maritime Simulation & Training Center by Det Norske Veritas

MITAGS-PMI
MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES
PACIFIC MARITIME INSTITUTE

Study Name	Full-Mission Ship Simulation Study Part A (Phase I)
Project Location	Port of New York and New Jersey
Purpose	Development of best practices for the navigational transits of Ultra Large Containerships (ULCV) in the Port of NY/NJ
Customer	Port of New York / New Jersey Shipping Association
Bidder Legal Name and Location	The MMP MATES Program, DBA the Maritime Institute of Technology & Graduate Studies, and the Pacific Maritime Institute (MITAGS-PMI). 692 Maritime Boulevard Linthicum Heights, MD 21090-1952 Tel: 410-859-5700 Fax: 410-859-8416 Email: exdir@mitags.org Web: http://www.mitags-pmi.org
Bidder Description	The MM&P Mates Program is a 501(c)9 VEBA Non-profit Trusteeship. The "MATES Program" was founded by the International Organizations of Masters, Mates and Pilots and the leading U.S. Flag ship operators in 1968. Its mission is to enhance professionalism through the development and presentation of internationally recognized programs in leadership, education, training and safety for the maritime industry. MITAGS and PMI are the primary training and simulation centers for the MMP professional deck officers and pilots. Tax ID Number: 13-2577386. MD Tax Exemption Number: 31000665 Dun and Bradstreet Number: 010094977
Draft Release Date	September 16, 2016
Project Leader	Mr. Glen Paine, Executive Director, MMP MATES Program
Authorized Signature	

MITAGS-PMI accepts no liability for the use of the findings, conclusions and recommendations provided by the conning pilots in this simulation study. Additionally, MITAGS-PMI cannot be held responsible for errors in the data provided by the client and other third parties used for the programming of the simulator hydrodynamic ship / tug models, and databases.

TABLE OF CONTENTS

Table of Figures

Table of Tables

1. BACKGROUND AND PURPOSE

The Port of New York and New Jersey has completed a major navigational channel deepening and improvement project. The controlling depths of the channels have been increased to 50 feet at mean low, lower, water. Additionally, the project includes raising the Bayonne Bridge to allow passage of higher ultra large container vessel (ULCV) air drafts. The bridge project is expected to be completed in 2017.

The Port of NY/NJ, through the Deep Draft Working Group of the Harbor Operations Committee, desired to conduct a full-mission ship simulation study to develop the "best practices" for ULCV transits to the major container terminals within the area. This includes APM / Maher Terminals in Port Elizabeth, Port Newark Container Terminal, GCT New York LP Terminal (Howland Hook), and GCT Bayonne LP Terminal (Global Marine).

The Maritime Institute of Technology and Graduate Studies (MITAGS) provided this service in two Parts.

Part A, Phase I evaluated 14,000 TEU ULCV MSC Kalina Class (max LOA 366 x beam 51 meters). Phase I used full-mission ship simulation (FMSS) to assist in the development of "best practices" for handling ULCV. (Phase II sessions will occur at later dates to familiarize the other pilots and tug masters on the what was learned in Part A, Phase I.)

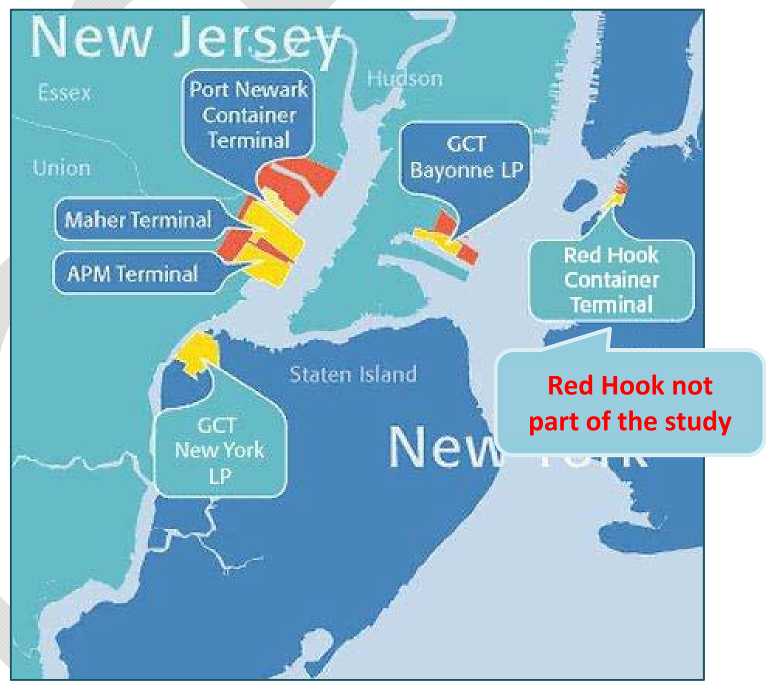


Figure 1: Layout of NJ/NY Terminal Area

Part B, Phase I evaluation was similar, but used the 18,000 TEU Maersk Triple E ULCV Class (max LOA 399 x beam 59 meters) instead of the Kalina Class. The goal was to determine the feasibility and challenges to address for this vessel class. *(The results of this Study is in a separate report.)*

The MITAGS simulators are capable of providing the most realistic presentation in the world. The theater projection area is over twenty-four meters wide and twelve meters in height. This provides unsurpassed depth perception and visual accuracy. The FMSS simulator, operated by the Sandy Hook and docking pilot(s), were integrated with two assist-tug simulators operated by experienced tug masters. The simulator's "auto-tug feature was used as well.

Figure 2: Port Elizabeth / Newark, NJ

For more information on MITAGS, please visit www.mitags-pmi.org, and YouTube® for video excerpts of previous simulation projects: http://www.youtube.com/user/MaritimeInstitute.

1.1 SIMULATION STUDY OBJECTIVES

The 14,000 TEU ULCV Simulation Study provides findings, conclusions, recommendations and supporting data for the following objectives:

1. Recommendations on "best practices" for ULCV inbound / outbound transits and berthing evolutions to / from APM/Maher/PNCT (Port Elizabeth/Port Newark) with similar sized ULCVs berthed on both sides of the channel.
2. Recommendations on "best practices" for ULCV inbound / outbound transits and berthing evolutions to / from GCT New York LP (Howland Hook). Note: In the interest of time, the pilots' removed this objective since the Terminal does not have cranes capable of handling the larger ULCVs and no immediate plans for replacements.
3. Recommendations on "best practices" for ULCV inbound / outbound transits and berthing evolutions to GCT Bayonne LP (Bayonne Marine Terminal / Port Jersey).
4. Identified environmental operational limits for wind directions / speed, and water current velocities / directions.
5. Assessed limitations of the existing assist tug capabilities (number, type, and power) needed for safe handling of ULCV Class under various environmental conditions.
6. Feasibility of ULCV meeting Panamax Class size vessels at selected channel reaches in order to expedite traffic flow.
7. Recommendations on "best practices" for responding to propulsion, rudder, and / or tug failures at selected channel reaches.
8. Recommendations for future pilot / tug master familiarization training.

1.2 SCOPE OF WORK

Part A, Phase I modeled the 14,000 TEU ULCV Class entering and departing Port Elizabeth / Port Newark, and Bayonne Terminals to / from the Verrazano Bridge. The environmental conditions to be evaluated started from slack water up to maximum flood / ebb, and wind conditions from calm up to 20 knots.

Deliverables – Parts A & B Phase I Studies

The following services were provided to meet the study's objectives:

- Updated the existing MITAGS visual New York Harbor database to include the heightened Bayonne Bridge and changes to Port Elizabeth, Port Newark, Howland Hook, and Global Marine Container Terminal Berths capable of handling the ULCVs.
- Updated the depth contours based on the ACOE soundings. This enhanced the simulation of the "bank effect" experienced by a deep-draft vessel transiting in a restricted channel.
- Modified USACOE water current data to be uploaded into the simulator for exercises. Waterway Simulation Technology (WST) programmed 48 different water current models that covered two different Hudson River flow conditions, and multiple times. Each model is a single point in time.
- Modified the MITAGS library's hydrodynamic ship model of the *MSC Kalina* Class to drafts of 42'-00" and 49'-00." The models were even keel. The Kalina models represented ULCV with maximum LOA of 1200 x 168' beam.

- Programmed hydrodynamic ship models of the Maersk Triple E Class to drafts of 42'-00" and 49'-00" (Part *B, Phase I).*
- Provided the MITAGS library's ASD "Edward J. Moran" tug model.
- Provided MITAGS library Transas Conventional #4 tug model to represent the class of conventional tugs that are currently used for post panamax vessels.
- Programmed the "Brian McAllister" ASD model.
- Assisted in the development of the test matrix with client.
- Pre-validated database and models with Sandy Hook Pilots and Docking Masters on May 3 – 6, 2016. Also contracted with a United Kingdom pilot to assist in the model validation process.
- Provided pilot plug interface for the pilots' portable navigation system.
- Provided one FMSS and two tug bridges for one-way traffic simulation tests, and two, FMSS and two tug bridges for two-way traffic tests.
- Conducted simulation tests with appropriate support staff of shiphanding expert, simulator operator, and engineering support.
- Contracted with Towing Solutions, Inc. to observe tests and make recommendations related to the use of assist tugs.
- Provided report of simulation tests with findings, conclusions, recommendations, and supporting data.
- Contracted with Waterway Simulation Technology (WST) to complete a surge study to calculate the approximate forces and moments a 9,000 TEU Containership, and Aframax tanker, moving at speeds from 4 to 8 knots, would exert on a tanker moored parallel to the ship channel in still water at select distances off the moored vessel. This was compared against the forces and moments generated by models of the *MSC Kalina Class* and *Maersk Triple E* transiting at the same speeds and distances. (*A separate report.)*

1.3 ASSUMPTIONS

MITAGS used the following assumptions to develop this RFQ.

1. The Port Authority provided the necessary data in the appropriate format (AutoCAD®) for programming any updates to the terminal's areas not depicted on the existing NOAA Charts into the database. This included location of berths, bulkheads, dimensions of container cranes, and depth soundings alongside.
2. The Port Authority provided accurate electronic pictures of the facilities to assist in creating a realistic image of the terminals.
3. The Pilots provided the climatological data on the environmental conditions simulated and included in the test matrix. This included prevailing wind directions / strengths.
4. The Pilots assisted in securing the ACOE water current data.
5. The Pilots assisted in securing ACOE final channel surveys with depths soundings, contours, and bank slopes.
6. The Port Authority provided accurate illumination guides for terminal lights for night visuals.

7. MITAGS test matrix assumed one-way traffic for most exercises. Select meeting situations in the Kill Van Kull were conducted using two bridges integrated together. This allowed pilots to conn both bridges.

8. Made four tugs available for each exercise. The assist tugs included two, 46-ton BP conventional, and two, ASDs with bollard pull between 80 to 85 tons.

9. The Pilots provided information on the placement size of target vessels placed alongside the berths at 5c-IMTT, Buckeye Bayonne, Gordon's Terminal, Pier A-IMTT.

1.4 ASSUMPTIONS AND LIMITATIONS

Inherent in any simulation is the accuracy of the data programmed into the simulator. MITAGS simulation exercises are based on the information provided by the client. The accuracy of this data will have a major impact on the validity of the test results.

The hydrodynamic models used in the simulation were vetted by experienced pilots, MITAGS staff, and company representatives. The model behaviors are based on the pilot card, windage, general arrangement plans, squat table, and other data provided by client or other sources. The model behaviors, as calculated by the simulator, are adjusted based on the consensus opinion of the MITAGS staff and the pilots. Since the adjustments are "subjective," the recommended model adjustments may vary depending on the collective experience of the testing captains and pilots at each session. The models were a good approximation of the particular classes of vessels. Specific vessels in "real-world" situations may handle significantly different from those programmed into the simulator.

The MITAGS simulator provides a close approximation of vessel squat in shallow water. However, an adequate safety margin needs to be used in order to account for changes in squat due to vessel speeds, displacements, channel shoaling, and tidal actions. In this study, squat was generally not a significant factor due to the water depths and slow speeds.

Due to the underwater volume of these vessels, substantial surge forces may occur in confined waters even at low speeds. *Port Elizabeth Reach* and *Port Jersey* warrant special attention due to restricted configurations. This analysis is beyond the capabilities of full-mission ship simulation.

Model behavior is highly dependent on the accuracy of depth contours (shape), the current and wind flows. In "real world" situations, such forces could vary significantly over the operating area. In addition, the models used in these tests were representative of "vessel classes" similar in size and displacement. Vessels of the same class may have significant differences in handling characteristics in real-word conditions.

Water currents were based on U.S. Army Corps. Engineers models. However, at the time of simulation, there was no field measure data available at Bergen Point for validation purposes. Additional current meters are being installed at Bergen Point and other areas. Once installed the simulated current models should be compared.

The "auto-tug" feature of the simulator provides a more realistic simulation of the assist tug than vector forces, but is not as accurate as having a tug bridge integrated with the full-mission simulator. Auto-tugs and up to two integrated tug bridges were used in these tests.

The test results assumed experienced pilots and tug masters operating vessels with the current technology. Operational limits should take into account the actual tug capabilities, and the need for all local pilots and tug masters to gain experience. Limitations can be gradually reduced as the pilots and tug masters gain experience.

1.5 PROJECT TEAM AND SIMULATION FACILITIES

Project team members are listed below. The team members are highly experienced in channel design / modeling, simulation and shiphandling. The full-mission shiphandling simulator meets or exceeds the Det Norske Veritas (DNV) standards. MITAGS-PMI is DNV certified as a "Maritime Training and Simulation Center." *Please refer to the MITAGS-PMI Simulation Capability & Facilities Guide for further details on team member qualifications and simulation capabilities.*

Table 1: Part A, Phase I Support Team

MITAGS Team Member	**Position and Duties**
Mr. Glen Paine Executive Director	Responsible for overall coordination with client representatives and ensured the necessary resources were allocated to the project.
Mr. Hao Cheong Ship Modeler	Responsible for the overall simulation technical support of project. Assisted in collecting the data for modeling the terminals and vessels. Served as liaison with MITAGS Simulation Engineering Staff.
Mr. Richard Jewart Visual Database Modeler	Head Programmer for Visual Databases at MITAGS-PMI.
Ms. Carolina Madrid Ship Modeler	Responsible for the programming of the ship models, databases, and underwater depth contours. Also provides support for simulator projection system and maintenance during tests.
Captain Curtis Fitzgerald SHS Consultant	Responsible for pre-validating the ship model with Capt. Michael.
Captain Larry Bergin Shiphandling Consultant Project Leader	Responsible for providing conning the simulated vessels and expertise in the handling of large deep-draft vessels in pilotage waters.
Captain Greg Brooks, TSI Assist Tug Consultant	Provided comments and suggestions on the use of assist tugs during transits and berthing evolutions. Co-author of Final Report.
Mr. Mark Hokenson, Simulator Operator	Responsible for the overall operation of the simulator during the tests. Reports to MITAGS SHS Project Leader.
Tug Simulator Operator	Responsible for assisting tug masters in the proper use of tug bridges.
Sandy Hook, Docking Masters, and Tug Captains	
Captain R. J. Schoenlank	Senior Pilot and President, Sandy Hook Pilots
Captain J. C. Oldmixon	Sandy Hook, Conning Pilot
Captain Robert J. Blake	Sandy Hook Conning Pilot
Captain Stephen E. Naples	Sandy Hook Conning Pilot
Captain John J. DeCruz	Sandy Hook Conning Pilot
Capt. Jack Olthuis	Executive Director, Sandy Hook Pilots
Capt. Bobby Flannery	Moran Docking Master and Conning Pilot
Capt. Robert Ellis	McAllister Docking Master and Conning Pilot

Table 1: Part A, Phase I Support Team	
Capt. Nathan Oliveira (6/29 to 7/1)	Moran Tug Master and operator of tug bridge
Capt. Matt Kicklighter	McAllister Tug Master and operator of tug bridge
Observers	
Capt. Fabrizio Vaccaro (6/29 to 7/1)	Assistant Vice President of Marine Operations, Mediterranean Shipping Company (MSC)
ADM. Samuel DeBow	National Ocean Service (NOAA) to determine real-time products and services that may assist in the transit of these vessels.

1.6 TIME LINES AND TEST LOCATION

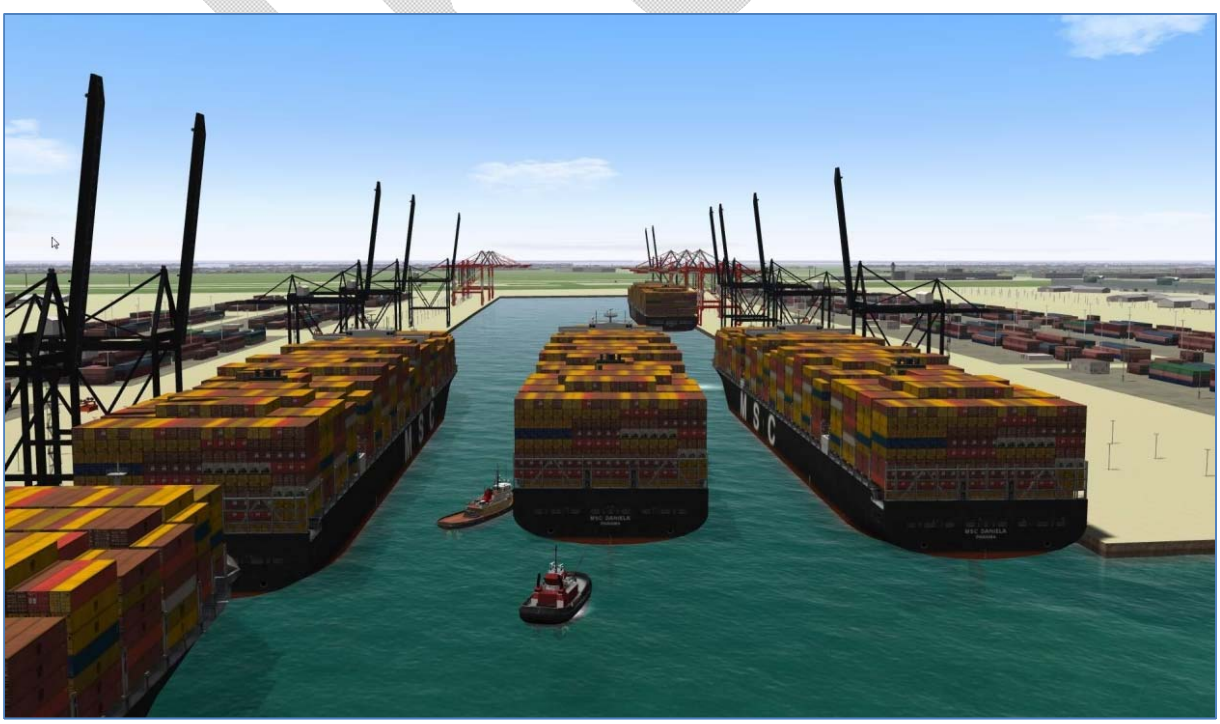
The Study took place at the Linthicum Heights, Maryland Campus of the Maritime Institute of Technology and Graduate Studies. This campus is located near the Baltimore / Washington International Airport (BWI) and has easy access to the AMTRAK® BWI Baltimore Station as well as Interstate I-95. Hotel accommodations were made available on the 40-acre campus.

Part A, Phase I (14,000 TEU ULCV) took five business days to complete (Monday, June 27, 2016, to Friday, July 1, 2016).

Part B, Phase I (18,000 TEU ULCV) took four days to complete (Tuesday, August 23, 2016 to Friday, August 26, 2016). The results are contained in a separate report.

Familiarization training for the other pilots and tug masters not participating in the test will occur at later dates. Parts A & B Phase II training is estimated to take 2 days per session.

Figure 3: *Kalina* Entering Port Elizabeth Branch Reach with same ship class (14,000 TEU) at berths



2. HYDRODYNAMIC SHIP MODELING

The ship models, used in the study included two load conditions. Each hydrodynamic model was pre-validated by the MITAGS-PMI shiphandling experts comparing the model to sea trial data, tank tests (if available), pilot / captain reports, and vessels of similar class and size. The models were also validated by pilots that had experience handling these vessel classes. The models used data provided by MSC and Maersk Lines. Please refer to Appendices for more detailed information on the handling characteristics of each model.

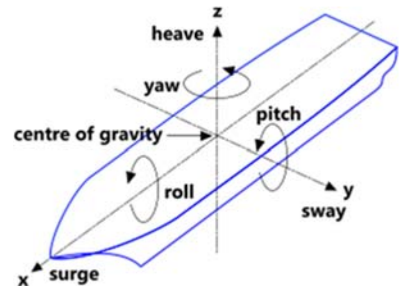


Figure 4: Model Motion

Table 2: Ship Models Used in the Study

Ship Models	Part A 14,000 TEU ULCV MSC Kalina Class	Part B 18,000 TEU Maersk Triple E	Assist Tug Transas Conventional #4	Assist Tug Brian A. McAllister	Assist Tug* Edward J. Moran
Bridge Location	Forward	Forward	n/a	n/a	n/a
Maximum Container Load	14,000 TEU	18,000	n/a	n/a	n/a
Displacement at 42' Draft	172,769	206,397	n/a	n/a	n/a
Displacement at 49' Draft	198,160	240,905	n/a	n/a	n/a
Wind Area with Max Deck Load in Load & Ballasted (sq. meters)	14526m^2 at 42' draft 14,000m^2 at 49'draft	15,633m^2 at 42' draft 16,555M^2 at 49'draft	n/a	n/a	n/a
Length (meters)	366 (1,201')	399 (1,308')	126 feet	99.1 feet	100 feet
Beam	51.2 (168')	59 (193.5')	34 feet	40 feet	37.1'
Trim	even	even	even	even	even
Load Draft	14.9 (49')	14.9 (49')	12'-06"	18.9 feet	16 feet
Mid Load Draft	12.8 (42')	12.8 (42')	n/a	n/a	n/a
Engine kW and Propeller	Low Speed Diesel, Single Screw FPP	Low Speed Diesel, Twin Screw FPP	Conventional twin screw	6,770 BHP	6,000 BHP
Rudder Type	1, Semi suspended	2, Semi suspended		ASD	ASD
Bow Thrusters	2, Bow	2 at 2,500kW each	n/a	n/a	n/a
Stern Thrusters	n/a	n/a	n/a	n/a	n/a
Chock and Bitt SWL/Bollard Pulls	75 metric tons	75/ 150	46 metric tons	85 metric tons +	83 tons
Chock and Bitt Locations	Fwd. / Aft	Fwd. / Aft	n/a	n/a	n/a
Tug Location Restrictions	TBD	TBD	n/a	n/a	n/a

*The model *Edward J. Moran* was programmed for the Savannah River Pilots ULCV Tests. It should have similar horsepower and bollard pull as the new Moran boats being built at Washburn & Doughty.

The test matrix used assessed the impact of the following forces on the handling of these simulated vessels:

- Prevalent local environmental conditions (waves, wind, currents, and tides).
- Forces created by tugs.
- The reduction in under keel clearance due to squat and interaction.
- Bank effects depending on the channel conditions and ship operating speed.
- Drift angles created by wind forces from various directions.
- Acceleration and deceleration of model.
- Rudder / propulsion forces needed to maintain track line.

Figure 5: MSC Kalina Class entering the Kill Van Kull

3. DATABASES' DEVELOPMENT

The MITAGS Simulation Engineering Department used proprietary Transas® database modeling software to import the electronic chart display information system (ECDIS) data. This software automatically transferred the information from ECDIS into simulator database elements, and links the visual and radar databases. The ECDIS data included:

- Hydrographic: depth points, depth lines, depth contours, drying areas, three dimensional (3D) channel bottom.
- Landmass: 3D terrain, DEM data, coastlines, islands, pier structures, etc.
- Navigation Aids: buoys, ranges, and lighthouses.
- Navigation Signals: color, light timing, light sector, etc.

The database was then overlaid with the terminal design(s), approach channels, and any other navigationally significant feature that was available. The database included ECDIS and RADAR displays.

Figure 6: Sample Visual Graphics[1]

[1] The visual depicts the existing Bayonne Bridge raised for the purposes of the simulation study. The pilots did not evaluate placement for maximum air draft for maneuvering at Bergen Point. The bridge visuals can be updated at a later date for future training requirements.

Table 3: Electronic Chart Data Used for Developing Visual Databases

New York_F Database Information			
Database version: 6.40.000.24062.55			
Build data: 7/1/2016			
Exercise area size: 47.9 x 43.0 nautical miles			
Number of lighthouses: 75			
Number of buoys: 384			
Database purposes			
New York_F exercise area is designed for the purposes of navigational training.			
Database bounds			
New York_F exercise area exists within the rectangle with following coordinates:			
SW corner: 40°09.00N 74°13.99W			
NE corner: 40°51.99N 73°11.00W			
List of used electronic nautical charts			
NM	Number	Scale	Date of last correction
1	u12339	10000	08.04.2004
2	u12334	10000	03.03.2004
3	u12335	10000	08.04 2004
4	u12333	15000	08.04.2004
5	u12401	15000	08.04.2004
6	u12402	15000	08.04.2004
7	u12366	20000	08.04.2004
8	u12326	80000	08.04.2004
Created by			
6/29/2016			
The following updates have been added in the database.			
1. Updated all of the navigational aids to NOAA ENC charts dated March 2016 〉 US4NY1AM 〉 US5NJ11M 〉 US5NJ13M 〉 US5NJ14M 〉 US5NY1BM 〉 US5NY1CM 〉 US5NY1DM 〉 US5NY1IM 〉 US5NY12M 〉 US5NY19M			
2. Imported the depth survey of 2015 from the Army Corp			
3. Imported the depth survey of 2014 and 2016 from NOAA			
4. Added more visual details around Port Elizabeth, Global Marine Terminal, Howland Hook Terminal and also along the coastline.			
5. Raised the Bayonne Bridge to meet the specified clearance			

3.1 UNDERWATER CONTOURS

The first stage of the programming used the underwater contours based on the NOAA electronic chart for that area from the Transas® World Library. It was then enhanced with bathymetric data provided by the Army Corps of Engineers for the navigation channel, and NOAA for deep water adjacent to the channels. This created more realistic bank slopes and contours. The bathymetric data coordinates were in latitude and longitude and referenced to WGS-84 datum. Coordinate format was degrees and decimal degrees to six places. Isolated shallow spots were removed from the channels, and alongside the berths at Global Marine Terminal, Port Elizabeth, and Howland Hook.

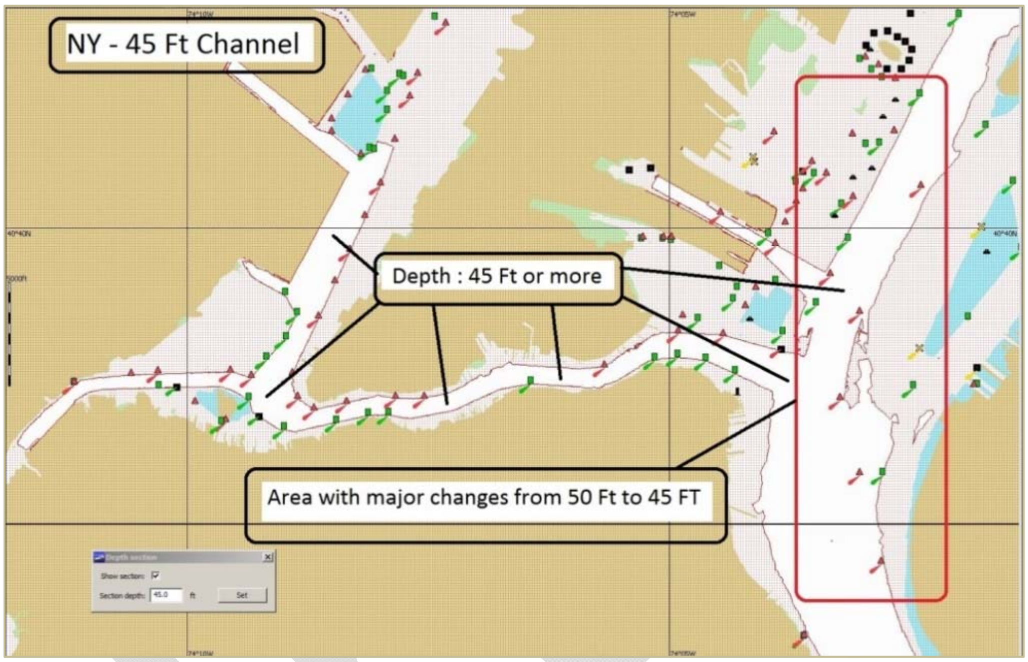


Figure 7: Depth Areas of 45 feet or More at MLLW

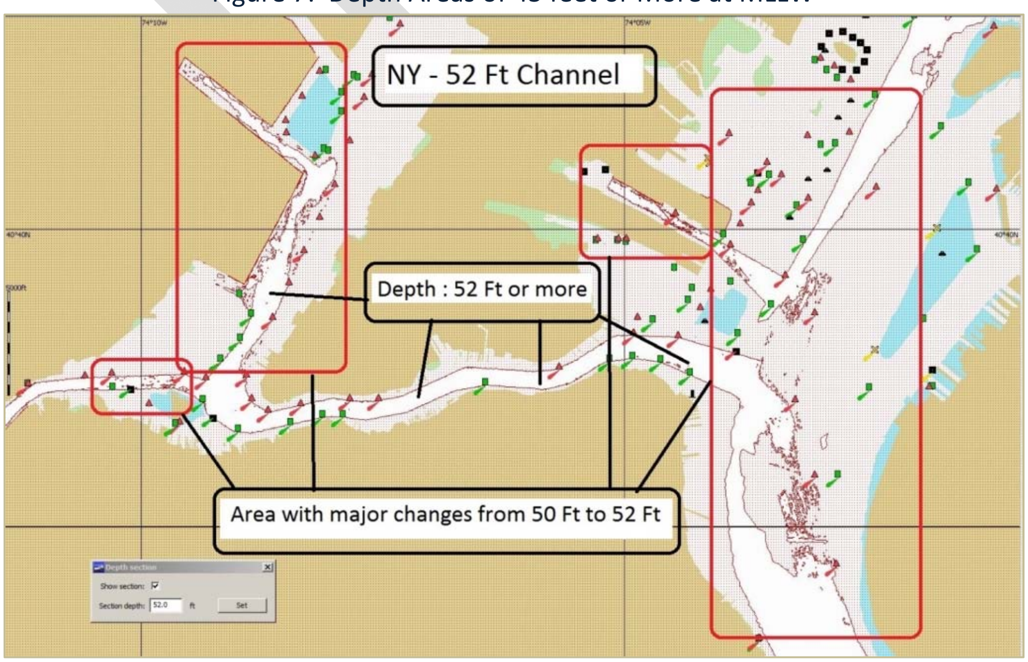


Figure 8: Depth Areas of 52 Feet or More at MLLW

3.2 WATER CURRENTS

The water current models used in the Study, were based on U.S. Army Corps of Engineers (ACOE) data. Waterway Simulation Technology (WST) formatted the data in 48 different files[2] that were capable of being loaded into the Transas Simulator. Each file represented the current flows throughout the testing area at a single point in time.

May 10, 2012 - After Spring Tide - 51,300 cfs on Hudson River (Magnitude in Knots)							
File	Goethals Bridge	Bergen Pt.	Port Elizabeth	Constable Hook Range	Port Jersey	Verrazano Bridge N	Verrazano Bridge S
NY-3120	0.31	1.28	0.29	0.60	0.08	0.50	0.29
NY-3121	0.16	1.44	0.39	0.70	0.39	1.26	0.91
NY-3122	0.54	1.57	0.50	0.85	0.81	1.73	1.40
NY-3123	1.03	1.36	0.49	0.76	1.01	1.98	1.59
NY-3124	1.18	0.60	0.31	0.23	0.97	1.67	1.26
NY-3125	0.78	0.54	0.04	0.43	0.58	0.62	0.60
NY-3126	0.12	1.03	0.58	0.70	0.00	0.70	0.21
NY-3126(1.25)	0.15	1.29	0.73	0.88	0.00	0.88	0.26
NY-3127	0.60	0.76	0.80	0.70	0.64	1.46	0.85
NY-3128	0.87	0.35	0.62	0.52	0.91	1.77	1.14
NY-3129	0.95	0.10	0.47	0.27	0.99	1.78	1.20
NY-3130	0.89	0.04	0.37	0.19	0.93	1.59	1.09
NY-3131	0.85	0.12	0.25	0.06	0.74	1.16	0.83
NY-3132	0.68	0.37	0.08	0.19	0.50	0.64	0.49
NY-3133	0.47	0.76	0.10	0.45	0.14	0.23	0.16
NY-3134	0.12	1.67	0.37	0.85	0.43	1.46	1.09
NY-3135	0.49	2.04	0.62	1.05	0.89	2.00	1.61
NY-3135(1.25)	0.61	2.55	0.78	1.31	1.11	2.50	2.01
NY-3135(1.5)	0.74	3.80	0.93	1.60	1.34	3.00	2.42
NY-3136	1.38	1.32	0.54	0.66	0.97	1.80	1.47
NY-3137	1.13	0.37	0.04	0.45	0.62	0.70	0.76
NY-3138	0.31	1.09	0.70	0.58	0.12	0.35	0.21
NY-3139	0.74	0.50	0.74	0.41	0.29	0.95	0.14
NY-3140	0.72	0.16	0.37	0.21	0.64	1.09	0.66
NY-3141	0.72	0.06	0.31	0.25	0.87	1.63	1.13
NY-3142	0.91	0.16	0.43	0.37	0.95	1.75	1.16
NY-3143	1.01	0.19	0.49	0.25	0.76	1.28	0.89
		Flood Tide					
		Ebb Tide					

April 8, 2012 - Spring Tide - 7,062 cfs on Hudson River (Magnitude in Knots)							
File	Goethals Bridge	Bergen Pt.	Port Elizabeth	Constable Hook Range	Port Jersey	Verrazano Bridge N	Verrazano Bridge S
NY-2352	0.97	1.78	0.62	0.95	1.03	2.19	1.77
NY-2353	1.40	1.18	0.52	0.62	1.14	2.21	1.63
NY-2353(1.5)	2.10	1.77	0.83	0.93	1.71	3.32	2.45
NY-2354	1.24	0.31	0.29	0.10	0.95	1.51	1.16
NY-2355	0.58	0.70	0.14	0.62	0.45	0.27	0.45
NY-2356	0.31	1.05	0.72	0.76	0.19	1.01	0.39
NY-2357	0.68	0.80	0.83	0.78	0.83	1.61	1.01
NY-2357(1.25)	0.85	1.00	1.04	0.98	1.04	2.01	1.26
NY-2357(1.8)	1.22	1.44	1.49	1.75	1.50	2.90	1.82
NY-2358	0.93	0.43	0.66	0.52	1.01	2.00	1.34
NY-2359	0.95	0.31	0.54	0.33	1.09	1.98	1.36
NY-2359(1.5)	1.43	0.47	0.81	0.50	1.64	2.97	2.04
NY-2359(2.3)	2.19	0.71	1.25	0.76	2.50	4.55	3.12
NY-2360	0.91	0.23	0.50	0.31	0.97	1.69	1.16
NY-2361	0.87	0.10	0.35	0.12	0.74	1.09	0.78
NY-2362	0.74	0.78	0.04	0.49	0.37	0.12	0.14
NY-2363	0.31	1.86	0.33	0.91	0.23	1.34	0.99
NY-2364	0.35	2.15	0.60	1.05	0.80	1.94	1.55
NY-2365	1.18	1.73	0.60	0.83	1.01	2.08	1.63
NY-2366	1.26	0.43	0.25	0.08	0.91	1.53	1.28
NY-2367	0.52	0.43	0.17	0.49	0.58	0.70	0.70
NY-2368	0.23	0.80	0.52	0.58	0.17	0.19	0.17
NY-2369	0.43	0.50	0.54	0.47	0.43	1.16	0.47
NY-2370	0.72	0.43	0.50	0.54	0.89	1.73	1.18
NY-2371	0.91	0.45	0.56	0.52	1.03	2.02	1.38
NY-2372	0.99	0.41	0.60	0.41	0.99	1.77	1.24
NY-2373	1.01	0.19	0.37	0.10	0.70	0.91	0.64
NY-2374	0.64	1.28	0.12	0.70	0.33	0.19	0.14
NY-2375	0.04	1.63	0.39	0.74	0.16	1.09	0.81
		Flood Tide					
		Ebb Tide					

Figure 9: WST Water Current File Names

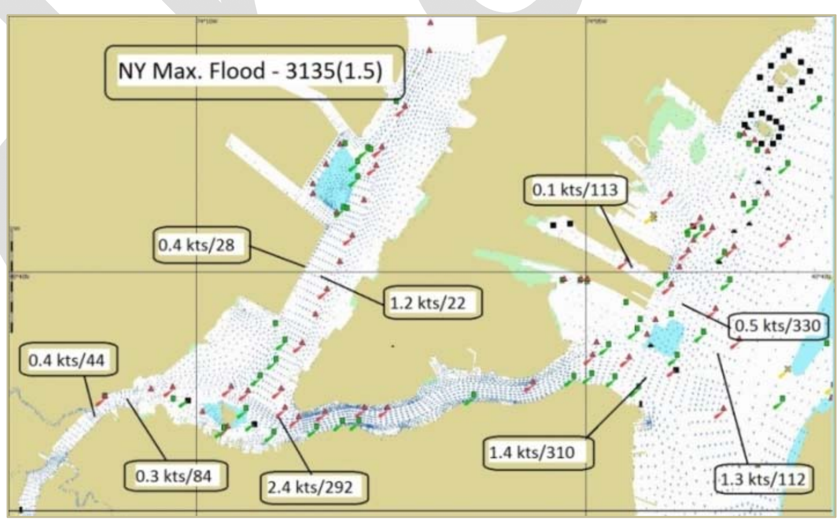


Figure 10: Sample Flood Current Data Points

[2] Please refer to the Appendices for a more detailed explanation of how the water current models were developed and programmed.

During the pre-validation exercises, the pilots noted that the directions of flows were accurate, but the velocities were less than they experience in real-world situations in the Bergen Point area. WST increased the velocities of each data point by a certain percentage (see file names highlighted in yellow in figure 10 above). After the changes, the pilots felt the ship model reaction to the current was more realistic. However, it did raise some concern about the accuracy of the velocities and the magnitude of the model responses to the current forces.

Transiting through Bergen Point (inbound / outbound) was determined to be the controlling factor of the transit. The ULCVs would have to time their transits to make the turn at Bergen Point when the tidal currents velocities were low. This meant determining time "windows" on either side of slack water-high, and slack water-low that the velocities would be low enough for safe transits. Theoretically, there would be four different time windows per twenty-four hour tidal cycles (two highs, two lows). However, the Kalina at 49' draft would be limited to the periods before / after slack water-high in order to have enough under keel clearance.

To determine which current model files to use, the pilots analyzed the NOAA predicted current tables for the Bayonne Bridge KVK location (the closest reference to Bergen Point). They were able to determine that, on average, the change in current velocity on either side of slack waters over time can be roughly calculated as a percentage of the max current velocity during a particular tide cycle. The relationship determined was as follows:

Flood to High Water Slack (High Water)

- 1.5 hours before the end of the flood-high water, the current strength was approximately 60% the of the predicted max flood current.
- 1 hour before the end of flood-high water, the current strength was approximately 43% of the predicted max flood current.

High Water Slack Ebb Begins

- 1 hour into the ebb, the current strength was approximately 40% of the predicted max flood current.
- 1.5 hours into the ebb, the current strength was approximately 54% of the predicted max flood current.

Ebb to Slack Low Water

- 1.5 hours before the end of ebb-low water, the current strength was approximately 60% of the predicted max flood.
- 1 hour before the end of the ebb-low water, the current strength was approximately 40% of the predicted max flood.

Slack Flood Begins (Low Water)

- 0.5 hour (30 minutes) into the flood, the current strength was approximately 30% of the predicted max flood.
- 1 hour into the flood, the current strength was approximately 60% of the predicted max flood.
- 1.5 hours into the flood, the current strength was approximately 85% of the predicted max flood.

Assuming 2.55 knots as the average maximum flood current at Bergen Point, the following current velocities were calculated based on percentages:

Flood to High Water Slack (High Water)

- 1.5 hours before the end of flood-high water, 60% of 2.55 knots: 1.53 knots flood
- 1 hour before the end of flood-high-water, 43% of 2.55 knots: 1.09 knots flood

High Water Slack Ebb Begins

- 1 hour into the ebb, after high water, 40% of 2.55 knots: 1.02 knots ebb
- 1.5 hours into the ebb, after high water, 54% of 2.55 knots: 1.38 knots ebb

Ebb to Slack Low Water

- 1.5 hours before end of ebb-low water, 60% of 2.55 knots: 1.53 knots ebb
- 1 hour before the end of ebb-low water, 40% of 2.55 knots: 1.02 knots ebb

Slack Flood Begins (Low Water)

- 0.5 hour into the flood after low water, 30% of 2.55 knots: 0.77 knots flood
- 1 hour into the flood after low water, 60% of 2.55 knots: 1.53 knots flood
- 1.5 hours into the flood after low water 80% of 2.55 knots: 2.1 knots flood

From this information, the pilots went back to the WST current model files and selected models where the maximum current at Bergen Point were the closest to the following values:

1. 1.02 knots to represent 40% of ebb.
2. 1.53 knots to represent 60% of ebb.
3. 1.09 knots to represent 43% of flood.
4. 1.53 knots to represent 60% of flood.

