	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments: FELT COMFORTABLE W/ 25 KTT KNOWING NOW HOW VESSEL HANDLES

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments: IMO, FOR SAFETY PORT NEEDS IMPROVEMENTS.

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 3

Run #: 25

Date: 14 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: 15 Kts - OK

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all
Stress Level	5	4	3	2	1

Difficult

Comments:

Additional Comments:

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 1

Date: 14 FEB 2003

Run #: 26

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory	
Vessel Trackline						
- Vessel position with regard to centerline	5	4	3	2	1	
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1	
- Vessel position with regard to ships at the berth	5	4	3	2	1	
- Maneuvering room at turning basin	5	4	3	2	1	
Vessel Controllability						
- Engine reserve	5	4	3	2	1	
- Rudder reserve	5	4	3	2	1	
- Course Control	5	4	3	2	1	
- Speed Control	5	4	3	2	1	
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~	NA
- Thruster reserve	5	4	3	2	1	

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: South wind @ 25.
Kept vessel 5.8 in harbor + 6.2 @ CT-2
7.5 @ E. Basin. Had to keep 20°
rudder to maintain heading.

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments: Must increase RPM for short durations to counter weather vane effect.

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 2

Run #: 27

Date: 14 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: NO PROBLEMS WHATSOEVER AT 15 KNOTS / NORTH WIND

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:

Port Canaveral Berth Access
Final Evaluation Form

Pilot #: 1 Date: 2-14-03

1) Were there any differences in the response of the simulated ship model(s) when compared to your experience with the actual ship(s)? (Indicate if no relevant experience.) Please indicate how any differences may have affected the results of the simulation study.

No experience w/ actual ship.

2) Were there any differences in the effect on the vessel of the simulated wind and current when compared to your real-world experience, or with your expectations. If so, please indicate how this difference may have affected the results of the simulation study.

Simulated ship weathervaned (turned into the wind) more than expected. Therefore approximate rudder angle of 15° to 20° was needed to compensate for weather vane effect, leaving only 15° rudder for steering.

Also, ship did not set sideways as much as expected even w/ 25 knots on beam.

3) Of the conditions tested with the Voyager Class maneuvering model, which do you consider were the most challenging? Please explain.

South winds are more challenging than north winds due to the fact that you have to hold the ship tight along the piers + ship moored on the south side. Surging will be increased the closer to the ships you are. The higher the winds the more difficult, needing more speed to maintain position, therefore surging ships more.

North winds allow you to cut up into east, + middle basin entrances.

Configuration Specific Comments

CONFIGURATION 1: Existing Port Conditions

4) In your opinion does the existing Entrance Channel configuration pose any difficulty for maneuvering the Voyager Class vessel for arrivals and departures? Please explain.

Arrival yes - If winds exceed. 15 Knots, the crab will increase unless we increase speed, there by surging ship.

Departure yes - same as above.

5) Do you feel that the unimproved Inner Reach to the West Basin portion of the transit poses any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, including specific conditions of wind, weather or time of day that would impact the transit.

Yes, as stated above, you must stay extremely close to a ship at N-N. Inbound, while the port quarter comes close to the shoals on the South side with North wind.

If south wind it is difficult to turn out of the basin due to the need to hold tight to the south side shoal near buoys 15 + 19, + not set to north.

6) Is the existing, unimproved West Basin adequate in dimension and configuration to maneuver a vessel of the Voyager Class to/from the target berth (CT 10) under the normal range of conditions (wind and weather) experienced at the port? If not, please explain any deficiencies.

yes.

CONFIGURATION 2: Near-Term Improvements – Dredging (6 locations)

7) Under the second configuration that included the various near-term dredging projects, do you feel that the improved areas in the Inner Reach to the West Basin portion of the

port pose any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, specifying what deficiencies previously noted above would be corrected by these improvements.

These 6 dredged areas greatly improved the safety margins required to transit the port. Speed can be kept down somewhat depending on wind conditions, due to utilizing these dredged areas. As speed is kept down to approx. 5, 8 Knots, surging should be minimal.

CONFIGURATION 3: Long-Term Improvements – Outbound Range, Channel Widening, Shoreline Re-alignments

8) Please comment on the usefulness of the Outbound Channel Range, including in what ways it improves the navigation for departure and/or arrival.

It is imperative to have the outbound range due to the sheer size of the ship and trying to keep her in position, in the channel. This can be accomplished w/ the range + the ship can be keep tight on the windward side of the channel with confidence to maintain safety margins.

9) Please explain how the channel widening corrects any previously noted deficiencies or enhances navigability of the Inner Reach with respect to harbor transits of large vessels, and specifically with respect to the Voyager Class vessel.

With winds of 25 Knots, the extra room was necessary in order to keep surging to a minimum. This can be accomplished due to 2 reasons. 1. Physically keeping the Voyager away from the ships on the south side

2. Larger crab angle can be safely maintained with relatively slower speeds due to the newly dredged areas.

10) In what way do the shoreline realignments along the Inner Reach (between the Trident Basin and the Middle Basin) and within the West Basin (cutoff of corner area) enhance the safety of navigation in general, and specifically as relates to ships of the Voyager Class? Please be as specific as possible.

Inner Reach Shoreline (north side) Same reasons as #9.

Also the area near buoy #14A allows us to cut up into middle basin earlier as this is the tightest area in the port especially w/ ships at SCP-1.

