ATTACHMENT 3
SHIP SIMULATION REPORT

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Date Received:
September 8, 2016 mb

BRAZOS PILOTS ASSOCIATION
FREEPORT, TEXAS

Dear SWG District Commander:

The Brazos Pilots Associates want to thank the Corps for initiating the Freeport Harbor Improvement Project. Our organization is continually looking for improved safety and navigation capacity for Freeport Harbor Ship Channel. Any improvements that can be provided to enhance the channel will help the pilots to achieve this goal.
In May 2016, two of the Brazos Pilots participated in a vessel simulation. The simulation investigated the handling and maneuverability of a Panamax size vessel through Reach 2 with the following proposed channel improvements:

- Channel widening through the Reach 2 to 400 feet;
- Bend Easing along the south-east corner of the bend where the Wave Barrier is located;
- Inclusion of a turning notch in the upper basin; and
- A wider berth at Berth 7 which was added during the course of the simulation.

It was determined that a wider berth at Berth 7 would allow for safer outbound transit. Furthermore, it was determined during the simulation that additional tug assistance was needed for safe navigation. While a channel width greater than 400 feet would be ideal, the attached summary of the STAR Center simulation indicates that when the proposed channel improvements are made, it is possible for Panamax class vessels to navigate through Reach 2 using adequate tug assistance at a reduced speed, subject to usual operational procedures and conditions. The additional dredging planned for widening the berth area at Berth 7 will facilitate the approach to and from the berth when angling from the turn in the Upper Turning basin.
We look forward to working with the Corps and Port Freeport to continually improve the operations and safety of the Freeport Harbor Channel.

Sincerely,

Captain Daniel Blanton
President

PO Box 2246 * Freeport, TX 77542 * 979-233-1120 * Fax 979-233-7071 * www.brazospilots.com

STAR Center
Simulation, Training, Assessment & Research
2 West Dixie Highway • Dania Beach, Florida 33004
TEL 954-921-7254 • 800-445-4522 • FAX 954-920-4268 • 800-431-8815
www.star-center.com • email@star-center.com

6 June 2016

FREEPORT, TX CONTAINERSHIP EVALUATION 2016

OVERVIEW

The port of Freeport, Texas has constructed a container terminal along the Brazos River channel. This winding channel is a remnant of the Brazos River which was diverted north of the present channel. The strong river currents and silting problems were eliminated by the diversion. The winding channel still requires a 180 degree course change in order to reach the container terminal Berth #7. Our simulation study examines access by a Panamax container vessel to this new terminal via the Brazos channel. This study was conducted at the STAR Center located in Dania Beach, Florida during the period 4-6 May 2016. See **Figure 1 -Port Freeport Existing Channel** below.

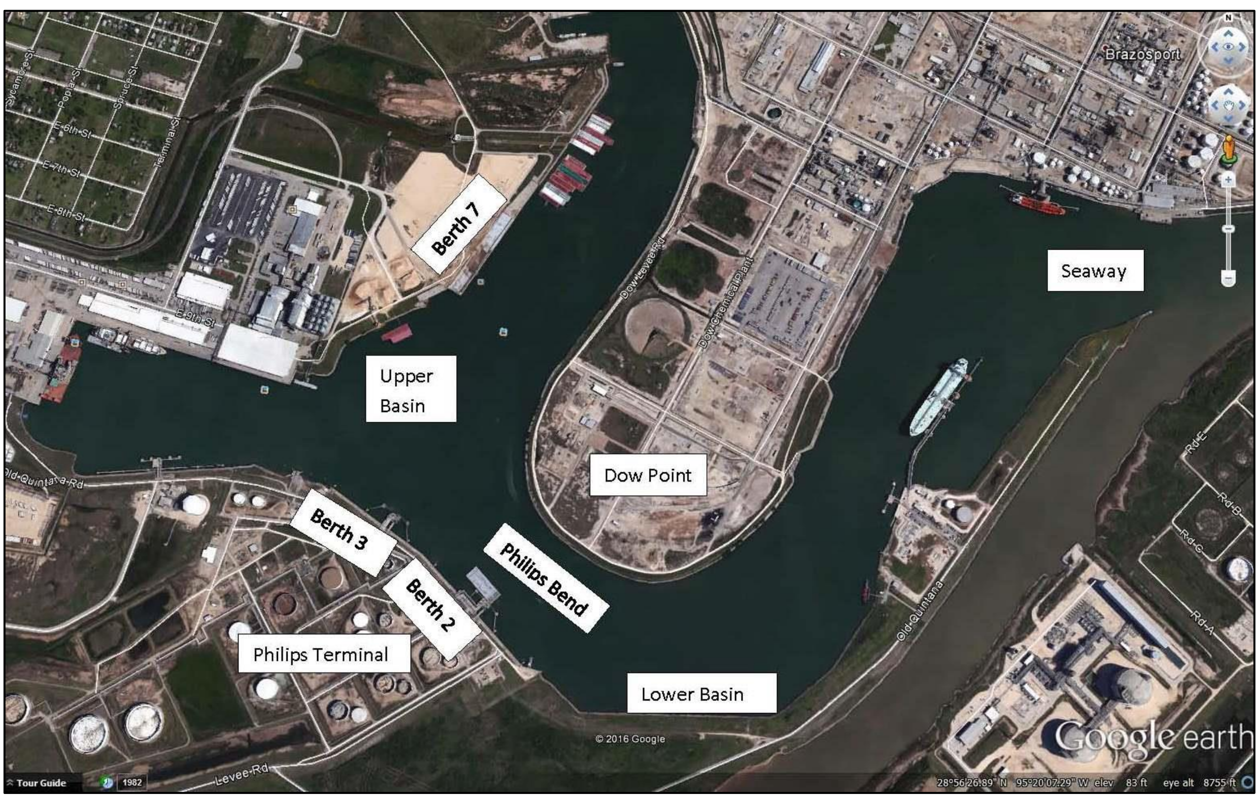

Figure 1 – Port Freeport Existing Channel

A similar study, previous to this one was conducted at the STAR Center in January 2014. This study was five days in duration, and was designed to examine Post-Panamax container ships entry and exit from the container terminal berth #7. During this study five different dredge plan options were evaluated in order to examine this goal. Each option presented different pros and cons for the transit of these container vessels. Channel widths of between 275 and 632 feet in the Phillips Bend area of the channel between the Lower and Upper Basins were tested. The narrowing of the channel bounded by the southern portion of Dow Point and Berth #2 at the Phillips Terminal proved to be the most difficult and challenging portion of the transit for the shiphandlers. Test results indicated that it would be necessary to dredge and widen both the Lower and Upper basins. The results provided by that study, many lessons-learned and practical solutions were incorporated in this study and dredge plans. Expectations of providing a channel width ample for the safe transit of Post-Panamax size vessels were set aside in view of the many limiting factors in channel expansion in this critical area.

In view of the limitations and lessons-learned suggested by the previous study, our simulation study will evaluate two dredge plan options, a 375 foot and a 400 foot channel width in this crucial area of Philips Bend. Both of these options rely on a deepened and widened Lower and Upper basin area. Minimum depths in both plans are 46 feet as is the entire channel. Perhaps most importantly, our test vessel is Panamax and not Post-Panamax size as tested in the previous study.

Figure 2 – Dredge Plan 375 Foot and **Figure 3 – Dredge Plan 400 Foot** are presented below.

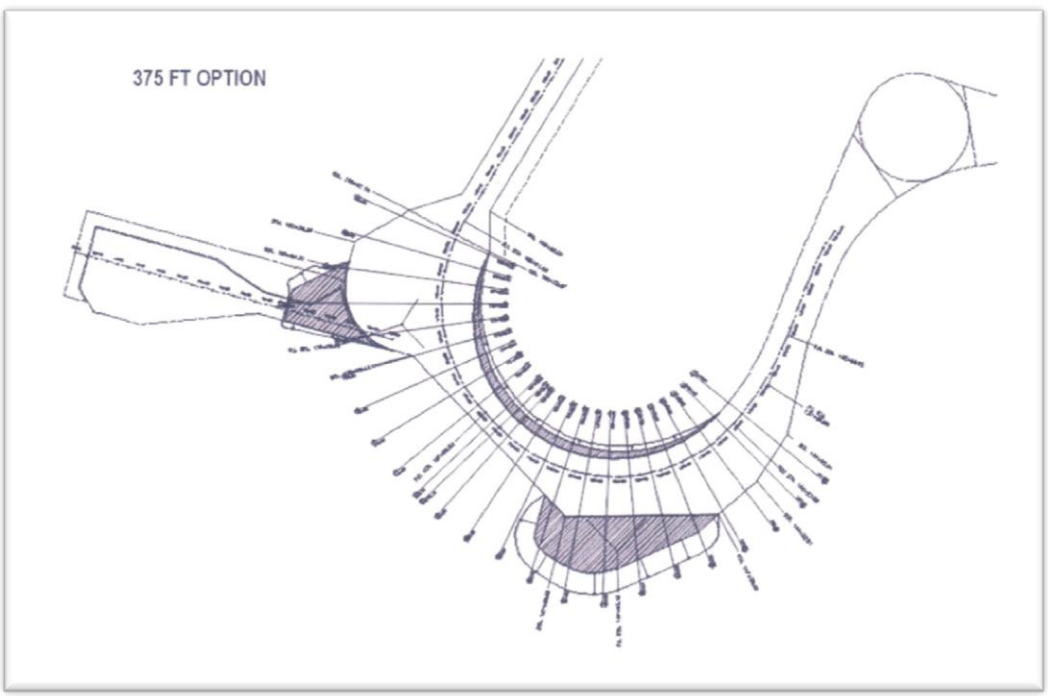

Figure 2 – Dredge Plan 375 Foot

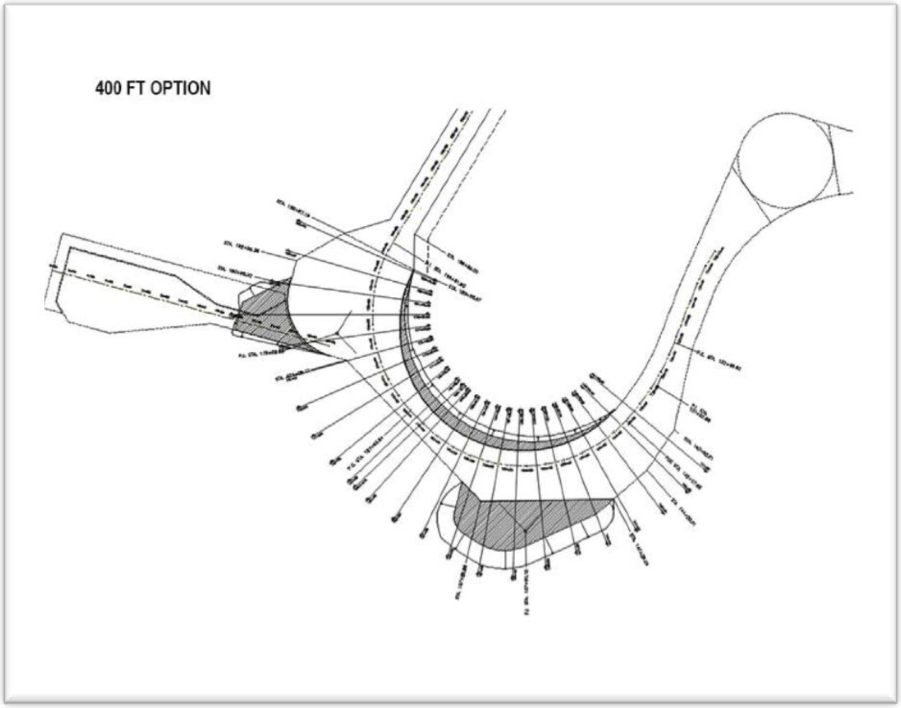

Figure 3 – Dredge Plan 400 foot

PARTICIPANTS

Two Brazos Pilots, from the Brazos Pilots Association, actively participated as shiphandlers in the study and operated the test vessel during each of the simulation exercises. Additional observers included, commissioners and port staff from Port Freeport, United States Army Corp of Engineers (USACE), and HDR Engineering, Inc. attended and observed the simulation exercises. These various participants were able to provide explanations and advice concerning the reasoning behind the dredge plan limits and constraints provided valuable insight for our resulting analysis. A Biscayne Bay Pilot participated by observing first day exercises and provided his comments and suggestions for successful run completions in the proposed channel in Port Freeport based on his experience in PortMiami narrow channel navigation with containerships.

STAR Center provided a Senior Researcher to schedule and oversees the simulation project, a vessel Mate to assist the shiphandlers, a technician to monitor simulator equipment, and a simulator operator to operate the simulator equipment and record data used for later analysis of simulation results. A project facilitator monitored each exercise, conducted briefings before each exercise and debriefings after each simulation exercise.

SIMULATOR MODELS

Geographic Database

The geographic database used for the study was available at STAR Center having been used in the previous study. Modifications were made to this database to conform to a 375 foot, and a 400 foot dredge plan options. A “Birds Eye” view visual representation of vessel location within the channel similar to ECDIS was available to the shiphandler as well as a radar display. Other displays normally available on a Navigation bridge such as engine RPM, Thruster indicator, course and speed indicators were also available.

Hydrodynamic Model

The hydrodynamic vessel model of the “*CMA CGM Virginia*” was constructed by STAR for use in the study. The “*CMA CGM Virginia*” is a Panamax sized container vessel. The particulars for this model are presented in **Table 1 – Vessel Particulars** below.

Table 1 – Vessel Particulars

Vessel Name	CMA CGM Virginia
Displacement (t)	76,940
Condition	Loaded
LOA (ft)	964.6
Beam (ft)	105.6
Draft (ft)	42.6
Propulsion	Diesel
Propeller HP	77,769
Bow Thruster HP	2,447
Rudder Type	Normal

ASSIST TUGBOATS

Three (3) Azimuthing Stern Drive (ASD) tugboats were available to the shiphandler in all simulation exercises. Each of these tugs is rated at 68 tons bollard pull at full power. ASD tugs are extremely maneuverable vessels capable of providing multidirectional forces when attached to any large vessel.

TEST PROCEDURES

Inbound and outbound runs of our test vessel in prevailing local wind conditions in the area were tested. In order to maximize the number of simulation runs that could be conducted during this three day study, simulation runs are shortened allowing us to focus on the Lower and Upper Basins and the turn area below Dow Point. Generally, simulation runs began just east of the 90 degree turn at Seaway. They ended each run, whether inbound or outbound, after the vessel completed the channel transit of Phillips Bend between the Lower and Upper basins.