Approximate Bergen Point Transit Time Windows

Based on above, the ULCV should have the following time windows where, on average, the maximum predicated current at Bergen point would be the following percentage less than max current:

- 60% or less: 1.5 before to 2.0 hours after high-water slack; 1.5 hours before to 1.0 after low-water slack.
- 40% or less: 1.0 before either side of high-water slack; 1.0 hour before to 45 minutes after low-water slack.

Again, note that the Kalina at 49' draft can only use the time windows around high water to ensure enough under keel clearance.

3.3 WIND DIRECTIONS AND SPEEDS

Wind directions and speeds were controlled from the operator console. The directions, and speeds (including gusts), were provided by the local pilots. In most cases, the wind directions and velocities selected were the most challenging. Maximum wind speed tested was 30 knots.

3.4 VISIBILITY; DAY NIGHT SCENES

Tests were conducted with clear visibility during daylight hours. However, the simulator operator was capable of simulating rain squalls, fog, low-altitude clouds, and night visuals.

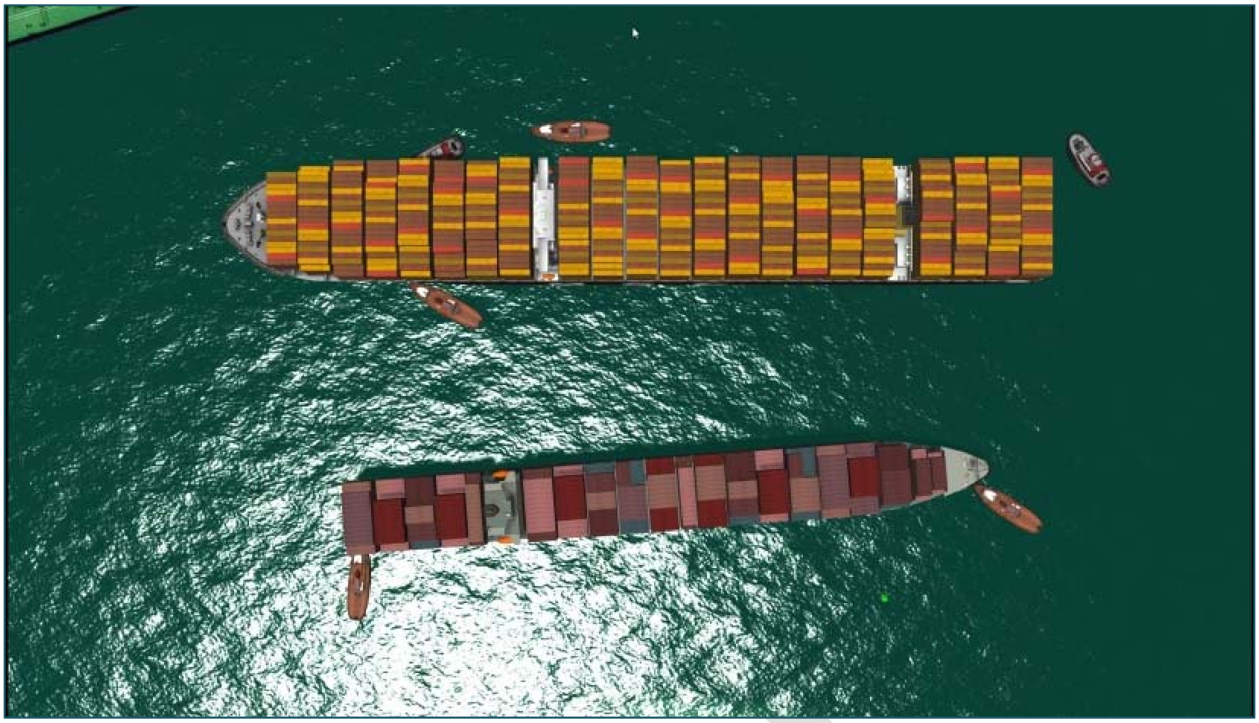


Figure 11: Kalina Meeting Panamax in the KVK

4. WATERWAY SIMULATION TECHNOLOGY (WST) SUPPORT STUDIES

WST generated a separate "*Memo for the Record of Passing Effects on Moored Vessels in Kill Van Kull 6-4-16.*" The Study placed a target vessel in the approximate position of the Hess (Buckeye) – Bayonne Terminal berths. It then calculated the forces each vessel class would generate on the berth when transiting along the centerline of the channel at various speeds. The *Kalina* generated a similar amount of forces at 5 knots as compared to the 9,000 TEU transiting at 6 knots. The Triple E Class generated similar forces at 4 knots as compared to the 9,000 TEU at 6 knots. The pilots used this as guidance for the maximum speed to transit in the KVK where the theoretical forces are no greater than currently produced by the A-Class Maersk vessel transits. Note that the forces' calculations were based on maintaining position on the center line of the channel. Forces rapidly increase as distance between the transiting ship and berth decreases.

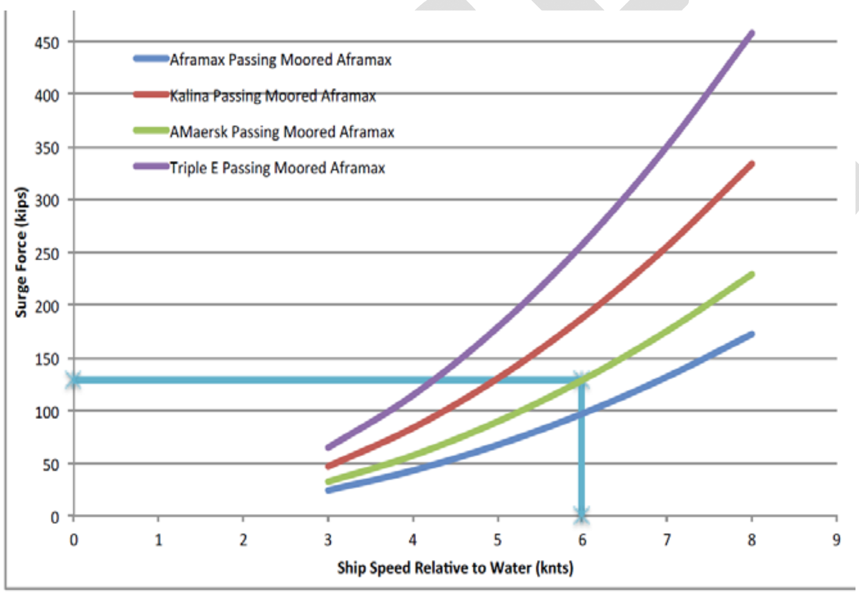


Figure 6: Moored Aframax Forward Surge Forces

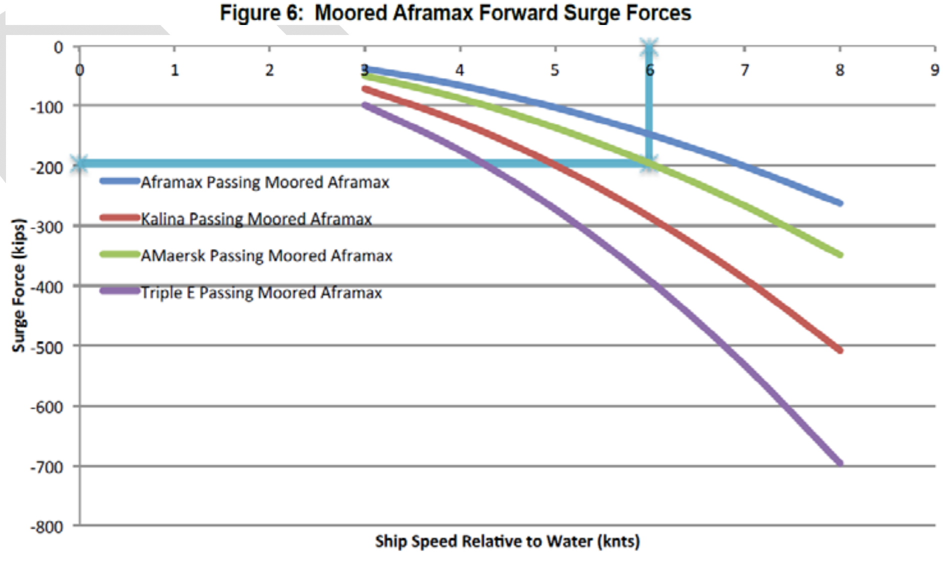


Figure 7: Moored Aframax Aft Surge Forces

Figure 12: Excerpt of Surge Forces vs. Speed by Vessel Class in the KVK from the WST Report.

5. MANEUVERING STUDY METHODOLOGY

MITAGS programmed the deepened navigation channels, turning basin, and container berths. MITAGS modified the *MSC Kalina* hydrodynamic ship models to the requested drafts (42' and 49'). The tide was set at mean lower, low water (MLLW) unless otherwise specified by the conning pilot. All models used the maximum deck load windage area.

The test matrix was developed by the pilots to formulate the "best practices for handling 14,000 ULCVs to the specific container terminals, suggested environmental limits (wind, current, tide, and visibility), and assist tug requirements. The exercises used the Kalina Class Models at the 42' and 49' drafts. Target ships were place on the container berths to better simulate the restrictions expected. All simulation exercises were run in "real time." This meant that it took close to the same amount of time in the simulator as in the real world. To maximize the simulator time, the exercises were stopped when the objectives were achieved. In order to make better use of the simulator time, the pilots decided not to evaluate Howland Hook, Staten Island Terminal since these berths are not equipped to handle the 14,000 TEU Class of containership ships. In five days, the pilots completed thirty-eight runs.

A few runs evaluated the feasibility of a ULCV meeting a Panamax Class vessel (965'x 106') in the Kills. The study also assessed the minimum safe transit speeds that allowed the pilot to maintain the desired track line, and maximized the effectiveness of the escort tugs[3].

5.1 EXERCISE SCENARIOS

After each run, the coning pilot and tug operator were debriefed and requested to fill out a run questionnaire. At the end of the simulation, final evaluations were requested from all participants and a consensus on the parameters needed to handle this class of ship on a routine basis. The majority of runs focused on the turn at Bergen Point.

5.2 18,000 TEU ULCV PART B, PHASE I

The methodology used for the 18,000 ULCV study was based on lessons learn from the Kalina Study. The preliminary results are included in a separate report. Additionally, we expect the report to be updated as the pilots that did not participate in the Studies rotate through the familiarization sessions.

3 The effectiveness of escort tugs reduces as the ULCV transit speed increases.

6. TOWINGS SOLUTIONS OBSERVATIONS

Towing Solutions, Inc., is a recognized expert in the area of assist tugs. MITAGS contracted with TSI to observe the simulation and provide suggestions on ways maximize the efficiencies of the assist tugs.

To evaluate the feasibility of bringing these large ships into the Port of New York/New Jersey, the Sandy Hook Pilots, Docking Masters representing the Metro Pilots Association and Harbor Pilots of New York/New Jersey, and two tug Captains representing McAllister Brothers Inc. and Moran Towing Inc. conducted 38 runs of various lengths over five days to develop procedures, if possible, to safely and consistently bring these large ships into both Port Elizabeth and Global Terminal in Port Jersey. For all of these runs, the hydrodynamic ship was modeled after the ULCV *MSC Kalina* at either a 42' or 49' draft. The tug packages consisted of a mix of up to four tugs. The newly modeled *Brian McAllister* was used to model a 6,500 hp. with a bollard pull rating of 85 metric tons. This model was also used to simulate the *James D. Moran* which is 85-ton, 6,000 hp. ASD. In addition to the two tractors, the Docking Masters (DMs) would also use one or two 46-ton conventional boats (Brendan McAllister and McAllister Sisters). These boats were always controlled by the simulator operator with advice provided by Captain Brooks, if there was a question as to the DM's order. Generally, the noted percentage of current referred to the maximum current at Bergen Point.

To ease the review of this data, the run information will be presented in nine sub-sections:

1. Full (or near full) runs inbound or outbound from Stapleton Anchorage to Port Elizabeth.
2. Rounding Bergen Point Inbound from Bergen Point East Reach to Buoy 3 in Newark Bay.
3. Rounding Bergen Point Outbound (Buoy 3) in Newark Bay to Bergen Point East Reach.
4. Inbound from Buoy 10 Newark Bay to Port Elizabeth.
5. Outbound from Port Elizabeth to Buoy 10 Newark Bay.
6. Inbound from Upper Bay Buoy 30 to Global Terminal (Port Jersey).
7. Outbound from Global Terminal (Port Jersey) to Upper Bay Buoy 30.
8. Emergency turns above and below the Verrazano Narrows Bridge.

6.1 FULL LENGTH RUNS

Run #1 – Familiarization Run

Pilot: Flannery Kalina at 42’

Start: St. George Ferry slip @ 8 knots Finish: Buoy 3 Newark Bay

Wind: NE 15 Current: Slack

Tugs: Brian Center Lead Aft Brendan Port Quarter James Port Bow

Run Description

In this first familiarization run, the pilots used the tugs to maintain a modest speed while transiting the Kills. During this run, four important lessons became apparent and were discussed after the run in two sessions.

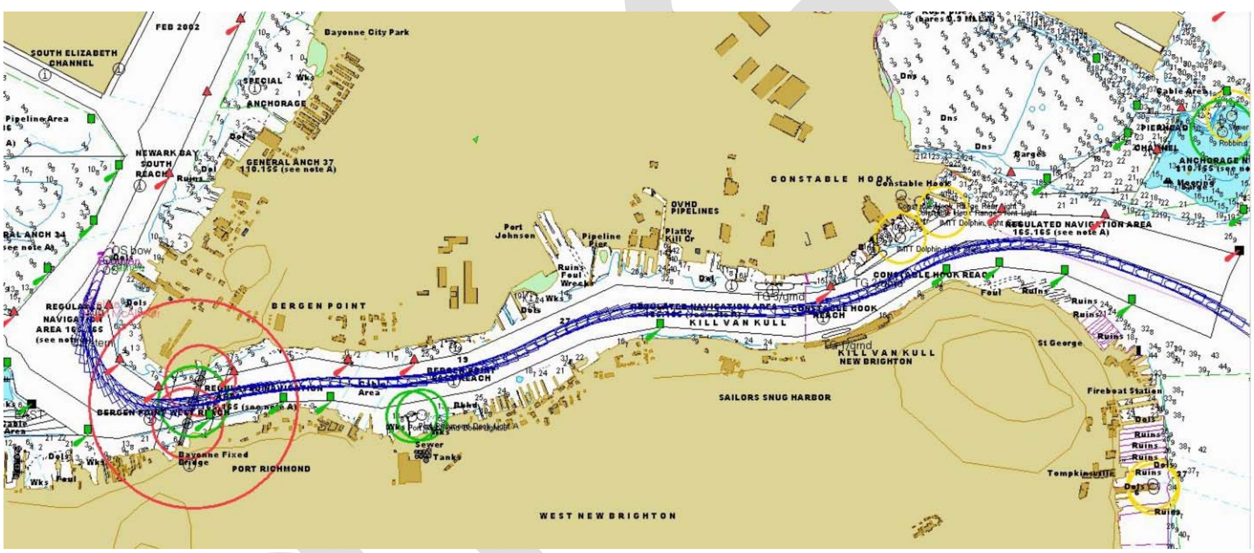


Figure 13: Run 1 Familiarization

1a. The model’s behavior was very heavy and sluggish when responding to its rudder.

1b. As the Docking Master entered the turn at Bergen Point, with the ship making only 2.9 knots ahead, the Docking Master ordered the tug into a “direct pull, port 90° at full power. What was not considered was the fact that the ship’s stern was moving to port at 2.3 knots and the tug cannot “walk” sideways at that speed even when at full power. Therefore, the tug “stalled” behind the ship. As can be seen in the screenshot below, the tug is perhaps at a 60° angle to the ship’s centerline, but the towline is almost in line with the ship. The towline forces were mostly retarding the ship versus assisting the turn. In this case, the tug would be more effective if it had been used in the “powered indirect” mode. In this maneuver the tug drives out into the position illustrated below, as he is not presenting the boat’s broadside to the water flow, the boat can very quickly get into the proper position to work.

Figure 14: Tug Stalling trying to Accomplish a 90° Direct Pull at Bergen Point

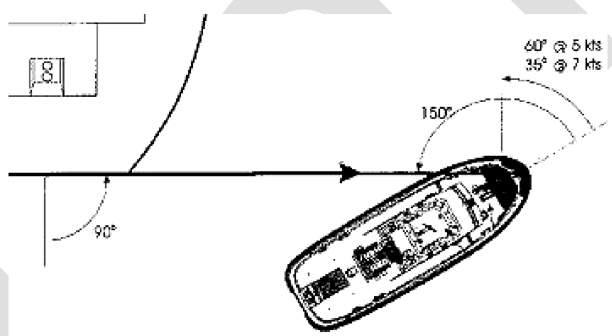


Figure 15: Example of Powered Indirect Maneuver

1c. If the Docking Master wants the tug to respond very quickly, he / she can order the boat "powered indirect, port – stop and hold (position)". Responding to this order the tug boatman would run his boat out so that his towline is roughly 70° to the ship's centerline and then run parallel with the ship until given the order by the Docking Master to work. [**Note:** the boat stops with his towline at the 70° as the tug will move forward when finally ordered to work. The towline shouldn't pass 90°. Otherwise the wire may be cut by rubbing against the ship's transom. Even if the tug cannot work at full power in this positon because of the slow speed of the ship (as in this case), the towline forces produced are primarily steering forces.

1d. Another limitation of the direct-pull 90° command with 200' of towline, was the boat probably would not have cleared the buoys marking the edge of the channel (please note the plot on the following page). For the rest of the exercise, the tugboatmen worked at getting comfortable operating on a shorter towline. This is another advantage of using the powered indirect maneuver as the overall distance that the tug extends past the side shell of the ship is greatly reduced versus in the direct pull mode.

Note: The conversation that took place to introduce the lessons learned 1b – 1d took place in the tug simulator with Captain Flannery, while Captain Ellis was conned from the main bridge. The next run around Bergen Point, Captain Flannery successfully used these procedures.

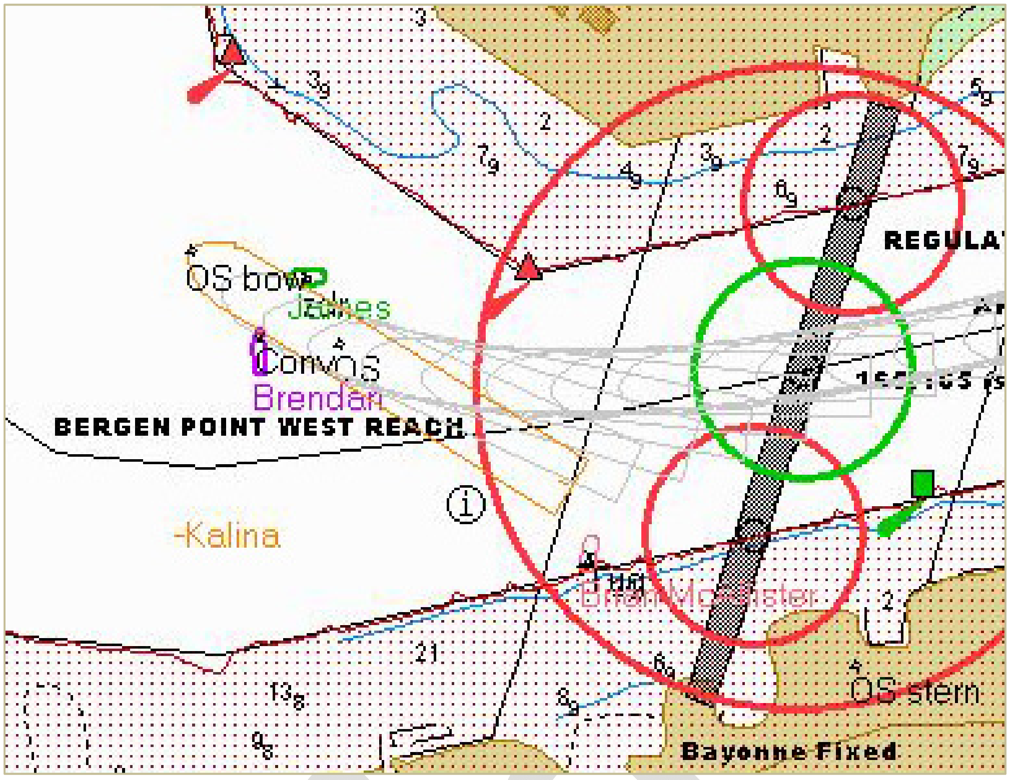


Figure 16: Tug operating close to edge of the channel

Run #2 – Familiarization Run

Pilot: Ellis Kalina at 42’

Start: City Dock @ 5 knots Finish: Buoy 3 Newark Bay

Wind: NE 20 Current: 60% Flood

Tugs: Brian Center Lead Aft Brendan Port Bow James Starboard Bow

Run Description

This run turned out to be a good learning experience on how the Transas simulation system works. In this case, Captain Ellis thought that his tugs would be made up when the simulation started. Because of this assumption, he agreed to start the exercise with his ship approaching a modest turn. By the time that the tugs had moved into position and tethered, the ship had drifted to the southern side of the channel, but the ship did not ground. From this point Captain Ellis struggled with the 60% flood tide pushing the ship along. It should be understood that while the ship did not ground it was not an acceptable run due to the control difficulties with this amount of flood tide.

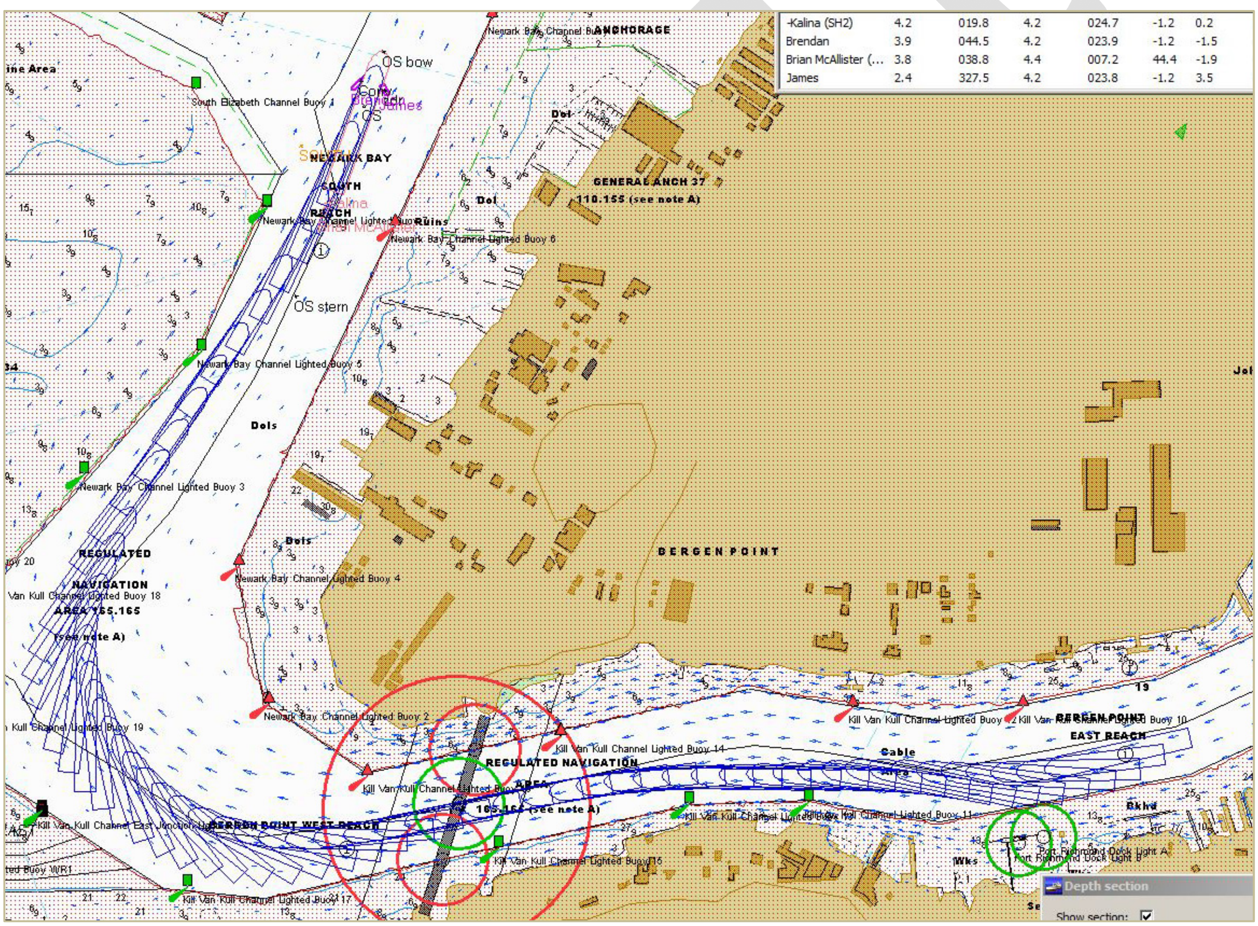


Figure 17: Run 2 – Familiarization

Run #3 – Familiarization Run

Pilot: Flannery Kalina at 42’

Start: City Dock @ 5 knots Finish: Buoy 3 Newark Bay

Wind: NE 20 Current: 40% Flood

Tugs: Brian Center Lead Aft Brendan Port Bow James Starboard Bow

Run Description

This run was essentially a repeat of Run 2 with the current reduced to a 40% flood and the new tug procedures employed. As can be seen, the Docking Master was able to maintain excellent control over the ship during the entire run. While making the turn at Bergen Point, the Docking Master did not have to use the stern tug any harder than 25%.

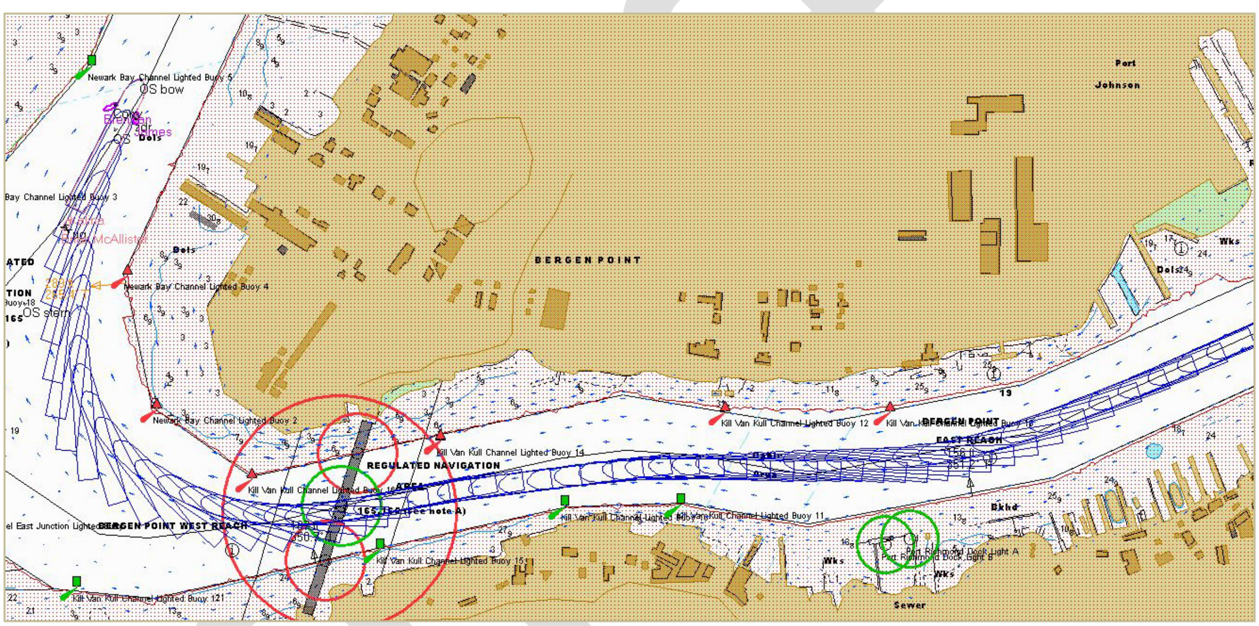


Figure 18: Run 3 - 40% Flood Current Evaluation

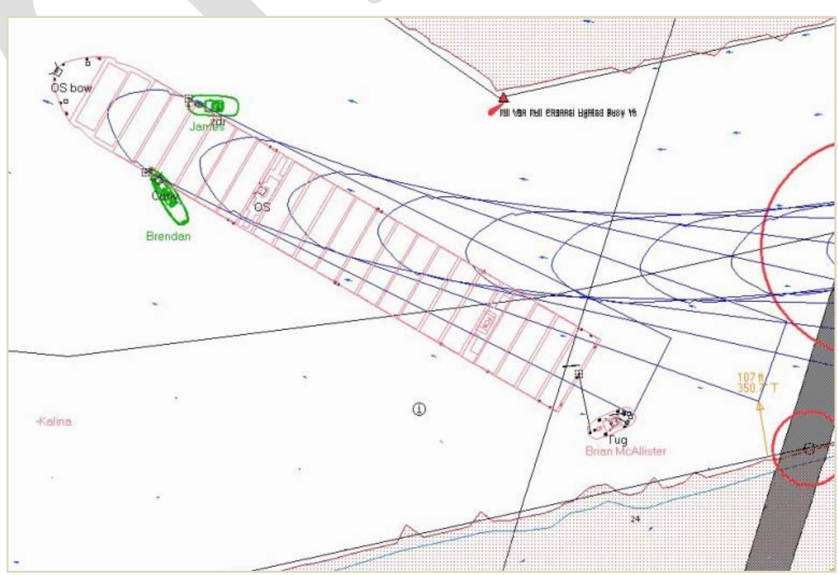


Figure 19: Tug performing “Powered Indirect” Maneuver

Run #4 – 60% Flood Current Evaluation

Pilot: Ellis Kalina at 42’

Start: City Dock @ 5 knots Finish: Buoy 3 Newark Bay

Wind: NE 20 Current: 60% Flood

Tugs: Brian Center Lead Aft Brendan Port Bow James Starboard Bow

Run Description

Again the 60% flood created difficulties for the Docking Master as he tried to keep the ship’s speed within reason and yet still be able to make these turns as the ship was really being negatively affected by the current.

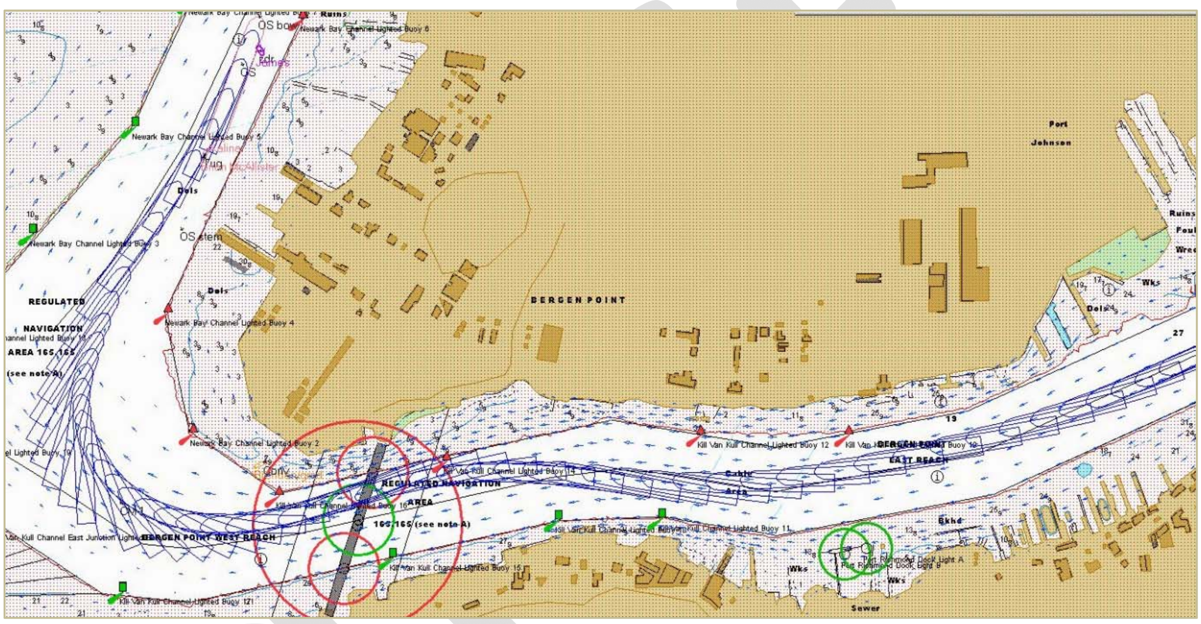


Figure 20: Run 4 – 60% Flood Current

Figure 21: Run 4 –Turing into Port Elizabeth

Run #5 – 60% Ebb Current Evaluation

Pilot: Flannery Kalina at 42’

Start: City Front @ 5 knots Finish: Buoy 3 Newark Bay

Wind: NE 20 Current: 60% (2.1 knot) Ebb

Tugs: Brian Center Lead Aft Brendan Port Bow James Starboard Bow

Run Description

As this was the first time that the Docking Masters were able to “see” how well the Kill Van Kull ebb currents had been modeled, Captain Flannery took his time and generally tried to keep from getting set to one side of the channel of the other. I think it is also important to understand that as well as checking tidal currents, they are doing this while learning the handling characteristics of this extremely large and heavy ship. In this run, Captain Flannery found the ship handled well but he was set towards Buoy 10 a bit and then came within 86 feet of buoy 16 marking the tip of Bergen Point. Overall, Captain Flannery accepted the current model without comment. Understanding that this was the DM’s first day of handling these ships everyone seemed pleased with the progress. The tug Captain, Matt Kicklighter from McAllister was very complimentary of the DM’s use of the tugs in the powered indirect mode and their use of the new commands.

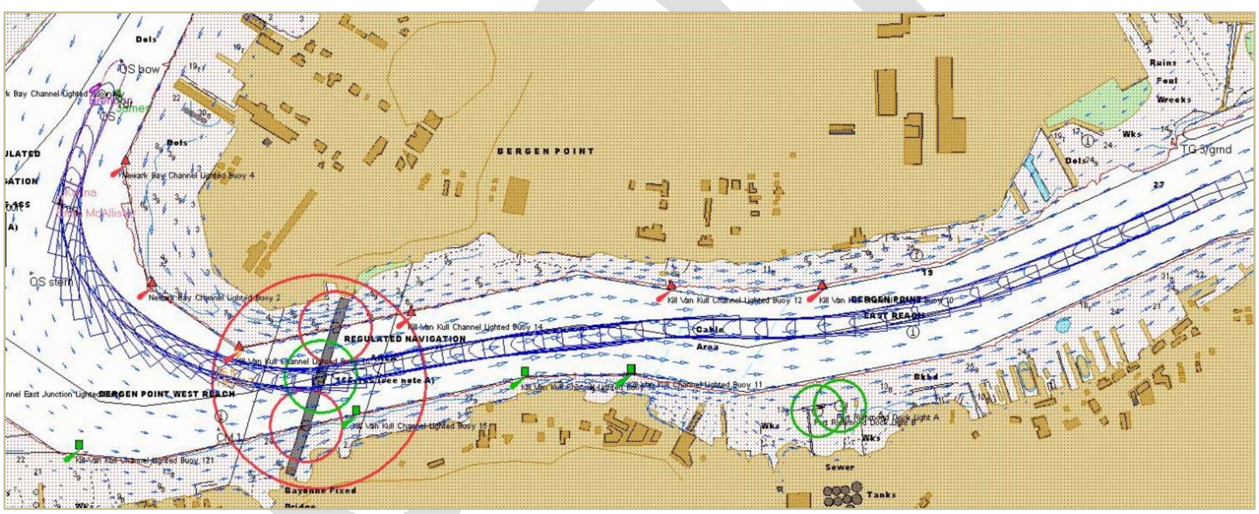


Figure 22: Run 5 - 60% Ebb Current

Run #8 – 60% Flood Current Evaluation

Pilot: Ellis Kalina at 42’

Start: Newark Bay buoy 3 @ 5 knots Finish: Con Hook Reach

Wind: NW 20 Current: 60% Ebb

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

For this last run of Day 1, we tried to push the envelope a bit by setting up a “worst case” outbound transit where the ship would have the wind and the current on its stern as they rounded Bergen Point. Captain Ellis did a very nice job negotiating the Bergen Point turn approaching the Bayonne Bridge at near center span, but then the wind and current set the ship down to the south.

Captain Ellis did a beautiful job of maintaining the ship in the Bergen Point West Reach but after making the turn into the Bergen Point East Reach the ship continued to sag and came very close to the southern edge of the channel. Finally, on entering the Con Hook Reach, the ship’s stern was extremely close to the channel edge.

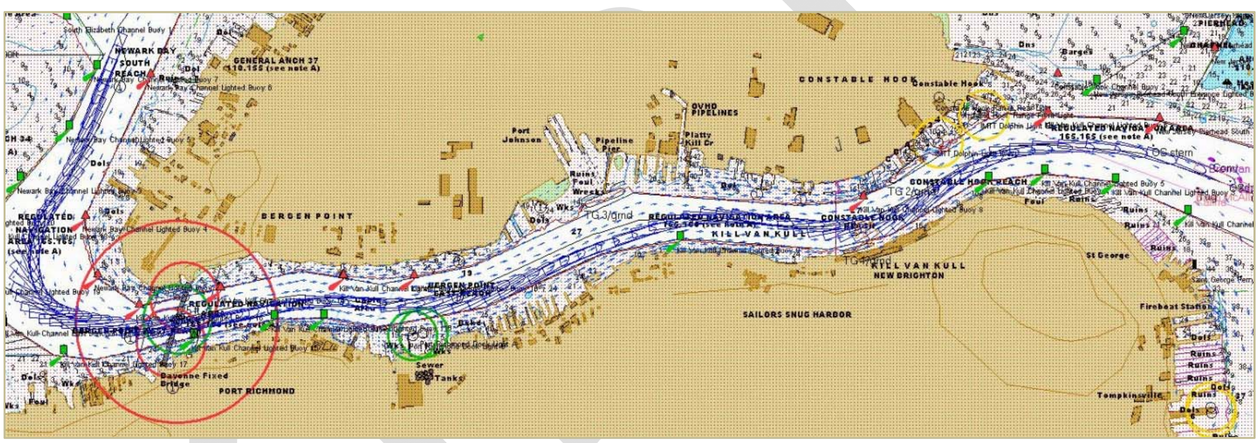


Figure 23: Run 8 – NW @ 20 knots / 60% Ebb

Run #9 – 40% Ebb Current Evaluation

Pilot: Flannery Kalina at 42'

Start: Newark Bay buoy 3 @ 5 knots Finish: Con Hook Reach

Wind: NW 20 Current: 40% Ebb

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

Due to our concerns with the results of Run 8, we repeated that exercise but lowered the ebb current to 40% (from 60% in Run 8). Captain Flannery made a good turn around Bergen Point using the *Brian McAllister* in the powered indirect mode and ended the turn with the ship on the centerline of the channel; but the ship very quickly began to sag down to the south side of the main channel as he was attempting to line up with the center of the Bayonne Bridge span (the ship ended up in the Southern third of the channel).

Having observed the wind effects on the ship the night before, the Docking Master purposely attempted to hold the ship to the north side of the channel to the degree he could, but still found the model uncomfortably close to the south side of the channel as he exited the Bergen Point East Reach and similarly exiting the Con Hook Reach. During the debrief he noted that his strategy of deliberately trying to run on the north side of the channel. This would preclude meeting any other ship when transiting Kill Van kill under these environmental conditions. In his debrief, Captain Flannery stated that they would have to keep trying different tug packages and positions until they found a solution.