The shiphandlers were given the option of utilizing between one and three of the available tugboats. These tugboats were positioned on the test vessel and utilized in whatever way the shiphandler was comfortable utilizing the tugboats. Vessel start speed was also at his discretion.

Prior to the start of a simulation exercise the shiphandler was briefed on wind direction and velocity. During discussions with the shiphandlers at the outset of our project, it was determined that narrow channel conditions would limit maximum safe wind conditions not to exceed 20 knots. Wind direction in the area is generally easterly, from north northeast through south southeast.

At the conclusion of each exercise a debriefing of the shiphandler was conducted. This debriefing involved verbal comments as well as completion of a “Run Evaluation Form” soliciting his impressions of the simulation run. These “Run Evaluation Forms” will accompany this report.

Additionally, vessel track plots were recorded to show the position and that swept path of the test vessel during each exercise from beginning to the end of the exercise. These track plots also accompany this report.

Twenty Three exercises were completed during this study of which Fourteen were inbound, and Nine outbound. Particulars of each run are presented in the **Table 2 - Run Matrix**.

Table 2 – Run Matrix

Run #	Inbound Outbound	Pilot	Wind Dir/Speed	Tug	Dredge Plan	Comments
1	Inbound	1	None	2	400	Familiarization
2	Inbound	1	NNE/10	2	400	Grounded Lower basin
3	Inbound	1	NNE/10	2	400	Close w/moored vessel
4	Outbound	1	NNE/10	3	400	Grounded Upper basin
5	Outbound	1	NNE/10	3	*400	
6	Inbound	1	NNE/20	3	*400	Close w/moored vessel
7	Inbound	1	SSE/20	3	*400	
8	Inbound	1	E/10	3	400	
9	Inbound	1	E/20	3	400	
10	Outbound	1	E/20	3	400	Grounded Lower basin
11	Outbound	1	E/20	3	400	
12	Inbound	2	E/10	3	375	Comm prob. Stop Ex.
13	Inbound	2	E/10	3	375	Grounded Lower basin
14	Inbound	2	E/10	3	400	
15	Outbound	2	E/20	3	400	Grounded Lower basin
16	Outbound	2	E/10	3	400	
17	Inbound	2	E/20	3	400	
18	Inbound	2	E/20	3	375	
19	Outbound	2	E/20	3	375	
20	Inbound	2	SE/20	3	400	
21	Inbound	2	NNE/20	3	400	
22	Outbound	2	SE/20	3	400	Grounded Berth #7
23	Outbound	2	SE/20	3	400	

*Note: An additional 2 foot tidal depth was added in run numbers 5,6, and 7. No vessel improvement was noted and the additional depth was removed

CHALLENGES FOR THE SHIPHANDLER

Channel

The challenge for the shiphandlers is better understood if some of the more difficult areas are described here. The overall width of the channel with the exception of the area of Phillips Bend may not be considered extremely narrow for a Panamax size vessel transiting in a straight-line under normal conditions. However, the almost 90 degree turn at the area identified as Seaway and the 180 degree turn required at Phillips Bend provide additional challenges. In Phillips Bend the swing of the bow or stern of the vessel in order to negotiate the turns can easily double the swept path required to complete the turn. This fact makes it impossible to remain center channel, forces the shiphandler to hug the north bank side of the channel, giving room for stern swing. Hugging the bank-side of the channel has its own set of difficulties when manuvering known as “bank effects” may cause a vessel to sheer away from the bank toward opposite side of the channel.

Channel depths provide an under keel clearance of 3 to 4 feet for our test vessel at slow speeds. When turning a vessel in shallow water however, this minimum under keel clearance can cause any vessel to respond slowly and sluggishly to turning forces.

Tugboats

Turns of 90 or 180 degrees in a narrow channel can be expected to require tug assistance in addition to use of engines and bow thrusters. The three ASD type tugboats available at the Port can provide the much needed assistance. In order to utilize maximum available power of these tugs: attaching two tugs at the bow, one on each shoulder, and one on the stern is optimum. The two tugs at the bow provide steering, and the stern arresting tug provides stopping power as well as steering. Shiphandlers must consider that attaching a tug at each shoulder increases the swept path of the vessel adding tugboat width or length to the containership's width. When transiting the shiphandler must also ensure that there is ample room and water depth for the tugboats to work.

Moored Vessels

Transiting vessel speeds must be kept to a minimum in this narrow channel especially in the vicinity of the adjacent moored vessels. Our containership is powered by a slow speed Diesel as are most of today's container vessels and minimum speeds are 6 or 7 knots. Intermittent engaging of the ships engines and tugboat speed arresting is necessary to maintain minimum speeds. Vessel speed when passing a moored vessel is usually considered safe when in the 3 to 4 knot range. This speed, coupled with a passing distance of between 200 and 250 feet is generally considered safe and causes minimum surge affects to a moored vessel. For the shiphandler however, these slow speeds (2-3 knots at Philips Bend) also dampen much of the effect of the ships rudder during turning maneuvers.

EXERCISE RESULTS

During the first three exercises on the first day the shiphandlers utilized two tugboats to assist in vessel maneuvers. In each of the cases a tug was attached at the port and starboard shoulder, and during maneuvers the port shoulder tug moved to the ship stern. The vessel had a successful run on the first run and very unfavorable Pilot ratings. The ship grounded on the second run and had a near allision with the vessel moored at Berth #2 on the third run. At this point it was suggested that the Pilot use three tugboats to more safely complete the upcoming exercises. Three tugs were utilized in all exercises for the remainder of our project. Subsequent runs 4 thru 11 were completed with varying degrees of success. Four of the runs were successfully completed while three other runs were problematic. Speed control was the biggest problem for the shiphandler. Steering the vessel occupied all three tugs during much of the transits. When rounding Phillips Bend the right or Dow Point side of the channel was favored and extensive use of the tugs was required to combat bank affects much of the time.

There were two groundings in run numbers 4 through 10. Grounding occurred in each basin. The grounding in the Upper Basin in run number 4 was attributed to a brief moment of inattention by the shiphandler but resulted in a dredge plan modification of both the 375 and 400 foot plan. This modification increased the width of the berthing box at the southern end of the terminal. The dredged area extension that was added was added into the STAR Center's databases. All subsequent runs utilized the expansion of this area in this project. This rectangular area at the Terminal Berth #7 has been dredged to 46 feet. This area was added to our database after run Number 8 and used in all subsequent runs. See **Figure 4 – Run Number 9, Expanded Berth Area in Red** below.

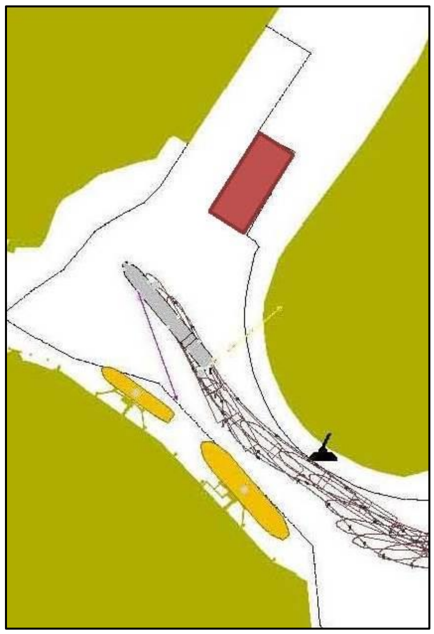

Figure 4 – Run Number 9, Expanded Berth Area in Red

The grounding in the Lower Basin in run number 10 was avoidable and attributed to excessive speed.

Comments by the shiphandler via the "Run Evaluation Form" rated the transits very difficult, very stressful and vessel performance unsatisfactory. Some problems of vessel control were attributed to excessive speed. The shiphandler expressed a difficulty in controlling vessel speeds. Maneuver room in the Lower Basin and Upper Basin appeared to be ample and satisfactory for the shiphandler to turn or slow the vessel prior to entry into Phillips Bend if speeds were kept to a minimum.

The Biscayne Bay Pilot who observed first day exercises provided comments and suggestions for successful run completions. He commented about keeping the vessel speed down in order to be able to pass ships at the docks at a reasonable speed and not cause ship to ship interaction. He also recommended using three or four tugs in order to maintain control of the ship at low speeds. Another suggestion he made was to stay in center of the channel to keep the tugs safe from damage by coming in contact with the bank. He also pointed out that staying in the center of the channel will keep the ship from experiencing unpredictable bank forces.

Day two and three yielded exercises and results much the same as day one. 12 simulation runs were completed 4 of which were conducted in the 375 foot wide Phillips Bend channel and 8 in the 400 foot channel configuration.

In this 375 foot channel, runs 12 and 13 concluded in a grounding while runs 18 and 19 were completed successfully. The successfully completed runs 18 and 19 were rated as difficult and stressful, but vessel performance was rated higher than some runs completed in the 400 foot channel. This inconsistency was probably due to both the increased familiarization with the "*CMA CGM Virginia's*" performance and with the channel itself in the latter runs. There was evidence that runs conducted in the latter part of the project were more successful overall than earlier efforts.

The project called for the maneuver of a containership larger than that currently visiting at the port, and the proposed dredged channel is also new to the shiphandlers. Some learning curve improvement is to be expected in later exercises.

Repetition whether via simulations or in actual practice at the Port will no doubt enhance shiphandler performance. Multiple transits will also enable additional confidence on the part of the shiphandler.

It should be mentioned here that the job of a pilot is to advise and guide a vessel whether inbound or outbound at Freeport. His expertise is vessel maneuvers and is the local area expert, familiar with the environmental conditions, tug capabilities, and especially familiar with the channel. Expert familiarization with the channel can only be gained by repeated trips in the channel. For this reason, we expect that after completion of the dredging identified in the 400 foot plan, Brazos River Pilots, our shiphandlers, will experience less stress and task difficulty than that expressed in many of the simulation exercises.

No one cause was identified as contributing to the success or failure of each exercise. Each transit did depended heavily on course and steering corrections quickly and forcefully applied.

COMMENTS

Observations and simulation exercise analysis indicate that safe inbound and outbound transits of the Panamax size vessel "*CMA CGM Virginia*" is possible after completion of the 400 foot dredge plan.

The integral parts of this dredge plan are the deepening an expansion planned for what we identify as the Upper and Lower Basins. The maneuver room offered at these areas is key in the successful transits of the Phillips Bend channel portion.

The additional dredging planned for widening the berth area at Berth #7 is indicated to facilitate approaching the berth at arrival and departing when angling for the turn in the Upper Basin.

Successful transits by the containership vessel in the latter part of our project reinforce our belief that a strategy that may be different from that presently used for smaller vessels visiting the Port is necessary. Although not in all cases, when the shiphandler attempts to drive the ship around the turn in Phillips Bend success is less likely. Simply put, when the vessels stern is swung toward the Phillips terminal docks, which happens both inbound and outbound, its swept path in many instances is equal to or greater than the available channel width.

The recommended and observed strategy when inbound with a Panamax size vessel is to fully utilize the available maneuver room in the Lower Basin to slow or stop if necessary, turn approximately 90 degrees and position the vessel to enter Phillips Bend parallel to Berth #2. Utilizing this approach will "straighten" the transit and require little or no vessel turning/swinging in this section of channel. Run number 21 is an example of utilization of the Lower Basin to straighten the Philips Bend transit. It is presented in **Figure 5 – Run Number 21 Lower Basin** below.

Figure 5 – Run Number 21 Lower Basin

Strategy for outbound transits will generally be the same however turning to parallel Berth # 2 will be accomplished in the Upper Basin, and result in the same straight line transit. After clearing Berth #2 the vessel may commence a gradual turn or complete the 90 degree turn in the Lower Basin. The three tugs will be utilized to turn the ship in the Lower Basin and then to control the ship as it slowly passes the ships at berths 2 & 3 in the middle of the channel.

RECOMMENDATIONS

- The use of three assist tugboats is recommended in all cases whether inbound or outbound. Although wind conditions in simulation were incorporated up to 20 knots, shiphandlers made no mention of unwanted effects of these winds or attribute any additional problems caused by them. Maximum safe wind conditions at the port should be limited to a 20 knot maximum provided the three tugs are in use.
- Daylight transits only until additional experience is gained.
- One-way traffic only.
- Because the channel is bounded closely by land from Seaway to Terminal Berth #7, no additional buoys or leading lights are necessarily indicated.
- The additional dredging adjacent to Berth # 7 is indicated and recommended.
- Recommend having the Brazos Pilots observe operations with the Biscayne Bay Pilots bringing in Panamax class container ships into and out of PortMiami in order to see how ships of this class are handled using tugs in narrow channel conditions.
- Recommend Brazos pilots have two additional simulation days at the STAR Center 360 simulator in order to gain additional experience with Panamax size containerships prior to their first arrival in Freeport, TX.