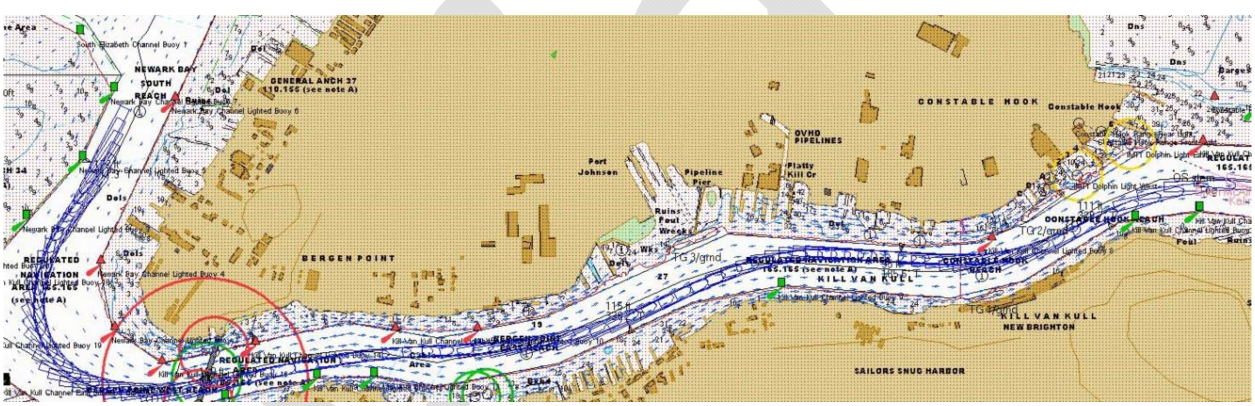


Figure 24: Run 9 – NW @ 20 knots / 40% Ebb

Run #10 – 40% Ebb Current Evaluation

Pilot: Ellis Kalina at 42’

Start: Newark Bay buoy 3 @ 5 knots Finish: Con Hook Reach

Wind: NW 20 Current: No Current

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

For Run 10 it was decided to repeat Run 9 but remove the current from the exercise to try and identify which environmental (wind or current) was the dominant maneuvering issue. The Docking Master made a textbook approach to the turn at Bergen Point, and ended up in the northern side of the channel. The ship was rather benign without the current in the equation and the pilot did not have to use the tugs much at all.

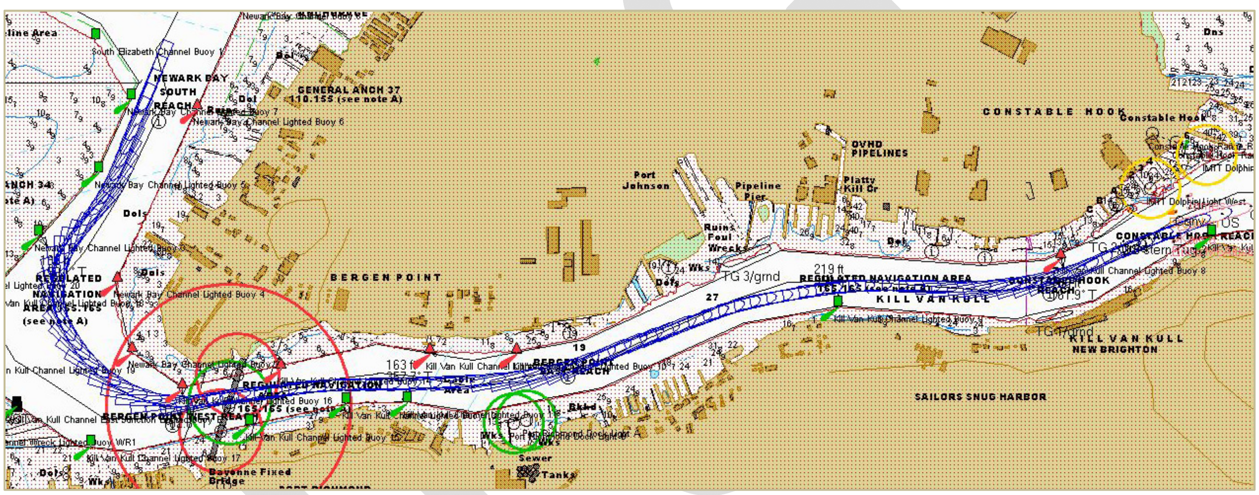


Figure 25: Run 10 – NW @ 20 / No Current

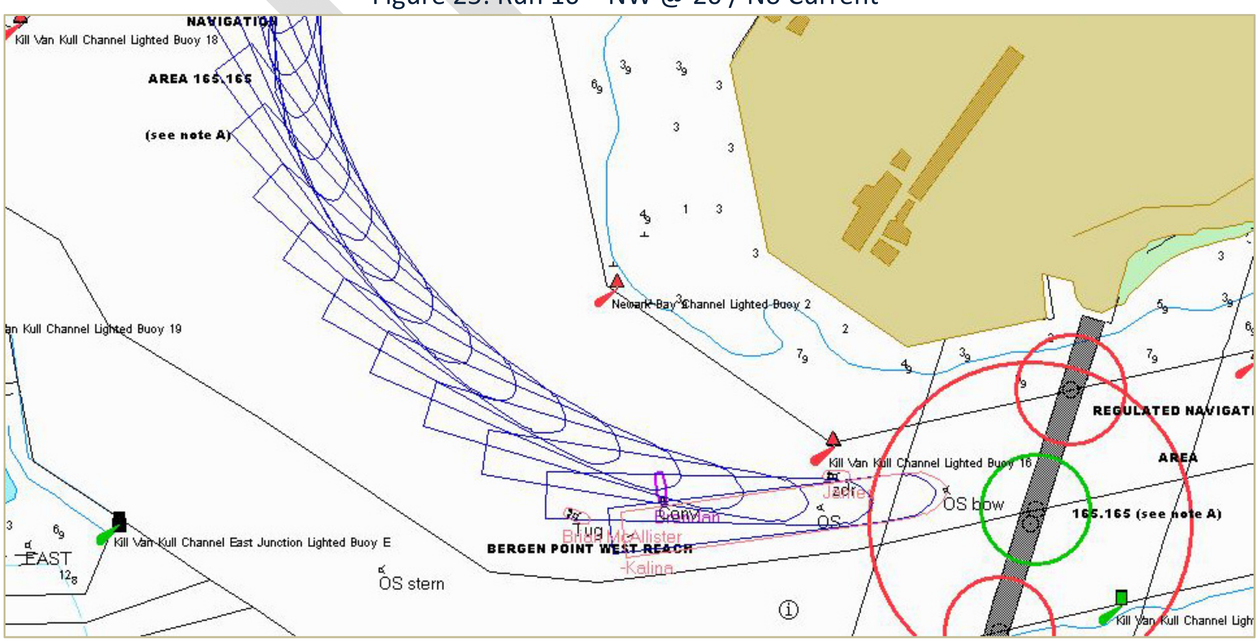


Figure 26: Run 10 Bridge Approach

Run #34 – 60% Flood - Ship to Ship Passing Evaluation

Pilot: Flannery Kalina at 49’

Start: Stapleton Anchorage

Pilot: Ellis Arthur Maersk

Start: Newark Bay buoy 3

Finish: Port Elizabeth

Wind: N 20 Current: 60% Flood

Tugs: Brian Center Lead Aft James Starboard Bow

Brendan Port Bow Sisters Running Free

Run Description

To test the possibility of meeting another ship in Kill Van Kull versus a one-way traffic scheme for these big ships, a test meeting was conducted with the *Kalina* meeting the *Arthur* in the Kills. Ideally, this meeting should have taken place on a strait section of the channel either in Bergen Point East Reach or in Constable Hook Reach.

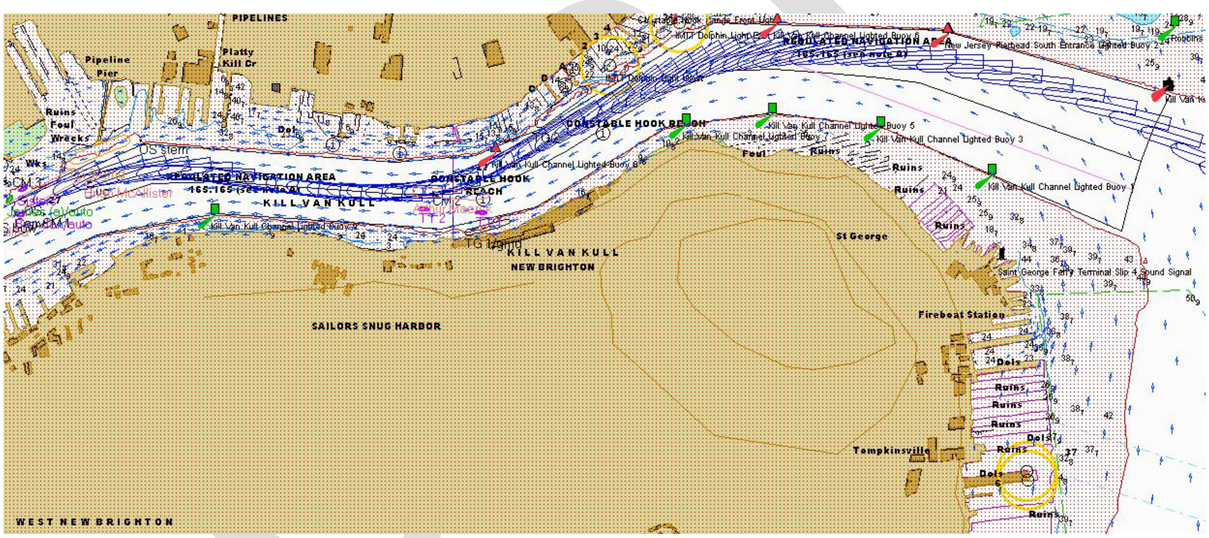


Figure 27: Run 34 – Ship to Ship Meeting

The Docking Masters’ timing was off and they met just as the *Arthur Maersk* was turning on to the west end of Con Hook Reach. This meeting place forced the *Kalina* well to the north of the channel to avoid a collision with the *Arthur Maersk* (Panamax). While the two ships did not collide, the *Kalina* just barely missed colliding with a tanker (25’) moored at the IMTT tanker berth. Further, the *Kalina* was so far to the north of the channel she would have run aground if we had continued the exercise.

Both Docking Masters agreed, at least initially, that no meeting situations be allowed in the Kill Van Kull or Newark Bay.

6.2 BERGEN POINT INBOUND

Run #11 – 49' Draft evaluation

Pilot: Flannery Kalina at 49'

Start: IMTT Texas Dock @ 5 knots Finish: Newark Bay buoy 3

Wind: NE 20 Current: No Current

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

With the ship at this deeper draft, a four-foot tidal height was added to the simulation to simulate the conditions the deeper loaded ship would enter the port. Approaching the Bayonne Bridge, the Docking Master used the tugs to slow the ship and passed under the bridge with the ship making 3.87 knots. With the bow under the bridge the Docking Master ordered the C/L aft tug (*Brian McAllister*) to conduct the powered indirect maneuver but the tugboatman suggested a direct pull due to the ship's speed (3.19 knots). But again while making this turn the ship's pivot point appears to be near the ship's bridge and the stern swings very wide. The stern cleared Buoy 13 by 75' and 88' just west of the Bridge.

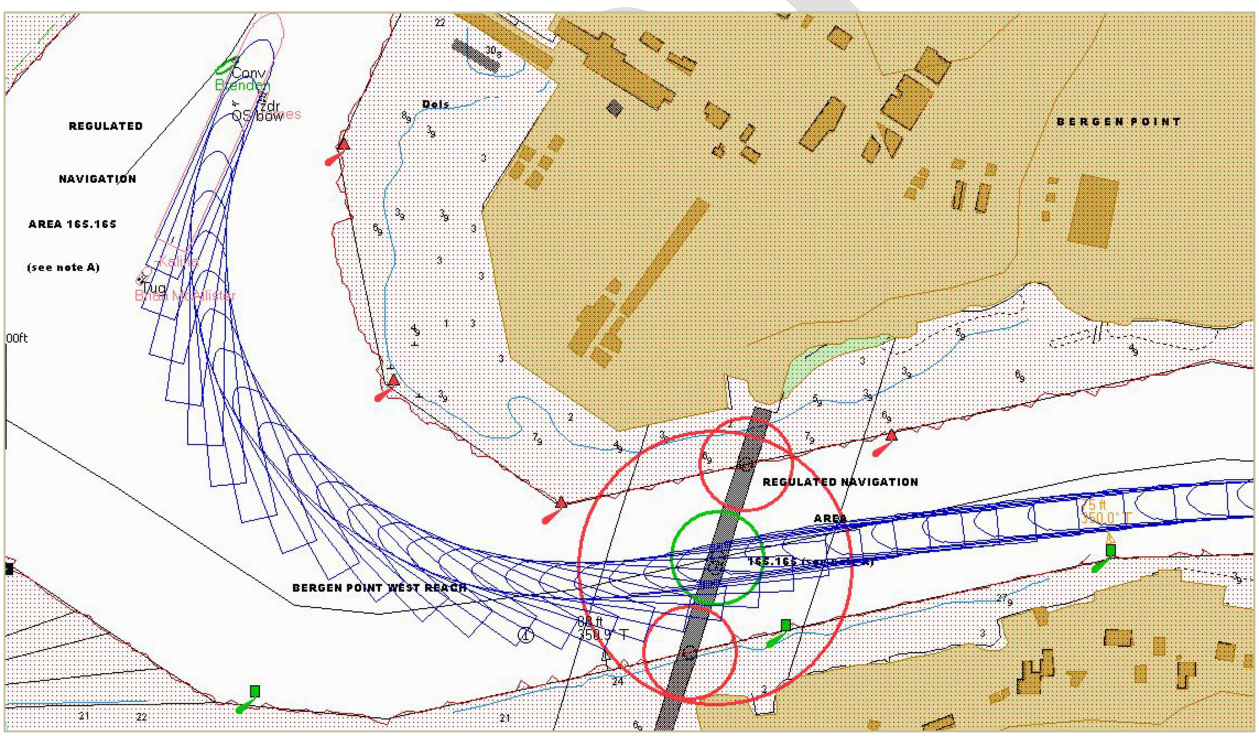


Figure 28: Run 11 – 49' draft – NE@20 / No Current

Run #12 – 49' Draft evaluation

Pilot: Ellis Kalina at 49'

Start: IMTT Texas Dock @ 5 knots Finish: Newark Bay buoy 3

Wind: NE 20 Current: 40% Flood

Tugs: Brian Center Lead Aft James Starboard Bow Brendan Port Bow

Run Description

For the second 49' draft run, we have added a 40% flood current to the exercise. The Docking Master got a little out of shape at the start of the exercise, but caught the ship and made a very nice run down to Bergen Point and cleared Buoy 13 by 175'. The ship actually seems to handle better at the deeper draft.

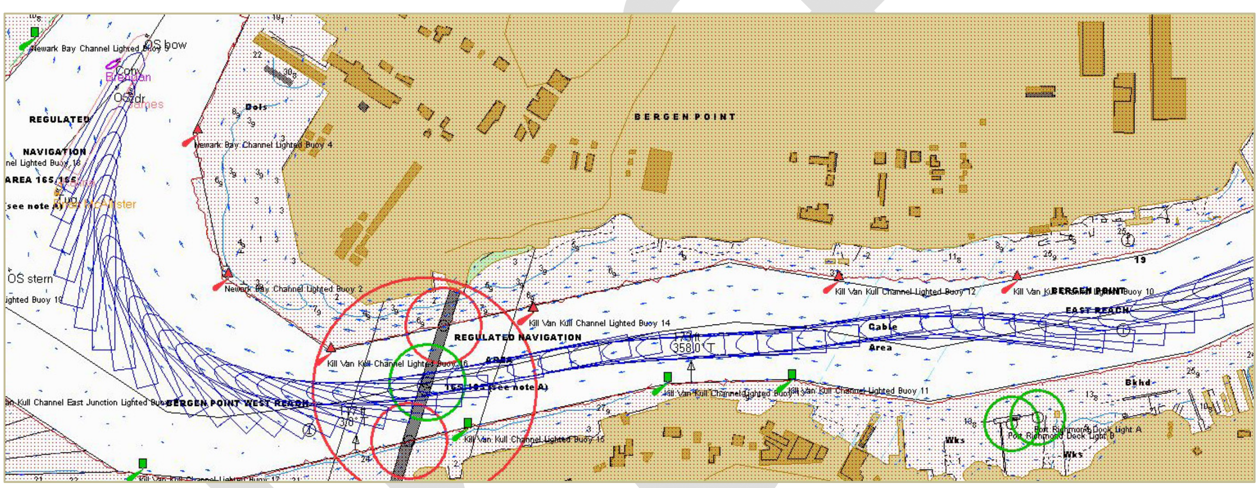


Figure 29: Run 12 – 49' draft – NE@20 / 40% Flood

Run #13 – 49 Draft evaluation

Pilot: Flannery Kalina at 49’

Start: IMTT Texas Dock @ 5 knots Finish: Newark Bay buoy 3

Wind: NE 20 Current: 60% Flood

Tugs: Brian Center Lead Aft James Starboard Bow Brendan Port Bow

Run Description

This was another excellent in-bound run for Port Elizabeth. The Docking Master generally maintained the ship’s wheelhouse in the center of the channel which allowed the stern to swing wide at the turns. The Docking Master used the tugs to slow the ship as it approached the Bayonne Bridge and the ordered the tug into the powered indirect mode when he initiated the turn. When making the turn at Bergen Point, the stern of the ship cleared the southern bank by 109 feet. Good use of the tug commands.

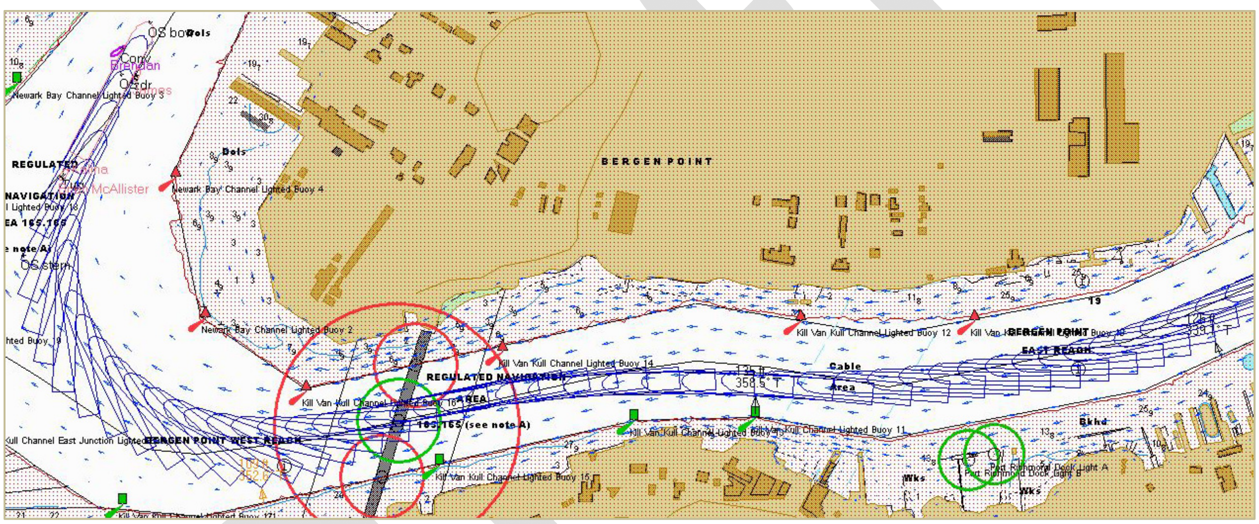


Figure 30: Run 13 – 49’ draft – NE@20 / 60% Flood

Run #14 – 49 Draft Evaluation

Pilot: Ellis Kalina at 49’

Start: IMTT Texas Dock @ 5 knots Finish: Newark Bay buoy 3

Wind: NE 20 Current: 40% Ebb

Tugs: Brian Center Lead Aft James Starboard Bow Brendan Port Bow

Run Description

This was our first run with the ebb current at 49 feet and the Docking Master struggled a bit coming within 80 feet of buoy 10 and 85 feet to buoy 16. The tugs were used to slow the ship down as it approached the Bayonne Bridge. Since the ship was very close to Bergen Point the Docking Master was forced to start his turn late, and had the C/L aft tug working in the direct mode at full power for about five minutes during the turn.

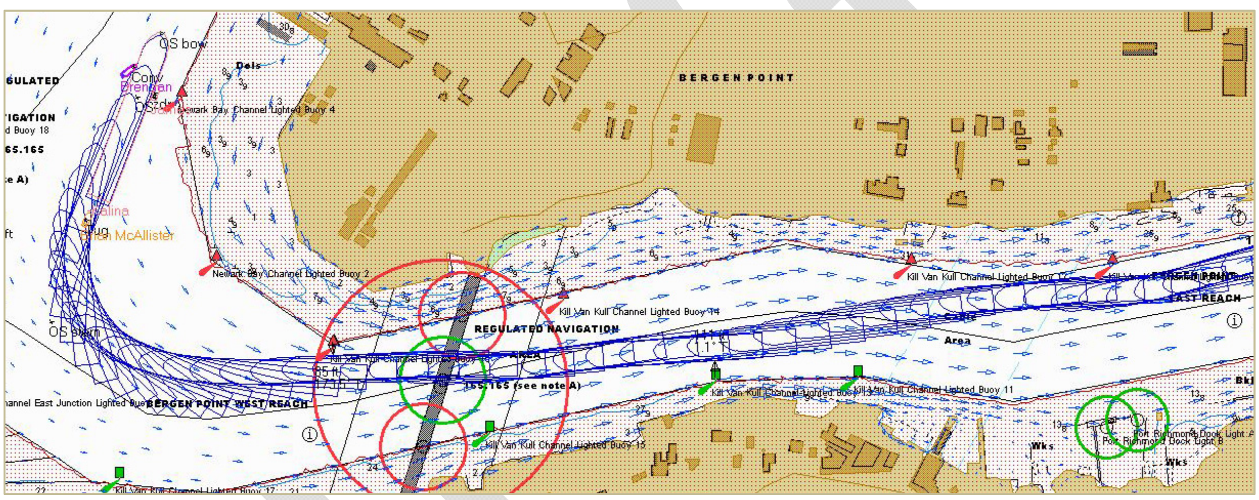


Figure 31: Run 14 – 49’ draft – NE@20 / 40% Ebb

Run #15 – 49 Draft Evaluation

Pilot: Flannery Kalina at 49’

Start: IMTT Texas Dock @ 5 knots Finish: Newark Bay buoy 3

Wind: NE 20 Current: 60% Ebb

Tugs: Brian Center Lead Aft James Starboard Bow Brendan Port Bow

Run Description

This run demonstrates that the Docking Masters were now getting much more comfortable with how this big ship handled, and the water current model. Approaching the Bayonne Bridge in the middle of the channel, Captain Flannery backed all three boats hard to get the ship to slow down for making the turn, but this worked out very well. The ship cleared Buoy 16 by 201 feet.

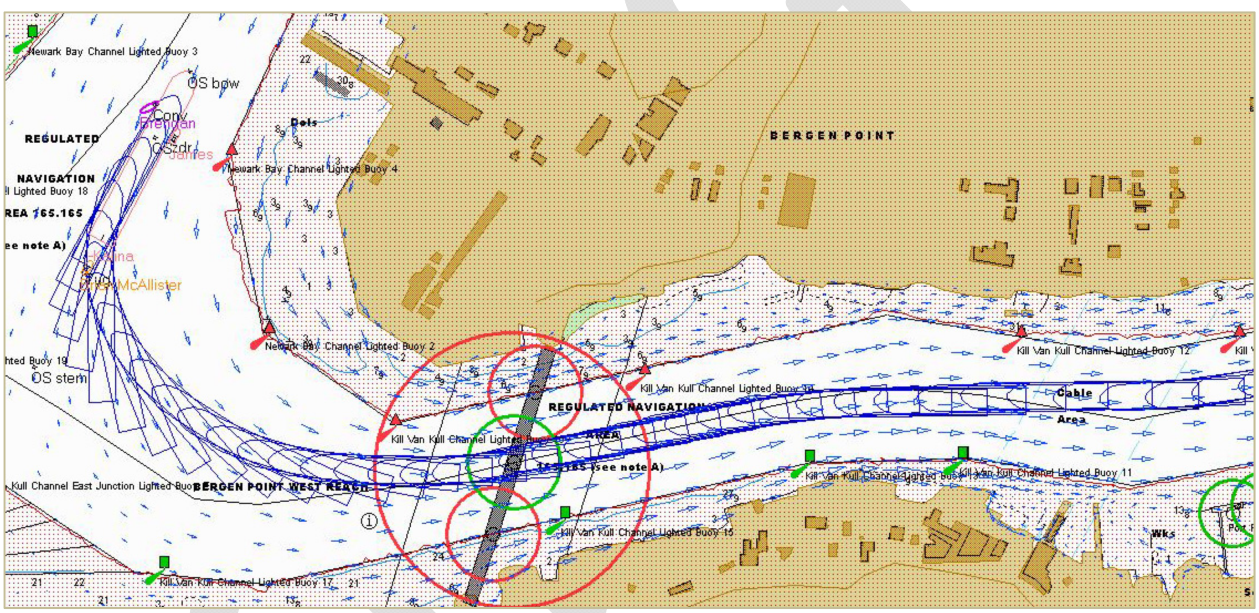


Figure 32: Run 15 – 49’ draft – NE@20 / 60% Ebb

6.3 BERGEN POINT - OUTBOUND

Run #6 – 40% Flood Current Evaluation

Pilot: Ellis Kalina at 42’

Start: Newark Bay buoy 3 @ 5 knots Finish: Bergen Point East Reach

Wind: NW 20 Current: 40% Flood

Tugs: Brian Center Lead Aft James Starboard Bow Brendan Port Bow

Run Description

The start of this run was flawed as the ship did not have enough speed at start of the exercise and the Northwest wind started pushing the ship sideways (the ship should have been located on the starboard side of the channel), but Captain Ellis was able to get the ship underway safely and elected to continue with the run. He quickly established his desired turn rate and used the *Brian McAllister* on the center lead aft to adjust this rate of turn as he desired. He eventually ended up a little too far south when passing under the Bayonne Bridge, but he caught the slide and very quickly had the ship in the center of the channel. Very nice run after a shaky start.

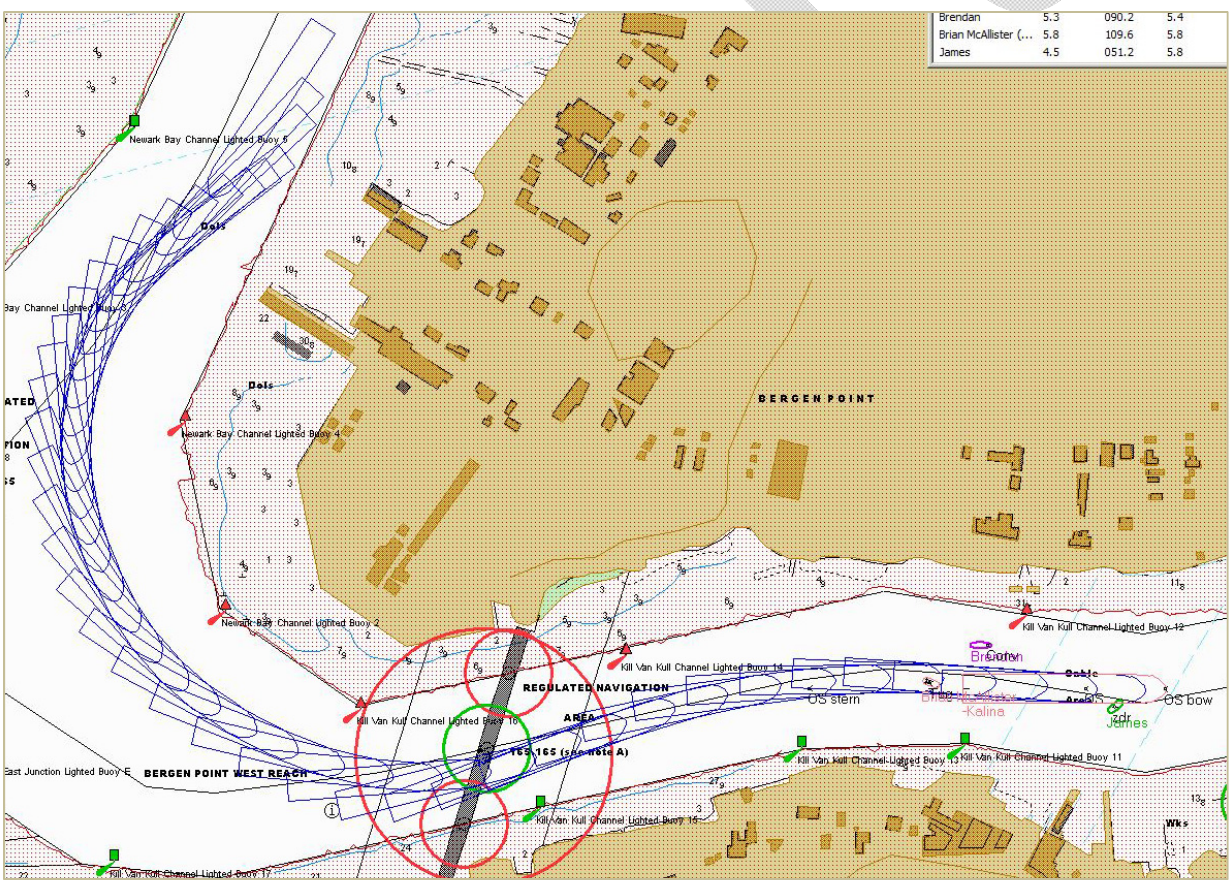


Figure 33: Run 6 – NW@20 - 40% Flood

Run #7 – NW@20 - 40% Flood Current Evaluation

Pilot: Flannery Kalina at 42'

Start: Newark Bay Buoy 3 @ 5 knots Finish: Bergen Point East Reach

Wind: NW 20 Current: 60% Flood

Tugs: Brian Center Lead Aft James Starboard Bow Brendan Port Bow

Run Description

This was an uneventful run, even though the Docking Master was making the turn at Bergen Point with a 60% Flood and 20 knots of wind from the northwest. Despite the adverse conditions the Docking Master maintained complete control over the ship at all times.

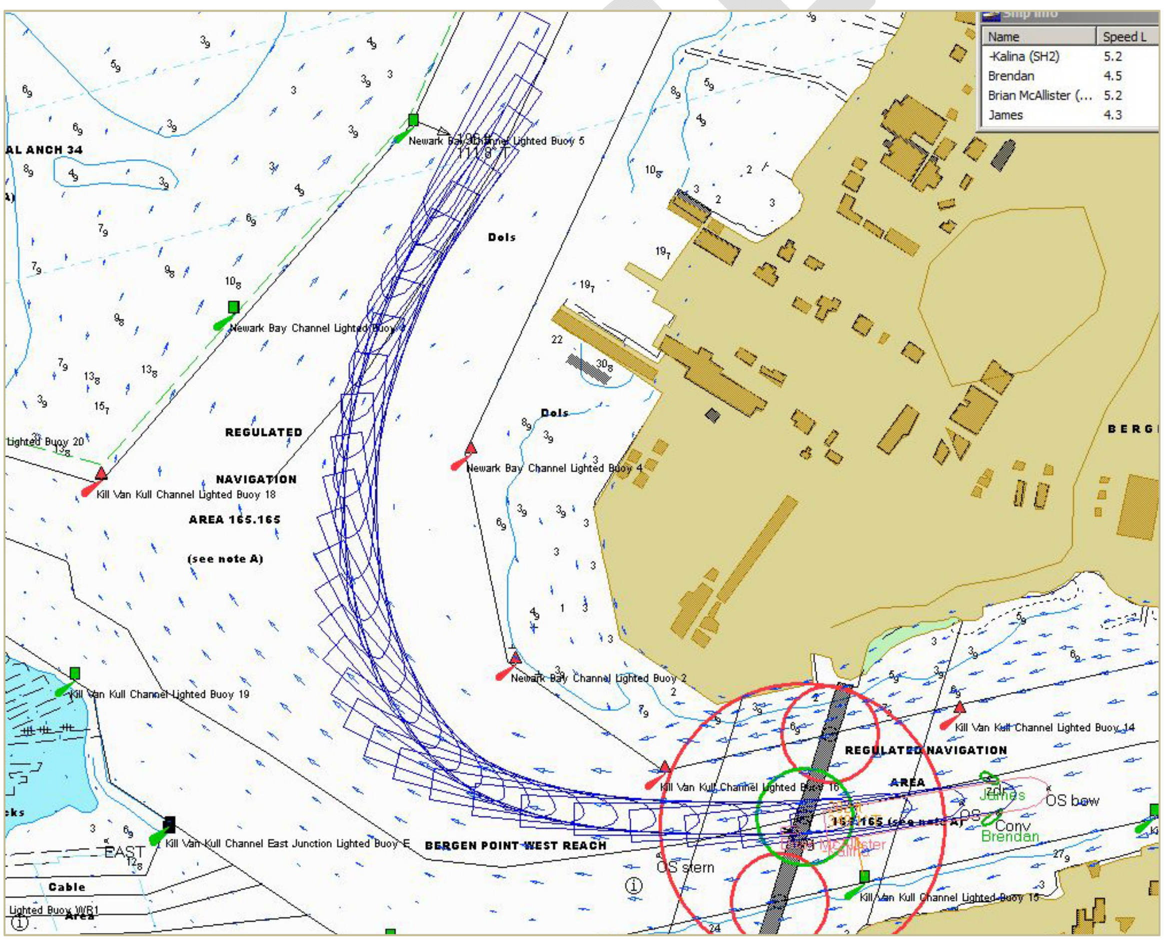


Figure 34: Run 7 – 42' Draft – NW@20 - 60% Flood

Run #16 – 40% Ebb Current Evaluation

Pilot: Ellis Kalina at 49'

Start: Newark Bay buoy 3 @ 5 knots Finish: Bergen Point East Reach

Wind: NW 20 Current: 40% Ebb

Tugs: Brian Center Lead Aft James Starboard Bow Brendan Port Bow

Run Description

This run was a good example of how much control the two Docking Masters have developed over this ship in just two days. This was a beautiful run and was a great way to close out Day 2. Captain Ellis positioned the bow of the ship closer to the Bayonne side of the waterway in anticipation of the ship's reaction to the south due to the current and passed under the center of the bridge.

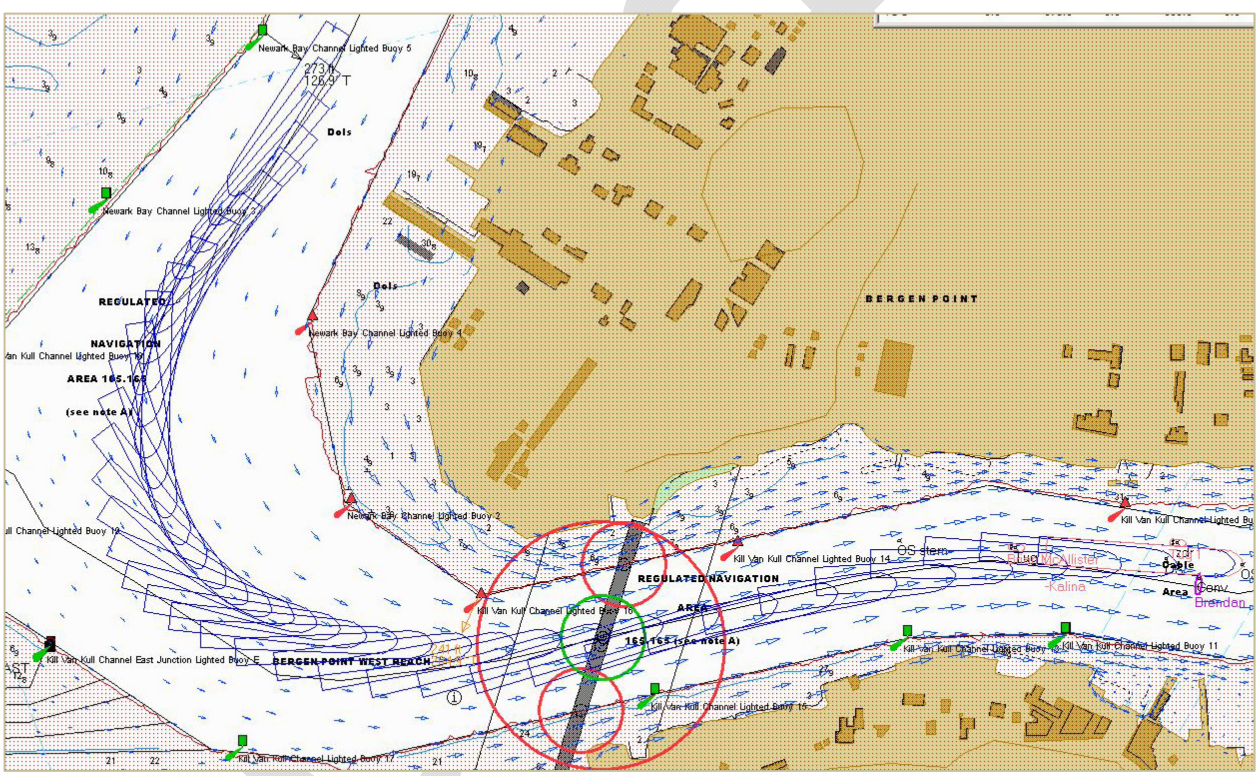


Figure 35: Run 16 – 49' draft – NW@20 / 40% Ebb

Run #17 – 40% Flood Current Evaluation

Pilot: Flannery Kalina at 49’

Start: Newark Bay Buoy 3 @ 5 knots Finish: Bergen Point East Reach

Wind: NW 20 Current: 40% Flood

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

On this run Captain Flannery initially used the bow tugs to slow the ship prior to entering the turn at Bergen Point. At 3.9 knots the Docking Master gave the C/L aft tug (*Brian McAllister*) the order to get into position to perform an indirect maneuver to starboard. Initially, the DM gave the tug an order for an easy indirect to starboard which he then increased to full power. For the rest of the turn the DM modulated the C/L aft tug’s power setting to maintain a 16°/m turn rate on the ship as they came around the turn. In his notes on the maneuver, the DM stated that he expected to feel the flood current sooner to help stop his slide. This was a very smooth run with very good tug coordination, but ended within 80 feet of the southern edge of the channel.

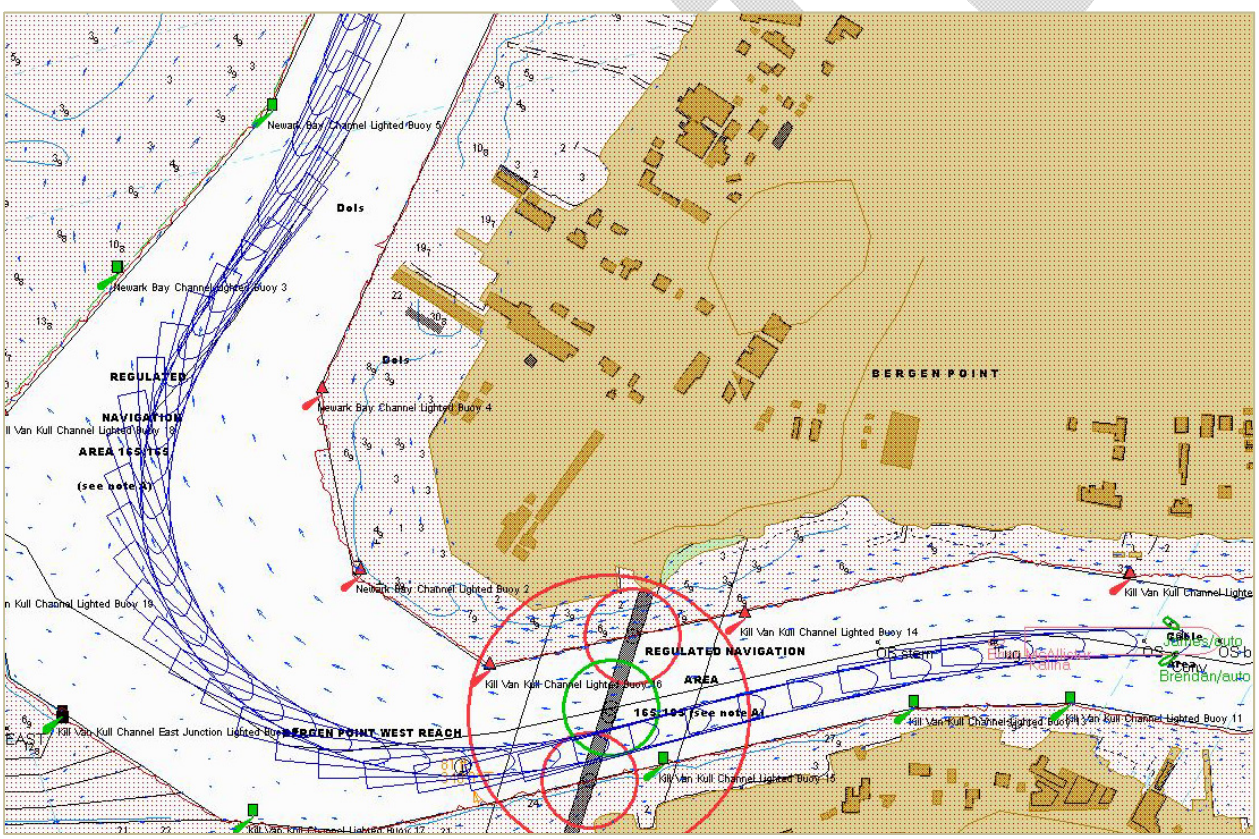


Figure 36: Run 17 – 49’ draft – NW@20 / 40% Flood

Run #18 – 60% Ebb Current Evaluation

Pilot: Ellis Kalina at 49'

Start: Newark Bay Buoy 3 @ 5 knots Finish: Bergen Point East Reach

Wind: NW 20 Current: 60% Ebb

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

The Docking Master initially had the C/L aft tug (*Brian McAllister*) backing in line at 'easy' and then up to half power. With the ship making 4.0 knots the DM ordered the *Brian* to pull in a direct pull, 90° to starboard at full power. The tug Captain operating the *Brian* noted a towline tension of 83 tons when working at full power. During this run the DM took the ship further to the west when making this turn to allow himself more time to get the ship lined up for the bridge centerline. The closest the ship came to the edge of the channel was 312'. An excellent run under challenging conditions.