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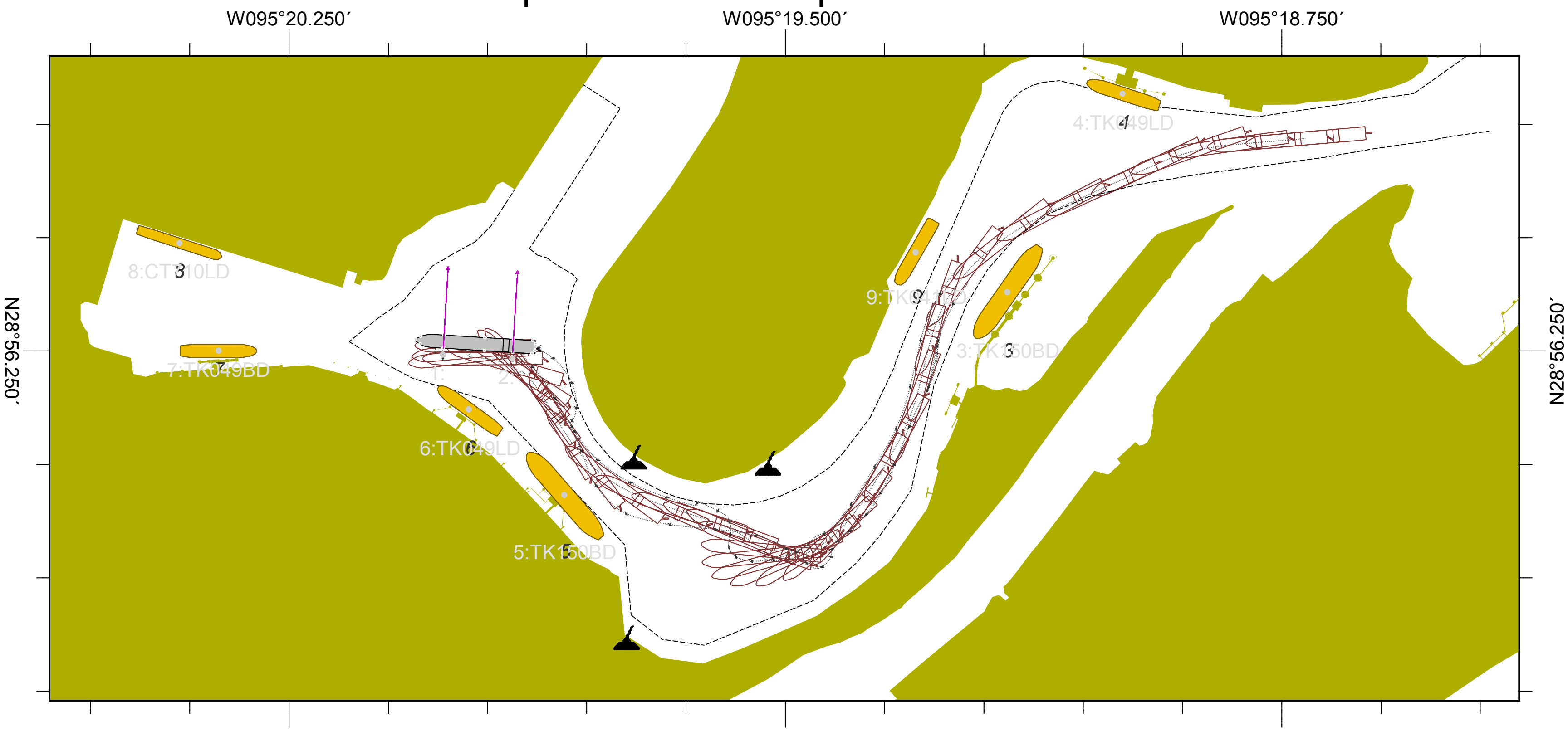
Freeport Containership Evaluation 2016



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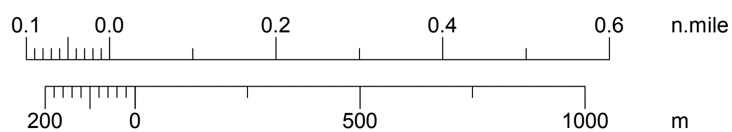

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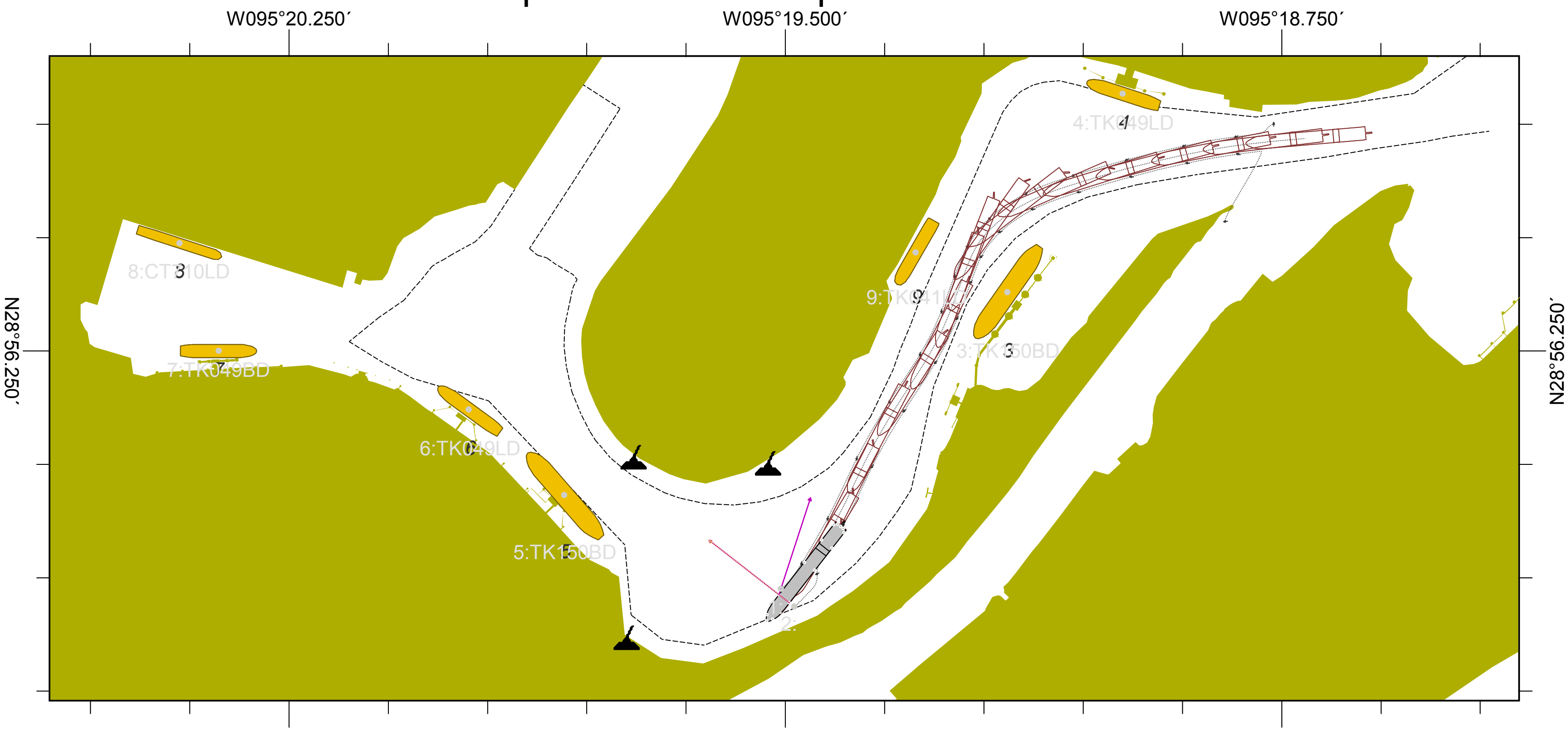
Heading marker period (s)	60
Shape outline every	01:00

Freeport Containership Evaluation 2016



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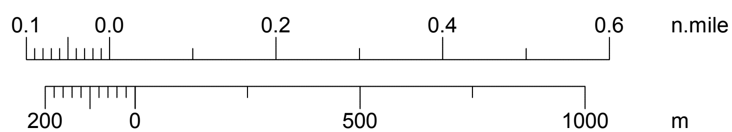

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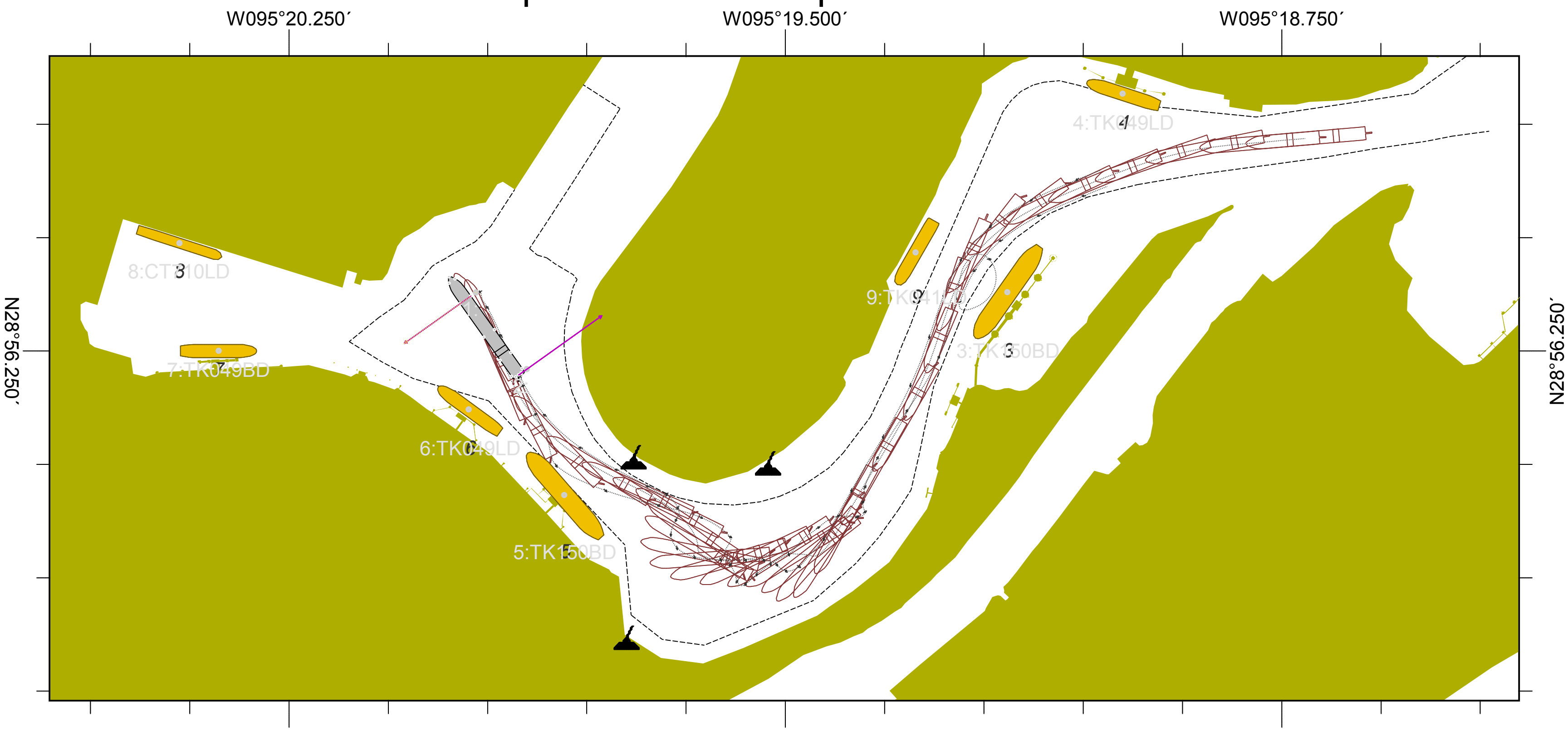
Freeport Containership Evaluation 2016



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0.1 0.0 0.2 0.4 0.6 n.mile

200 0 500 1000 m

Comments: Run #3: Pilot-1: Wind-NNE 10Kts, No Current

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Heading marker period (s)	60
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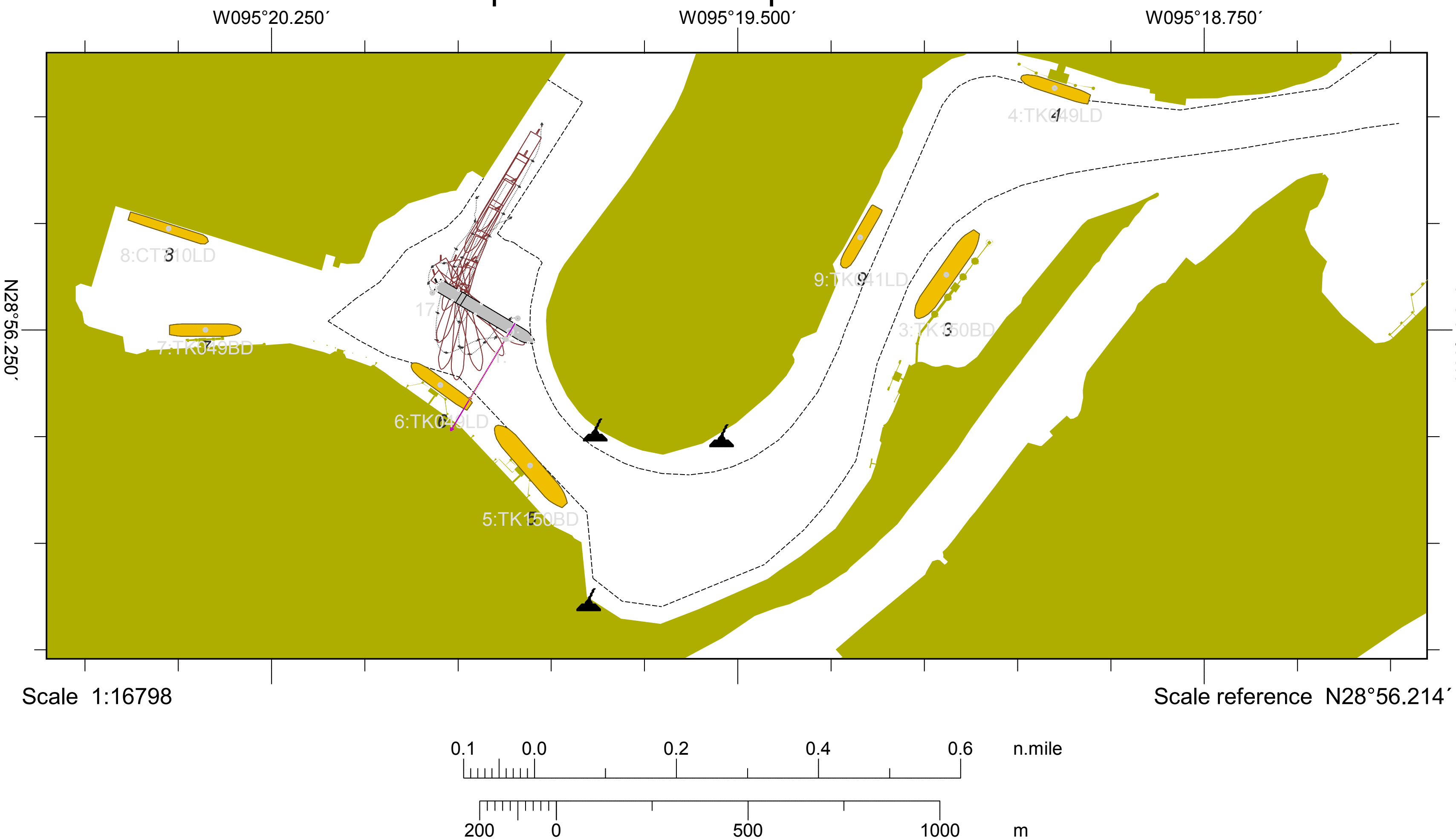
Freeport Containership Evaluation 2016