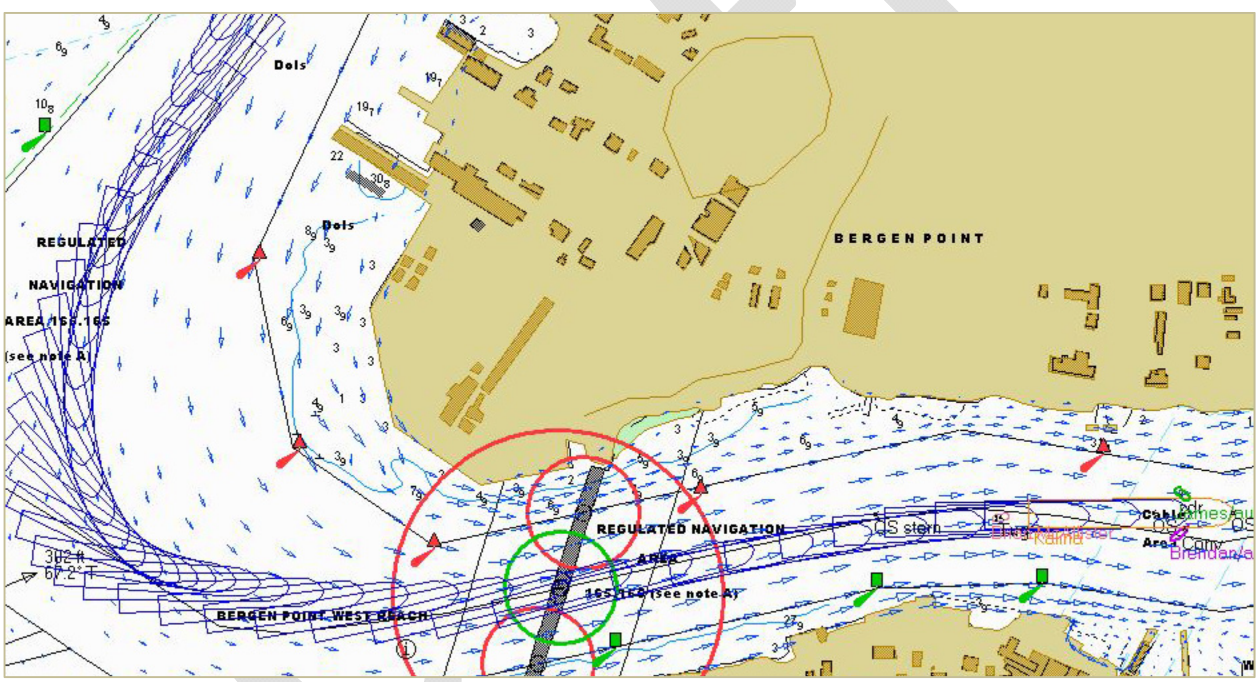


Figure 37: Run 18 – 49' draft – NW@20 / 60% Ebb

[Note: Towing Solutions does not think that the direct pull performance of 83 tons could be realized at a ≈90° to the ship at this speed. We know of no ASD design (especially one with an escort keel) that can produce even half of this performance. But, as the pilot eased the boat off of this full power order quickly, it is of little consequence to the success of the run.**]**

Run #19 – 60% Flood Current Evaluation

Pilot: Flannery Kalina at 49'

Start: Newark Bay Buoy 3 @ 5 knots Finish: Bergen Point East Reach

Wind: NW 20 Current: 60% Flood

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

Captain Ellis did a good job fighting his way around Bergen Point with this heavy flood current as he was being set to the west as soon as the bow of the ship entered the flood stream flowing past the point. To make the turn, he had all three tugs and the bow thrusters working at full power and still only cleared the edge of the basin by 114 feet! Once he was able to get the ship turned into the current he - proceeded out of the basin and under the center on the Bayonne Bridge. During the debrief session, Captain Ellis recommended that sailings from Port Elizabeth not be attempted under these current conditions.

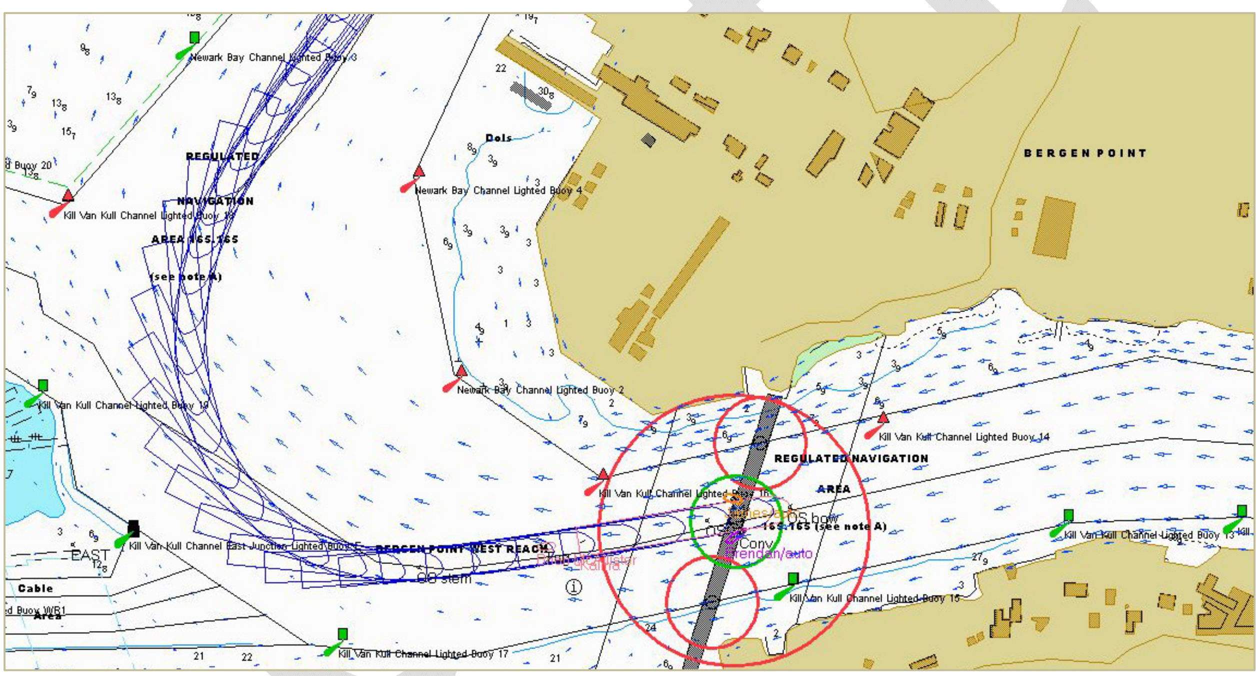


Figure 38: Run 19 – 49' draft – NW@20 / 60% Flood

Run #27 – 40% Ebb Current Evaluation

Pilot: Flannery Kalina at 49'

Start: Newark Bay Buoy 10 @ 5 knots Finish: Bayonne Bridge

Wind: NW 20 Current: 40% Ebb

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

This run was conducted at the beginning of Thursday morning to demonstrate to an MSC representative how the ship can handle the turn at Bergen Point. Everything went well with the run as Captain Flannery used the tugs to first slow the ship, and then using the powered indirect mode maintained his desired turning rate to pass under the bridge at mid-span.

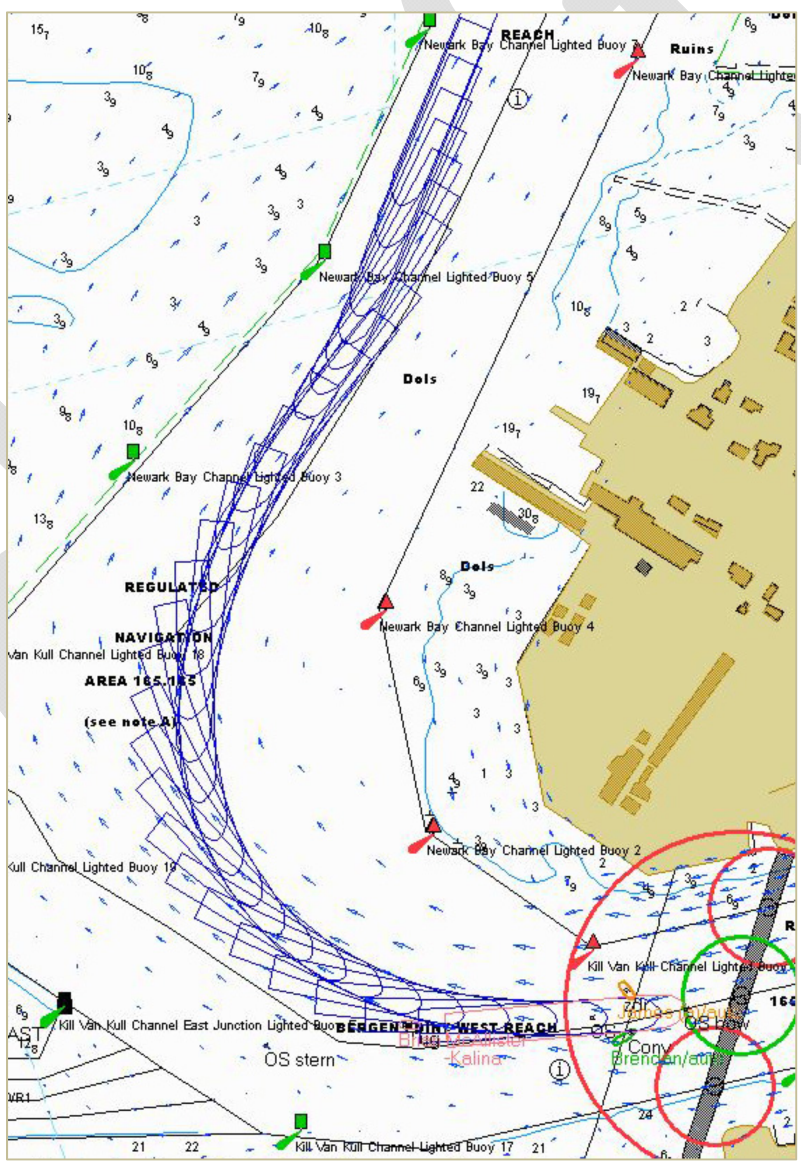


Figure 39: Run 27 – 49' draft – S@20 / 40% Ebb

6.4 INBOUND FROM BUOY 10 NEWARK BAY TO PORT ELIZABETH

Run #20 – Flood Current Evaluation

Pilot: Ellis Kalina at 49'

Start: Newark Bay Buoy 10 @ 5 knots Finish: Port Elizabeth Berth 57

Wind: Calm Current: 40% Flood (1 knot)

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

For this first run into Port Elizabeth, the team placed a *Kalina* size container ships on all berths (including the two berths at the corner junction into Port Elizabeth) to minimize the Docking Master's maneuvering room. Captain Ellis clearly did not want to get anywhere near the two ships moored at the corner, so he made a wider turn to ensure clearance, but then the ship slid to the north and came very close (43 feet) to the flats to the north of the channel. Once Captain Ellis got the ship back under control he smoothly moved the ship down the channel with very little room to spare for his tugs.

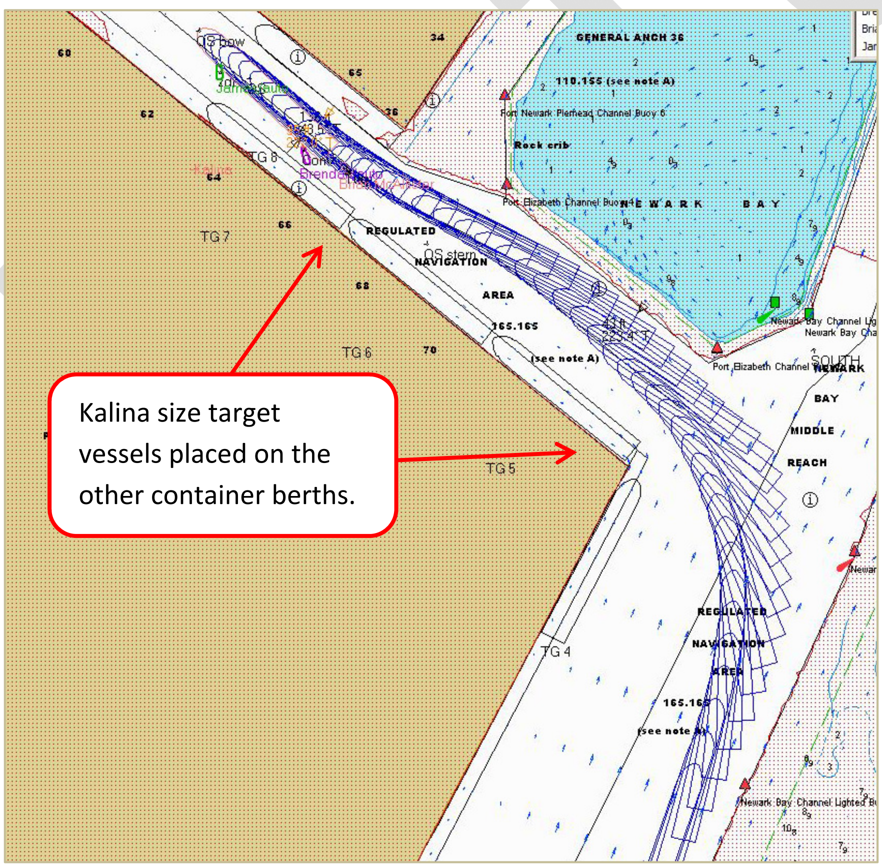


Figure 40: Run 20 – 49' draft – Calm / 60% Flood

Run #21 – 60% Flood Current Evaluation

Pilot: Flannery Kalina at 49'

Start: Newark Bay Buoy 10 @ 5 knots Finish: Port Elizabeth Berth #57

Wind: S 20m Current: 60% Flood

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

For this second run into Port Elizabeth, the ship located on the north side of the corner into Port Elizabeth was removed to provide more room for the ULCV to enter the channel. However, the run in was made more difficult for the Docking Master with a southerly 20 knot wind added to the equation. Approaching the turn into the port, Captain Flannery had *the ship well on the starboard side of the channel and used the tugs to slow the* Kalina down, but could not stop due to the flood current. Entering at 3.0 knots the DM aggressively used the tugs to turn the ship into the Port Elizabeth channel, but again, the flood current swept the ship to the north and the tugs had to be worked quite hard to keep from touching the shoal. As it turned out the ship cleared the channel edge by 36 feet. The DM got the ship under control, but when passing between two of these ULCVs there was little room for the tugs to work.

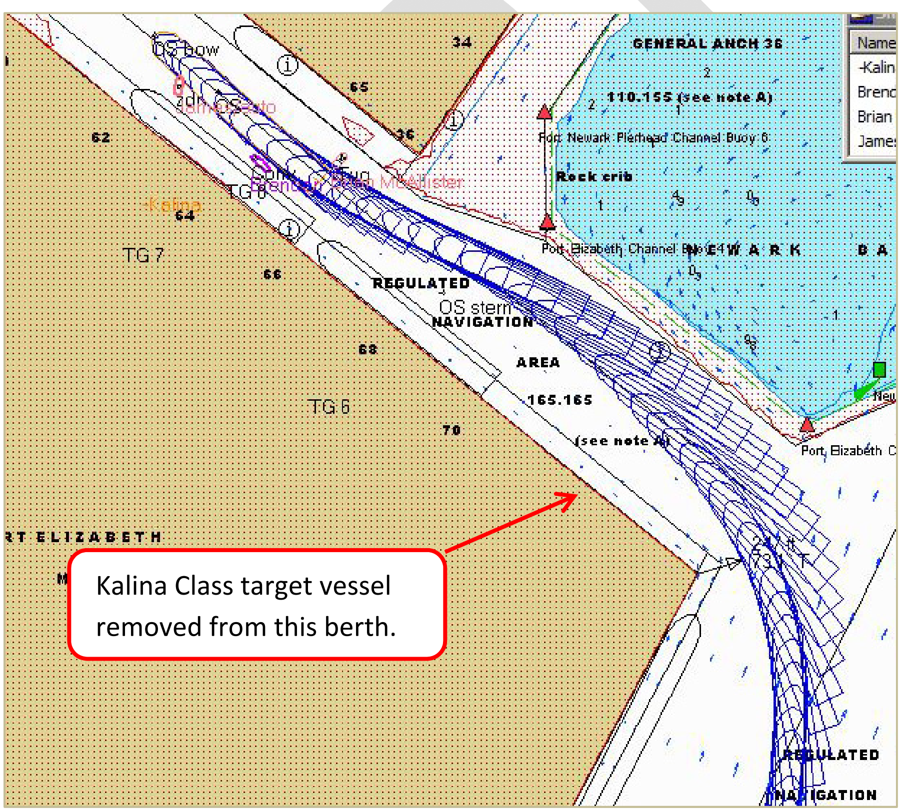


Figure 41: Run 21 – 49' draft – S@20 / 60% Flood

Run #22 – 40% Ebb Current Evaluation

Pilot: Ellis Kalina at 49’

Start: Newark Bay Buoy 10 @ 5 knots Finish: Port Elizabeth Berth #57

Wind: N 20 Current: 40% Ebb

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

For Run 22 the team decided to demonstrate turning into Port Elizabeth with an ebb tide and a north wind. Captain Ellis took advantage of the *Kalina’s* tendency to swing her stern wide when making a turn and used this to make a very sharp turn with the ship with the C/L lead aft tug pulling initially at a 45° angle to starboard, to initiate the turn and also slow the ship. The *James*, located on the port bow, initially was pushing at half power to hold the bow up against the wind. By adjusting the power settings used on the tugs, the DM executed a controlled turn.

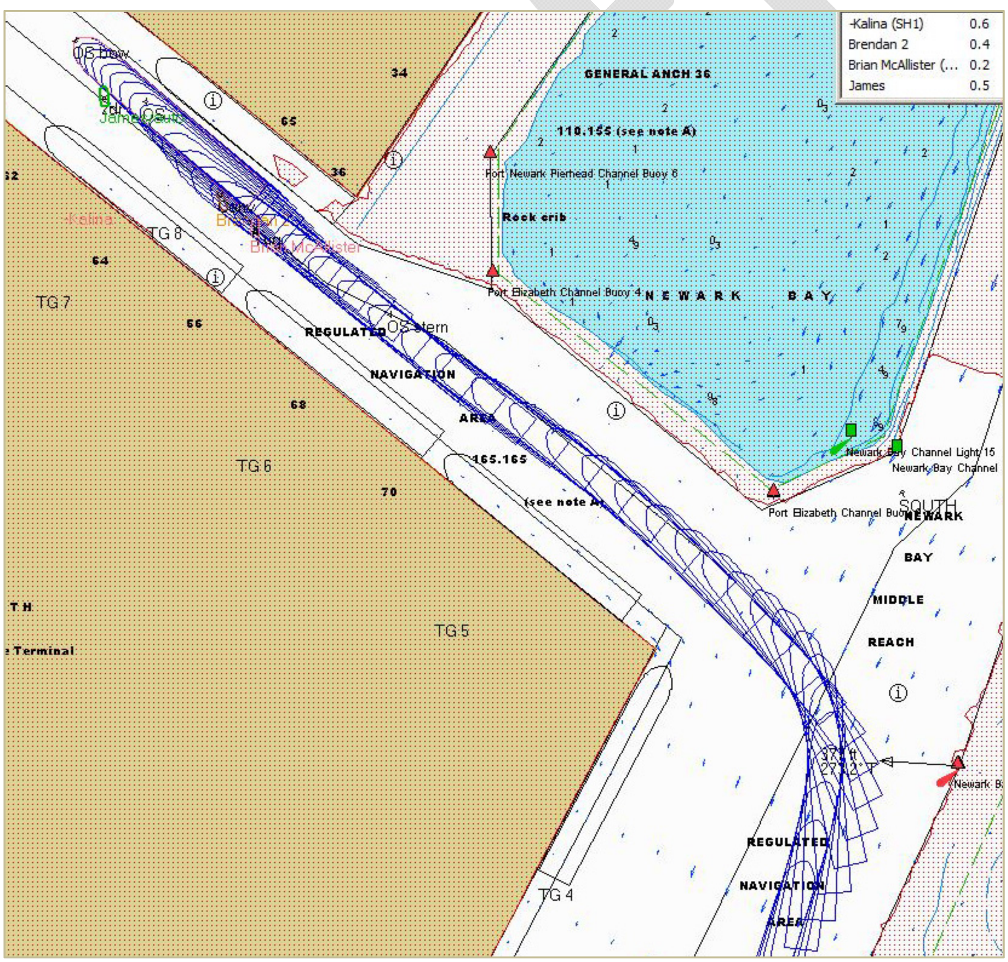


Figure 42: Run 22 – 49’ draft – N@20 / 40% Ebb

Run #23 – Flood Current Evaluation [Stern In]

Pilot: Flannery Kalina at 49’

Start: Newark Bay Buoy 10 @ 5 knots Finish: Port Elizabeth Berth #57

Wind: S 20 Current: 60% Flood

Tugs: Brian Center Lead Aft James Port Bow Brendan Port Quarter

Run Description

In debriefing, Captain Flannery questioned his starting position as he had allowed the ship to slide over closer to the ship at the corner berth, which then limited his ability to turn the vessel when he wanted to, as his stern was now swinging in towards the other ship (cleared by 12’). By the time that his stern was clear of the berthed ship, and stared the stern swing to port, model was sliding bodily sideways with the current. The three tugs could not arrest the sideway motion and the ship grounded on the shoal. Under these conditions, Captain Flannery recommends four tugs to safely handle these ships with some spare power available to the Docking Master if required. (Current file #2353 -1.8 knot flood velocity at Bergen Point.)

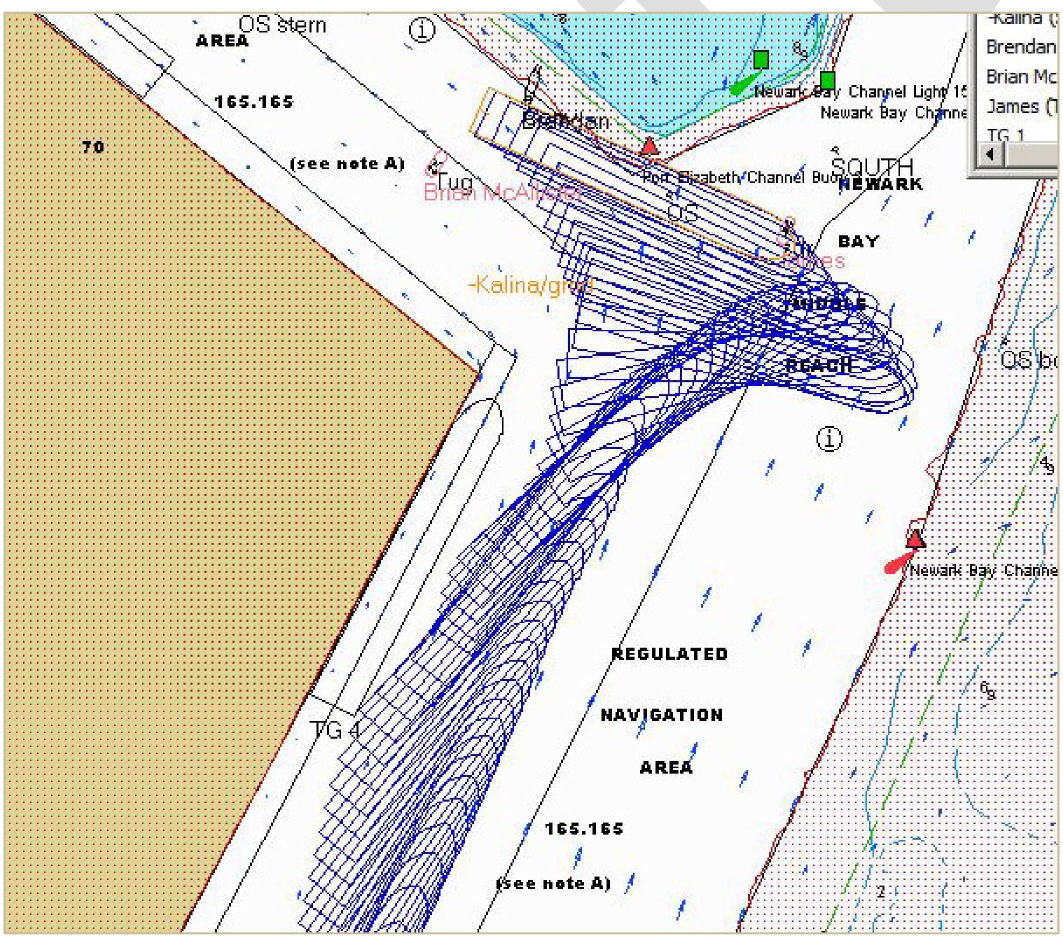


Figure 43: Run 23 – 49’ draft – S@20 / 60% Flood [Stern In]

Run #24 – 40% Ebb Current Evaluation [Stern In]

Pilot: Flannery Kalina at 49’

Start: Newark Bay Buoy 10 @ 5 knots Finish: Port Elizabeth Berth #57

Wind: S 20 Current: 40% Ebb (1 knot)

Tugs: Brian Center Lead Aft James Center Lead Forward Brendan Starboard Bow

Run Description

As Captain Flannery stated the initial approach was made by keeping the ship in the middle of Newark Bay South Reach to allow room for the stern to swing to port as the pilot maneuvers the ship to line up to back into the Port Elizabeth South Reach. The turn was made, but as the ship started to back into the slip, the pivot point of the ship moved aft a bit. The consequence of this change was that the 80t tug working forward (James) could not hold up his end of the ship (confirming Captain Flannery’s suggestion that under these conditions this should be a four boat job). Once turned and backing down the Port Elizabeth channel, the ship was still a handful to control in the narrow maneuvering channel left when ULCVs are berthed on both sides of the channel.

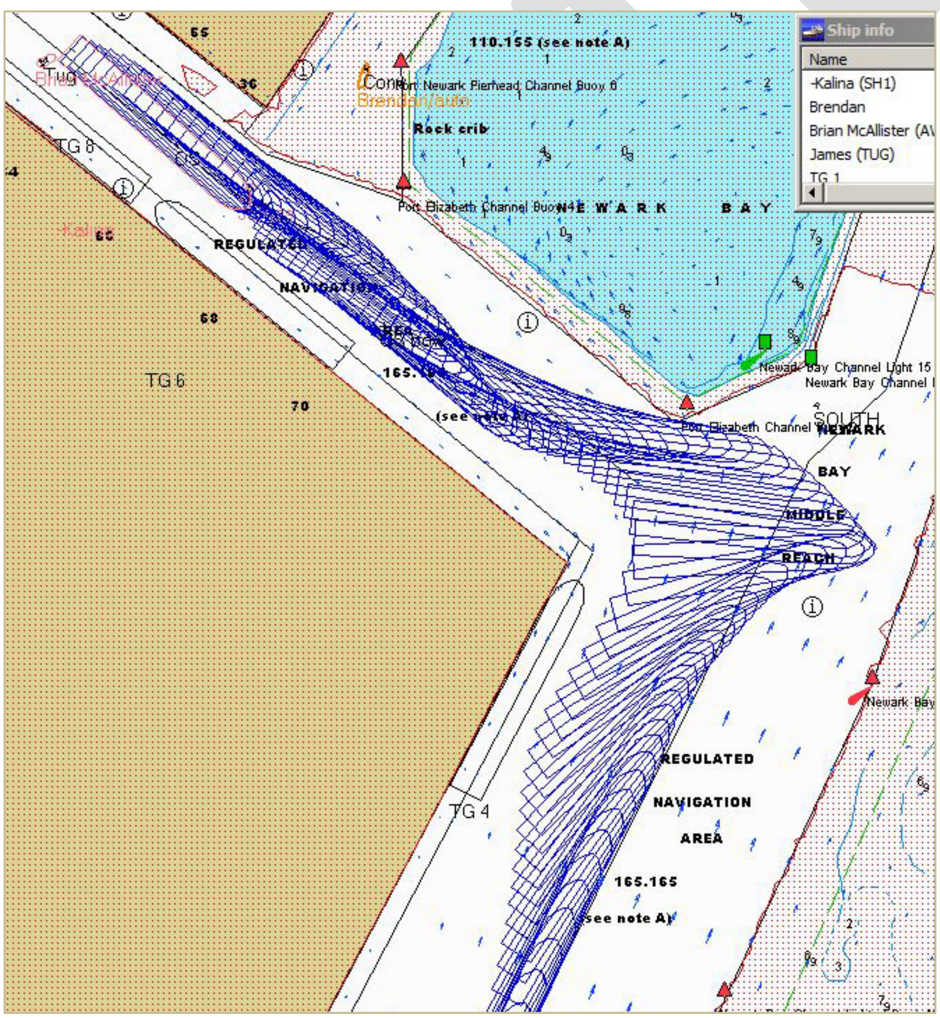


Figure 44: Run 24 – 49’ draft – S@20 / 40% Ebb [Stern In]

Run #25 – 40% Ebb Current Evaluation [Stern In]

Pilot: Ellis Kalina at 49'

Start: Newark Bay Buoy 10 @ 5 knots Finish: Port Elizabeth Berth #57

Wind: N 20 Current: 40% Ebb

Tugs: Brian Center Lead Aft James Center Lead Forward Brendan Starboard Quarter

Run Description

Captain Ellis made a nice approach to the turn point but had a little too much speed on the *Kalina. The DM* could not stop the forward progress of the ship as he turned the ship ≈93° required to back into the Port Elizabeth Channel. This run was stopped at this point, and Captain Ellis repeated the run with far better results. In the debrief, Captain Ellis did question how slow the model was to stop from 0.9 knots ahead.

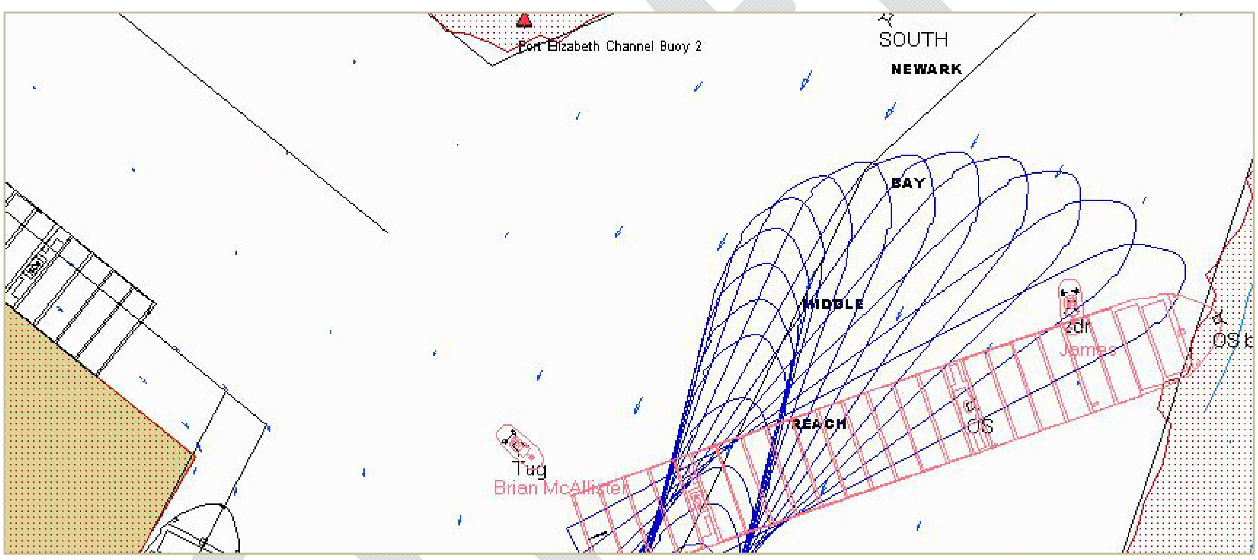


Figure 45: Run 25 – 49' draft – N@20 / 40% Ebb [Stern In]

Run #26 – 40% Ebb Current Evaluation [Stern In]

Pilot: Ellis Kalina at 49'

Start: Newark Bay Buoy 10 @ 5 knots Finish: Port Elizabeth Berth #57

Wind: N 20 Current: 40% Ebb

Tugs: Brian Center Lead Aft James Port Bow Brendan Starboard Bow

Run Description

In this run, Captain Ellis was careful to get the ship almost dead in the water before he began to swing the ship. He then stopped the swing backing into the Port Elizabeth channel. This was a good example of energy control with these large ships. A very excellent run!

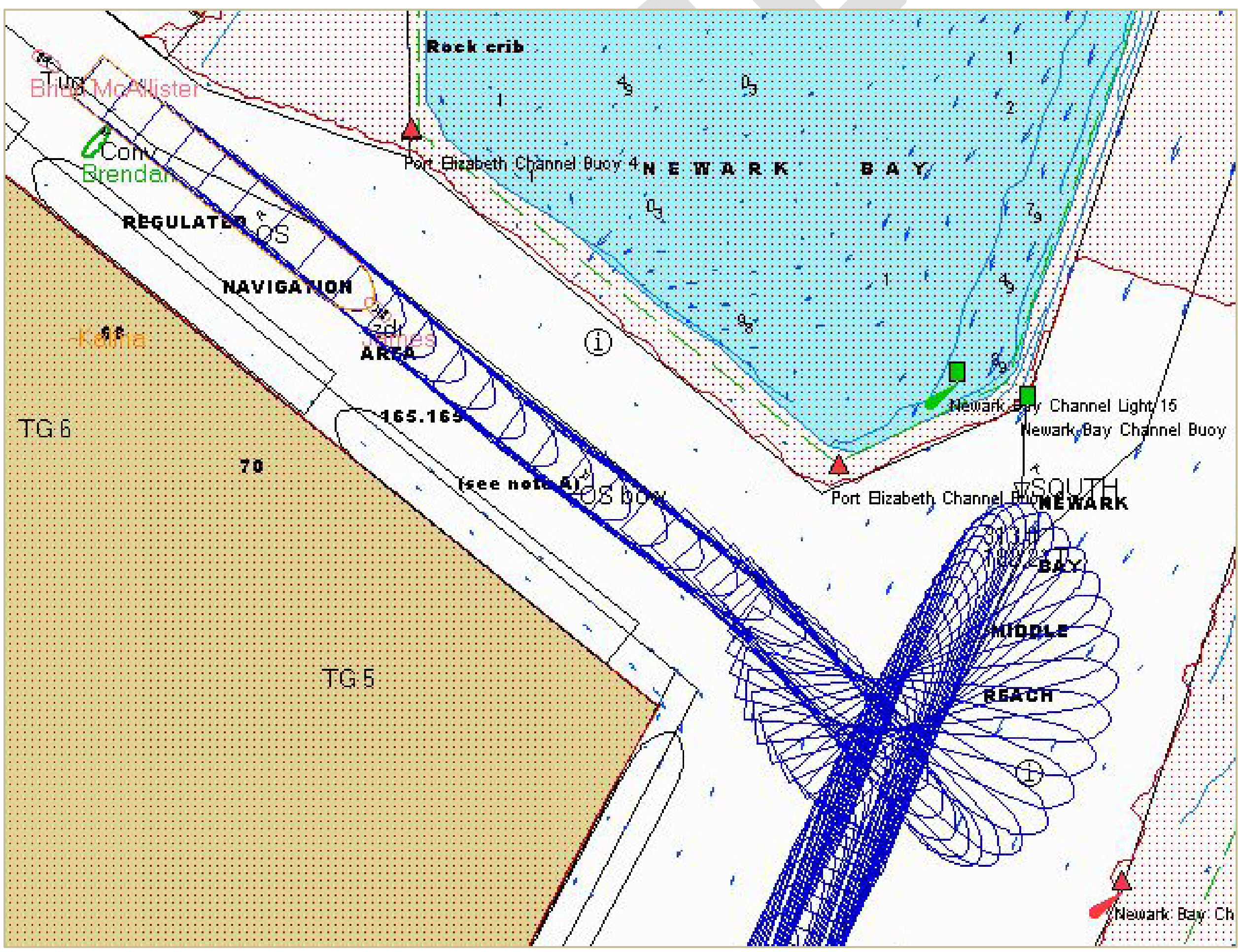


Figure 46: Run 25 – 49' draft – N@20 / 40% Ebb [Stern In]

6.5 OUTBOUND FROM PORT ELIZABETH TO BUOY 10 NEWARK BAY

Run #28 – 60% Ebb Current Evaluation [Stern First]

Pilot: Ellis Kalina at 49'

Start: Port Elizabeth Berth #57 Finish: Newark Bay Buoy 10

Wind: N 20 Current: 60% Ebb

Tugs: Brian Center Lead Aft James Center Lead Forward Brendan Port Quarter Sisters Port Shoulder

Run Description

For this run, the team decided to give the Docking Masters a fourth tug (46t Conventional) to ensure that the DM's have the power that they think they will need to safely conduct this maneuver. One of the significant issues that the DM's had was the limited room to work the tugs when ULCVs are moored on both sides. Captain Ellis did an excellent job in moving this ship at an average speed of 3.5 knots in a near straight line out to the main Newark Bay Channel; stopped the ship with 105' of clearance on his stern, and then neatly turned the ship to head southward to sea. This was a very beautiful run to watch.

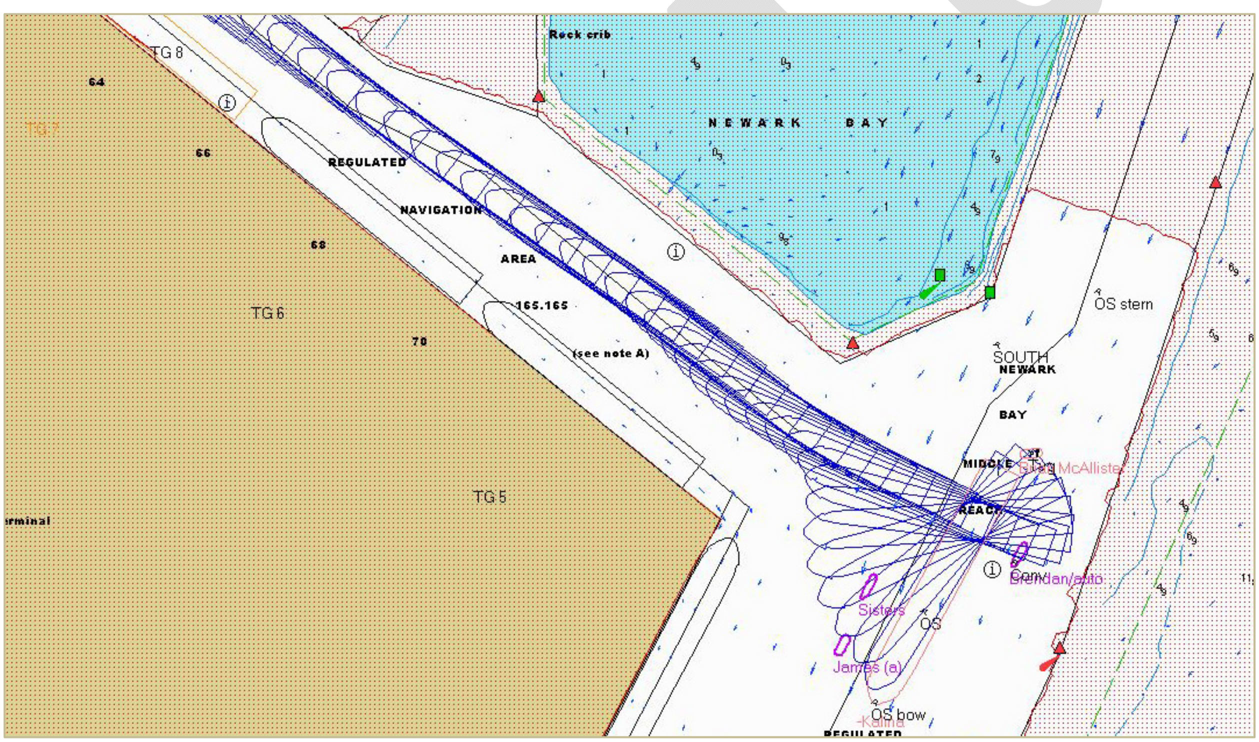


Figure 47: Run 28 – 49' draft – N@20 / 60% Ebb [Stern First]

Run #29 – Flood Current Evaluation [Stern First]

Pilot:	Flannery	Kalina at 49’	
Start:	Port Elizabeth Berth #57	Finish:	Newark Bay Buoy 10
Wind:	S 20	Current:	60% Flood
Tugs:	Brian Center Lead Aft	James Center Lead Forward	
	Brendan Starboard Shoulder	Sisters Starboard Quarter	

Run Description

This run started off well with the vessel being pulled off the berth by the *James* and *Brian*. As soon as they could get in-between the ship and the berth, the *Brendan* and *Sisters* were brought alongside the starboard side of the ship. However, the ship was moving sideways a little fast and when the Docking Master stopped the lateral motion, the ship’s stern was within 58 feet of the ship moored on the opposite of the channel. Working the tugs on both sides of the ship made for tight quarters for the tugs. Clearing the inner berths, the ship picked up a very slight shear to the south that the DM had to address with the tugs to get the ship laterally away from the corner of the Port Elizabeth berthing area. Once in the Newark Bay main channel with plenty of room to the shoaling area, the DM neatly turned the ship and headed south. (Current File # 2353 – 1.8 knots flood at Bergen Point.)