Comments: Run #4: Pilot-1: Wind-NNE 10Kts, No Current

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Heading marker period (s)	60
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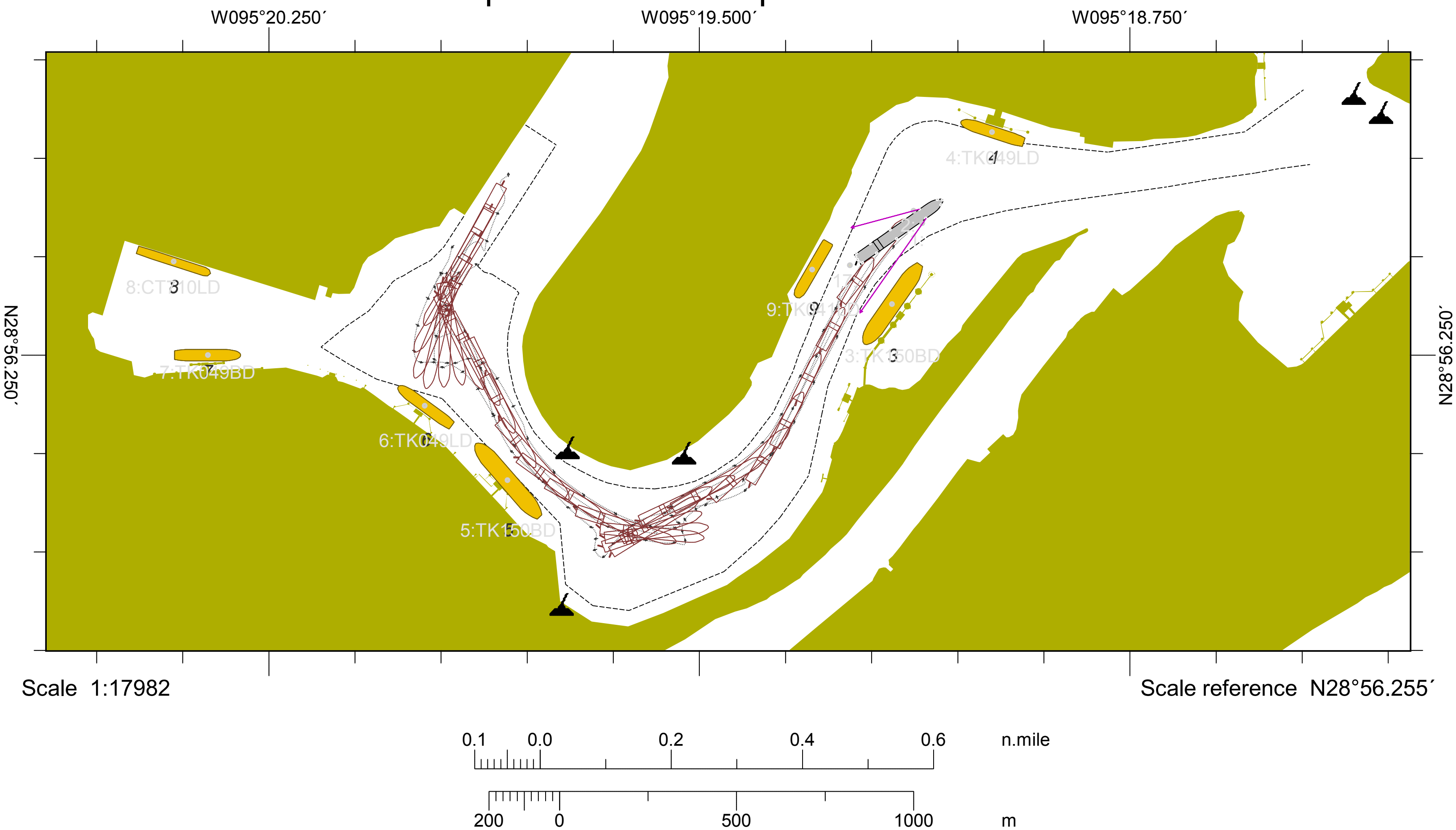
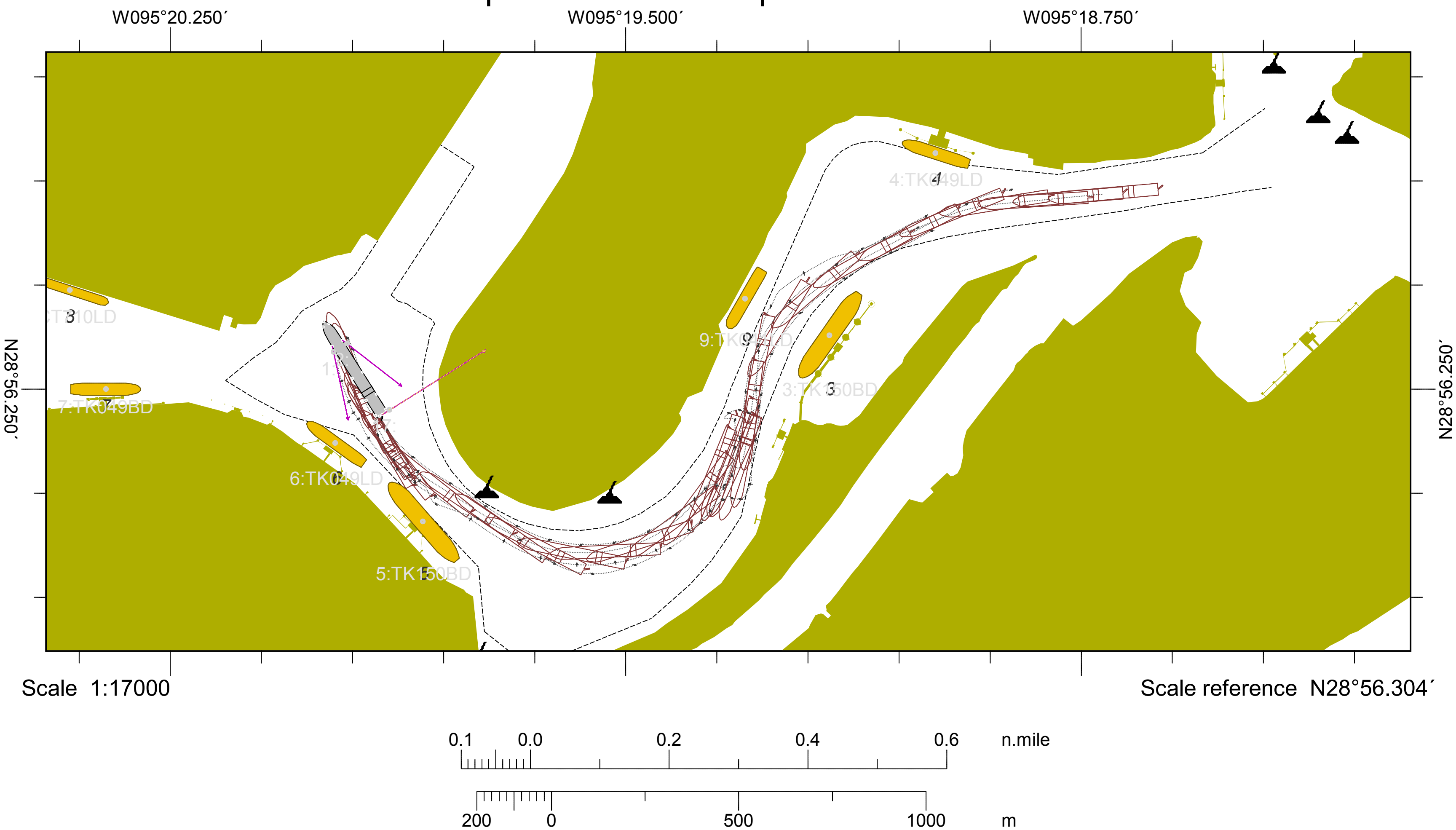
Freeport Containership Evaluation 2016



Comments: Run #5: Pilot:1- Wind-NNE 10Kts Current None

Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

Freeport Containership Evaluation 2016



Comments: Run #6: Pilot-1 Wind: NNE 20Kts
Current; None

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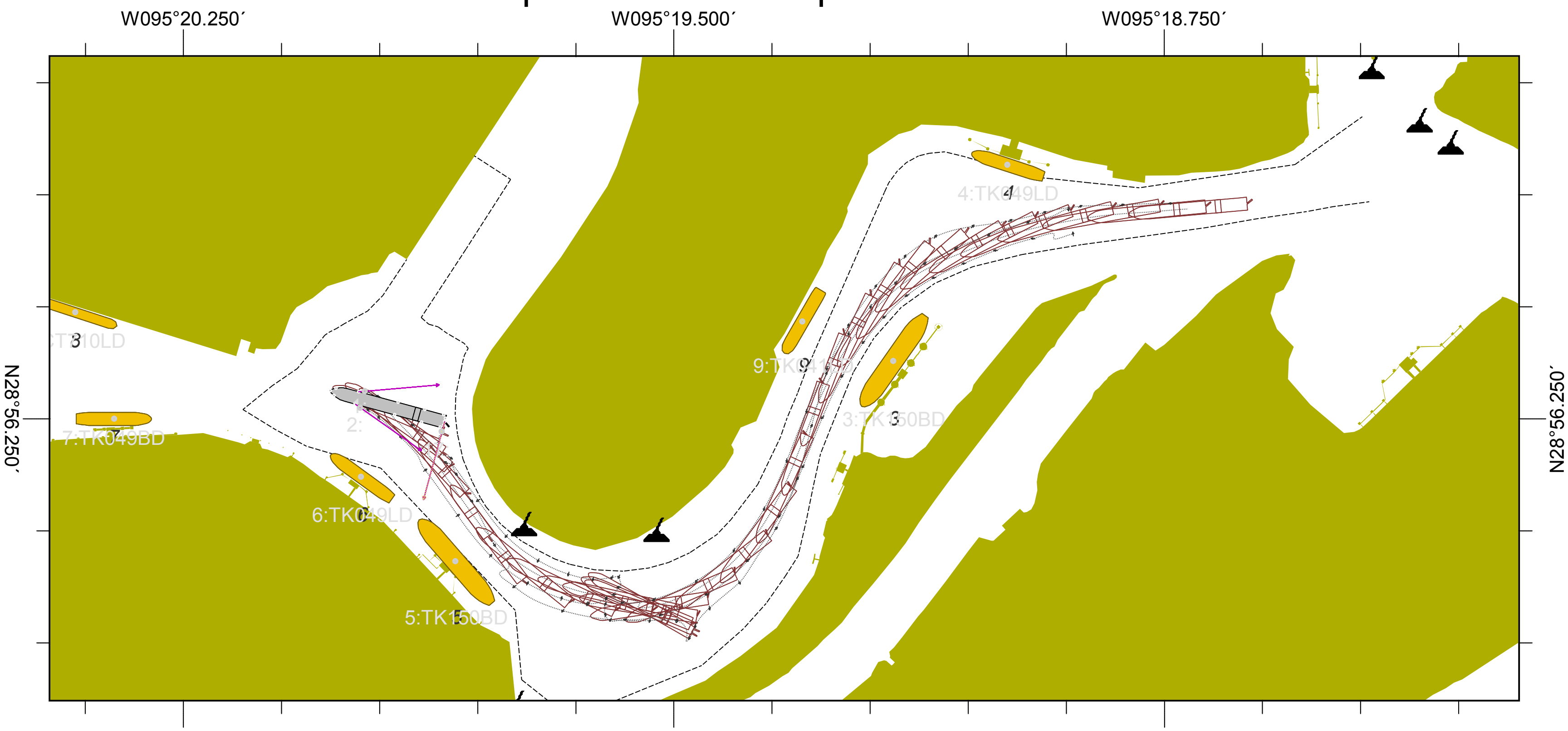
Freeport Containership Evaluation 2016



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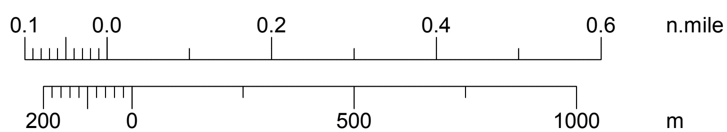

Comments: Run #7: Pilot-1 Wind: SSE 20Kts
Current; None

Line sample period (s)	30
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Heading marker period (s)	60
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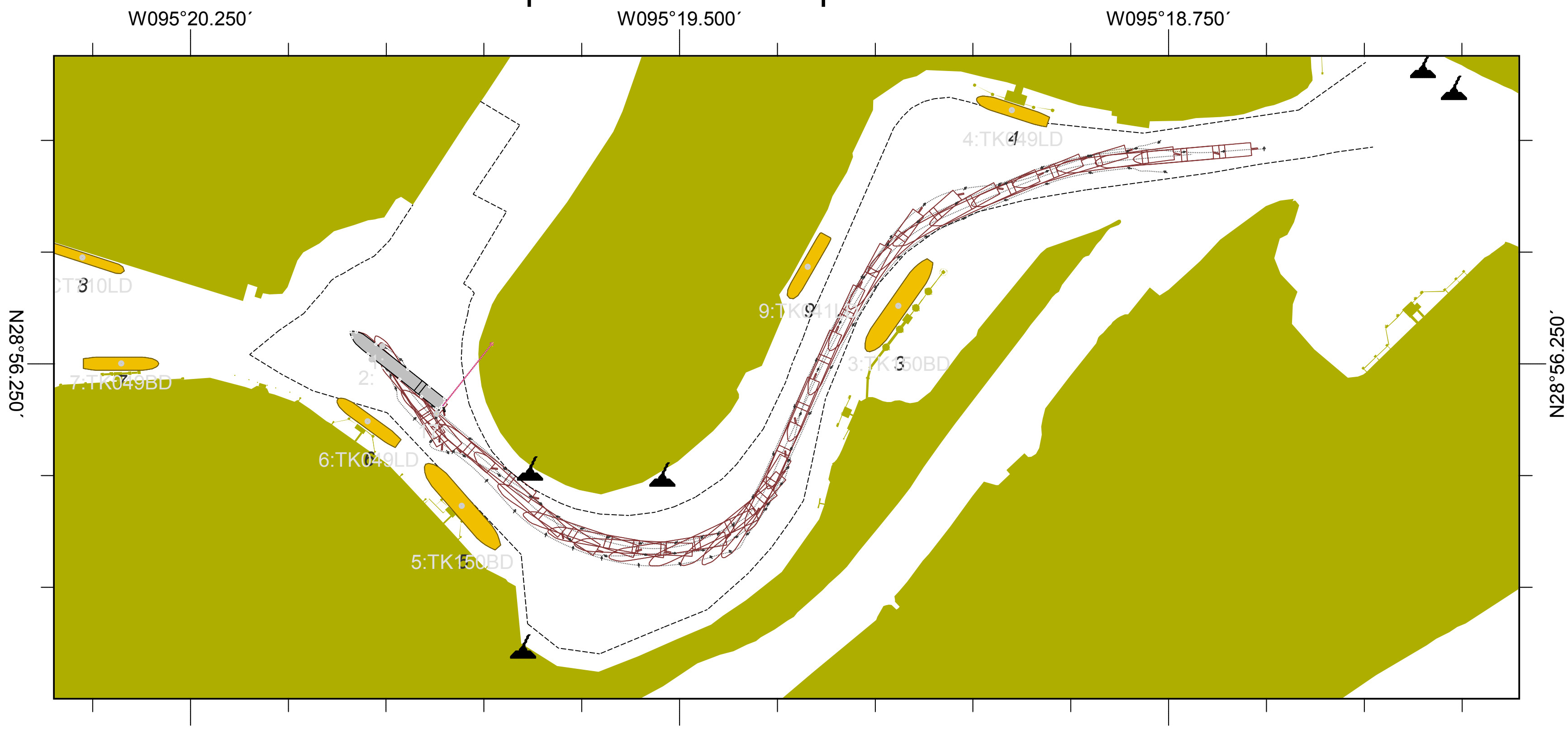
Freeport Containership Evaluation 2016



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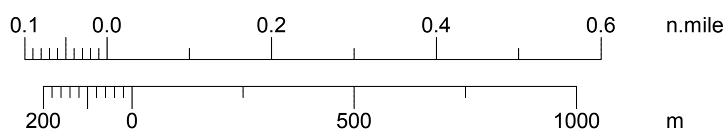

Comments: Run #8: Pilot:1- Wind:E 10 kts Current: None

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Heading marker period (s)	60
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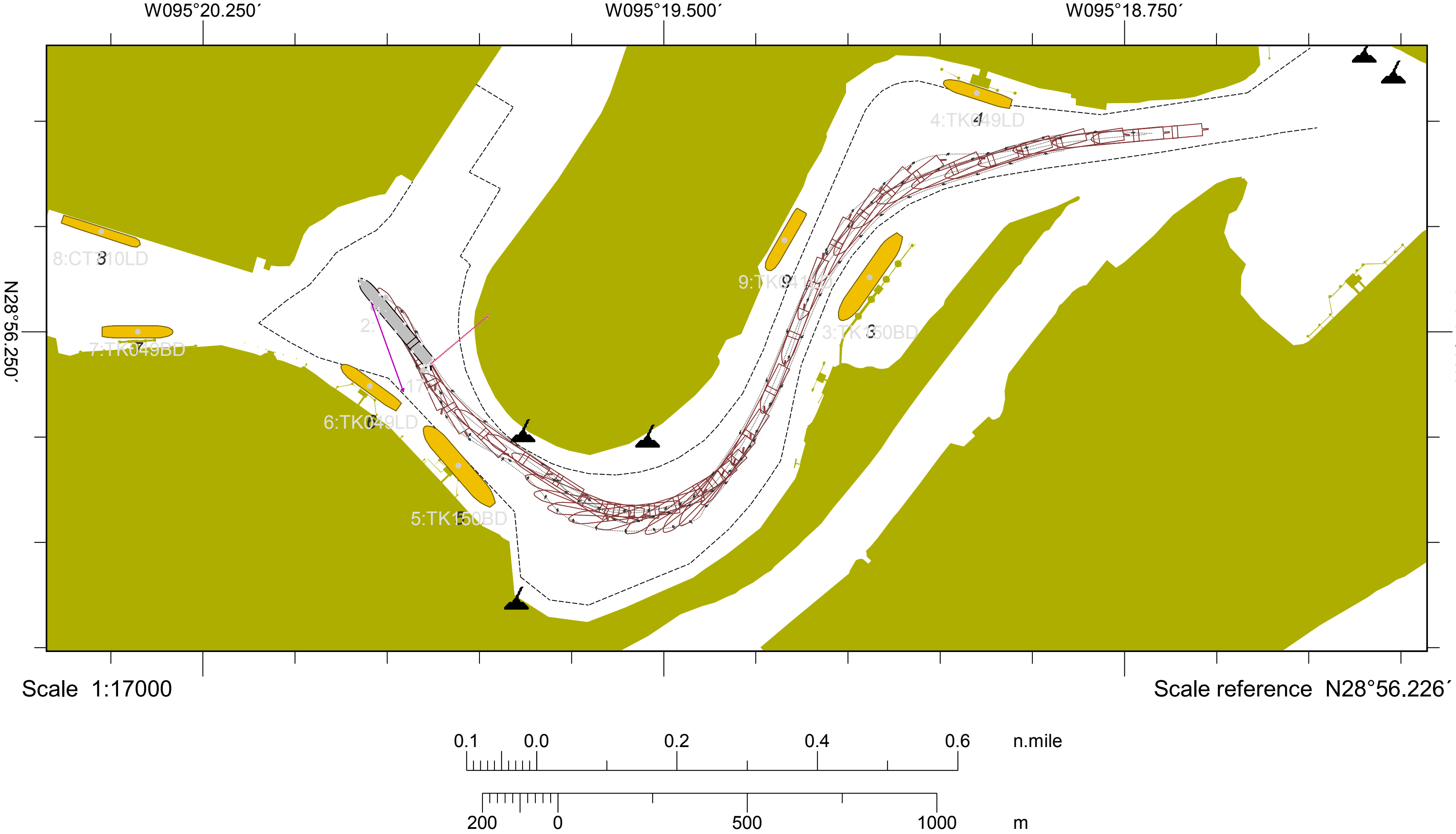
Freeport Containership Evaluation 2016



Comments: Run #9- Pilot:1- Wind:E 20Kts

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Heading marker period (s)	60
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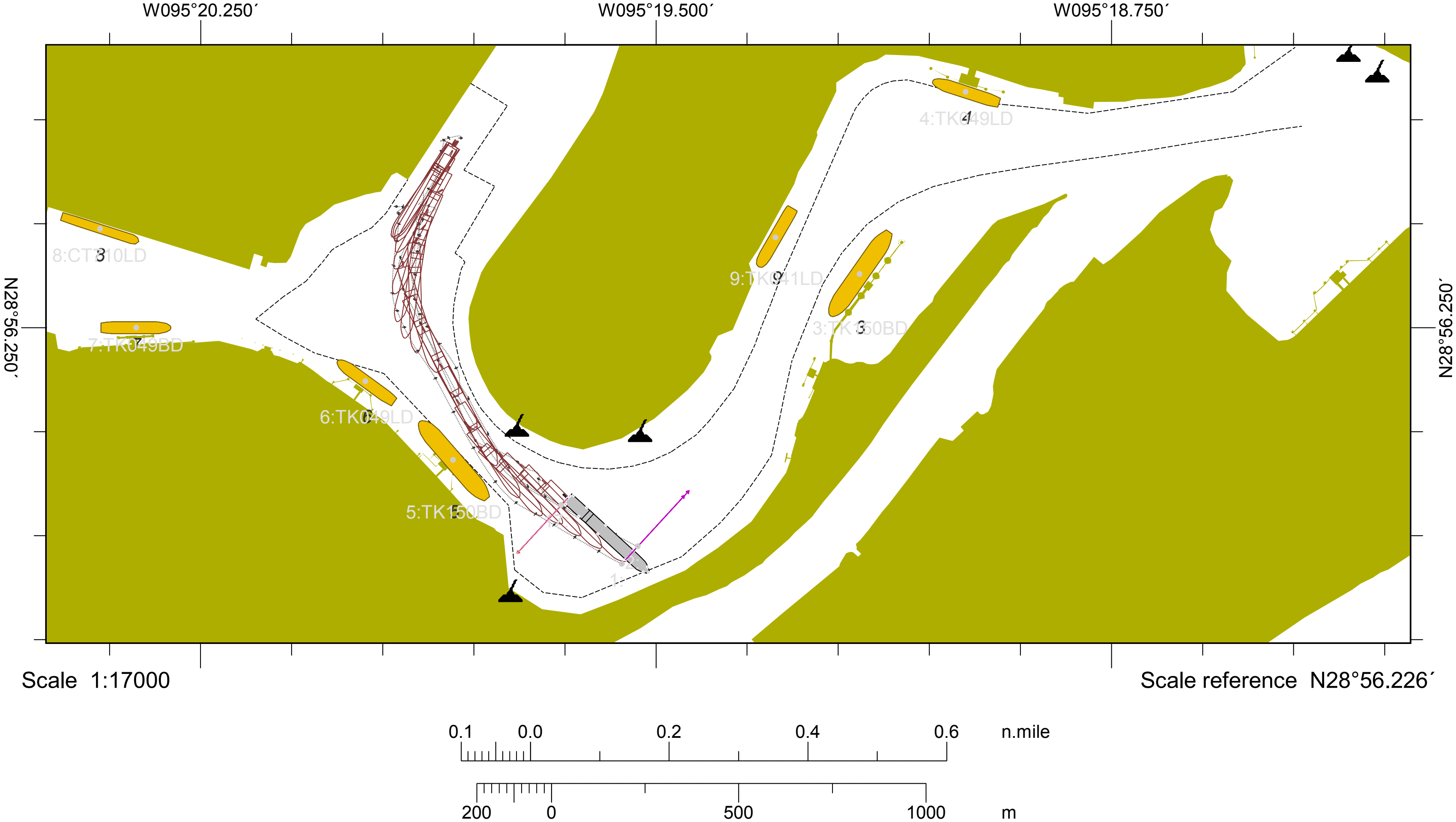
Freeport Containership Evaluation 2016



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Comments: Run #10- Pilot:1- Wind:E 20Kts

Line sample period (s)	30
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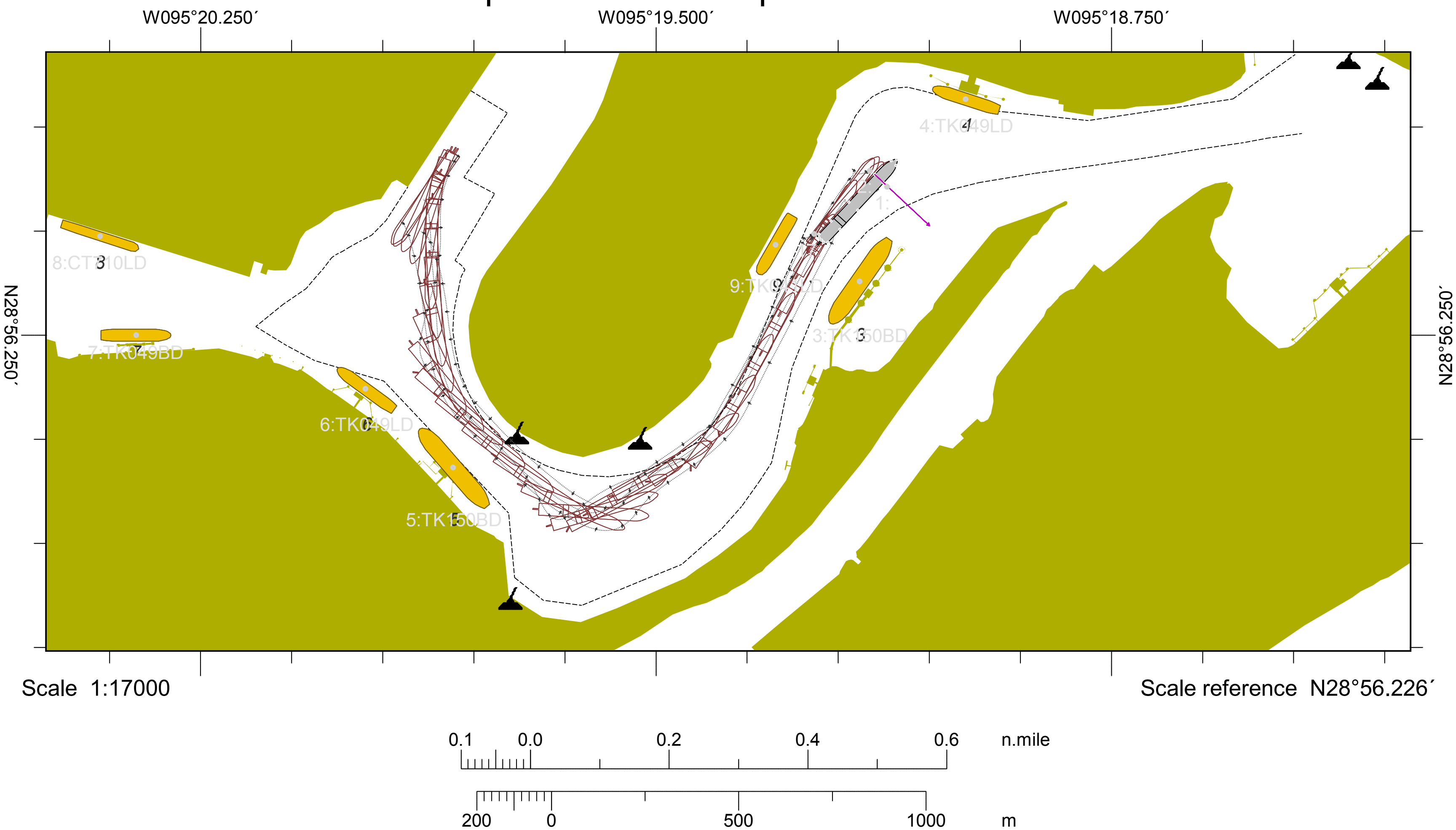
Heading marker period (s)	60
Shape outline every	01:00