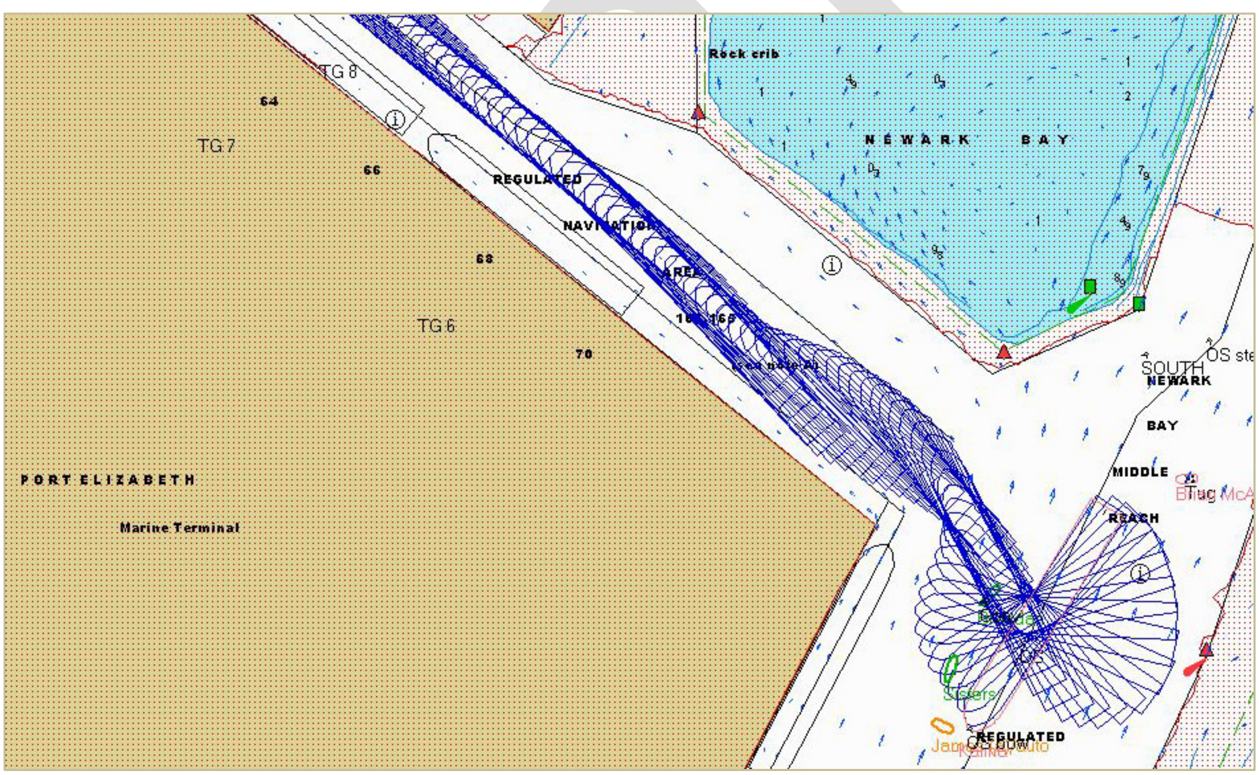


Figure 48: Run 29 – 49’ draft – S@20 / 60% Flood [Stern First]

Run #30 – 40% Flood Current Evaluation [Bow First]

Pilot: Ellis Kalina at 49'

Start: Port Elizabeth Berth #57 Finish: Newark Bay Buoy 10

Wind: N 20 Current: 40% Ebb

Tugs: Brian Center Lead Forward James Center Lead Aft

Brendan Starboard Quarter Sisters Starboard Bow

Run Description

To save time, the run started with the *Kalina* already off her berth, and ready to accelerate down the channel. As the pilot was clearing the inner channel, he brought the ship further to the windward side of the channel, to ease his turn into the main Newark Bay Channel, clearing the stern of the last container ship moored on the north side of the inner channel by 47 feet. For the entire run, Captain Ellis kept the tractors made up at the center leads fore and aft and the two conventional tugs at the starboard shoulder and quarter.

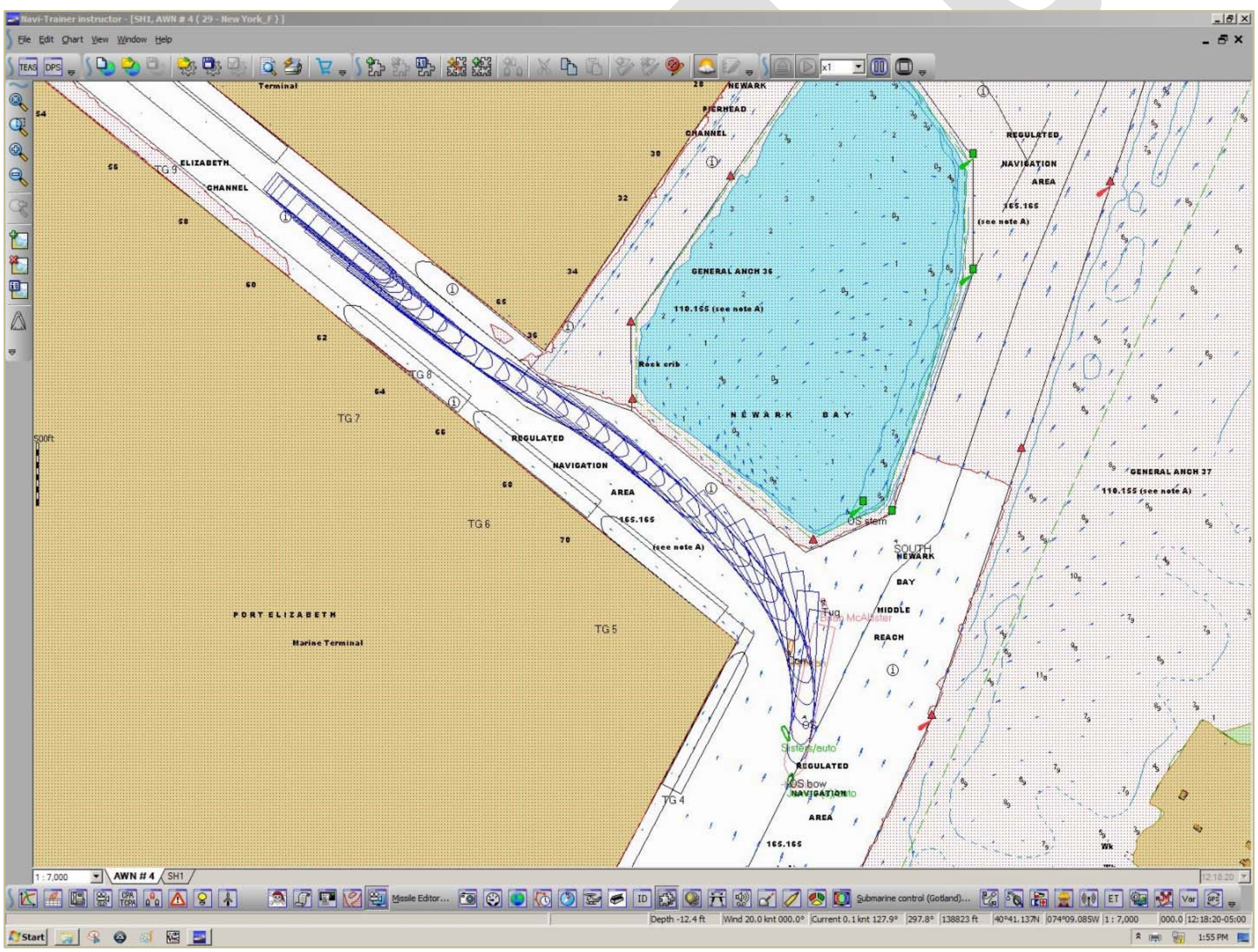


Figure 49: Run 30 – 49' draft – N@20 / 40% Flood [Bow First]

6.6 INBOUND FROM UPPER BAY TO BUOY 30 TO GLOBAL TERMINAL (PORT JERSEY)

Run #31 – 40% Flood Current Evaluation

Pilot: Ellis Kalina at 49'

Start: Upper Bay Buoy #30 Finish: Global Terminal Bayonne

Wind: S 20 Current: .09 Knots Flood

Tugs: Brian Center Lead Aft James Port Bow

Brendan Starboard Bow Sisters Starboard Quarter

Run Description

For these runs the team set a passenger ship berthed on the southern side of the entrance and a small bulker on the other side to narrow the available room. Captain Ellis was a little surprised that the rate of turn was not a bit higher turning from the main ship channel in the upper Bay to run south of the Jersey Flats. Even with the southerly wind and flood current, the ship did not seem to slide too badly, but an earlier turn would have improved the margin of errors under these conditions. Once out of the current in the Upper Bay the passage to the terminal was uneventful.

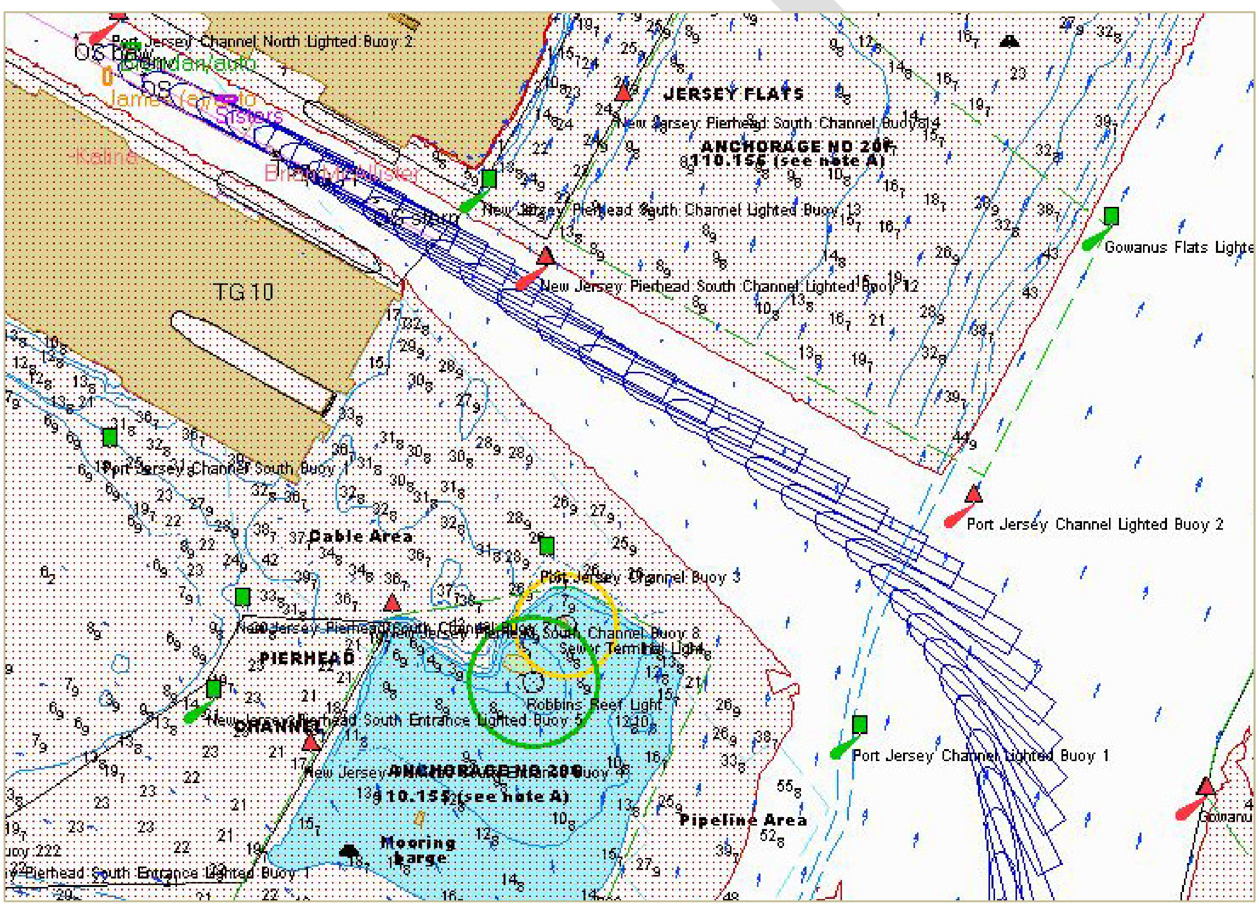


Figure 50: Run 31 – 49' draft – S@20 / 40% knots Flood

Run #32 – 40% Ebb Current Evaluation

Pilot: Flannery Kalina at 49’

Start: Upper Bay Buoy #30 Finish: Global Terminal Bayonne

Wind: N 20 Current: 40% Ebb

Tugs: Brian Center Lead Aft James Port Shoulder

Brendan Port Bow Sisters Port Quarter

Run Description

During this run, Captain Flannery made a nice turn out of the upper bay channel, but as the ship approached the entrance to the Global channel the ship sagged a bit down onto the passenger ship passing it with a CPA of 98’. This was a nice controlled run.

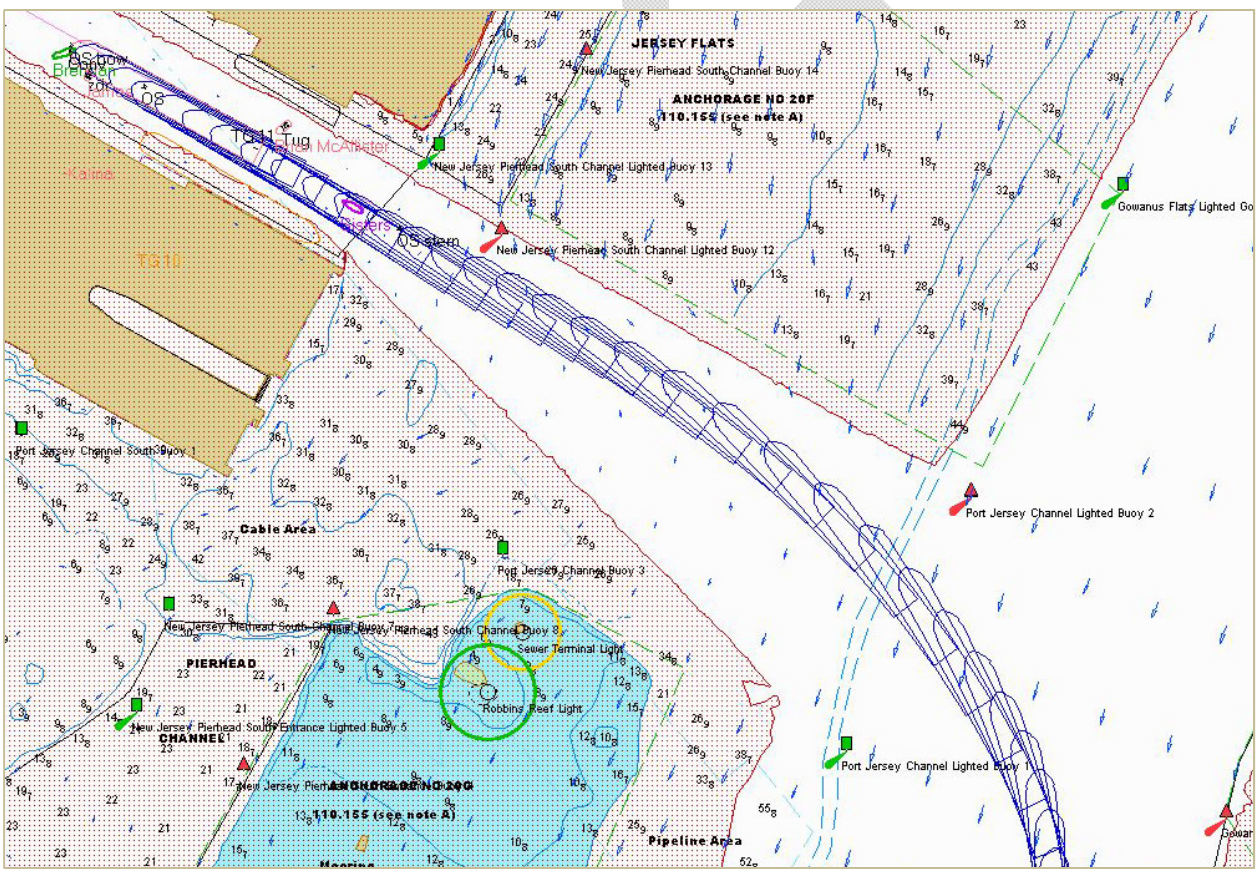


Figure 51: Run 32 – 49’ draft – N@20 / 40% knots Ebb

6.7 OUTBOUND FROM GLOBAL TERMINAL (PORT JERSEY) TO UPPER BAY BUOY 30

Run #33 – Slack Water - Stern First Departure Evaluation

Pilot: Ellis Kalina at 49’

Start: Global Terminal Bayonne Finish: Upper Bay Buoy #30

Wind: N 20 Current: Slack

Tugs: Brian Center Lead Aft James Center Lead Forward

Brendan Port Bow Sisters Port Quarter

Run Description

This run was the first of two stern first departures that were attempted. After he had cleared the berth, Captain Ellis let the ship climb a bit to the north so that the Kalina could pass between the two ships that were moored at the entrance to this waterway with an equal clearing distance on both sides of the *Kalina*. After passing these ships he took his ship down the center of the widener and then swung the ship when he was clear.

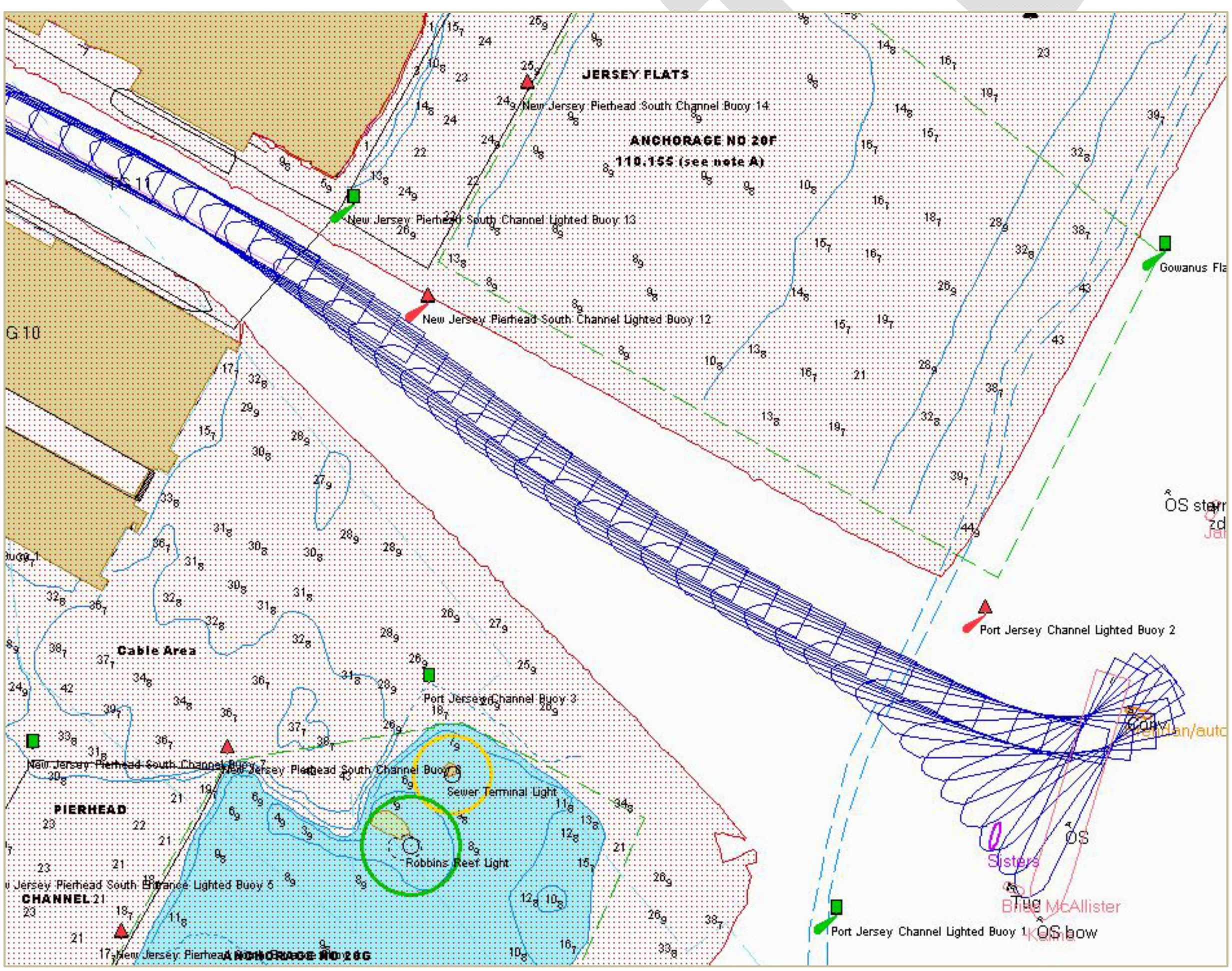


Figure 52: Run 33 – 49’ draft – N@20 / Slack – Stern First

Run #35 – Slack Water - Stern First Departure Evaluation

Pilot: Ellis Kalina at 49'

Start: Global Terminal Bayonne Finish: Upper Bay Buoy #30

Wind: S 20 Current: Slack

Tugs: James Center Lead Aft Brian Center Lead Forward

Brendan Port Quarter Sisters Port Bow

Run Description

To expedite this exercise, the ship was placed off the Global berth in the middle of the channel as we did not need to prove that four tugs would be able to lift the *Kalina* off the berth to start the exercise. Captain Ellis was able to easily maintain the ship in the center of the channel as he backed the ship out into the Upper Bay were he turned the vessel. The pilot did not have any difficulties with the maneuver.

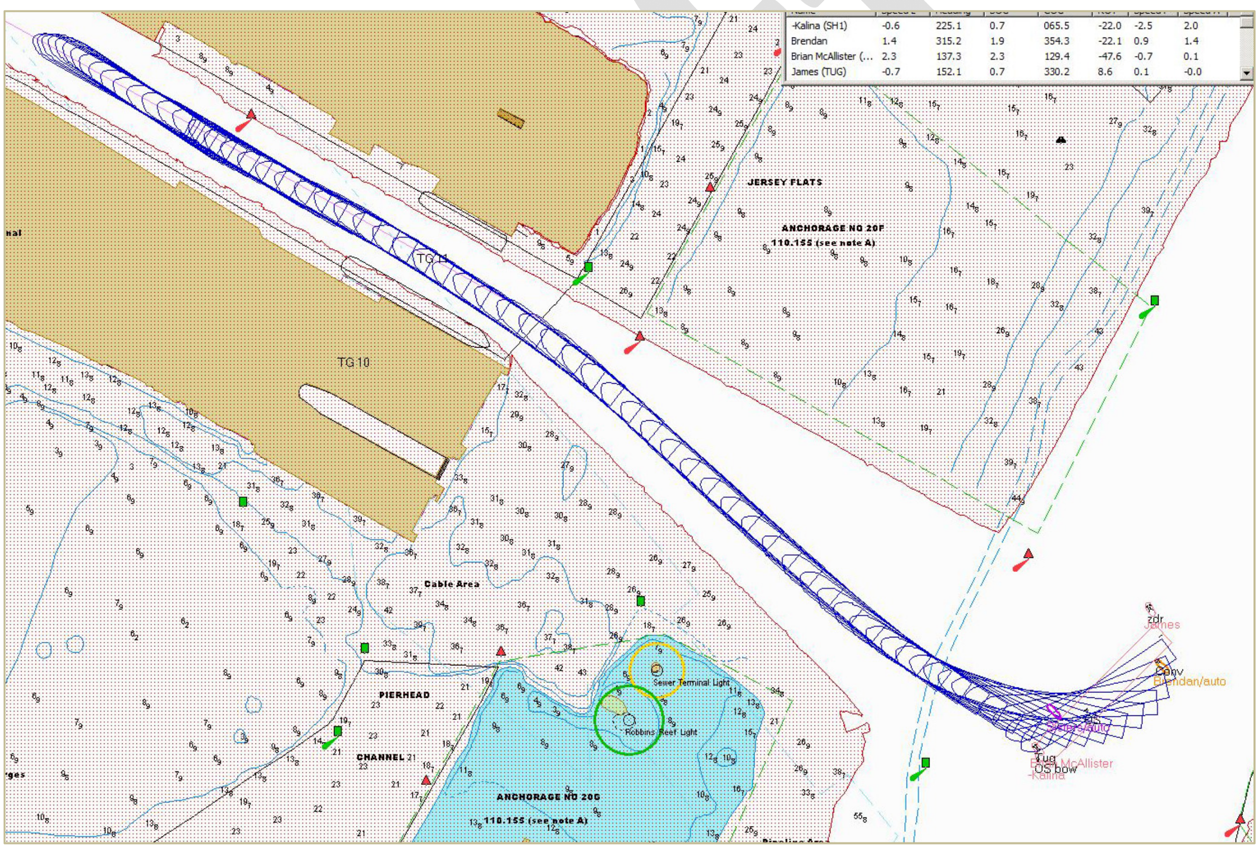


Figure 53: Run 35 – 49' draft – S@20 / Slack – Stern First

6.8 EMERGENCY 180° TURNS

Run #36 & 37 – Emergency 180° Turn

Pilot: R. Blake & S. Naples Kalina at 49’

Start: Abeam Norton’s Point Buoy 22 Finish: Upper Bay Buoy #30

Wind: S 20 Current: Slack

Tugs: Run 36: Brian Center Lead Aft James Center Lead Forward

Note: **Note:** in Run 37 the tugs, wind and currents were reversed

Run Description

Captain Blake’s run started out at 10 knots when passing buoy 22 (he would have preferred to be proceeding at a slower pace). The plan was to have two 80t ASDs waiting for the ULCV just above the Verrazano Narrows Bridge, to protect against a channel blockage occurring in the Upper Bay or Kill Van Kull. If so, the tugs would proceed to the ULCV and assist her to turn around and return to a safe anchorage outside of Ambrose Channel. As runs 36 & 37 demonstrated that these large ships can be easily turned. See Figure 55, illustrating runs 36 and 37 side by side.

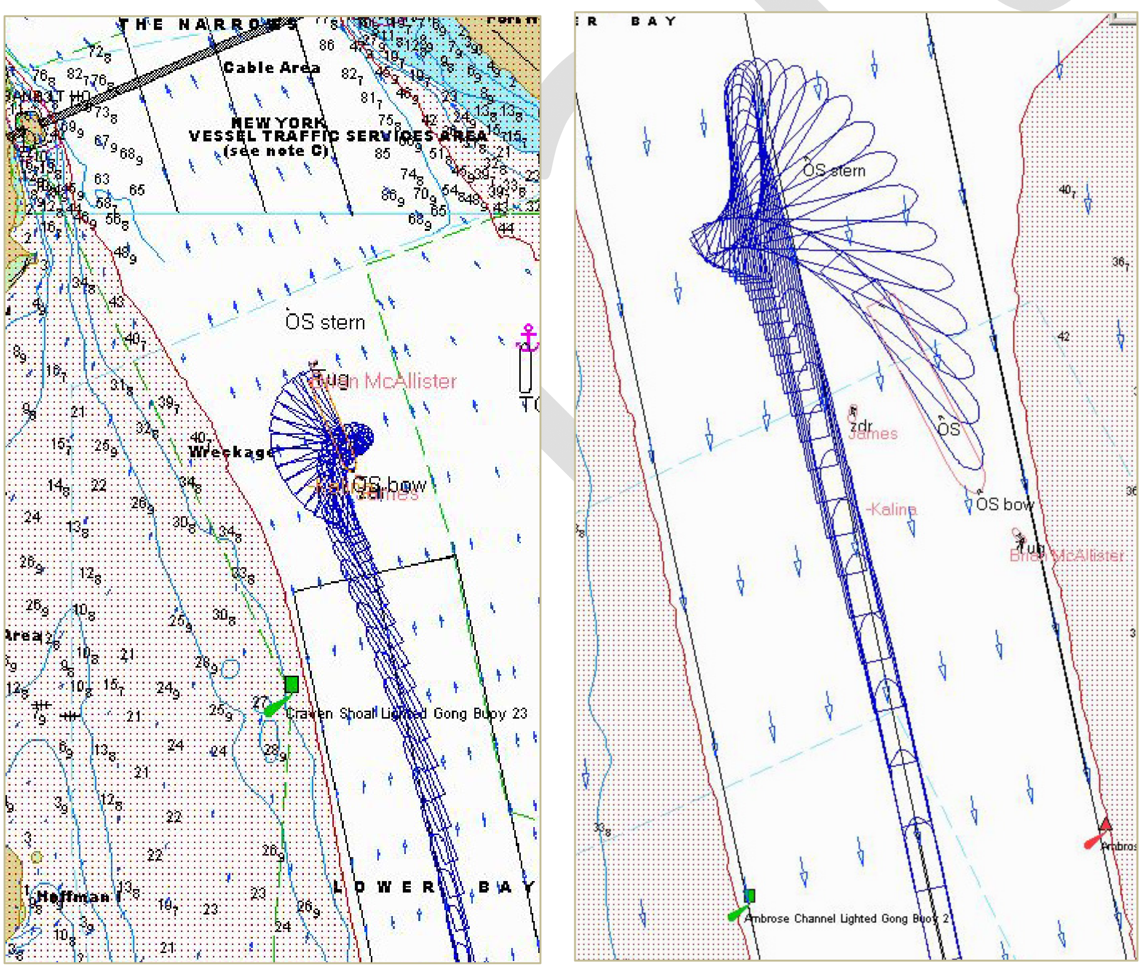


Figure 54: Run 36 – 49’ draft – S@20 / Flood Run 37 – 49’ draft – N@20 / Ebb

Run #38 – Emergency 180° Turn [Upper Bay]

Pilot: J. Oldmixon Kalina at 49'

Start: Abeam Norton's Point Buoy 22 Finish: Upper Bay Buoy #30

Wind: S 20 Current: Flood

Tugs: James Center Lead Aft Brian Center Lead Aft

Run Description

As with Runs 36 & 37, two runs were planned with the ship needing to turn around above the bridge with alternating winds and currents, but in the first case the ship ran aground on a small lump in the upper bay that is scheduled to be removed. As this grounding had no effect on the tug's proven ability to turn the ship, the run was not repeated due to time constraints. **[Note:** In this run both tugs were tethered aft, first to slow the ship and then to turn her.**]**

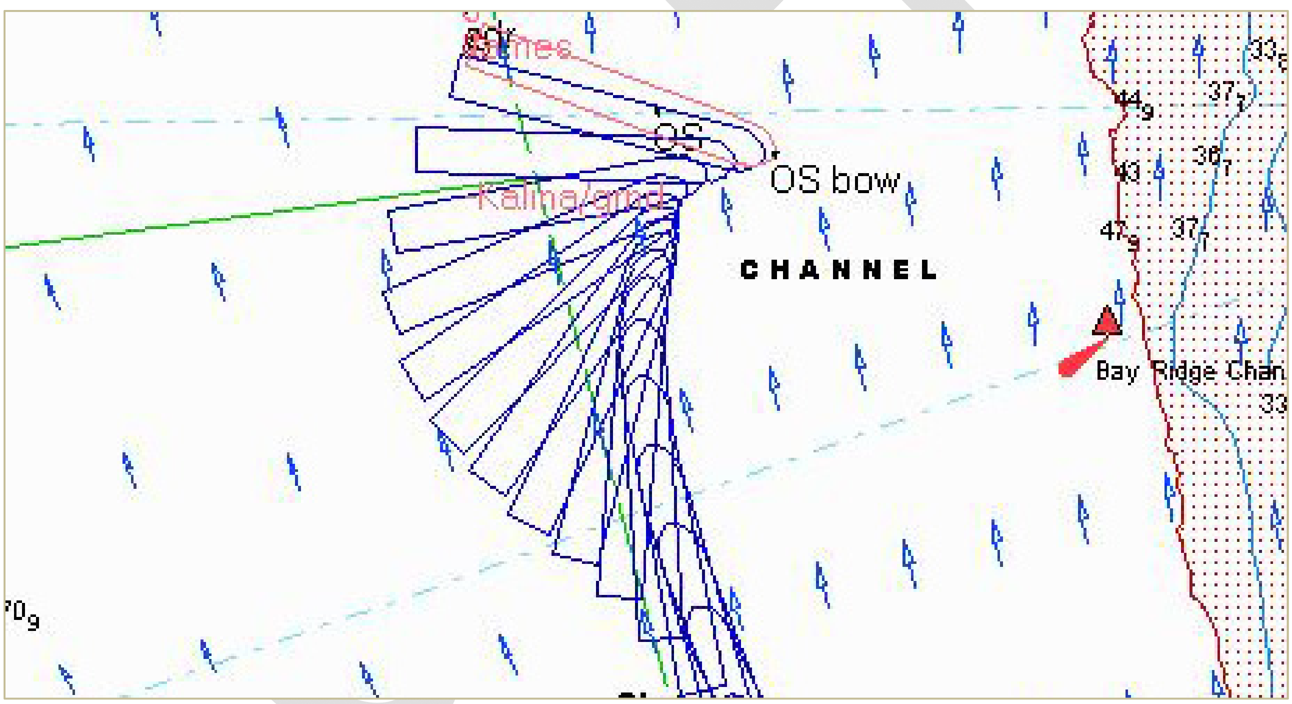
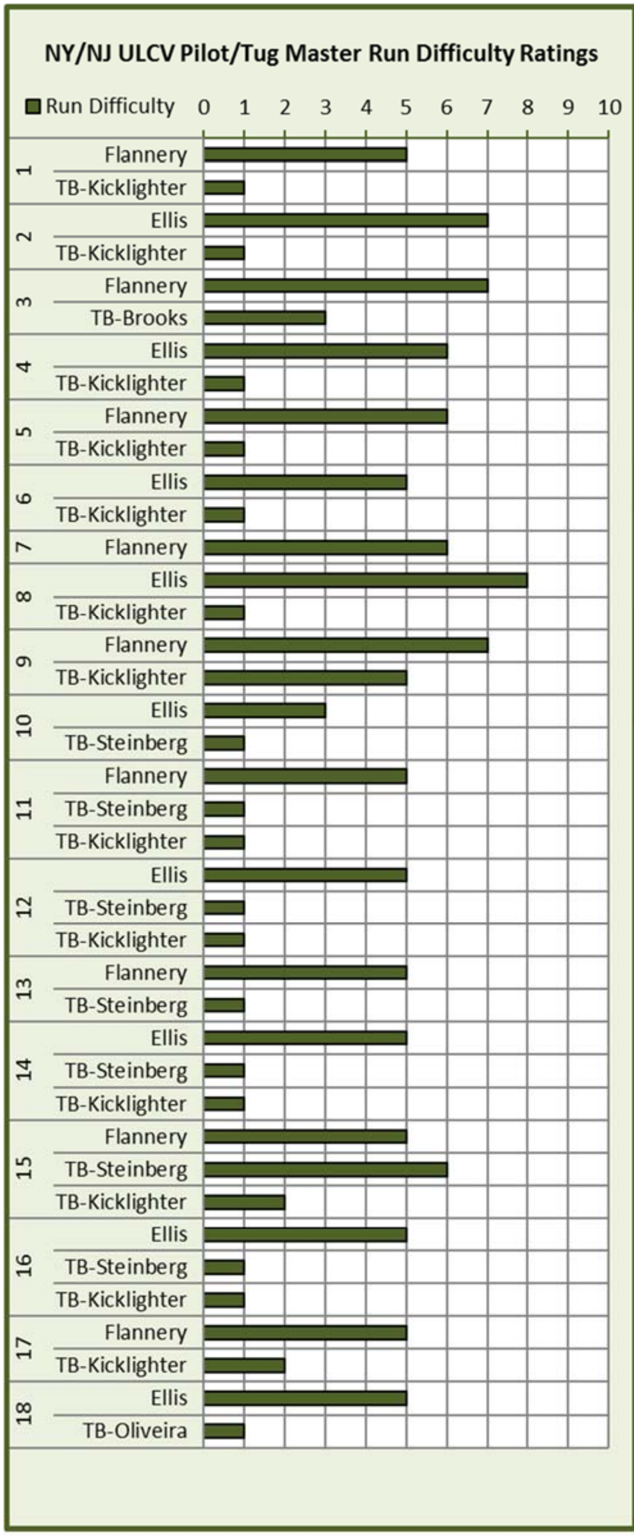
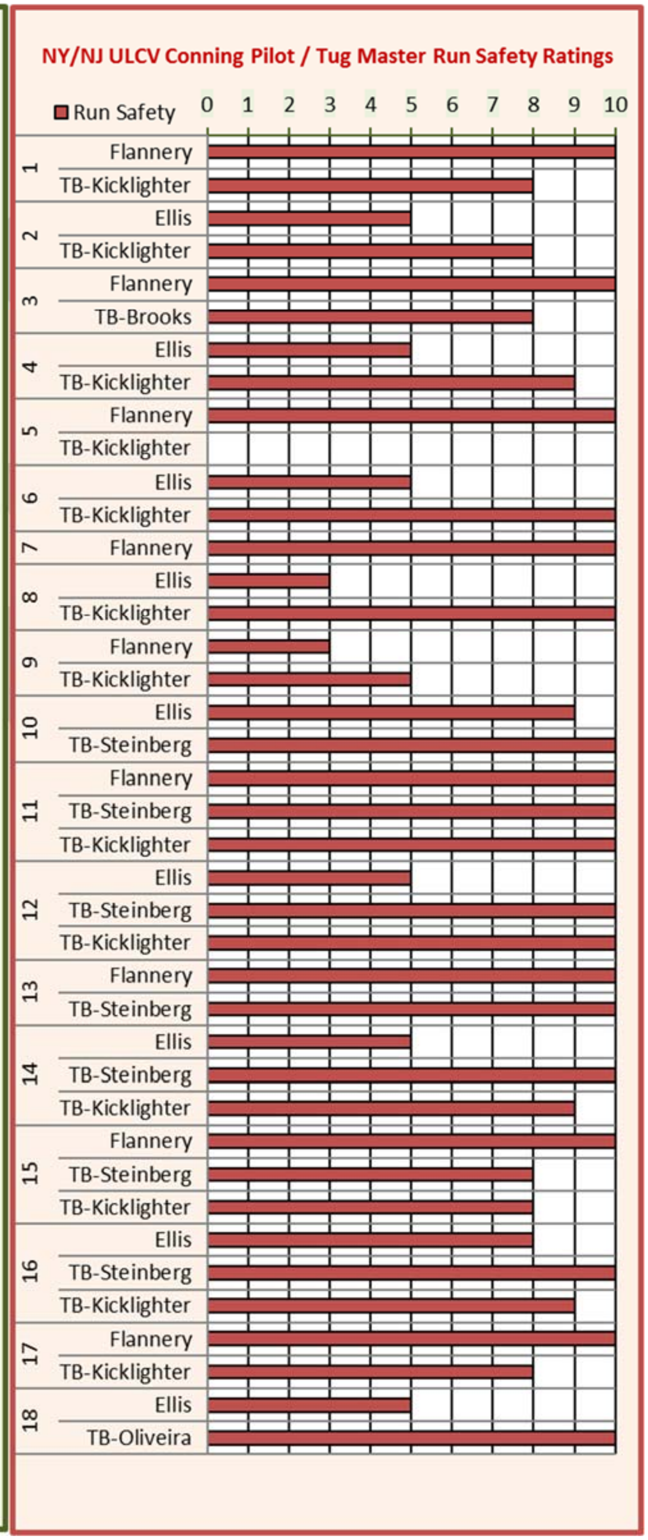