Freeport Containership Evaluation 2016



Comments: Run #11- Pilot:1- Wind:E 20Kts

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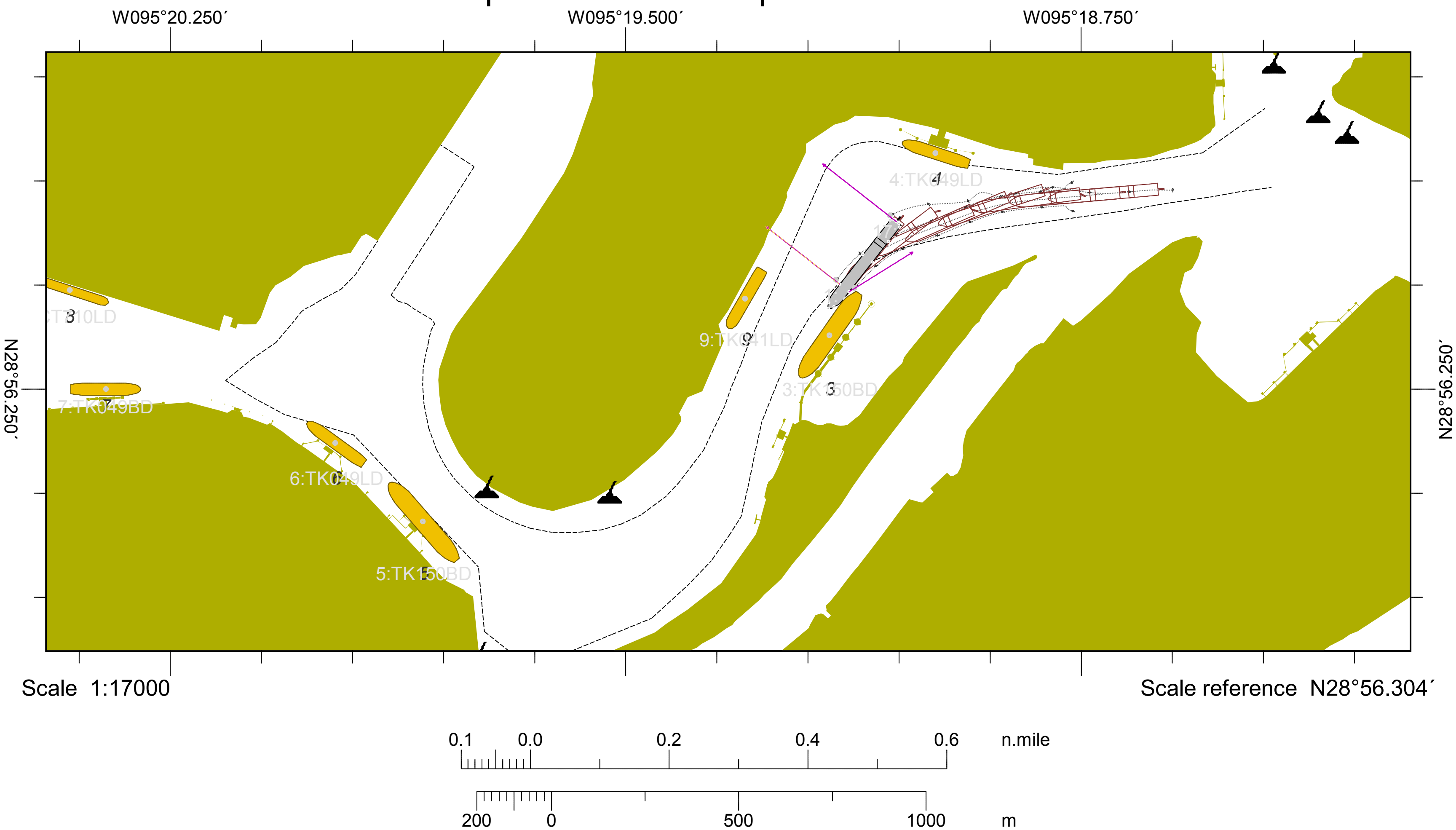
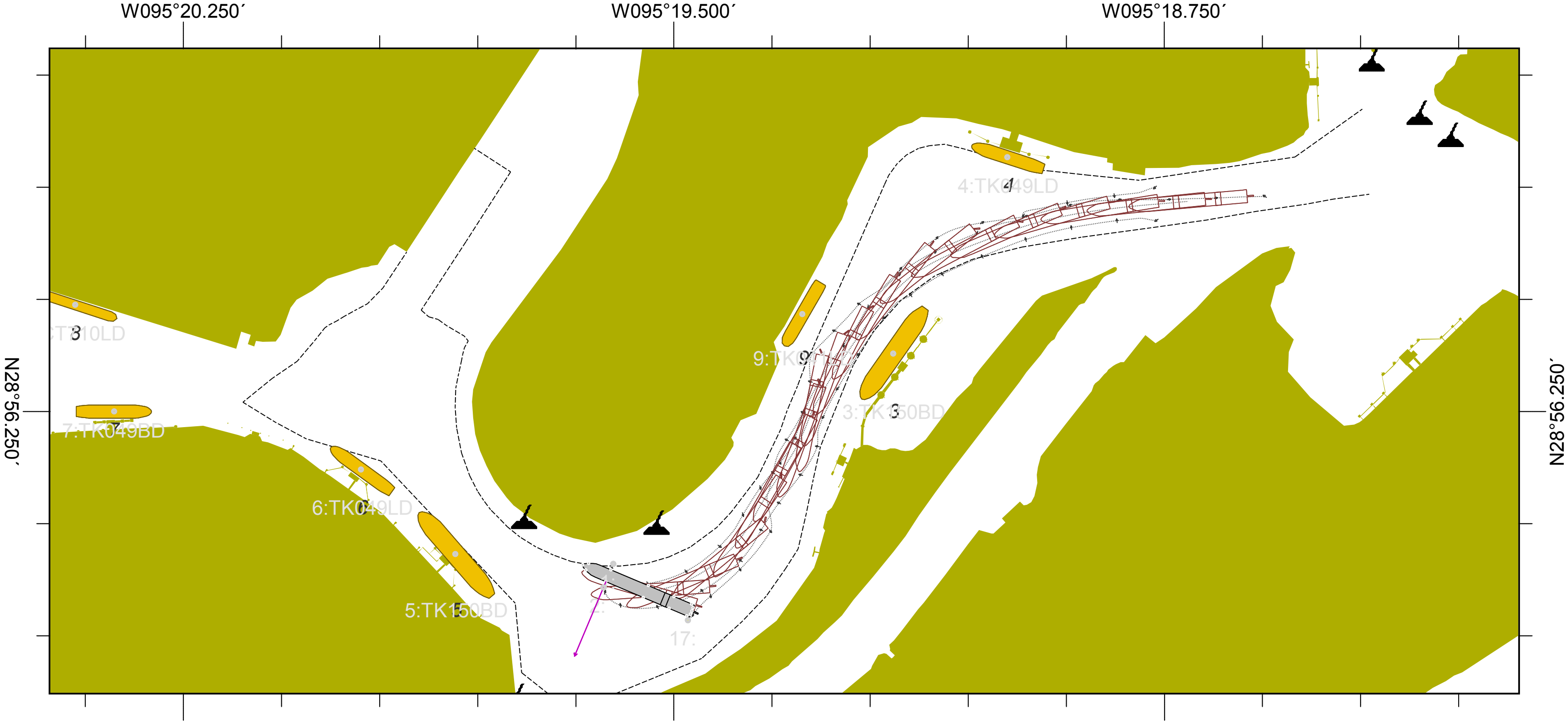
Freeport Containership Evaluation 2016



Comments: Run #12- Pilot: 2, Wind E 10Kts

Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

Freeport Containership Evaluation 2016



Scale 1:17000

Scale reference N28°56.304´

Comments: Run #13- Pilot: 2, Wind E 10Kts

Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

Freeport Containership Evaluation 2016

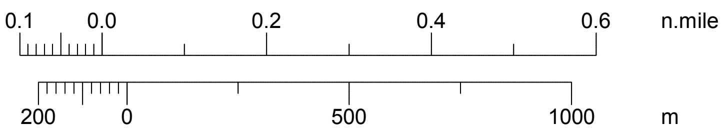
W095°20.250´ W095°19.500´ W095°18.750´

N28°56.250´

N28°56.250´

Scale 1:17000

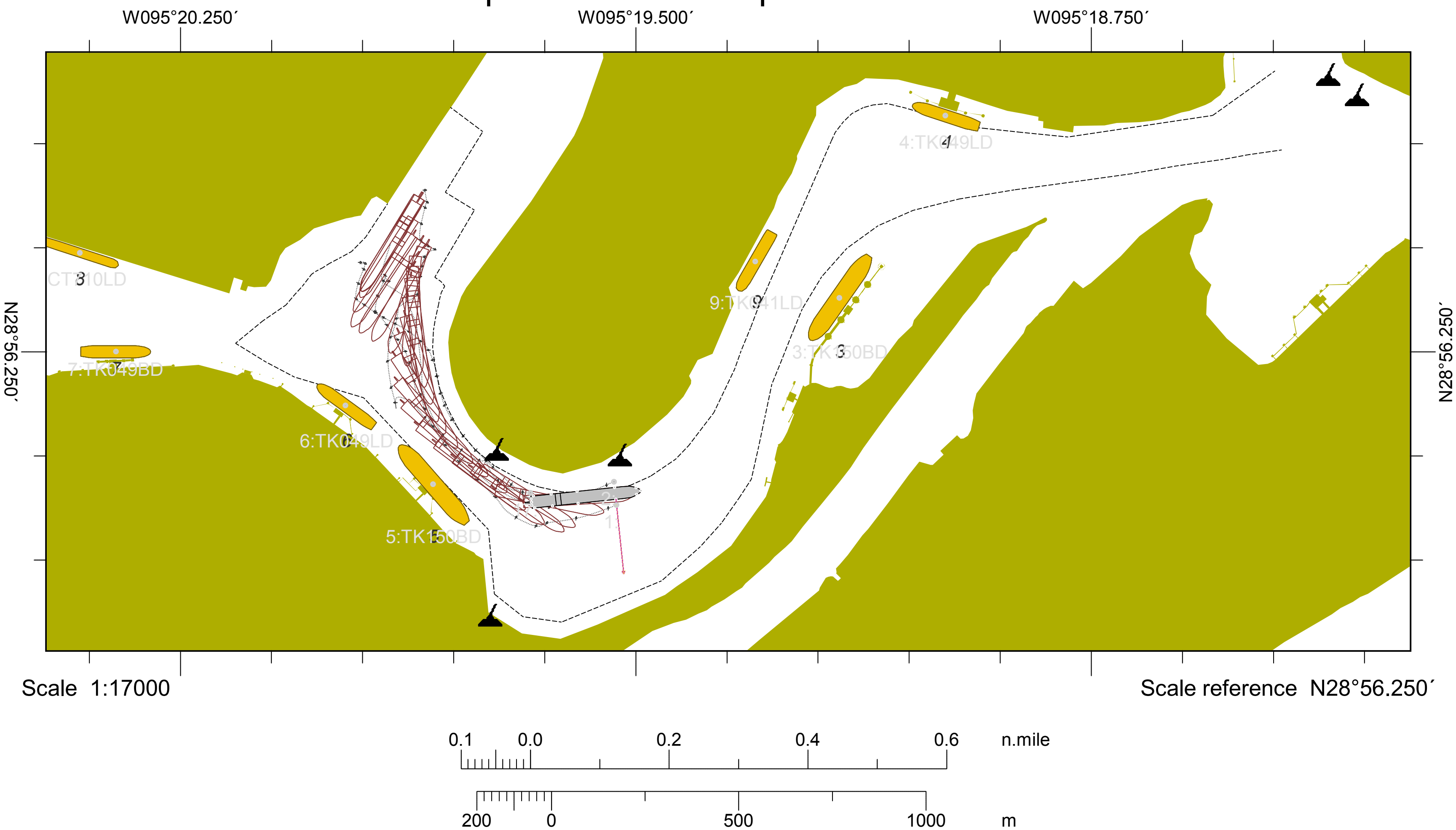
Scale reference N28°56.250´



Comments: Run #14- Pilot: 2, Wind E 10Kts

Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

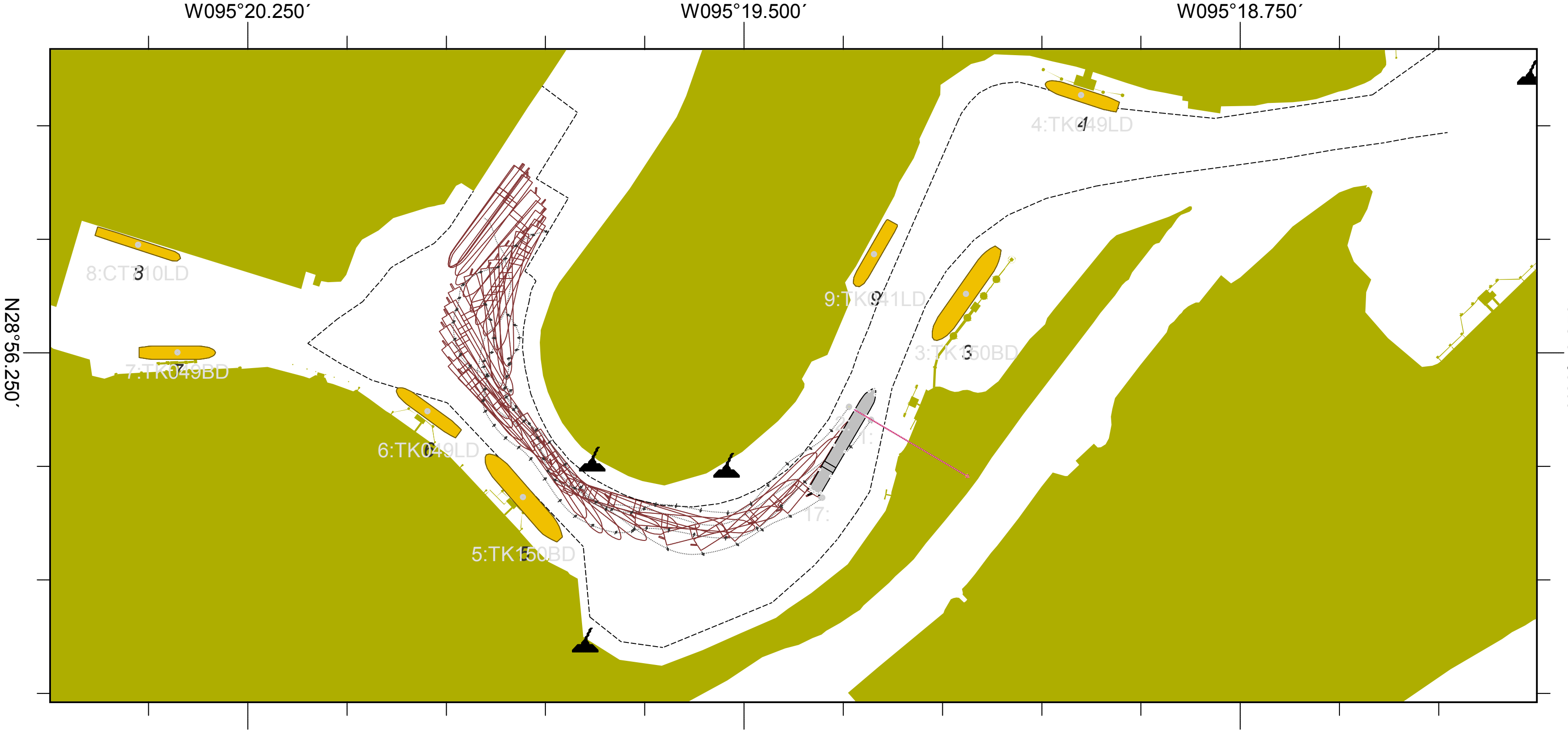
Freeport Containership Evaluation 2016



Comments: Run #15- Pilot: 2, Wind E 20Kts

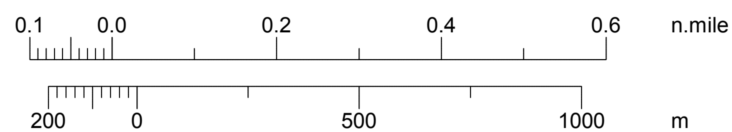
Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