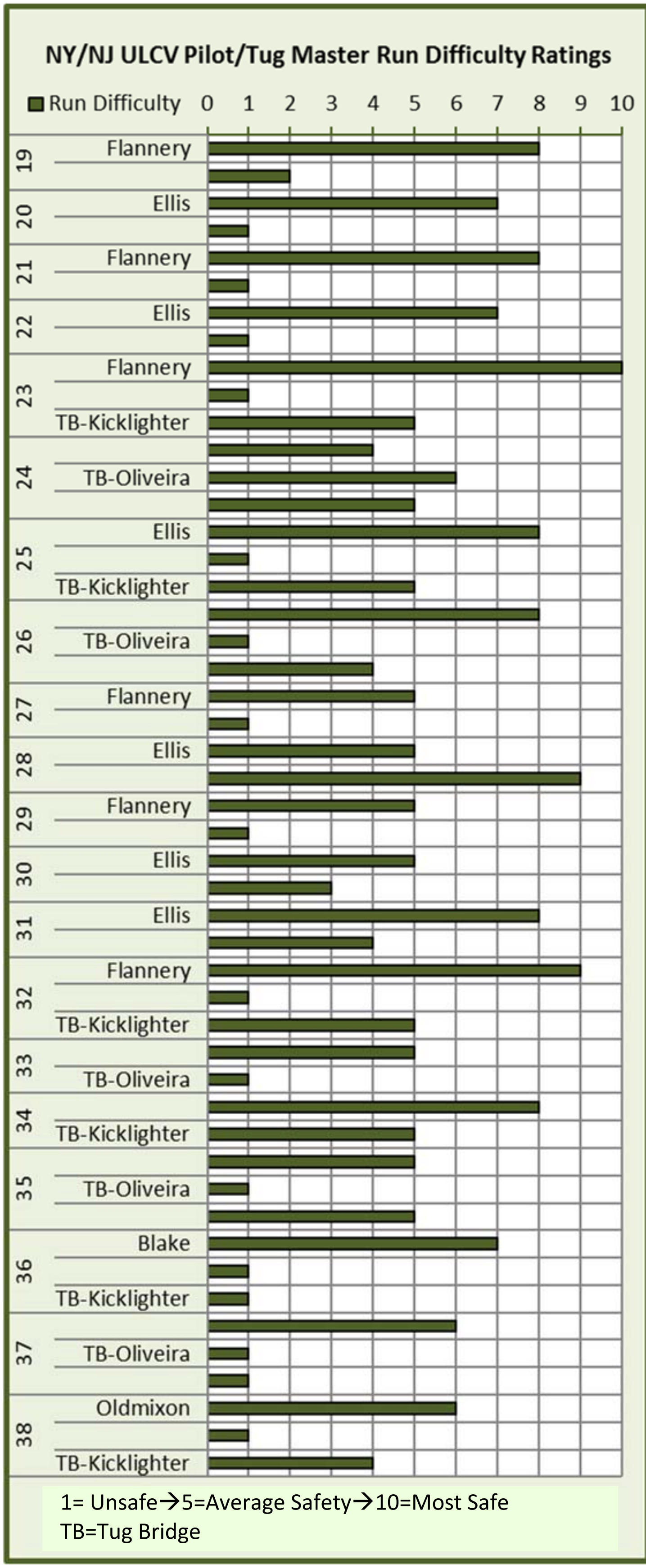
Figure 55: Run 38 – 49' draft – S@20 / Flood

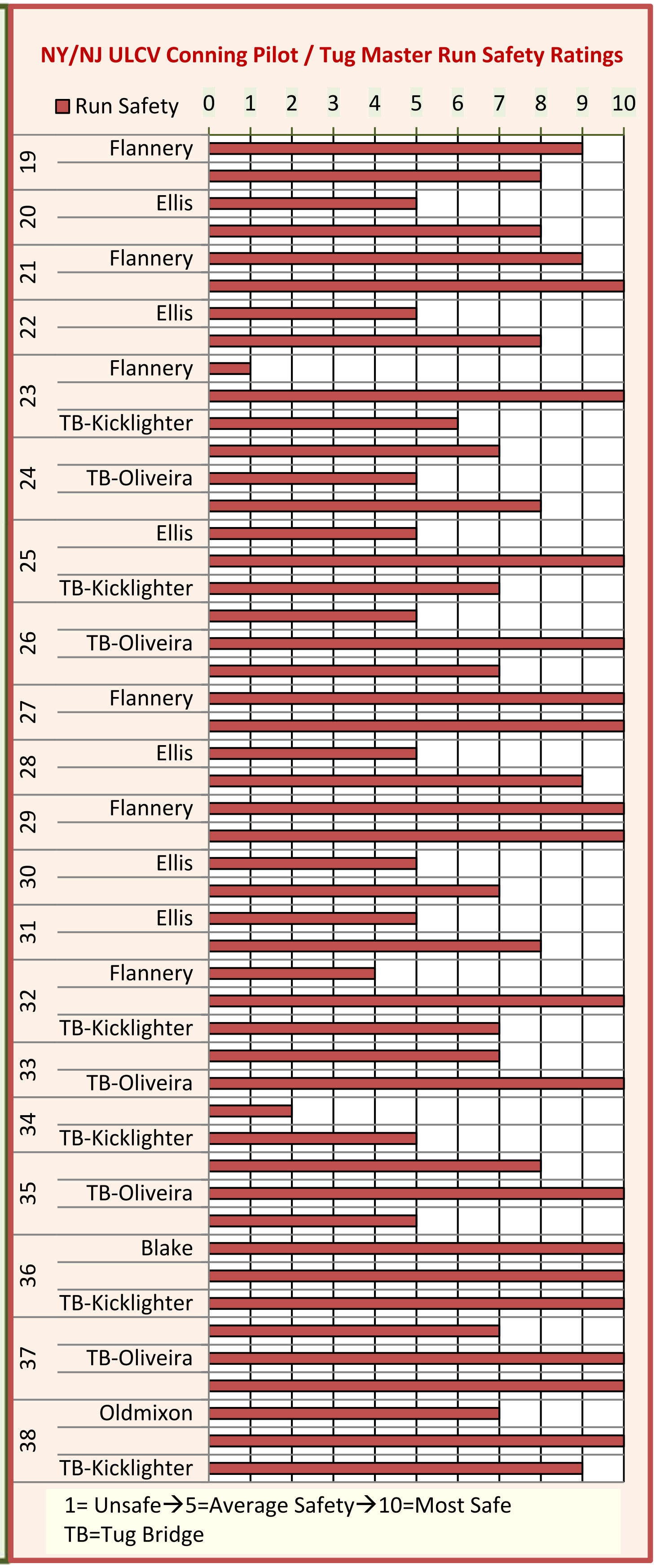
7. PILOT FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

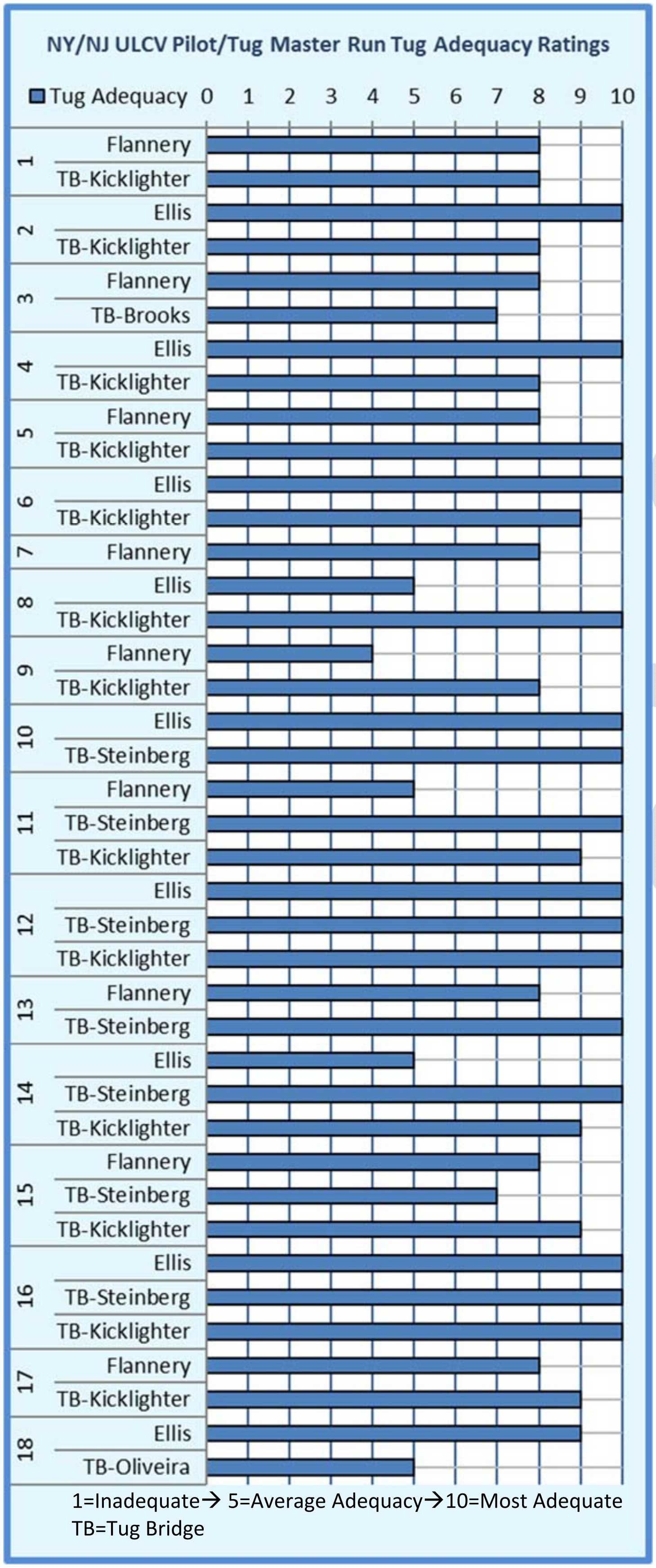
After each run, the conning pilot and tug operators filled out questionnaires that rated the safety and difficulty of the run. The scales used were from 1 to 10 with one being unsafe or not difficult, and 10 being very safe or very difficult. Note that a run can be difficult, but safe. Thirty-eight (runs) were completed in the June 2016 tests. The following graphs display side by side comparisons of the difficulty and safety ratings of the runs. "Tug Adequacy" graphs follow the difficulty and safety ratings.

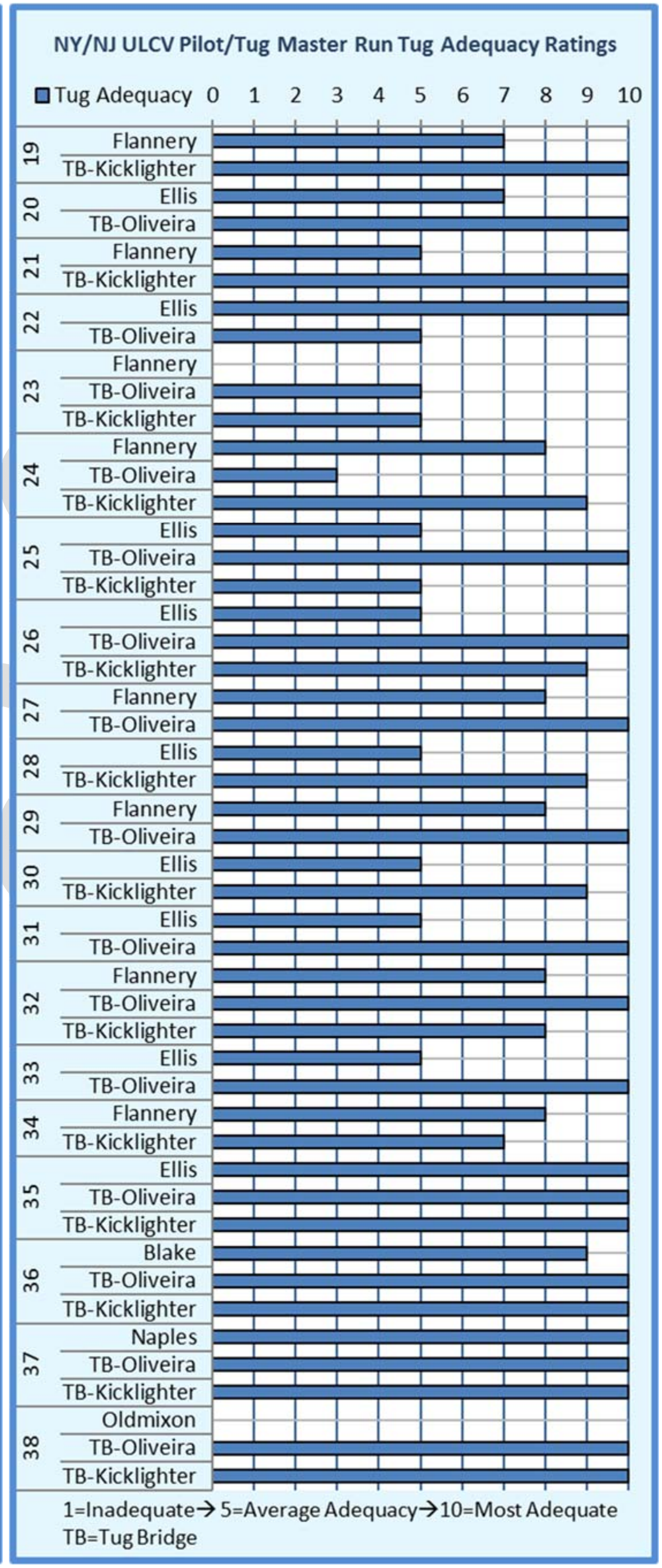





NY/NJ ULCV Pilot/Tug Master Run Difficulty Ratings
Run Difficulty
0 1 2 3 4 5 6 7 8 9 10
19 Flannery
20 Ellis
21 Flannery
22 Ellis
23 Flannery
TB-Kicklighter
24 TB-Oliveira
25 Ellis
TB-Kicklighter
26 TB-Oliveira
27 Flannery
28 Ellis
29 Flannery
30 Ellis
31 Ellis
32 Flannery
TB-Kicklighter
33 TB-Oliveira
34 TB-Kicklighter
35 TB-Oliveira
36 Blake
TB-Kicklighter
37 TB-Oliveira
38 Oldmixon
TB-Kicklighter
1= Unsafe→5=Average Safety→10=Most Safe
TB=Tug Bridge


NY/NJ ULCV Conning Pilot / Tug Master Run Safety Ratings
Run Safety
0 1 2 3 4 5 6 7 8 9 10
19 Flannery
20 Ellis
21 Flannery
22 Ellis
23 Flannery
TB-Kicklighter
24 TB-Oliveira
25 Ellis
TB-Kicklighter
26 TB-Oliveira
27 Flannery
28 Ellis
29 Flannery
30 Ellis
31 Ellis
32 Flannery
TB-Kicklighter
33 TB-Oliveira
34 TB-Kicklighter
35 TB-Oliveira
36 Blake
TB-Kicklighter
37 TB-Oliveira
38 Oldmixon
TB-Kicklighter
1= Unsafe→5=Average Safety→10=Most Safe
TB=Tug Bridge

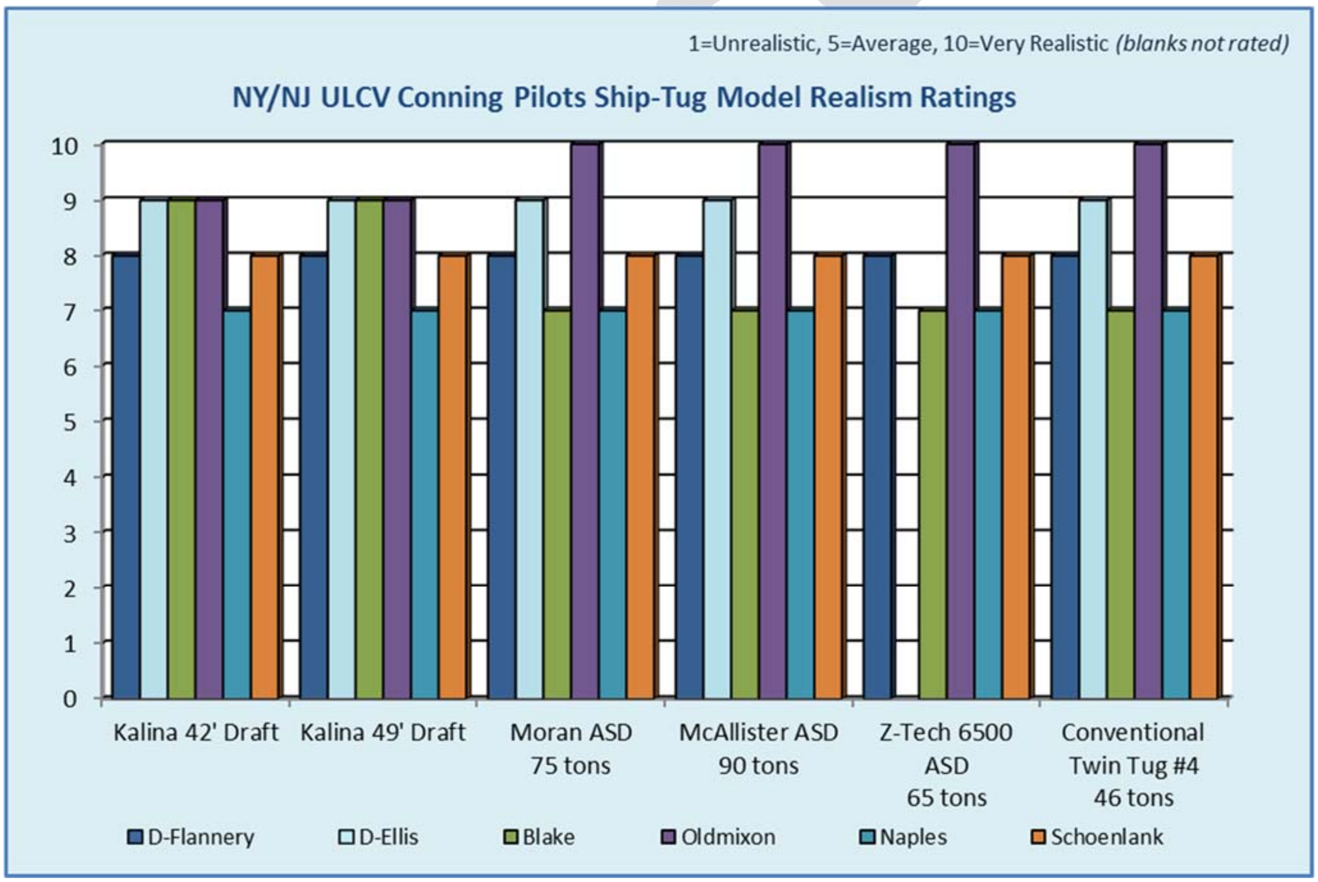

NY/NJ ULCV Pilot/Tug Master Run Tug Adequacy Ratings
Tug Adequacy
0 1 2 3 4 5 6 7 8 9 10
1 Flannery
TB-Kicklighter
2 Ellis
TB-Kicklighter
3 Flannery
TB-Brooks
4 Ellis
TB-Kicklighter
5 Flannery
TB-Kicklighter
6 Ellis
TB-Kicklighter
7 Flannery
8 Ellis
TB-Kicklighter
9 Flannery
TB-Kicklighter
10 Ellis
TB-Steinberg
11 Flannery
TB-Steinberg
TB-Kicklighter
12 Ellis
TB-Steinberg
TB-Kicklighter
13 Flannery
TB-Steinberg
14 Ellis
TB-Steinberg
TB-Kicklighter
15 Flannery
TB-Steinberg
TB-Kicklighter
16 Ellis
TB-Steinberg
TB-Kicklighter
17 Flannery
TB-Kicklighter
18 Ellis
TB-Oliveira
1=Inadequate→ 5=Average Adequacy→10=Most Adequate
TB=Tug Bridge


NY/NJ ULCV Pilot/Tug Master Run Tug Adequacy Ratings
Tug Adequacy
0 1 2 3 4 5 6 7 8 9 10
19 Flannery
TB-Kicklighter
20 Ellis
TB-Oliveira
21 Flannery
TB-Kicklighter
22 Ellis
TB-Oliveira
23 Flannery
TB-Oliveira
TB-Kicklighter
24 Flannery
TB-Oliveira
TB-Kicklighter
25 Ellis
TB-Oliveira
TB-Kicklighter
26 Ellis
TB-Oliveira
TB-Kicklighter
27 Flannery
TB-Oliveira
28 Ellis
TB-Kicklighter
29 Flannery
TB-Oliveira
30 Ellis
TB-Kicklighter
31 Ellis
TB-Oliveira
32 Flannery
TB-Oliveira
TB-Kicklighter
33 Ellis
TB-Oliveira
34 Flannery
TB-Kicklighter
35 Ellis
TB-Oliveira
TB-Kicklighter
36 Blake
TB-Oliveira
TB-Kicklighter
37 Naples
TB-Oliveira
TB-Kicklighter
38 Oldmixon
TB-Oliveira
TB-Kicklighter
1=Inadequate→ 5=Average Adequacy→10=Most Adequate
TB=Tug Bridge

7.1 FINAL QUESTIONNAIRE GRAPHS AND COMMENTS

At the end of the session, all participants were asked to fill out a final questionnaire that included questions about the overall realism of the simulation, and safety of the maneuvers under the tested conditions. The following tables summarize the results followed by the written comments. We can infer that the higher "realism" ratings are good indications of higher confidence levels in the accuracy of the results. The below ratings indicate that the hydrodynamic models were a good approximation of the handling characteristics of these vessels. However, the ratings are somewhat subjective since the pilots have not handled the *Kalina* Class in real-world conditions.

Note that sea trial information on the "Brian McAllister" tug model was unavailable since the tug is still under construction. However, the tug model performed as expected for a tug of that class. The other models have been routinely used on numerous projects and found to be performed as expected.



Pilot Ship and Tug Model Realism Comments

Ellis:

- Feels realistic, need to feel the real ship. Tractor tug captains report simulator is fairly spot on.

Naples:

- It is difficult for me to evaluate the realism since I have no experience with this size vessel to compare.

Schoenlank:

- We haven't been on extra-large to date. Relying on vetting process. Tug operators were convinced – good for me.

The next set of graphs rate the realism of the environmental forces applied during the simulation exercises. The ratings indicated high confidence levels in the accuracy of the environmental forces applied. Again, we must view the results with caution since none of the conning pilots have handled this class of vessel in the real-word.

Pilot Environmental Realism Comments

Ellis:

- Simulator feels fairly accurate. Haven't handled this size ship in real life.

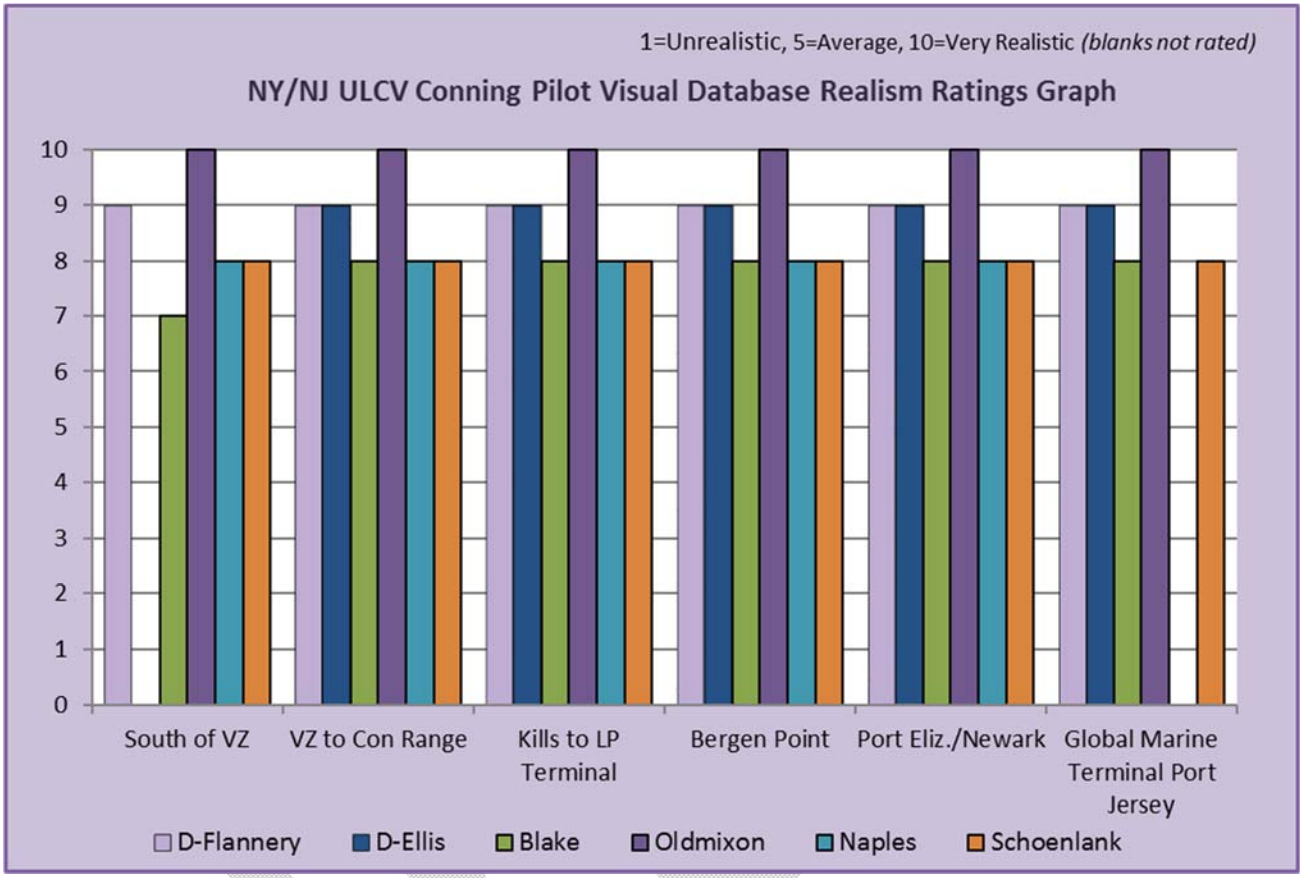
Naples:

- I'm not sure the currents at Began Point are exact but certainly workable.

Schoenlank:

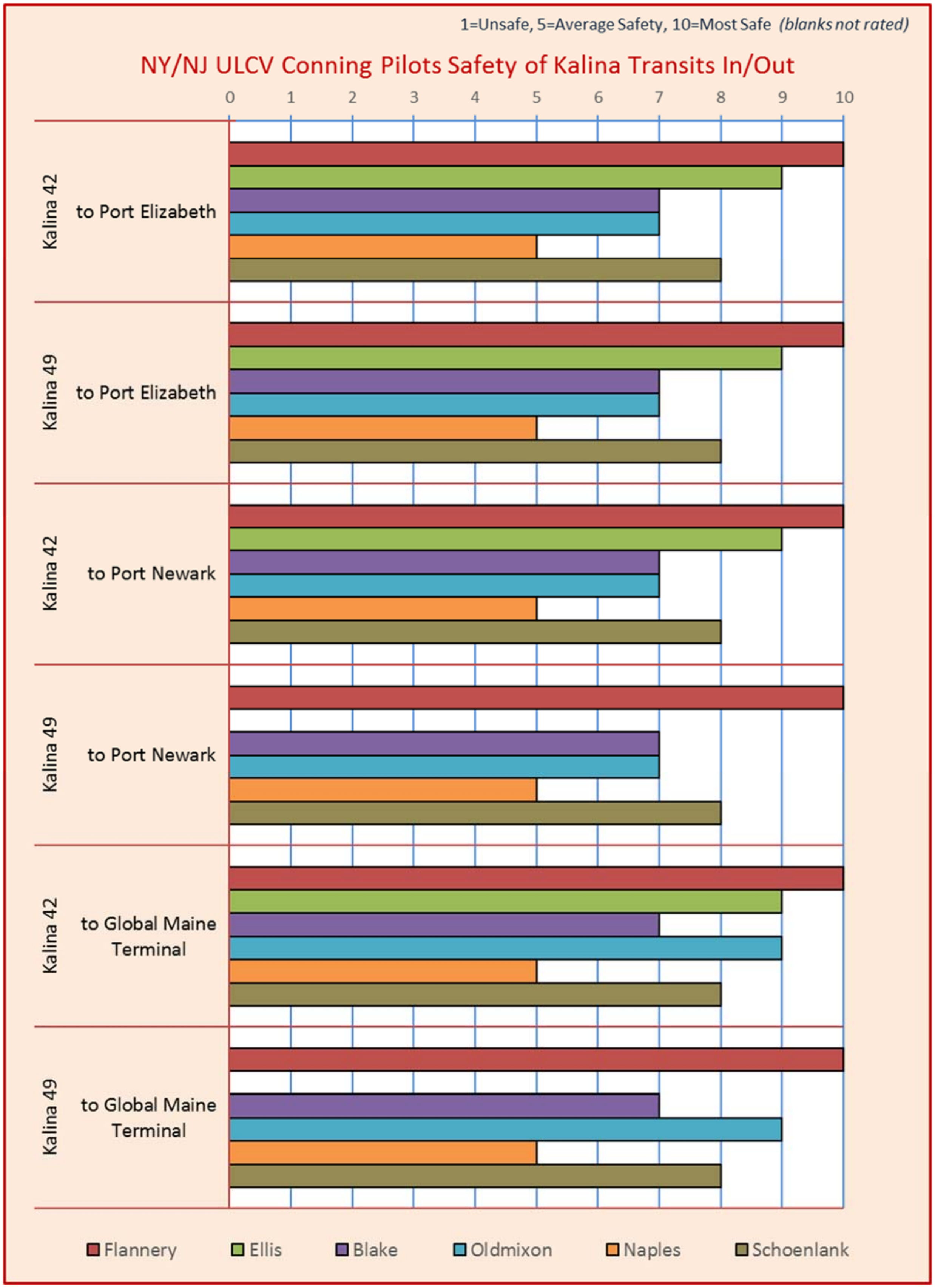
- Would like some evidence of wind, when it exists. Would like tide trail on buoys, if possible.

The graph below rates the realism of the visuals scenes as the model moves through the simulation exercise. Care is taken to ensure that all navigational aids are depicted. The high ratings indicated the pilots had confidence in using their standard visual cues during the simulated transits.



Safety of Transits

The following graphs summaries the pilot's overall assessment of the safety of transits in the tested conditions.



Pilot Comments on above ratings: Safety of maneuvers in Simulated Conditions, Kalina Transits In/Out.

Please identify maximum environmental conditions (wind, current, seas, visibility) and still achieve a safety score of 5 (average) or more for the vessel class in at the specified drafts. If a "5" cannot be achieved, please note reasons.

Flannery:

- With parameters that we established up to 20 knots.

Ellis:

- May wind 20 knots. Bergen Point, one hour either side of Battery High Water – Low Water to or from Newark Bay. Global Terminal SW arrival and departures.

Oldmixon:

- Wind: 20 knots, 4 tugs
- Current 1-1.3 knots, minimum two tractors
- Visibility 2-3 miles,
- (Tugs:) 3 preferred, 1 conventional

Naples:

- All passages are average (5) based on a slack water and 20 knots maximum wind.

Schoenlank:

- 20 knots maximum. One-hour either side of SW Bergen Point. Slack water only for Global Maine Terminal transits.

If unsafe to marginally acceptable, what changes, if possible, need to be made in order to achieve a score of "5" (average) or more?

Ellis:

- One-hour wither side of Battery High Water / Low Water Newark Bay Delaware or sailing.
- Global Terminal SW Departure and Arrival.

Schoenlank:

- Four tugs – two tractors and two conventional. Maybe third tractor replaces conventional tugs.


1=Unsafe, 5=Average Safety, 10=Most Safe (blanks not rated)
NY/NJ ULCV Conning Pilots Safety of Berthing/Unberthing Evolutions, and Safety of Kalina Ship to Ship Meetings Ratings Graph
0 1 2 3 4 5 6 7 8 9 10
Meeting
Kalina 49 at the Kills
Kalina 42 at the Kills
Berthing/Unberthing
Kalina 49 at GCT Bayonne LP
Kalina 42 at GCT Bayonne LP
Kalina 49 at Port Newark
Kalina 42 at Port Newark
Kalina 49 at Port Elizabeth
Kalina 42 at Port Elizabeth
Schoenlank
Naples
Oldmixon
Blake
Ellis
Flannery

Pilot Comments on ship to ship meetings (In the Kill Van Kull Reaches):

Please identify maximum environmental conditions (wind, current, seas, visibility), and still achieve a safety score of 5 or more for the vessel class in at the specified drafts. Please include the minimum number, type, and power of assist tugs.

Flannery:

- No meeting

Ellis:

- No Meeting Kalina in Kills.

Blake:

- Limit to size of meeting. Still to be determined!

Oldmixon:

- No meeting of other ships.

Naples:

- Should not be done.

Schoenlank:

- Meeting Panamax unacceptable. Smaller ship potentially ok, but undetermined yet.

If unsafe to marginally acceptable, what changes, if possible, need to be made in order to achieve a score of "5" or more?

Flannery:

- No meeting

Ellis:

- Limit size of vessel meeting (TBD)

Naples:

- Can't be changes.

Pilot Comments on Berthing/Unberthing

Please identify maximum environmental conditions (wind, current, seas, visibility), and still achieve a safety score of 5 or more for the vessel class at the specified drafts. Please include the minimum number, type, and power of assist tugs.

Flannery:

- 40% current, 20 knots wind.

Ellis:

- Battery, one hour either side for Port Newark or Port Elizabeth.
- Straight in and back out preferred, Port Elizabeth Channel.

Oldmixon:

- Wind 20 knots, 4 tugs.
- Current 1 knot to 1.3 knots.
- Visibility 2 – 3 miles.

Schoenlank:

- Head in to Port Elizabeth channel, back out recommended. 20 knots maximum wind conditions. Currents compliant with Berger Point zone restrictions. SW back only for Pt. Jersey.

If *unsafe to marginally acceptable*, what changes, if possible, need to be made in order to achieve a score of "5" or more?

Flannery:

- Two tractor and two conventionals.
- Two conventional tugs based on environmental conditions.

Naples:

- Must have slack water and less than 20 knots wind.

Pilot's Final Comments

Please write additional comments you would like to make concerning this project.

Flannery:

- I put 8 for realism for simulation. But, realize I don't think they can get any better, so therefore an 8 is a ten.
- I thank all the instructors for their help and professionalism. Top Notch.
- (Start with baby steps then go from there as we get used to handling these ships in real time.)

Ellis:

- The staff is excellent.
- The simulator feels realistic. I need to feel the ship characteristics in real life to be 100% sure.
- I would like to check out the rate of turn of the actual ship.

Blake:

- Concern with having a cruise ship alongside going into Global.

Schoenlank:

- Will submit list of group recommendations – Believe they are all valid, and concept of "e-pilot" can help significantly provided personalities don't get in way.
- Usage of tugs, and knowledge of tractor maneuvers and command need to improve with operations and pilots alike.
- Restrictions can hopefully be passed over time if reality proves they are too much.
- Thanks to all staff and MITAGS for productive and rewarding experience.

7.2 PRELIMINARY PILOT RECOMMENDATIONS

At the end of the Study, Captains' Robert Flannery, Robert Ellis, Nathan Oliveira, Matt Kicklighter, Jack Olthuis, John Oldmixon, Steve Naples, Robert Blake, Richard Schoenlank discussed what was learned and what is needed further investigation. The following preliminary recommendations are consensus opinions developed by the pilots and docking masters with input from other the attendees and the MITAGS staff. As with any simulation study, the local pilots and dockings masters will use this information to determine its applicability in real-world conditions, and any additional measures that may be needed for the safe navigation transits on a routine basis. Additionally, ULCVs are not a uniform class of vessels. Each vessel should be evaluated prior to entry.

The recommendations are for guidance. The final decision on whether a specific transit is safe to proceed and under what conditions rests with the master, docking master, and local pilot.

Ship modeled: MSC KALINA class – LOA 1,205' x Beam 168' x Draft 42' and 49'

1) Meeting other large vessels in KVK is NOT recommended – 623' x 105' tanker was tested several times – the size of smaller vessels that can meet was determined to be 500' or less, if agreed to by pilot, but the general impression was that the swept path of ULCV makes meeting situations questionable until practical experience with real vessels can be attained.

2) All wind constraints are 20 knots – in excess of this is not acceptable for these ships at this time until practical experience with real ships can be attained.

3) Visibility constraints remain at 1.5 miles Bergen Point.

4) Port Jersey jobs will remain slack water only. Transiting with a cruise ship at Cape Liberty and a car ship at NEAT was very tight, successfully done, but NOT recommended. Maximum of one vessel should be at those berths (never passing two). In addition:
   a. Concern expressed with displacement affect upon moored vessels from passing ULCV and required speed to transit safely.
   b. Recommended communication with any cruise ship moored at Cape Liberty to advise of the intended path of the container ship. Embarkation of personnel/passengers should be halted as ship transits past.
   c. Scheduling should be coordinated to have an inbound cruise ship hold up if containership is backing out, or due to back out within a short time. Containership should hold up if cruise ship is due to get underway within a short time (tidal parameters permitting). A cruise ship or car carrier at NEAT will need to move for a ULCV to enter or depart. Again, scheduling coordination is needed.

5) Transiting in/out Port Elizabeth Channel – recommended head in/back out transits with a minimum of 2 tractor tugs and 2 conventional tugs – perhaps a range of bollard pull capabilities for tugs can be identified.

6) The "through" Bergen Point window (meaning vessel should be either entering Bergen Point turn no sooner than, or leaving Bergen Point turn no later than) should start and end with 1 hour either side of slack water – with possible expansion as experience is gained. The intention is to keep the current at 40% or less. This translates to probably two ULCVs per slack water window, due to time constraints involved in slow transits through KVK due to displacement. Again, expansion is possible with experience.

7) Use of E-Pilot concept was very useful in helping to provide/confirm information, communication, observations of transit in effort to assist docking pilot during transit. Noted that navigation will be done for these vessels relying heavily on use of electronic aids – PPU is necessary – turning circles available as needed. Recommended 2-pilot system (E Pilot) on all moves. Guidelines will be developed and adopted for this purpose internally between Sandy Hook Pilots and Docking Pilots.

8) Clear berth should be confirmed prior to port entry – meaning confirmed sailing (no delay) from berth or empty berth.

9) Cranes at berth when coming alongside/sailing need to be bunched on the flat of the ship position, or completely out of the way – nothing fore and aft – booms completely raised. In addition, booms may need to be raised if extending out past beam of ships alongside other berths with ULCV transiting channel – depending on berth destination.

10) No bunker barges can be alongside with ULCV transits in Port Elizabeth Channel – confirm situation with understanding that they will move in anticipation of transit as ship enters port or prior to sailing.

11) ULCVs requiring the tidal window must sail on time – no delays as this sets any other ULCV sailing/inbound seeking same time window back as well – if delayed, wait until next window.

12) Two tractors need to be at Narrows 10 minutes before ULCV to assist in event of emergency turnaround/stop. One tug should be tethered center-lead aft as soon as possible for braking purposes as potentially needed. Maximum recommended speed for tethering is 8 knots. Tugs advise having crew notified and ready for tether in advance so no delays – also advise having spare tug line standing by on ship in event a tug line parts. Discussion of eye-to-eye line sections on tug line in the event a line parts was also mentioned.

13) Port Elizabeth Channel recommendations of more lines (4/3) for moored vessels… extra spring lines. This could also mean bollard reinforcement.

14) Awareness of bollard strength of bits aboard each ship. Should be included on pilot cards and compared to possible tug assistance parameters. Astern power questioned as represented on the EEE pilot card – indicative of unreliability of information in this regard. Astern power of these models / ships was very poor.

7.3 MITAGS OBSERVATIONS

Overall, the docking masters, the pilots, and tug operators provided a consistent assessment of the difficulty and safety of each run.

The tug operators did not rate any run over “5” which indicates average difficulty levels from their perspective. The docking masters, pilots and tug operators gave high ratings for tug adequacy for most runs. Out of thirty-eight runs, the lowest “adequacy” scores were Run Twenty-Four (3), and Run Nine (4). The rest were “5” or more. We can infer that the tug package used in the exercises provided sufficient power.

From the conning pilot perspective, most runs were rated at a high level of difficulty (6 to 10). Of the thirty-eight runs, only one run (10) was rated “5” or below, and nine were rated “8” or higher. This is a good indication that handling this class of vessel will be a challenge in tested conditions.

As mentioned earlier, although the “difficulty” ratings were high, this doesn’t necessarily mean the transits are unsafe under the right conditions. Of the thirty-eight runs, five (Runs 8, 9, 23, 32, and 34) were scored at below average safety levels. This is an indication that most of the runs were challenging, but the pilots felt they had control of the vessel in most conditions tested.