Freeport Containership Evaluation 2016



Scale 1:17000

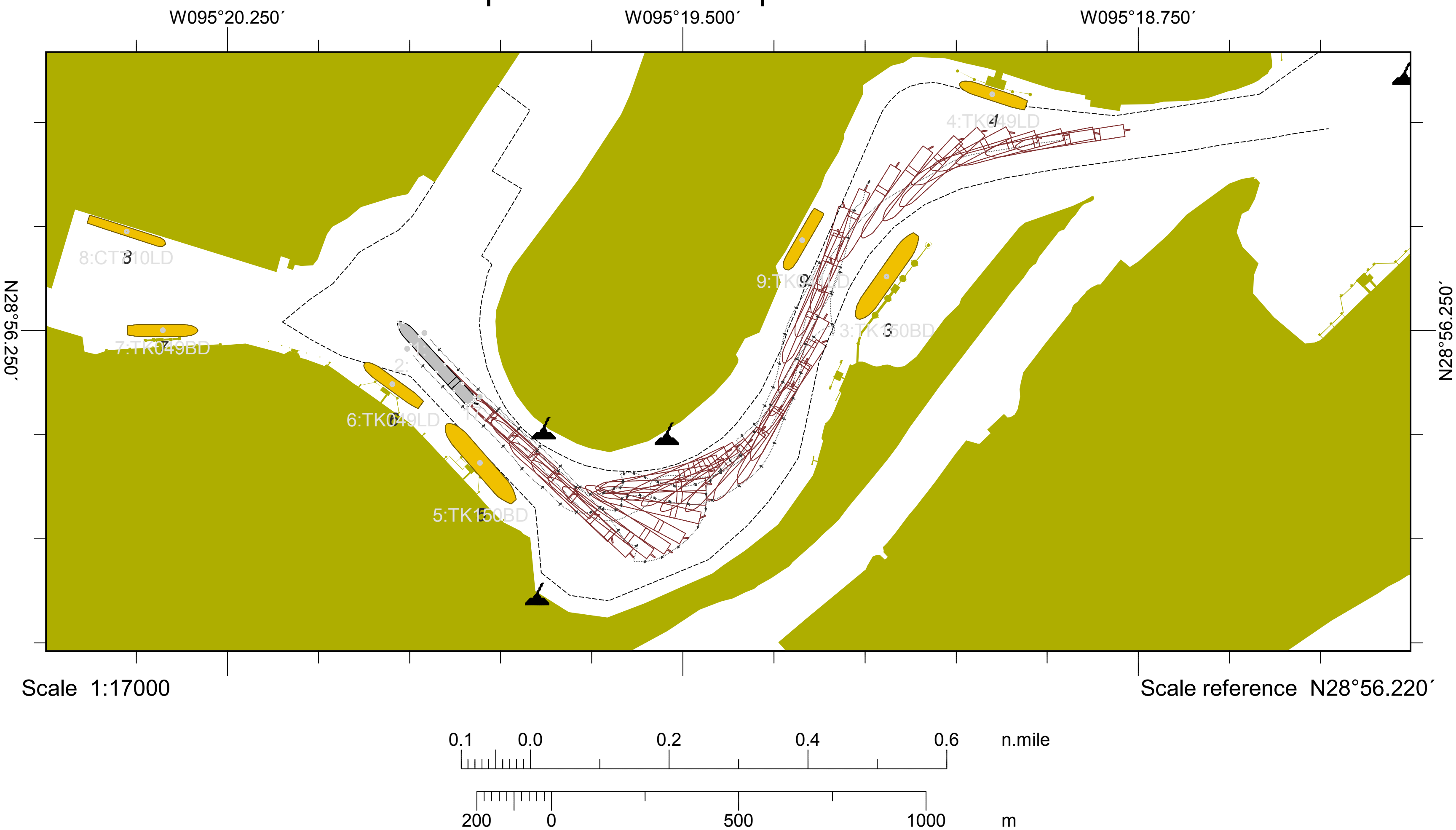
Scale reference N28°56.220´



Comments: Run #16: Pilot: 2, Wind:E 10Kts

Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

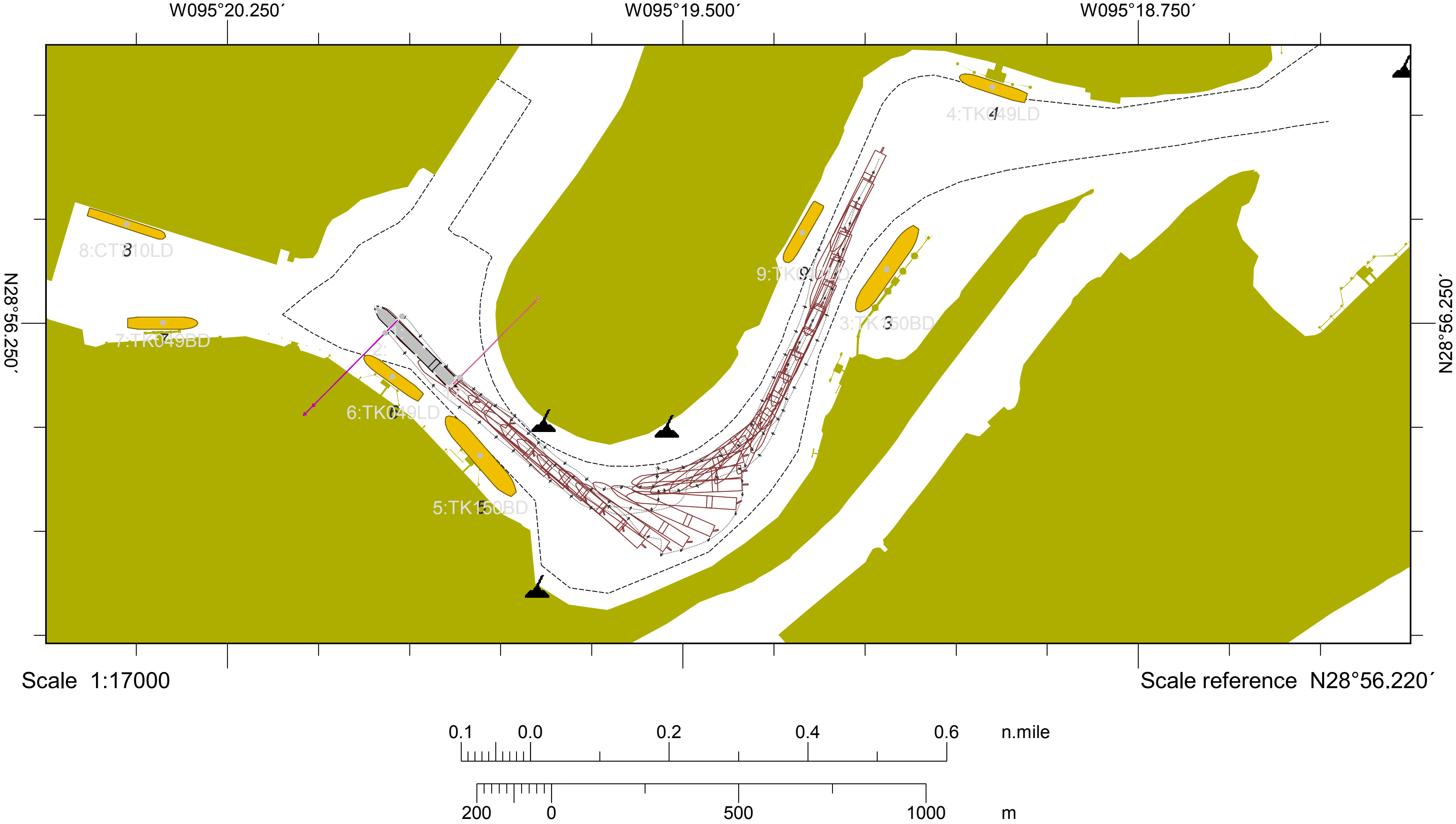
Freeport Containership Evaluation 2016



Comments: Run #17: Pilot: 2, Wind:E 20Kts	

Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

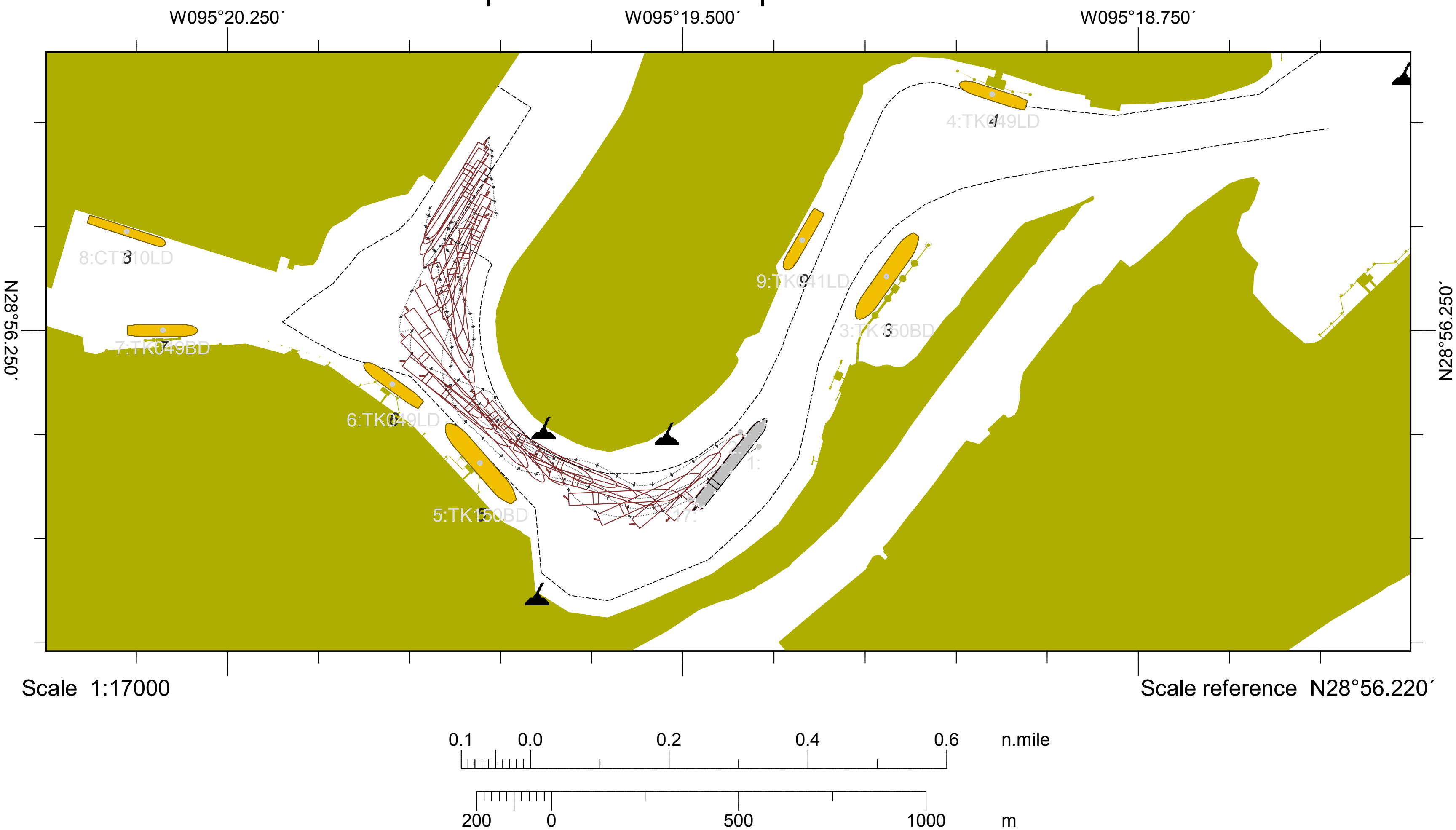
Freeport Containership Evaluation 2016



Comments: Run #18: Pilot: 2, Wind:E 20Kts

Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

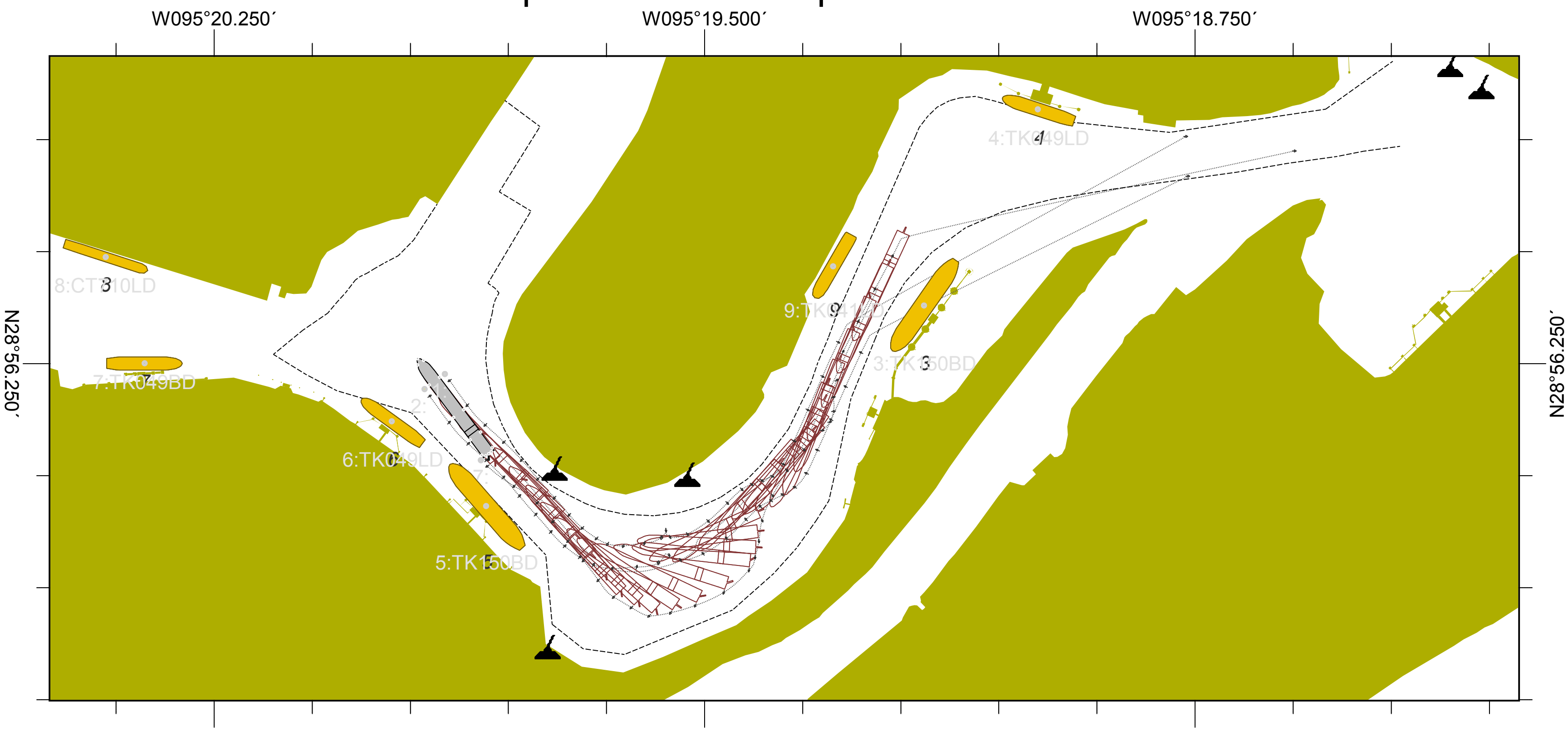
Freeport Containership Evaluation 2016



Comments: Run #19: Pilot: 2, Wind:E 20Kts

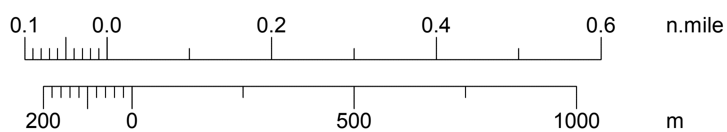
Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