From simulation studies and observations from conning pilots, we can make some general comments about the expected maneuvering characteristics of the *Kalina* in the real-world. They include the following:

1) Speed control is the most critical factor. It affects squat, interactive forces, and stopping ability.
2) These ships are heavy and momentum can be difficult to control. The hull block coefficient is closer to a bulk carrier than a containership.
3) The *Kalina* has a less favorable displacement to horsepower ratio than the Maersk A class, making it harder to maneuver.
4) The *Kalina* requires a lot of rudder to initiate a turn, especially at slow speeds.
5) Once the *Kalina* starts swinging in a turn, aggressive counter rudder is required to steady the ship on a desired heading.
6) The pivot point on the *Kalina* is not forward of the bridge - the bridge is at the approximate location of the pivot point.
7) The *Kalina* class requires an adjustment of one's situational awareness due to the bridge being slightly forward of midship.
8) Due to the location of the bridge on the *Kalina,* there are 480 feet of ship in front of you and it can look like a regular bridge aft ship.
9) When conning the *Kalina* there is a tendency to look at what is in front of you and not adequately allow for the 720 feet astern.
10) Conning this class of ships, especially in a narrow channel, requires a functional PPU or ECDIS, preferably both.
11) The utilization of two pilots may be needed in certain ports to reduce distractions and share workloads.
12) Ports will need to evaluate the number of tugs that will be made available to handle ships of this size along with an analysis of the bollard pull ratings of the tugs.
13) If you are using more than 85% of your resources (tugs, thrusters, rudder, propulsion), you are pushing the safety limits.

For safety purposes, the hydrodynamic model used a full deck load profile for wind area calculations. When the actual pro-forma load profiles are established, there may be value in updating the models to more accurately simulate the wind effects. For example, of the forces created by wind and currents, please review the table below. The table provides an estimate of the forces created by beam wind and current at zero ship speed. The theoretical force needed to counteract a beam wind on the Kalina at a 49' draft is 39.84 metric tons. If there was one knot current, add another 57.68 tons. The figure in the last column is the wind and current forces total plus a 20% safety factor for wind gusts and 30% factor for variabilities of the tugs[4].

[4] Thoresen, C. (2003). Tugboat Assistance. In Port designer's handbook recommendations and guidelines. London: Thomas Telford, and Zubaly, R. (1996). Applied Naval Architecture.

Note there are exponential increases in the forces exerted on the vessel as wind and current increase. A doubling of the wind speed (15 to 30 knots) increases the forces by more than three times. Further consideration should ensure that enough assist tug power is available to counteract unexpected conditions.

Table 4: Wind / Current Forces Table

	Load Condition	Wind Velocity (knots)	Wind Force (N)	Wind Force (t)	Current Velocity (knots)	Current Force (N)	Current Force (t)	Required Effective Bollard Pull (t)
Container Kalina_New York	Loaded (14.9 m)	15	354375.0	39.84	0	0.00	0.00	62.1
Displacement (t)	198160				1	513082.87	57.68	137.1
Length Over All (m)	366				2	2052331.50	230.70	362.1
Length Between Perps (m)	350				3	4617745.87	519.08	736.9
beam (m)	51.2	20	630000.0	70.82	0	0.00	0.00	110.5
draft (m)	14.9				1	513082.87	57.68	185.5
Lateral Wind Coefficient	0.75				2	2052331.50	230.70	410.4
Lateral Sway Coefficient	1				3	4617745.87	519.08	785.3
Windage Area (m^2)	14000	25	984375.0	110.65	0	0.00	0.00	172.6
Underwater Profile Area (m^2)	3783.5				1	513082.87	57.68	247.6
Block Coefficient	0.7255				2	2052331.50	230.70	472.5
Disp/Power (LT/hp)	2.70				3	4617745.87	519.08	847.4
(366 x 51.2 meters)		30	1417500.0	159.34	0	0.00	0.00	248.6
					1	513082.87	57.68	323.6
					2	2052331.50	230.70	548.5
					3	4617745.87	519.08	923.4

Formulas Used in Table

Wind Force = 0.5 x Cywind x 1.2 (air density) x Wind Velocity^2 x Windage Area

Cywind range from 0.60 to 0.75 for containerships. 0.75 used for safety factor.

Current Force = 0.5 x Cycurrent x 1,025 (seawater density) x Current Velocity^2 x Underwater Profile Area

Required Effective Bollard Pull = Sf x [(Wind Force x Fg) + Current Force], where Sf = Tugboat bollard pull factor = 1.3, Fg = gust factor = 1.2

Newton-to-Ton Conversion Factor = 1 ton/8896 Newton

Future Considerations

The study used water current models originally developed by the Army Corps of Engineers and modified by Waterway Simulation Study (WST) for loading into the Transas ship simulator. At the time of the Study, there were no current meters at Bergen Point (the most critical area) to validate the velocities. In order to achieve the proper ship model behavior at Bergen Point the current velocities were increased over the original algorithms. Once the water current meters have been installed at Bergen Point, the data should be compared against current models used in this study, and select exercises should be re-run to validate the accuracy of the current velocities used in the study.

The ULCV models' behaviors, at slow speeds, were closer to a bulk carrier than a containership. This was in keeping with the data used in the programming, and anecdotal evidence from pilots that have handled the Kalina Class. MITAGS will continue to update the models as more real-world experience is gained.

The large underwater volume of the ULCVs relative to the channel volume could create significant surge forces on moored vessels in confined waters. Keeping the speed off these vessels will be critical to managing the surge forces[5]. However, even at very slow speeds, surge may still be a significant factor in areas such as Global Marine Terminal, and / or Port Elizabeth Channel Reach where the water flow is restricted by the berths and other vessels. Suggest further study of the water flows created by a ULCV entering and departing these areas, to determine maximum safe speed of approach. These studies may indicate a need for changes in the mooring line configurations and stronger bollard and fendering arrangements.

The numbers, locations and sizes of the vessels at the berths in the Port Elizabeth / Global Marine Terminals will be significant factors in determining whether it is safe to transit. Various combinations of berth ships were evaluated and some had assist tug clearances of less than twenty feet. Suggest further study to develop guidelines for maximum beam combinations. Other suggestions include requiring the container crane booms in the up position, and berth vessels fully secured until the ULCV docking / undocking evolutions have been completed.

Even within the same ULCV Class, vessel maneuvering behavior can be different. Suggest the pilots consider simulating other classes of ULCV that are expected to call on NY/NJ.

ULCV transit restrictions will be a significant factor in managing the vessel traffic through the Kill Van Kull. Suggest the Port consider mechanisms for coordinating the activities of the various stake holders that use this waterway.

The upcoming familiarization sessions will generate additional insight on safe handling practices for the Kalina Class ULCVs. Suggest the pilots, docking masters, and attendees review their preliminary recommendations and update as needed based on the lessons learned.

Due to time constraints, only a limited number of "emergency exercises" were run in the vicinity of the Verrazano Bridge. Suggest further simulation to develop "best practices" for handling emergencies (propulsion / tug failures, etc.) at other points along the transit.

On behalf of the MITAGS-PMI team, we thank the participants and Port Authority, and the NY/NJ Shipping Association for their confidence in our simulation capabilities. We hope the lessons learned will contribute, in a small way, to the safe and efficient handling of the next generation of containerships. We wish the pilots and the Port every success in this new endeavor. Additionally, we look forward to the pilots' feedback on the simulation after they have handled the *Kalina* in the real-world.

[5] Please refer to the separate Waterway Simulation Technology Study mentioned in Section 4 of this report.

8. FINAL TEST MARIX

Run No. & Direction	1 Inbound			2 Inbound			3 Inbound			4 Inbound		
Pilot Name(s)	Flannery (Docking)			Ellis (Docking)			Flannery (Docking)			Ellis (Docking)		
Starting Location	Buoy# 28			City Dock			City Dock			City Dock		
Initial Heading & Speed	345 ° @ 8 Knots			245° @ 5 knots			245° @ 5 knots			245° @ 5 knots		
Database Used	BASE – New York_F			BASE – New York_F			New York_F			New York_F		
Ship Model & Condition	42' Kalina Partial Load			42' Kalina Partial Load			42' Kalina Partial Load			42' Kalina Partial Load		
Current File Name, Tide	Slack – 3122			Flood 3122			40% Flood 2353 (1.5)			Flood 3122		
Wind Dir. "From" Speed	NE @ 15 knots			NE @ 20 Knots			NE @ 20 Knots			NE @ 20 Knots		
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 Pierson-Moskowitz			Height: 1.3 Pierson-Moskowitz			Height: N/A Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz		
Visibility	Clear – Day			Clear – Day			Clear – Day			Clear – Day		
Tugs / McAllister / Moran	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James	Brendan	James	Brian
Bollard Pull	85	46	85	85	46	85	85	46	85	46	85	85
Live or Auto	Live	Auto	Auto	Live	Auto	Auto	Live	Auto	Auto	Auto	Auto	Live
Tug Initial Position	CLA	PQ Esc.	PB Esc.	CLA	PSH	SSH	CLA	PSH	SSH	PSH	SSH	CLA
All Fast Order	1	2	3	1	2	3	1	2	3	1	2	3
CPA to Chan. toe line during transit				46' @ buoy 5 Newark / 92' @ KVK buoy 17			107' @ Bridge					
CPA in Kills							156'			122' @ KVK Buoy 11		
CPA Other							289' Newark Buoy 4			0' @ KVK Buoy 14		
Ending Location	Buoy 4			Buoy 6 Newark			Buoy 5 Newark			Port Eliz / Newark Buoy 5		
Simulation Time	67 Minutes			36 minutes			29 minutes			28:55 minutes		

Run No. & Direction	5 Outbound			6 Outbound			7 Outbound			8 Outbound		
Pilot Name(s)	Flannery (Docking)			Ellis (Docking)			Flannery (Docking)			Ellis (Docking)		
Starting Location	City Dock			Port Eliz / Newark Buoy 1			Port Eliz / Newark Buoy 1			Port Eliz / Newark Buoy 1		
Initial Heading & Speed	245° @ 5 knots			203° @ 5 knots			203° @ 5 knots			203° @ 5 knots		
Database Used	New York_F			New York_F			New York_F			New York_F		
Ship Model & Condition	42' Kalina Partial Load			42' Kalina Partial Load			42' Kalina Partial Load			42' Kalina Partial Load		
Current File Name, Tide	Ebb 2357(1.8)			Flood 2353			Flood 3122			Ebb 2357 (1.8)		
Wind Dir. "From" Speed	NE @ 20 Knots			NW @ 20 Knots			NW @ 20 Knots			NW @ 20 Knots		
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz		
Visibility	Clear – Day			Clear – Day			Clear – Day			Clear – Day		
Tugs / McAllister / Moran	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James
Bollard Pull	85	46	85	85	46	85	85	46	85	85	46	85
Live or Auto	Live	Auto	Auto	Live	Auto	Auto	Live	Auto	Auto	Live	Auto	Auto
Tug Initial Position	SSH	PSH	CLA	SSH	PSH	CLA	CLA	PSH	SSH	CLA	PSH	SSH
All Fast Order	1	2	3	1	2	3	1	2	3	1	2	3
CPA to Chan. toe line during transit				0' @ SW Newark Buoy 4 – 6			190' @ Newark Buoy 5			Closest at start of exercise @ 140'		
CPA in Kills	164' @ KVK Buoy 19,						200' @ KVK Buoy 15			125' @ KVKs Buoy 15 0' @ Port Richmond		
CPA Other	86' @ KVK Buoy 16			99' @ KVK Buoy 15						0' across from KVK 8		
Ending Location	Port Eliz/Newark Buoy 3			KVK Buoy 12			Past KVK Lighted Buoy 12			Constable Hook Range		
Simulation Time	29:03 minutes			25:48 minutes			19:05 Minutes			48:10 minutes		

Run No. & Direction	9 Outbound			10 Outbound			11 Inbound			12 Inbound		
Pilot Name(s)	Flannery (Docking)			Ellis (Docking)			Flannery (Docking)			Ellis (Docking)		
Starting Location	Port Eliz / Newark			Port Eliz / Newark			KVK Buoy 10			Buoy 9 W of Kills		
Initial Heading & Speed	203° @ 5 knots			203° @ 5 knots			245° @ 5 knots			245° @ 5 knots		
Database Used	New York_F			New York_F			New York_F			New York_F		
Ship Model & Condition	42' Kalina Partial Load			42' Kalina Partial Load			49' Kalina Loaded			49' Kalina Loaded		
Current File Name, Tide	Ebb 3126			Slack			Slack, Tide 4'			Flood, Tide 4'		
Wind Dir. "From" Speed	NW @ 20 Knots			NW @ 20 Knots			NE @ 20 Knots			NE @ 20 Knots		
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz		
Visibility	Clear – Day			Clear – Day			Clear – Day			Clear – Day		
Tugs / McAllister / Moran	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James
Bollard Pull	85	46	85	85	46	85	85	46	85	85	46	85
Live or Auto	Live	Auto	Auto	Live	Auto	Auto	Live	Auto	Live	Live	Auto	Live
Tug Initial Position	CLA	SSH	PSH	CLA	SSH	PSH	CLA	PSH	SSH	CLA	PSH	SSH
All Fast Order	1	2	3	2	3	1	3	1	2	1	2	3
CPA to Chan. toe line during transit	172' @ Newark Buoy 5			188' @ Newark Buoy 3			88' W of Bridge			117' W of Bridge		
CPA in Kills	164' @ KVK Buoy 19, 115' across from Bridge			163' @ KVK 11, 219' @ KVK 9, 123' @ KVK 16			75' @ KVK 13			175' @ KVK 13		
CPA Other	95'@ KVK 8			186' @ KVK Buoy 8								
Ending Location	Con Range			Con Range			Port Eliz / Newark Buoy 4			Port Eliz / Newark Buoy 5		
Simulation Time	48 minutes			47 minutes			27 Minutes			28 minutes		

Run No. & Direction	Run 13 Inbound			Run 14 Inbound			15 Inbound			16 Outbound		
Pilot Name(s)	Flannery (Docking)			Ellis (Docking)			Flannery (Docking)			Ellis (Docking)		
Starting Location	Buoy 9 Kills			Buoy 9			KVK Buoy 9			Port Eliz / Newark Buoy 7		
Initial Heading & Speed	245° @ 5 knots			245° @ 5 knots			245° @ 5 knots			203° @ 5 knots		
Database Used	New York_F			New York_F			New York_F			New York_F		
Ship Model & Condition	49' Kalina Loaded			49' Kalina Loaded			49' Kalina Loaded			49' Kalina Loaded		
Current File Name, Tide	Flood 3122, Tide 4'			Ebb 3126			Ebb 2357 (1.8), Tide 4'			Ebb 3126, Tide 4'		
Wind Dir. "From" Speed	NE @ 20 Knots			NE @ 20 Knots			NE @ 20 Knots			NW @ 20 Knots		
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz		
Visibility	Clear – Day			Clear – Day			Clear – Day			Clear – Day		
Tugs / McAllister / Moran	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James
Bollard Pull	85	46	85	85	46	85	85	46	85	85	46	85
Live or Auto	Live	Auto	Live	Live	Auto	Auto	Live	Auto	Live	Live	Auto	Live
Tug Initial Position	CLA	PSH	SSH	CLA	PSH	SSH	CLA	PSH	SSH	CLA	SSH	PSH
All Fast Order	1	2	3	2	3	1	2	1	3	3	1	2
CPA to Chan. toe line during transit	109' West of Bridge			85' @ KVK Buoy 16						273' @ Buoy 5		
CPA in Kills	126' E of Buoy 10, 135' @ Buoy 11			80' @ E of KVK 10			302' @ KVK Buoy 10 201' @ KVK 16			24' off KVK 10		
CPA Other												
Ending Location	Port Eliz/Newark Buoy 5			Port Eliz/Newark			Port Eliz / Newark Buoy 4			VZ Bridge		
Simulation Time	29 minutes			30 minutes			27 Minutes			26 minutes		

Run No. & Direction	**17 Outbound**			**18 Outbound**			**19 Outbound**			**20 Inbound**		
Pilot Name(s)	Flannery (Docking)			Ellis (Docking)			Flannery (Docking)			Ellis (Docking)		
Starting Location	Port Eliz / Newark			Port Eliz / Newark			Port Eliz / Newark Buoy 7			Port Eliz/Newark Buoy 10		
Initial Heading & Speed	203° @ 5 knots			203° @ 5 knots			203° @ 5 knots			027° @ 5 knots		
Database Used	New York_F			New York_F			New York_F			New York_F		
Ship Model & Condition	49’ Kalina Loaded			49’ Kalina Loaded			49’ Kalina Loaded			49’ Kalina Loaded		
Current File Name, Tide	Flood 2353, Tide 4’			Ebb 2357 (1.8), Tide 4’			Ebb 3122, Tide 4’			Flood 2353(1.5), Tide 4’		
Wind Dir. "From" Speed	NW @ 20 Knots			NW @ 20 Knots			NW @ 20 Knots			0 Knots		
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz		
Visibility	Clear – Day			Clear – Day			Clear – Day			Clear – Day		
Tugs / McAllister / Moran	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James
Bollard Pull	85	46	85	85	46	85	85	46	85	85	46	85
Live or Auto	Live	Auto	Auto	Live	Auto	Auto	Live	Auto	Auto	Live	Auto	Auto
Tug Initial Position	CLA	SSH	PSH	CLA	SSH	PSH	CLA	SSH	PSH	CLA	SSH	PSH
All Fast Order	3	1	2	2	1	3	3	2	1	3	1	2
CPA to Chan. toe line during transit	N/A Closest at Exercise start						114’ between KVK E Jun. Lt Buoy E & KVK Lt Buoy 17			43’ Between Port Eliz Buoy 2 & 4.		
CPA in Kills	80’ West of Bridge			300’ @ KVK East Junction Lighted Buoy E								
CPA Other												
Ending Location	E. Bayonne Bridge			KVK Buoy 12			Bayonne Bridge			Port Eliz / Newark		
Simulation Time	24 minutes			23 minutes			23 Minutes			24 minutes		

Run No. & Direction	**21 inbound**			**22 Inbound**			**23 Inbound**			**24 Inbound**		
Pilot Name(s)	Flannery (Docking)			Ellis (Docking)			Flannery (Docking)			Flannery (Docking)		
Starting Location	Port Eliz/Newark Buoy 10			Port Eliz/Newark Buoy 10			Port Eliz / Newark Buoy 10			Port Eliz/Newark Buoy 10		
Initial Heading & Speed	025° @ 5 knots			025° @ 5 knots			025° @ 5 knots			025° @ 5 knots		
Database Used	New York_F			New York_F			New York_F			New York_F		
Ship Model & Condition	49’ Kalina Loaded			49’ Kalina Loaded			49’ Kalina Loaded			49’ Kalina Loaded		
Current File Name, Tide	Flood 2353(1.5), Tide 4’			Ebb 2359 (1.5), Tide 4’			Flood 2353(1/5), Tide 4’			Ebb 2353(1.5), Tide 4’		
Wind Dir. "From" Speed	NW @ 20 Knots			S @ 20 Knots			S @ 20 Knots			S @ 20 Knots		
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz		
Visibility	Clear – Day			Clear – Day			Clear – Day			Clear – Day		
Tugs / McAllister / Moran	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James
Bollard Pull	85	46	85	85	32*	85	85	46	85	85	46	85
Live or Auto	Live	Auto	Auto	Live	Auto	Auto	Live	Auto	Live	Live	Auto	Live
Tug Initial Position	CLA	SSH	PSH	CLA	SSH	PSH	CLA	PSH	CLF	CLA	PSH	free @ bow
All Fast Order	3	1	2	3	1	2	2	1	2	2	1	3
CPA to Chan. toe line during transit	247’ @ Corner Port Eliz.			377’ @ Newark Buoy 14			6’ @ stern of target 4			60’ from Buoy 2, 47’ @ target 8		
CPA in Kills										65’ @ target 4		
CPA Other	335’ @ moored ship						0’ @ buoy 2 Port Elizabeth					
Ending Location	Port Eliz / Newark			Port Eliz/Newark @ Berth			Aground			Port Eliz/Newark @ Berth		
Simulation Time	29 minutes			27 minutes			33 Minutes			48 minutes		

*For Run 22, Auto Tug Brendan (Conventional Tug 4) was switched for Conventional Tug 5, because it is 10’ shorter, though also slightly less powerful (45 vs. 32).

Run No. & Direction	25 inbound			26 Inbound			27 Outbound			28 Outbound			
Pilot Name(s)	Ellis (Docking)			Ellis (Docking)			Flannery (Docking)			Ellis (Docking)			
Starting Location	Port Eliz/Newark Buoy 10			Port Eliz/Newark Buoy 10			Port Eliz / Newark Buoy 7			Port Eliz/Newark@ berth			
Initial Heading & Speed	025° @ 5 knots			025° @ 5 knots			203° @ 1 knot astern			310° @ 1 knot astern			
Database Used	New York_F			New York_F			New York_F			New York_F			
Ship Model & Condition	49' Kalina Loaded			49' Kalina Loaded			49' Kalina Loaded			49' Kalina Loaded			
Current File Name, Tide	Ebb 2359(1.5), Tide 4'			Ebb 2359 (1.5), Tide 4'			Flood 3122, Tide 4'			Ebb 2359(1.5), Tide 4'			
Wind Dir. "From" Speed	N @ 20 Knots			N @ 20 Knots			NW @ 20 Knots			N @ 20 Knots			
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			Height: 1.3 @ 000° Pierson-Moskowitz			
Visibility	Clear – Day			Clear – Day			Clear – Day			Clear – Day			
Tugs / McAllister / Moran	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	James	Brian	Brendan	Sisters	James
Bollard Pull	85	46	85	85	46	85	85	46	85	85	46	46	85
Live or Auto	Live	Auto	Live	Live	Auto	Live	Live	Auto	Auto	Live	Auto	Auto	Auto
Tug Initial Position	CLA	SSH	PSH	CLA	SSH	PSH	CLA	SSH	PSH	CLA	PQ	PSH	CLF
All Fast Order	2	1	3	3	1	2	3	1	2	4	2	3	1
CPA to Chan. toe line during transit	0' @ shoal N of Buoy 14			313' @ Newark Buoy 15A			N/A closest @ start of run			60' from Buoy 2, 47' @ target 8			
CPA to Meeting Ship				36' astern of Brendan on target 6									
CPA in Kills										65' @ target 4			
CPA Other													
Ending Location	Aground shoal N of Buoy 14			Port Eliz/Newark @ Berth			Bayonne Bridge			Newark Bay Southbound			
Simulation Time	21:35 minutes			39 minutes			22 Minutes			48 minutes			

Run No. & Direction	29 Outbound				30 Outbound				31 Inbound				32 Inbound			
Pilot Name(s)	Flannery (Docking)				Ellis (Docking)				Ellis (Docking)				Flannery (Docking)			
Starting Location	Port Eliz/Newark Berth				Port Eliz / Newark @ Berth				Buoy 28 Gowanus Flats				Buoy 28 Gowanus Flats			
Initial Heading & Speed	309° @ 0 knots				129° @ 0 knots				012° @ 6 knots				012° @ 6 knots			
Database Used	New York_F				New York_F				New York_F				New York_F			
Ship Model & Condition	49' Kalina Loaded				49' Kalina Loaded				49' Kalina Loaded				49' Kalina Loaded			
Current File Name, Tide	Flood 2353(1.5), Tide 4'				Flood 2353(1.5), Tide 4'				Flood 3135 (1.25), Tide 4'				Ebb 2357 (1.8), Tide 4'			
Wind Dir. "From" Speed	S @ 20 Knots				N @ 20 Knots				S @ 20 Knots				N @ 20 Knots			
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 @ 000° Pierson-Moskowitz				Height: 1.3 @ 000° Pierson-Moskowitz				Height: 1.3 @ 000° Pierson-Moskowitz				Height: 1.3 @ 000° Pierson-Moskowitz			
Visibility	Clear – Day				Clear – Day				Clear – Day				Clear – Day			
Tugs / McAllister / Moran	Brian	Brendan	Sisters	James	Brian	Brendan	Sisters	James	Brian	Brendan	Sisters	James	Brian	Brendan	Sisters	James
Bollard Pull	85	46	46	85	46	85	46	85	46	85	46	85	85	46	46	85
Live or Auto	Live	Auto	Auto	Live	Live	Auto	Auto	Auto	Live	Auto	Auto	Auto	Live	Auto	Auto	Live
Tug Initial Position	P Stern	PSH	PQ	PSH	CLA	SQ	SSH	CLF	CLA	SSH	SQ	PSH	CLA	PSH	PQ	PSH
All Fast Order	4	3	2	1	4	2	1	3	4			1	4	2	1	2
CPA to Chan. toe line during transit	59' @ ship on berth 64 20' @ ship on berth 65				0 @ Shoal near buoy 4								98' @ cruise ship			
CPA to Meeting Ship	69' @ berth 20				0 @ ship @ berth 65											
CPA in Kills																
CPA Other									145' from ship on N Side							
Ending Location	Newark Bay				Port Eliz / Newark Buoy 14				Global Terminal				Global Terminal			
Simulation Time	58 minutes				18:20 Minutes				19 minutes				22 Minutes			

Run No. & Direction	33 Outbound				34 Inbound				35 Inbound			
Pilot Name(s)	Ellis (Docking)				Flannery (Meeting)				Ellis (Docking)			
Starting Location	Global Terminal				Buoy 26 Gowanus Flats				Global Terminal			
Initial Heading & Speed	300° @ 0 knots				345° @ 6 knots				299° @ 0 knots			
Database Used	New York_F				New York_F				New York_F			
Ship Model & Condition	49' Kalina Loaded				49' Kalina Loaded				49' Kalina Loaded			
Current File Name, Tide	Slack 2357 (1.8) Tide 4'				Flood 3135 (1.5), Tide 4'				Slack Tide 4'			
Wind Dir. "From" Speed	N @ 20 Knots				S @ 20 Knots				S @ 20 Knots			
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 @ 000° Pierson-Moskowitz				Height: 1.3 @ 000° Pierson-Moskowitz				Height: 1.3 @ 000° Pierson-Moskowitz			
Visibility	Clear – Day				Clear – Day				Clear – Day			
Tugs | McAllister | Moran	Brian	Brendan	Sisters	James	Brian	Brendan	Sisters	James	Brian	Brendan	Sisters	James
Bollard Pull	85	46	46	85	85	46	46	85	85	46	46	85
Live or Auto	Live	Auto	Auto	Live	Live	Auto	Auto	Auto	Live	Auto	Auto	Live
Tug Initial Position	CLF	PQ	PSH	CLA	CLA	SSH	SQ	PSH	CLF	PQ	SSH	CLA
All Fast Order	4	2	2	1	4	2	3	1	4	1	2	3
CPA to Chan. toe line during transit	119' @ car ship				25' off tanker at IMTT Berth				N/A Closest at start of run			
CPA to Meeting Ship												
CPA in Kills												
CPA Other												
Ending Location	Gowanus Buoy 30				Bergen Point East Reach				Bayonne Terminal 26			
Simulation Time	31 minutes				38:28 minutes				28 Minutes			

Run No. & Direction	36 Inbound				37 Inbound				38 Outbound			
Pilot Name(s)	Blake (Emergency Turn S. of Vz)				Naples (Emergency Turn S. VZ)				Oldmixon (Emer. Turn N. VZ)			
Starting Location	Ambrose Channel Buoy 22				Ambrose Channel Buoy 22				VZ Bridge			
Initial Heading & Speed	348° @ 10 knots				345° @ 10 knots				345° @ 8 knots			
Database Used	New York_F				New York_F				New York_F			
Ship Model & Condition	49' Kalina Loaded				49' Kalina Loaded				49' Kalina Loaded			
Current File Name, Tide	Flood 3135 (1.25) Tide 4'				Ebb 2359 (1.5), Tide 4'				Flood 3135(1.25),Tide 4'			
Wind Dir. "From" Speed	S @ 20 Knots				N @ 20 Knots				S @ 20 Knots			
Wave/Swell Dir. "From" Height (meters); Model	Height: 1.3 @ 000° Pierson-Moskowitz				Height: 1.3 @ 000° Pierson-Moskowitz				Height: 1.3 @ 000° Pierson-Moskowitz			
Visibility	Clear – Day				Clear – Day				Clear – Day			
Tugs | McAllister | Moran	Brian	Brendan	Sisters	James	Brian	Brendan	Sisters	James	Brian	Brendan	Sisters	James
Bollard Pull	85	46	46	85	85	46	46	85	85	46	46	85
Live or Auto	Live	Auto	Auto	Live	Live	Auto	Auto	Live	Live			Live
Tug Initial Position	CLA			CLF	CLF			CLA	PQ			SQ
All Fast Order	2			1	1			2	2			1
CPA to Chan. toe line during transit	478' @ W shoal				533' @ W shoal 233' @ E shoal				0 @ bump on aqueduct*			
CPA to Meeting Ship												
CPA in Kills												
CPA Other												
Ending Location	VZ Bridge				VZ Bridge				VZ Bridge Buoy 2 ran aground			
Simulation Time	22:37 minutes				23 minutes				14:49 Minutes			

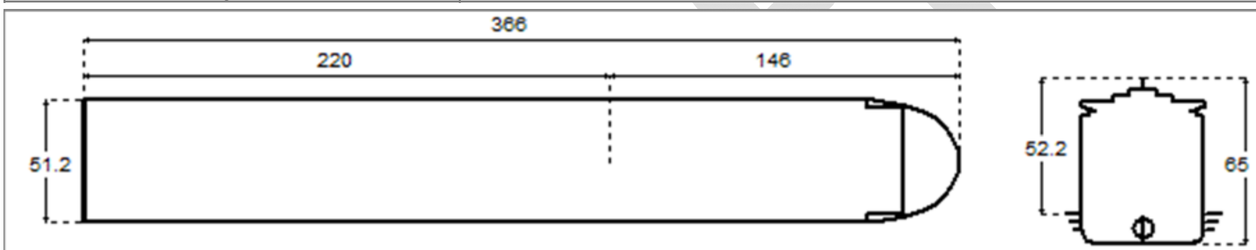
*Aqueduct "bump" will be removed by the time vessels of this size arrive.

APPENDIX A: Pilot Cards

Container Kalina_NewYork 3.0.45.1 * 42' Draft

PILOT CARD					
Ship name	Container Kalina_NewYork	3.0.46.1 *		Date	26.05.2016
IMO Number	N/A	Call Sign	N/A	Year built	1995
Load Condition	Partial Loaded 2				
Displacement	172769.22 tons		Draft forward	12.8 m / 42 ft 1 in	
Deadweight	135460 tons		Draft forward extreme	12.8 m / 42 ft 1 in	
Capacity			Draft after	12.8 m / 42 ft 1 in	
Air draft	52.2 m / 171 ft 8 in		Draft after extreme	12.8 m / 42 ft 1 in	

Ship's Particulars			
Length overall	366 m	Type of bow	Bulbous
Breadth	51.2 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	14 / 14		(1 shackle =27.5 m / 15 fathoms)
Max. rate of heaving, m/min	15 / 15		



Steering characteristics			
Steering device(s) (type/No.)	Semisuspended / 1	Number of bow thrusters	2
Maximum angle	35	Power	1700 kW / 1700 kW
Rudder angle for neutral effect	0.2 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	21 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	442.6 s	9.58 cbls	Advance	5.49 cbls
HAH to HAS	514.6 s	8.96 cbls	Transfer	2.08 cbls
SAH to SAS	619.6 s	9 cbls	Tactical diameter	5.1 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 73340 kW	Propeller type	FPP
Astern power	82 % ahead	Min. RPM	21
Time limit astern	N/A	Emergency FAH to FAS	26.2 seconds

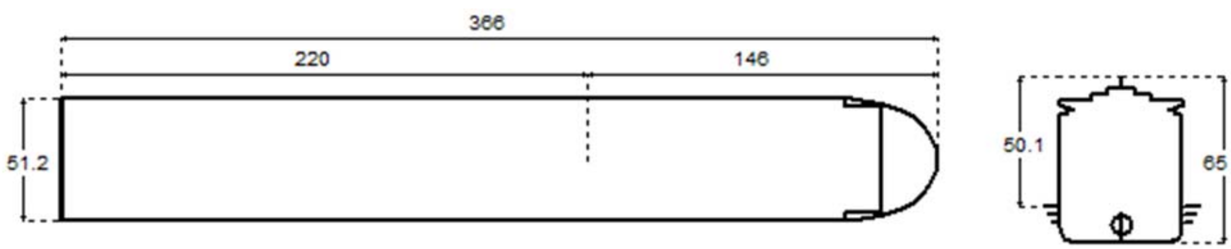
Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	25.1	66723	100.7	1.03
"FAH"	17.6	23280	70.4	1.03
"HAH"	14.1	11337	55.4	1.03
"SAH"	11.8	6249	45.4	1.03
"DSAH"	7.9	1538	28.3	1.03
"DSAS"	-3.1	1856	-28	1.03
"SAS"	-5	7591	-45.1	1.03
"HAS"	-6.2	13810	-55.1	1.03
"FAS"	-7.3	22736	-65.1	1.03
"FSAS"	-9.9	60189	-90.2	1.03

Container Kalina_NewYork 3.0.46.1 * 49' Draft

PILOT CARD				
Ship name	Container Kalina_NewYork 3.0.46.1 *		Date	26.05.2016
IMO Number	N/A	Call Sign: N/A	Year built	1995
Load Condition	Loaded			
Displacement	198160 tons	Draft forward	14.9 m / 49 ft 0 in	
Deadweight	135460 tons	Draft forward extreme	14.9 m / 49 ft 0 in	
Capacity		Draft after	14.9 m / 49 ft 0 in	
Air draft	50.1 m / 164 ft 9 in	Draft after extreme	14.9 m / 49 ft 0 in	

Ship's Particulars			
Length overall	366 m	Type of bow	Bulbous
Breadth	51.2 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	14 / 14	(1 shackle =27.5 m / 15 fathoms)	
Max. rate of heaving, m/min	15 / 15		



Steering characteristics			
Steering device(s) (type/No.)	Semisuspended / 1	Number of bow thrusters	2
Maximum angle	35	Power	1700 kW / 1700 kW
Rudder angle for neutral effect	0.2 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	21 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	475.6 s	9.97 cbls	Advance	5.6 cbls
HAH to HAS	555.6 s	9.39 cbls	Transfer	2.07 cbls
SAH to SAS	668.6 s	9.44 cbls	Tactical diameter	5.11 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 73340 kW	Propeller type	FPP
Astern power	82 % ahead	Min. RPM	21
Time limit astern	N/A	Emergency FAH to FAS	26.2 seconds

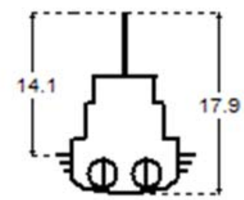
Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	23.7	67444	99.9	1.03
"FAH"	16.8	23214	70	1.03
"HAH"	13.6	11310	55.1	1.03
"SAH"	11.4	6236	45.2	1.03
"DSAH"	7.6	1536	28.2	1.03
"DSAS"	-3	1855	-28	1.03
"SAS"	-4.8	7585	-45	1.03
"HAS"	-5.8	13797	-55	1.03
"FAS"	-6.9	22712	-65	1.03
"FSAS"	-9.3	60143	-90	1.03

Conventional Twin Screw Tug 4 (bp 46.3t) TRANSAS 2.31.17.0 *

PILOT CARD					
Ship name	Conventional twin screw tug 4 (bp 46.3t) TRANSAS 2.31.17.0 *			Date	06.06.2013
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full load				
Displacement	686 tons		Draft forward	3.8 m / 12 ft 6 in	
Deadweight	N/A tons		Draft forward extreme	3.8 m / 12 ft 6 in	
Capacity			Draft after	3.8 m / 12 ft 6 in	
Air draft	14.11 m / 46 ft 4 in		Draft after extreme	3.8 m / 12 ft 6 in	

Ship's Particulars			
Length overall	38.43 m	Type of bow	-
Breadth	10.37 m	Type of stern	Transom
Anchor(s) (No./types)	1 (StbdBow)		
No. of shackles	9		(1 shackle =27.4 m / 15 fathoms)
Max. rate of heaving, m/min	30		



Steering characteristics			
Steering device(s) (type/No.)	Suspended / 2	Number of bow thrusters	N/A
Maximum angle	35	Power	N/A
Rudder angle for neutral effect	0 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	7 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	28.25 s	0.51 cbls	Advance	0.51 cbls
HAH to HAS	25.25 s	0.39 cbls	Transfer	0.18 cbls
SAH to SAS	24.25 s	0.27 cbls	Tactical diameter	0.46 cbls

Main Engine(s)			
Type of Main Engine	High speed diesel	Number of propellers	2
Number of Main Engine(s)	2	Propeller rotation	Inward
Maximum power per shaft	2 x 1840 kW	Propeller type	FPP
Astern power	80 % ahead	Min. RPM	5.83
Time limit astern	N/A	Emergency FAH to FAS	5.15 seconds

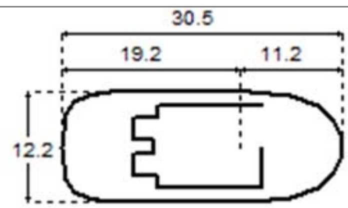
Engine Telegraph Table

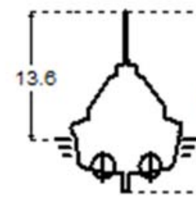
Engine order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	13.2	3652	252	0.64
"FAH"	11.8	2389	219.1	0.64
"HAH"	10.3	1455	185.9	0.64
"SAH"	8.6	792	151.4	0.64
"DSAH"	6.8	397	119.3	0.64
"DSAS"	-3.6	739	-110.8	0.64
"SAS"	-4.2	1083	-126	0.64
"HAS"	-4.8	1595	-143.9	0.64
"FAS"	-5.4	2207	-160.6	0.64
"FSAS"	-5.9	2920	-176.3	0.64

Tug Brian McAllister (85t bp) 3.0.57.1 *

PILOT CARD					
Ship name	Tug Brian McAllister (85tbp) 3.0.57.1 *			Date	22.06.2016
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full Load				
Displacement	763 tons		Draft forward	5.6 m / 18 ft 5 in	
Deadweight	343.35 tons		Draft forward extreme	5.6 m / 18 ft 5 in	
Capacity			Draft after	5.6 m / 18 ft 5 in	
Air draft	13.6 m / 44 ft 8 in		Draft after extreme	5.6 m / 18 ft 5 in	

Ship's Particulars			
Length overall	30.5 m	Type of bow	-
Breadth	12.2 m	Type of stern	U-shaped
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	11 / 11		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	10.2 / 10.2		





Steering characteristics			
Steering device(s) (type/No.)	Z-Drive / 2	Number of bow thrusters	N/A
Maximum angle	180	Power	N/A
Rudder angle for neutral effect	0 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	2 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	10.7 s	0.16 cbls	Advance	0.21 cbls
HAH to HAS	11.8 s	0.15 cbls	Transfer	0.06 cbls
SAH to SAS	12.9 s	0.13 cbls	Tactical diameter	0.16 cbls

Main Engine(s)			
Type of Main Engine	High speed diesel	Number of propellers	2
Number of Main Engine(s)	2	Propeller rotation	Right/Left
Maximum power per shaft	2 x 2524 kW	Propeller type	Azimuth FPP
Astern power	0 % ahead	Min. RPM	84.86
Time limit astern	N/A	Emergency FAH to FAS	11.9 seconds

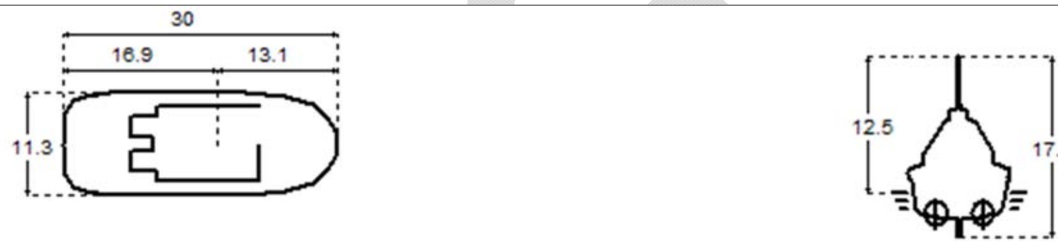
Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"100%"	11.9	4226	235	1
"90%"	9.8	2446	195.8	1
"80%"	9.1	1988	182.8	1
"70%"	8.4	1592	169.7	1
"60%"	7.8	1252	156.7	1
"50%"	7.2	965	143.6	1
"40%"	6.5	725	130.6	1
"30%"	5.8	528	117.5	1
"20%"	4.6	249	91.4	1
"10%"	4.2	199	84.9	1

Tug Edward Moran 3.0.63.0 *

PILOT CARD					
Ship name	Tug Edward Moran 3.0.63.0 *			Date	21.06.2016
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full Load				
Displacement	442.69 tons		Draft forward	4.88 m / 16 ft 0 in	
Deadweight	105 tons		Draft forward extreme	4.88 m / 16 ft 0 in	
Capacity			Draft after	4.88 m / 16 ft 0 in	
Air draft	12.52 m / 41 ft 2 in		Draft after extreme	4.88 m / 16 ft 0 in	

Ship's Particulars			
Length overall	30 m	Type of bow	-
Breadth	11.3 m	Type of stern	U-shaped
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	11 / 11		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	10.2 / 10.2		



Steering characteristics			
Steering device(s) (type/No.)	Z-Drive / 2	Number of bow thrusters	N/A
Maximum angle	180	Power	N/A
Rudder angle for neutral effect	-1.67 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	6 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	10.7 s	0.2 cbls	Advance	0.22 cbls
HAH to HAS	10.7 s	0.18 cbls	Transfer	0.11 cbls
SAH to SAS	10.7 s	0.17 cbls	Tactical diameter	0.2 cbls

Main Engine(s)			
Type of Main Engine	High speed diesel	Number of propellers	2
Number of Main Engine(s)	2	Propeller rotation	Left/Right
Maximum power per shaft	2 x 2424.5 kW	Propeller type	Azimuth FPP
Astern power	0 % ahead	Min. RPM	84.86
Time limit astern	N/A	Emergency FAH to FAS	15.6 seconds

Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"100%"	12.5	4607	235	1
"90%"	12.5	3548	215.4	1
"80%"	11.7	2774	198.5	1
"70%"	10.8	2167	182.8	1
"60%"	10.1	1735	169.7	1
"50%"	9.7	1365	156.7	1
"40%"	9.2	1201	150.1	1
"30%"	8.1	790	130.6	1
"20%"	6.7	404	104.5	1
"10%"	5.6	217	84.9	1

APPENDIX B: Container Kalina Swept Path Calculations

Table 5: **Swept Path: Kalina (meters)**

Bearing	**Length**	**Width**	**Total Swept Width**	**Percentage of Beam**
1	366	51.2	57.58	112.46%
2	366	51.2	63.94	124.89%
3	366	51.2	70.28	137.27%
4	366	51.2	76.61	149.62%
5	366	51.2	82.90	161.92%
6	366	51.2	89.18	174.17%
7	366	51.2	95.42	186.37%
8	366	51.2	101.64	198.51%
9	366	51.2	107.82	210.60%
10	366	51.2	113.98	222.61%
11	366	51.2	120.10	234.56%
12	366	51.2	126.18	246.44%

APPENDIX C: Description of Water Current Model Development by Waterway Simulation Technology

MEMORANDUM FOR: Glen Paine, Maritime Institute of Technology & Graduate Studies

SUBJECT: Navigation Channel Deepening in New York/New Jersey Harbor

The purpose of this memorandum is to provide a summary of the development of the numerical model currents developed for use by MITAGS in navigation analysis of various channels in the New York/New Jersey Harbor.

The numerical model used for the development of these currents was the current Adaptive Hydraulics (ADH) model being applied to the ongoing *Shoaling Associated with Navigation Channel Deepening in New York/New Jersey Harbor Study.* The current model for the NY/NJ area was developed by hydraulic engineers at the U.S. Army Engineers Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi.

The model was developed for project deepened conditions with a 50-ft depth for the navigation channels.

The numerical model simulation from which the data were extracted was the depth-averaged version of the study model. Therefore, the reported data are depth-averaged current velocities.

The numerical model resolution with bathymetric contours is show in Figure 1 for the harbor area. Also shown in Figure 1 are the zones within which hydrodynamic data were extracted.

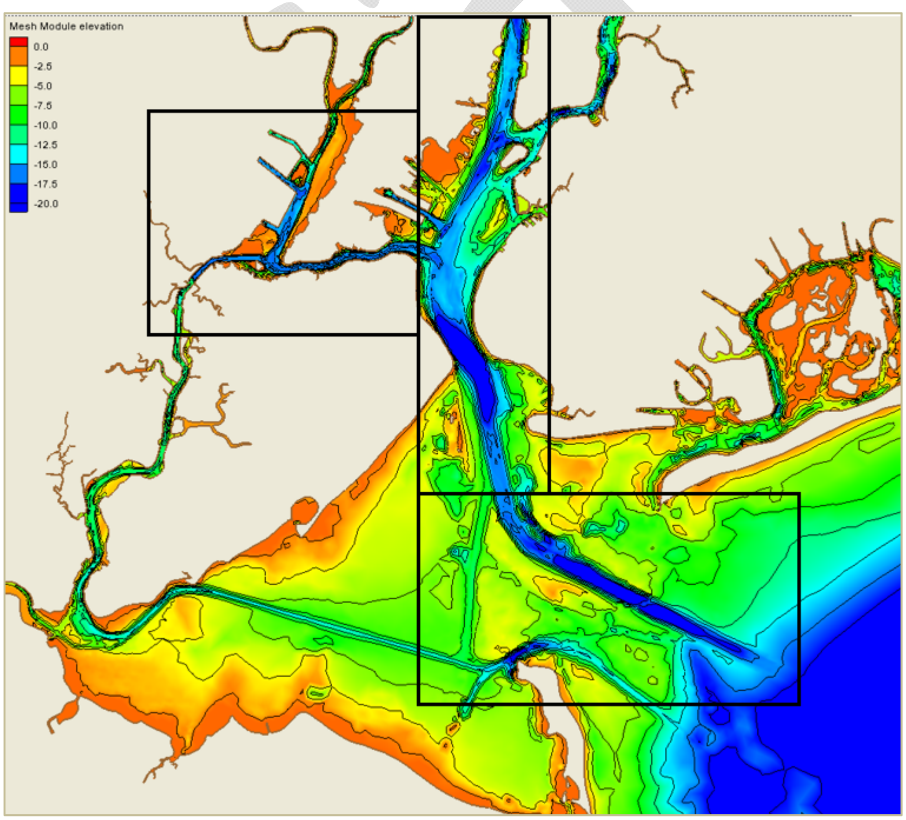


Figure 1. Numerical model bathymetric resolution and the extract windows for hydrodynamic data.

Details of tidal conditions and Hudson River discharge between hours 2000 (8AM 24 March) and 3500 (8PM 25 May) are presented in Figures 2 & 3. Two periods when data were extracted are highlighted in the figure. The two periods for extraction were 2352-2376 (8 April) and 3120-3144 (10 May). These two periods were selected because the first had full spring tides with a relatively low flow on the Hudson River of around 200 cms (7000 cfs). The second period was just following a spring tide with higher flows on the Hudson River, having just peaked on the previous day at 1453 cms (51300 cfs).

Current velocity patterns for the two periods are shown in Figures 4 through 9 for areas around the navigation channels.

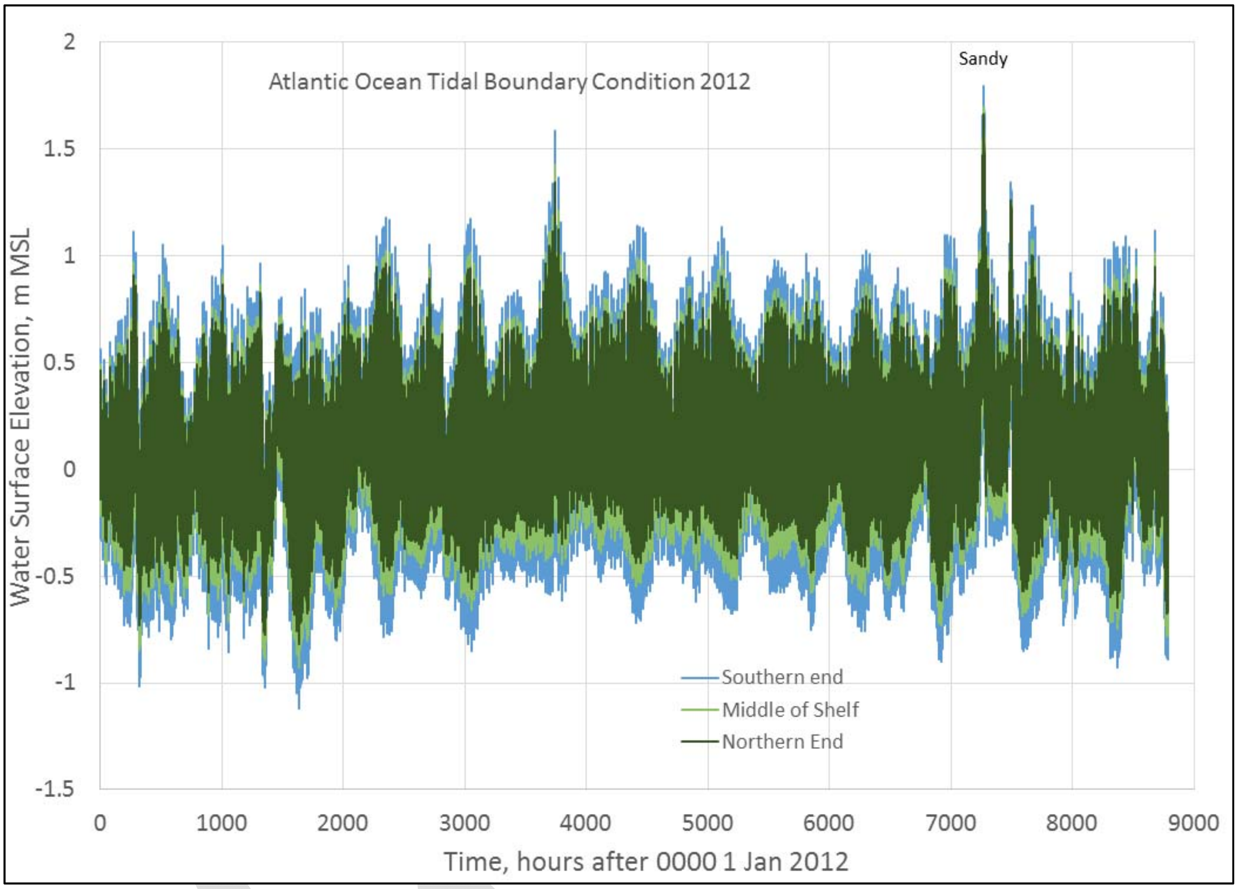


Figure 2. Tidal boundary conditions for the 2012 simulation.

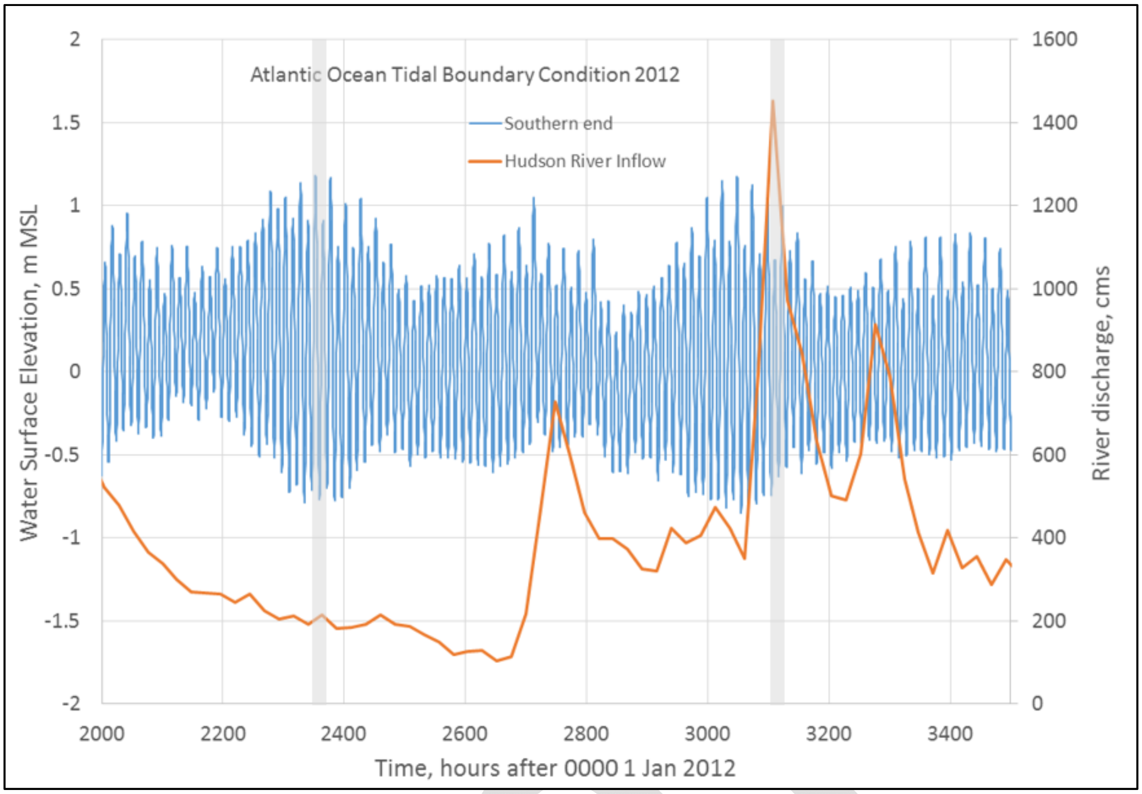


Figure 3. Details of tidal conditions and Hudson River discharge. The two periods when data were extracted are highlighted in the figure.

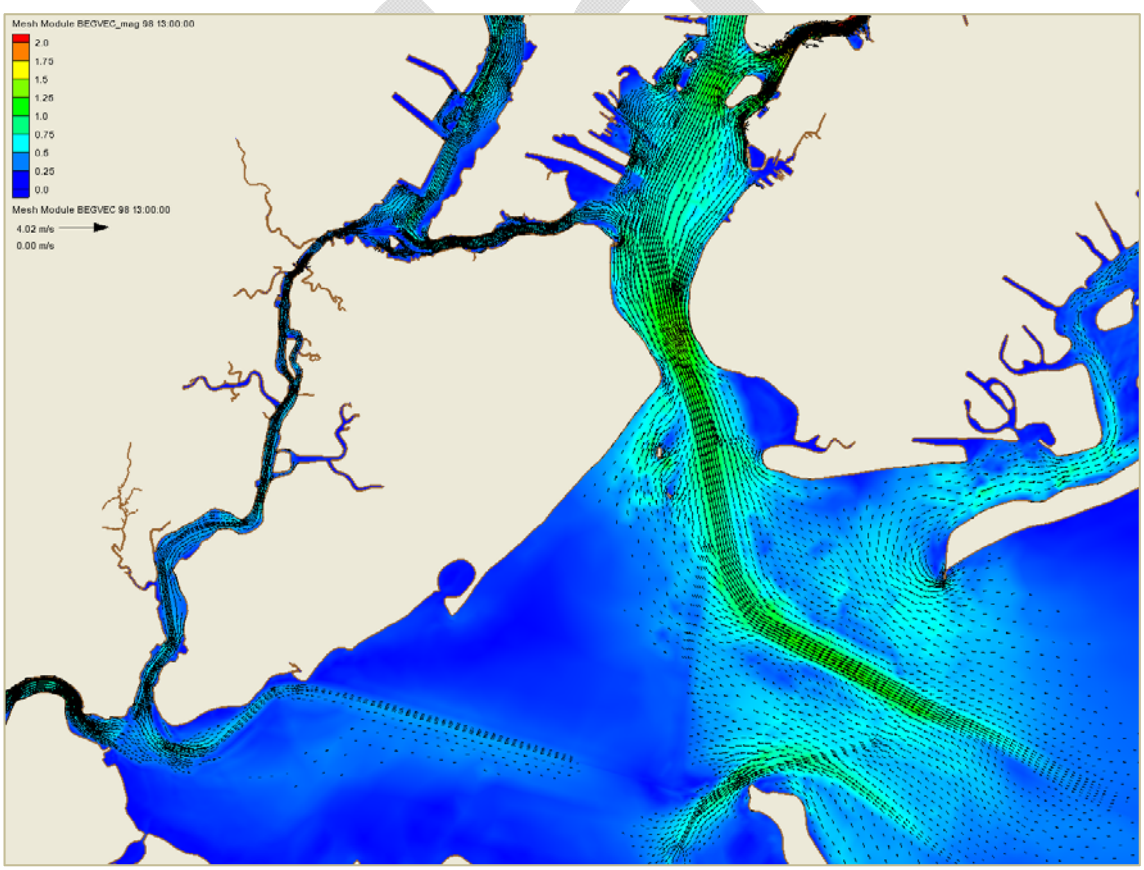


Figure 4. Flood currents over the navigation channel for time period 1, with low river flows

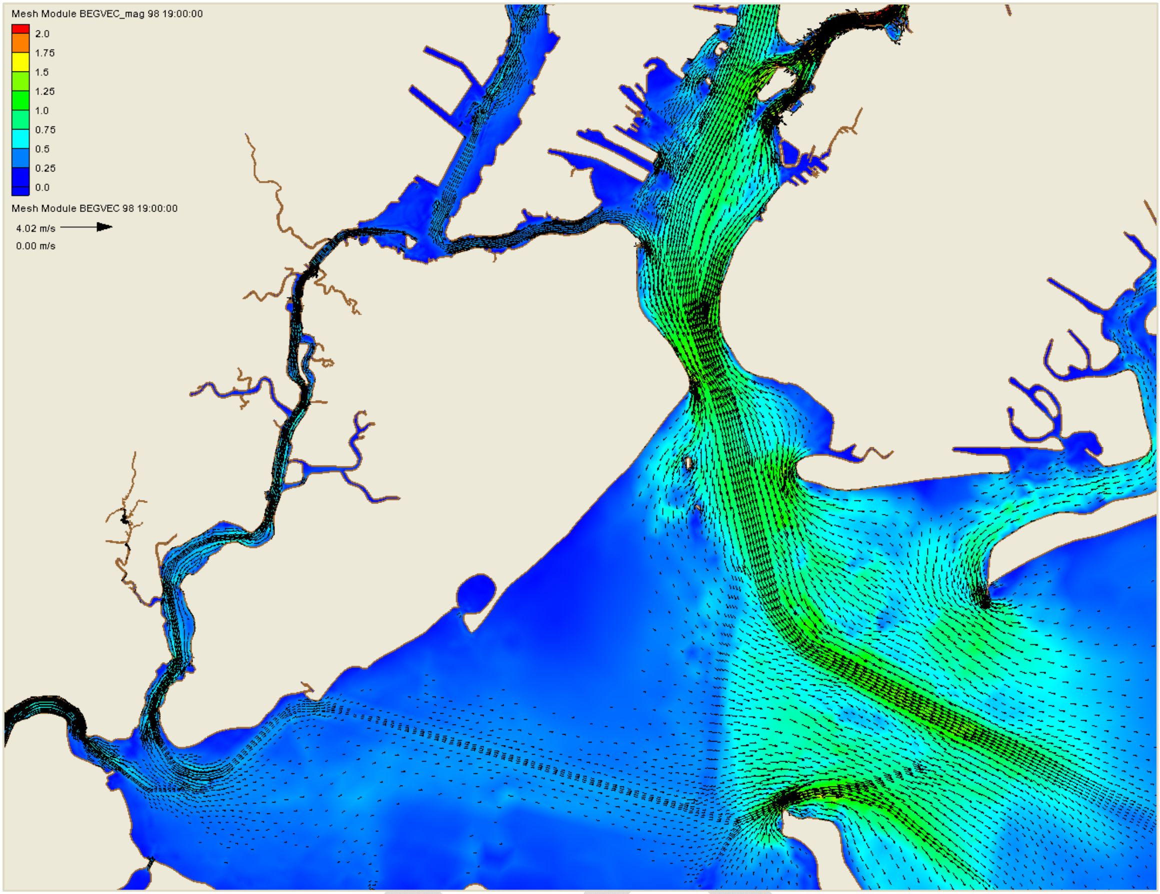


Figure 5. Ebb currents over the navigation channel for time period 1, with low river flows

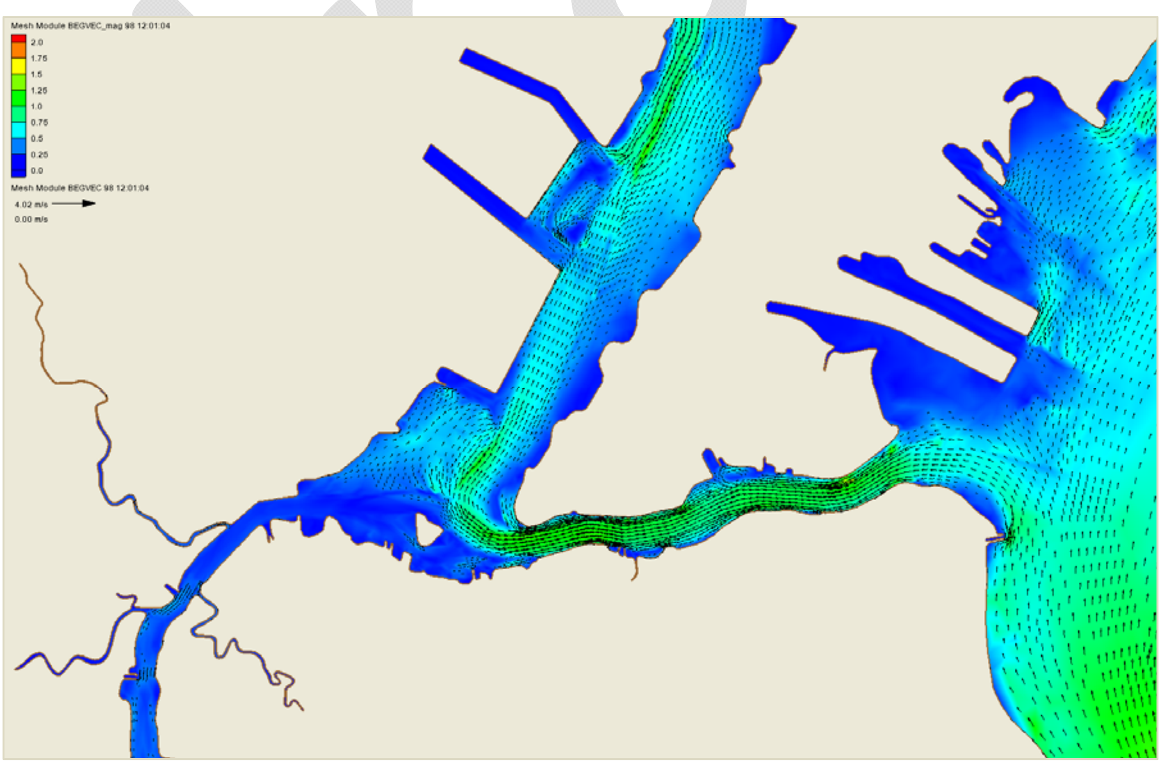


Figure 6. Flood currents in the inner navigation channel for time period 1, with low river flows

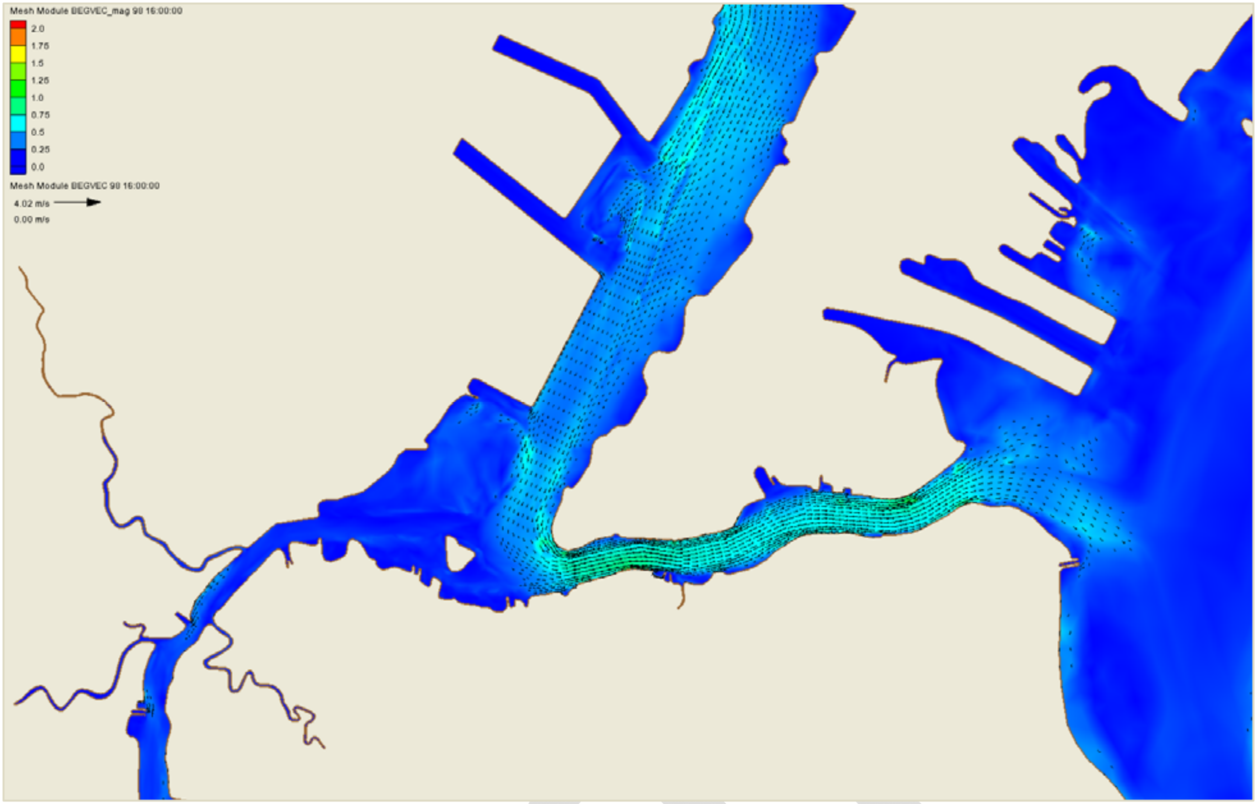


Figure 7. Ebb currents over the inner navigation channels for time period 1, with low river flows

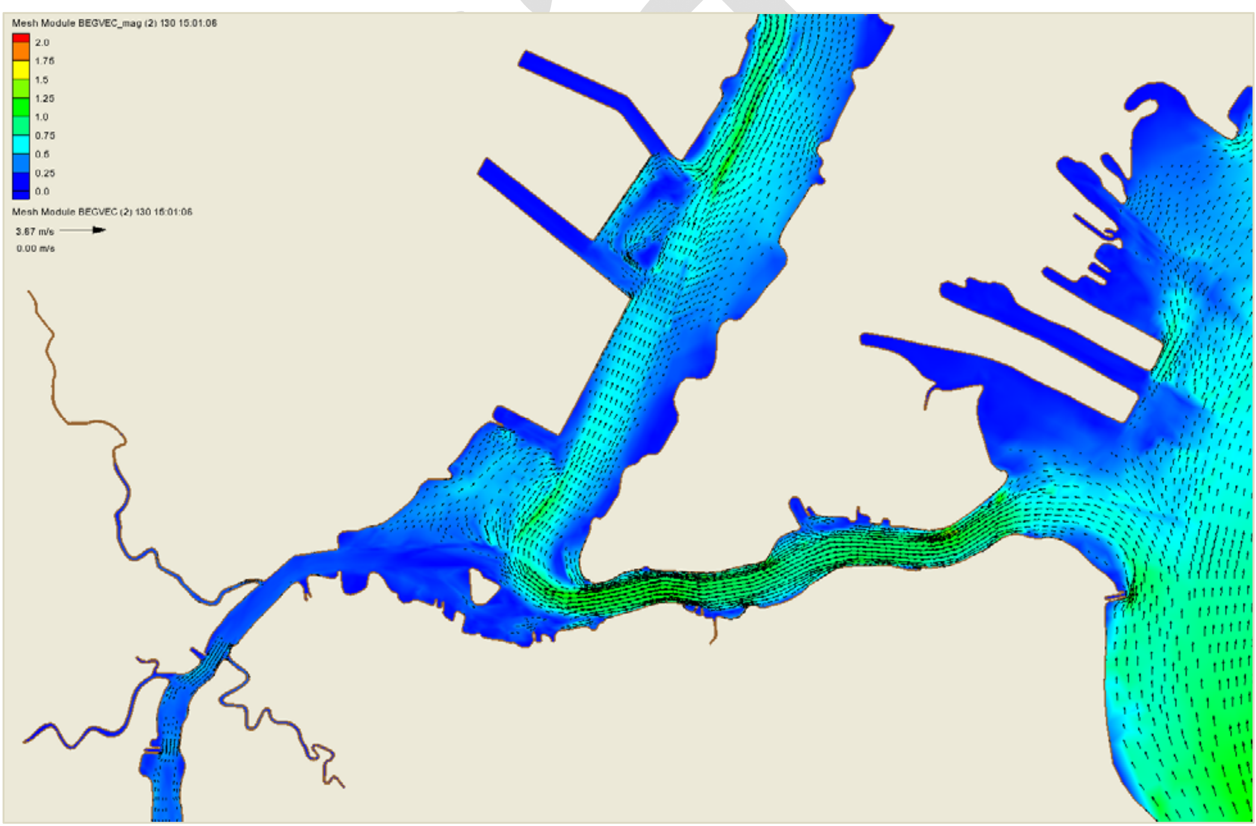


Figure 8. Flood currents over the inner navigation channel for time period 2, with high river flows

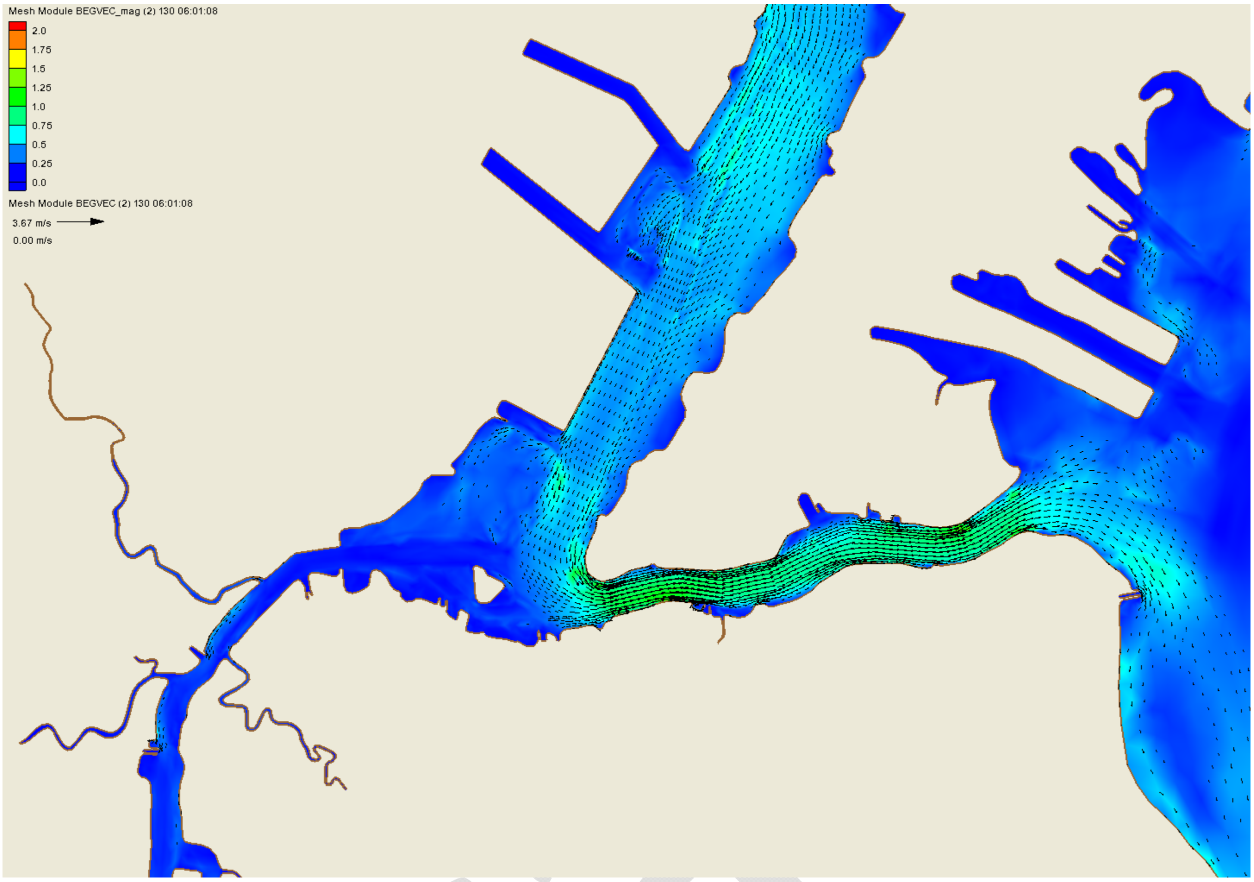


Figure 9. Ebb currents over the inner navigation channel for time period 2, with high river flows

In order to account for maximum ebb and flood current at different locations in the NY/NJ area, model data results were extracted at hourly intervals for both of the twenty-four periods listed earlier. These forty-eight hourly current files – tabulated below - were installed on the MITAGS simulator for use during initial testing with the Sandy Hook pilots. As can be seen in the lists, several additional current files were created by applying global multiplying factors to the original vector magnitudes contained in the individual hourly files. These latter files were used in order to meet pilot expectations in regard to how well the simulation replicated their experiences with ship handling in the various areas tested.

April 8, 2012 - Spring Tide - 7,062 cfs on Hudson River (Magnitude in Knots)

File	Goethals Bridge	Bergen Pt.	Port Elizabeth	Constable Hook Range	Port Jersey	Verrazano Bridge N	Verrazano Bridge S
NY-2352	0.97	1.78	0.62	0.95	1.03	2.19	1.77
NY-2353	1.40	1.18	0.52	0.62	1.14	2.21	1.63
NY-2353(1.5)	2.10	1.77	0.83	0.93	1.71	3.32	2.45
NY-2354	1.24	0.31	0.29	0.10	0.95	1.51	1.16
NY-2355	0.58	0.70	0.14	0.62	0.45	0.27	0.45
NY-2356	0.31	1.05	0.72	0.76	0.19	1.01	0.39
NY-2357	0.68	0.80	0.83	0.78	0.83	1.61	1.01
NY-2357(1.25)	0.85	1.00	1.04	0.98	1.04	2.01	1.26
NY-2357(1.8)	1.22	1.44	1.49	1.75	1.50	2.90	1.82
NY-2358	0.93	0.43	0.66	0.52	1.01	2.00	1.34
NY-2359	0.95	0.31	0.54	0.33	1.09	1.98	1.36
NY-2359(1.5)	1.43	0.47	0.81	0.50	1.64	2.97	2.04
NY-2359(2.3)	2.19	0.71	1.25	0.76	2.50	4.55	3.12
NY-2360	0.91	0.23	0.50	0.31	0.97	1.69	1.16
NY-2361	0.87	0.10	0.35	0.12	0.74	1.09	0.78
NY-2362	0.74	0.78	0.04	0.49	0.37	0.12	0.14
NY-2363	0.31	1.86	0.33	0.91	0.23	1.34	0.99
NY-2364	0.35	2.15	0.60	1.05	0.80	1.94	1.55
NY-2365	1.18	1.73	0.60	0.83	1.01	2.08	1.63
NY-2366	1.26	0.43	0.25	0.08	0.91	1.53	1.28
NY-2367	0.52	0.43	0.17	0.49	0.58	0.70	0.70
NY-2368	0.23	0.80	0.52	0.58	0.17	0.19	0.17
NY-2369	0.43	0.50	0.54	0.47	0.43	1.16	0.47
NY-2370	0.72	0.43	0.50	0.54	0.89	1.73	1.18
NY-2371	0.91	0.45	0.56	0.52	1.03	2.02	1.38
NY-2372	0.99	0.41	0.60	0.41	0.99	1.77	1.24
NY-2373	1.01	0.19	0.37	0.10	0.70	0.91	0.64
NY-2374	0.64	1.28	0.12	0.70	0.33	0.19	0.14
NY-2375	0.04	1.63	0.39	0.74	0.16	1.09	0.81

(shaded)	Flood Tide
(unshaded)	Ebb Tide

May 10, 2012 - After Spring Tide - 51,300 cfs on Hudson River (Magnitude in Knots)							
File	Goethals Bridge	Bergen Pt.	Port Elizabeth	Constable Hook Range	Port Jersey	Verrazano Bridge N	Verrazano Bridge S
NY-3120	0.31	1.28	0.29	0.60	0.08	0.50	0.29
NY-3121	0.16	1.44	0.39	0.70	0.39	1.26	0.91
NY-3122	0.54	1.57	0.50	0.85	0.81	1.73	1.40
NY-3123	1.03	1.36	0.49	0.76	1.01	1.98	1.59
NY-3124	1.18	0.60	0.31	0.23	0.97	1.67	1.26
NY-3125	0.78	0.54	0.04	0.43	0.58	0.62	0.60
NY-3126	0.12	1.03	0.58	0.70	0.00	0.70	0.21
NY-3126(1.25)	0.15	1.29	0.73	0.88	0.00	0.88	0.26
NY-3127	0.60	0.76	0.80	0.70	0.64	1.46	0.85
NY-3128	0.87	0.35	0.62	0.52	0.91	1.77	1.14
NY-3129	0.95	0.10	0.47	0.27	0.99	1.78	1.20
NY-3130	0.89	0.04	0.37	0.19	0.93	1.59	1.09
NY-3131	0.85	0.12	0.25	0.06	0.74	1.16	0.83
NY-3132	0.68	0.37	0.08	0.19	0.50	0.64	0.49
NY-3133	0.47	0.76	0.10	0.45	0.14	0.23	0.16
NY-3134	0.12	1.67	0.37	0.85	0.43	1.46	1.09
NY-3135	0.49	2.04	0.62	1.05	0.89	2.00	1.61
NY-3135(1.25)	0.61	2.55	0.78	1.31	1.11	2.50	2.01
NY-3135(1.5)	0.74	3.80	0.93	1.60	1.34	3.00	2.42
NY-3136	1.38	1.32	0.54	0.66	0.97	1.80	1.47
NY-3137	1.13	0.37	0.04	0.45	0.62	0.70	0.76
NY-3138	0.31	1.09	0.70	0.58	0.12	0.35	0.21
NY-3139	0.74	0.50	0.74	0.41	0.29	0.95	0.14
NY-3140	0.72	0.16	0.37	0.21	0.64	1.09	0.66
NY-3141	0.72	0.06	0.31	0.25	0.87	1.63	1.13
NY-3142	0.91	0.16	0.43	0.37	0.95	1.75	1.16
NY-3143	1.01	0.19	0.49	0.25	0.76	1.28	0.89
		Flood Tide					
		Ebb Tide					

APPENDIX D: Introduction to MITAGS and PMI

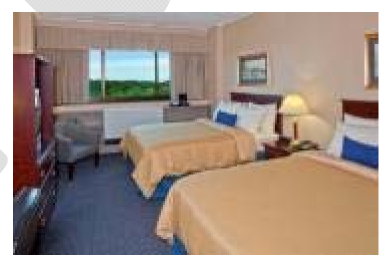
The Maritime Institute of Technology and Graduate Studies (MITAGS) and the Pacific Maritime Institutes (PMI) are non-profit, continuing education centers for professional mariners. The Institutes provide training for both civilian and military mariners at every level of their career.

MITAGS Location and General Facility Description

MITAGS is located less than five (5) miles from the Baltimore-Washington International Thurgood Marshall Airport (BWI). Complimentary shuttle links the campus with the airport, BWI Amtrak Rail, Baltimore Light Rail, and regional bus services. It is also near major tourist destinations; including Baltimore, Annapolis, and Washington, DC.

The MITAGS campus encompasses over forty (40) acres. The 300,000 square-feet facilities include:

- On campus hotel with 232 hotel rooms (3-STAR equivalent). Hotel and conference facilities approved by the International Association of Conference Centers (IACC).
- 500-seat dining facility, 250-seat auditorium, pub, and store.
- Indoor swimming pool, Jogging / walking trails, Nautilus® Fitness Room.
- Maritime Museum.
- ECDIS, Stability, LNG Cargo and Engine Room Training Software.
- Emergency Medical Lab.
- 16-station networked computer Lab.
- Two, 360° Transas Full-Mission Shiphandling Simulator integrated with a 120° Bridge Tug and a 300° Bridge Tug Simulators.
- 8-Ship Radar, Automatic Radar Plotting Aids (ARPA), and Electronic Chart Display and Information Systems (ECDIS) Simulators.
- Global Maritime Distress and Safety Systems (GMDSS) Communications Lab.
- Vessel Traffic System (VTS) Watchstander Training Lab.



PMI Location and General Facility Description

The Pacific Maritime Institute (PMI) is a subsidiary of MITAGS in Seattle, Washington. PMI is located approximately twenty (20) minutes from Seattle Tacoma (SEA-TAC) International Airport. Their waterfront facility is positioned directly within the Maritime Technology and Career Center. PMI offers the following onsite technology and training support facilities:

- 240° DNV Class A Full-Mission Bridge Simulator.
- Two 300° Full-Mission Tugboat Simulator.
- 6-Radar/Automatic Radar Plotting Aids (ARPA) Simulators.
- Two Electronic Chart Display and Information Systems (ECDIS)/Electronic Navigation Labs.
- Global Maritime Distress and Safety Systems (GMDSS) Communications Lab.
- 2-Simulation Debriefing Rooms and 12 conference / classrooms.
- Complimentary parking.

MITAGS DNV Class A Full-Mission Ship Simulator #1 (Bridge for Phase I and II Tests)

MITAGS Tug Bridge Simulator (Bridge for Phase I and II Tests)

Aerial Photograph of MITAGS Campus and Location Diagram