Freeport Containership Evaluation 2016



Scale 1:17000

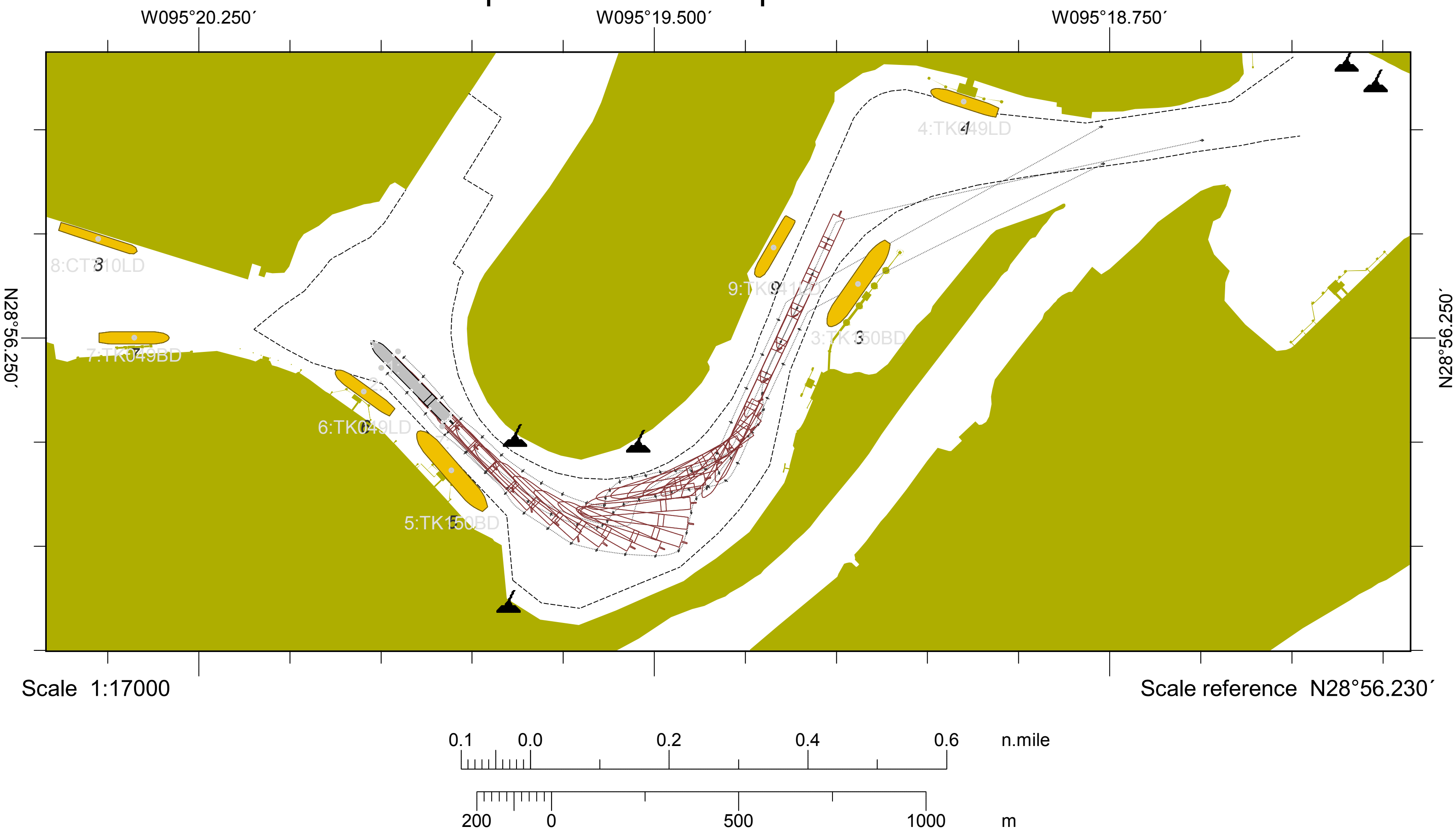
Scale reference N28°56.230´



Comments: Run #20: Pilot: 2- Wind: SE 20Kts

Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

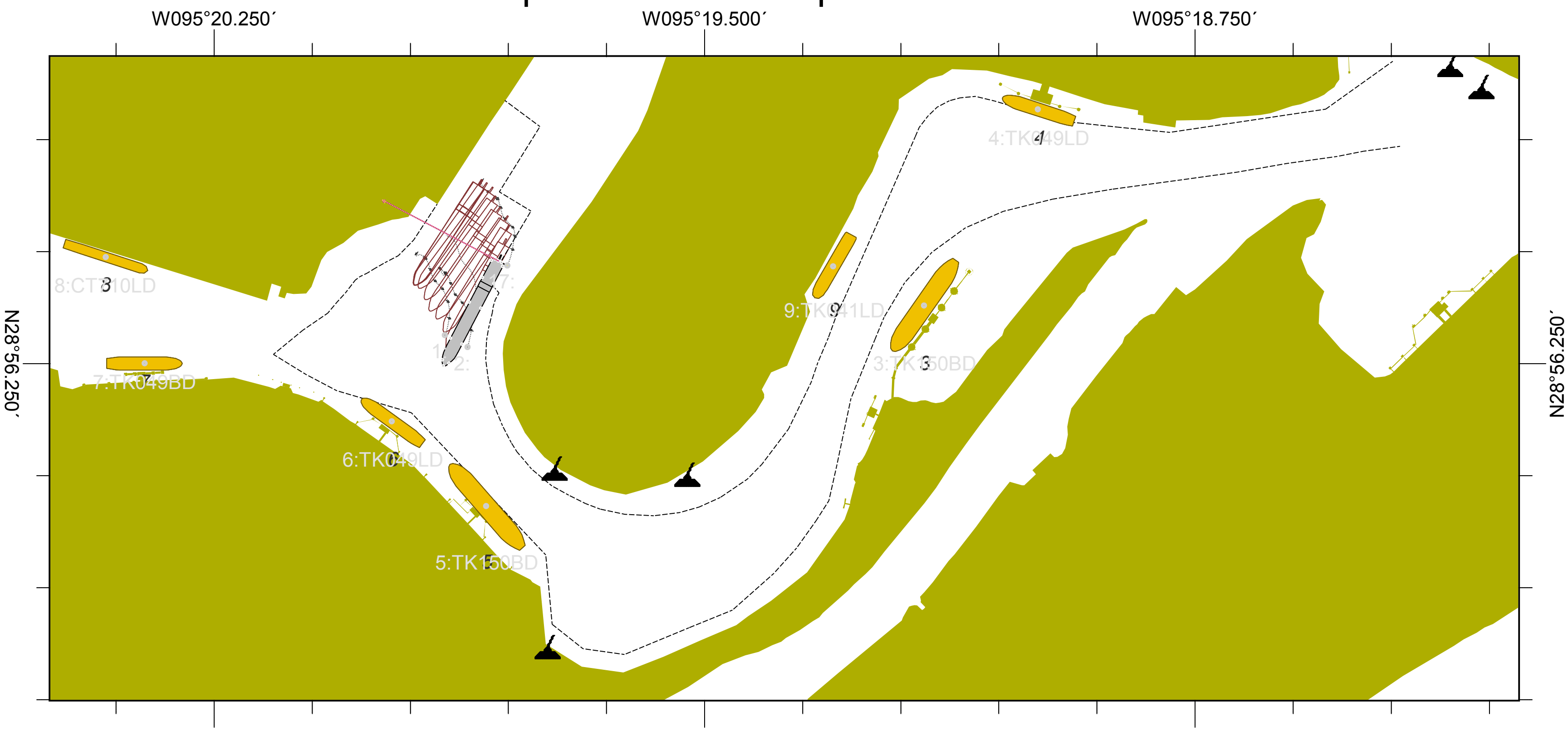
Freeport Containership Evaluation 2016



Comments: Run #21: Pilot: 2- Wind: NNE 20Kts

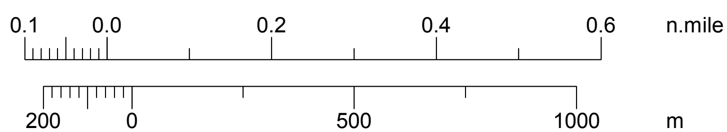
Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

Freeport Containership Evaluation 2016



Scale 1:17000

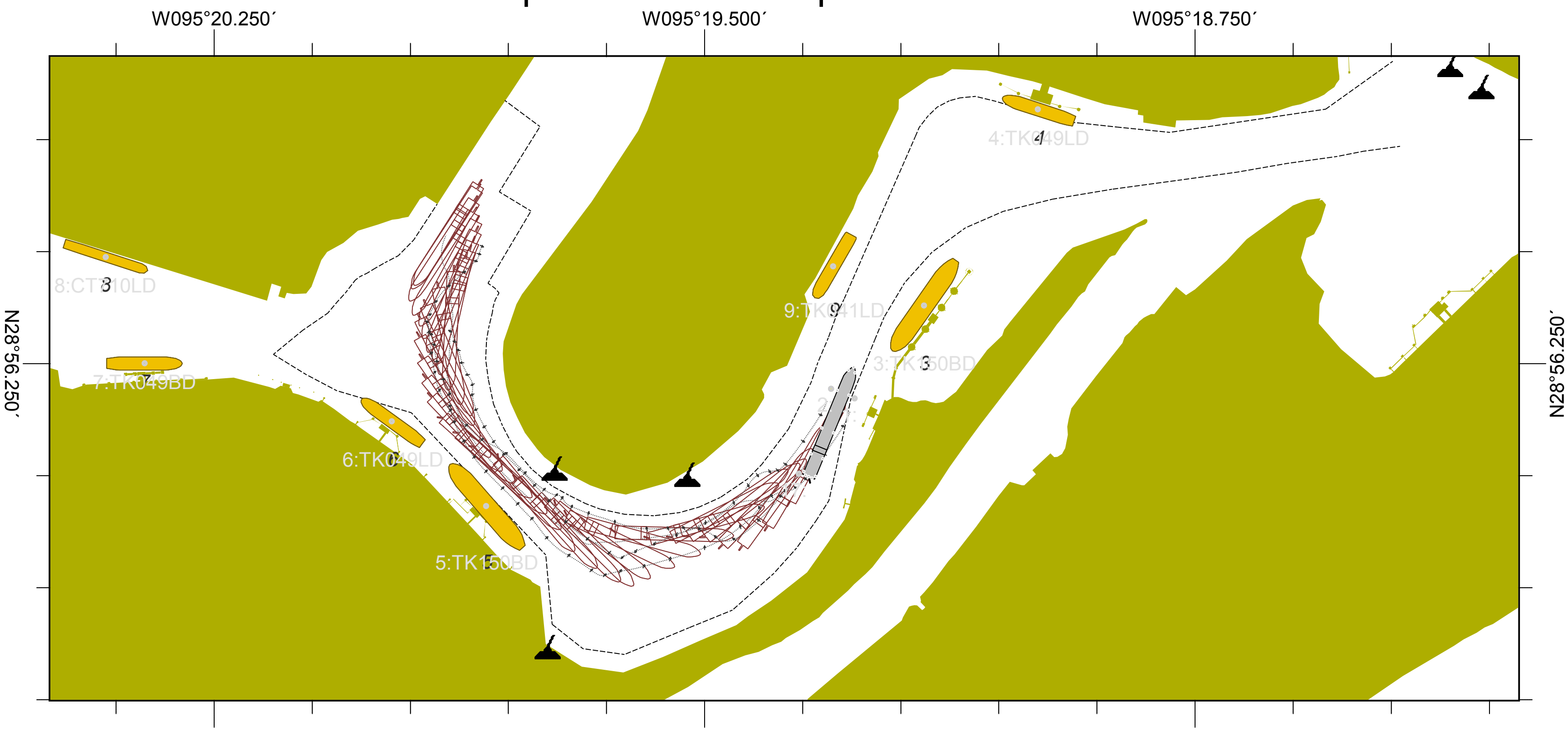
Scale reference N28°56.230´



Comments: Run #22: Pilot: 2- Wind: SE 20Kts

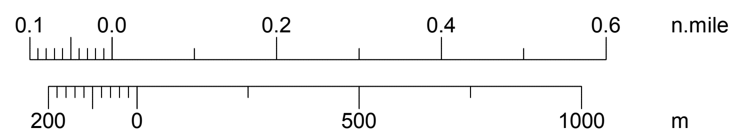
Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

Freeport Containership Evaluation 2016



Scale 1:17000

Scale reference N28°56.230´



Comments: Run #23: Pilot: 2- Wind: SE 20Kts

Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00