Cutoff at West Basin Same as #10

11) What in your opinion, should be a restricting upper limit wind condition (direction and speed) for operation of the Voyager Class vessel in the port. Be as specific as possible with reference to maintaining safe transit speeds and clearances to moored vessels, for both departure and arrival situations. This is only a recommendation for initial operations bearing in mind that experience gained with the actual vessel may require reevaluation of any limits or restrictions.

	inbound.		outbound.	
Port #1	N-20	S.-15	N-20	S-15
Port #2	N-30	S.-30	N-30	S-30
Port #3	N-35	S.-30	N-35	S.-30

Note, East + West winds can be slightly higher.

12) Do you have any suggestions or recommendations not addressed above?

All pilots should have been aboard the Voyager class ship for observation transits several times, before actually piloting. Some transits may be done on the simulator, but at least one aboard the actual ship.

Additional Comments:

Please use additional sheets if necessary to complete your responses.

Thank you for your participation in this important project!

Port Canaveral Berth Access
Final Evaluation Form

Pilot #: 2 Date: 14 FEB 2003

1) Were there any differences in the response of the simulated ship model(s) when compared to your experience with the actual ship(s)? (Indicate if no relevant experience.) Please indicate how any differences may have affected the results of the simulation study.

Unfortunately, until tomorrow I have no experience with the vessel and cannot make an observation at this time.

2) Were there any differences in the effect on the vessel of the simulated wind and current when compared to your real-world experience, or with your expectations. If so, please indicate how this difference may have affected the results of the simulation study.

Please see Question #1.

3) Of the conditions tested with the Voyager Class maneuvering model, which do you consider were the most challenging? Please explain.

I feel that the most challenging task was with Configuration #1 when the wind was out of the south at 25 knots with a half-knot of current setting to the north. This is due to the fact that with the requirement to slow down to a safe speed in the harbor it is necessary to have a large crab angle which with this length and air draft of vessel makes it extremely difficult to keep the entire ship in the channel. With the port having most of the berths on the south side of the channel ways, having to steer the vessel close to those ships in order to have the stern in good water in this configuartion makes the safety factor close to marginal; however, the job can be done with experienced pilots working at the 95% level of acceptable safety.

Configuration Specific Comments

CONFIGURATION 1: Existing Port Conditions

4) In your opinion does the existing Entrance Channel configuration pose any difficulty for maneuvering the Voyager Class vessel for arrivals and departures? Please explain.

Arrival_**With winds in excess of approximately 25 knots, it would be very difficult to maintain the highest standards of safety which we and the port should expect for the vessel and ships at the berths.**

Departure **Same answer**

5) Do you feel that the unimproved Inner Reach to the West Basin portion of the transit poses any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, including specific conditions of wind, weather or time of day that would impact the transit.

Certainly, the areas of concern that have been "fixed" in Configuration #2 would pose a difficulty unless they are addressed for those times when weather conditions exceed the 25 knot parameter I described previously. During the periods of the year between October – May when cold fronts are prevalent and during the summer when afternoon thunderstorms are more evident, tension would run high unless we have the improvements. Most significantly, south wind conditions are of greatest concern.

6) Is the existing, unimproved West Basin adequate in dimension and configuration to maneuver a vessel of the Voyager Class to/from the target berth (CT 10) under the normal range of conditions (wind and weather) experienced at the port? If not, please explain any deficiencies.

I am afraid the "normal wind and weather" includes that range of winds we encounter after cold fronts and during thunderstorms and I would have to say that I have grave concerns for the safe transit of this vessel during severe weather which is a certainty not just a possibility but a frequent reality. I offer this comment with the benefit of 18 years of piloting experience. The deficiencies are those areas addressed by Configuration #2.

CONFIGURATION 2: Near-Term Improvements – Dredging (6 locations)

7) Under the second configuration that included the various near-term dredging projects, do you feel that the improved areas in the Inner Reach to the West Basin portion of the port pose any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, specifying what deficiencies previously noted above would be corrected by these improvements.

I believe that the near term improvements if completed will take care of any and all concerns for safety that I address in earlier comments. These deficiencies would allow a slower transit speed ensuring safety to port structures, the vessel, and other ships at port berths. In addition, the vessel will have greater clearances on both the bow and stern to shoal water and other berthed vessels that will allow a margin of error in precision positioning that the existing configuration does not have.

CONFIGURATION 3: Long-Term Improvements – Outbound Range, Channel Widening, Shoreline Re-alignments

8) Please comment on the usefulness of the Outbound Channel Range, including in what ways it improves the navigation for departure and/or arrival.

This is an absolute essential piece of the ultimate navigational plan due to the fact that with a one-thousand foot long ship, when applying leeway (crab angle) to effect course over the ground, one's perspective is skewed due to the fact that the pilot is so near the bow that he must offest his position to windward of the center of the channel so that the stern is in safe water. This is difficult during the day and even more extreme when at night the only reference points available are the lights from buoys which are on the channel limits and not in such a position where they may be used to accurately ascertain one's position in reference to the center of the channel. This has been true since 1996 when we began bringing in large high-windage cruise ships and even more this year as we enter a new era in length and air draft of vessels.

9) Please explain how the channel widening corrects any previously noted deficiencies or enhances navigability of the Inner Reach with respect to harbor transits of large vessels, and specifically with respect to the Voyager Class vessel.

Without a doubt, the channel configuration under this section will enhance the safety of transits in conditions when winds exceed 25 knots due to the ability to have a larger crab angle at a slower speed thus ensuring overall safety of the transit.

10) In what way do the shoreline realignments along the Inner Reach (between the Trident Basin and the Middle Basin) and within the West Basin (cutoff of corner area) enhance the safety of navigation in general, and specifically as relates to ships of the Voyager Class? Please be as specific as possible.

Inner Reach Shoreline (north side**Coming from sea, the vessel will have to slow down from a speed of approximately 12 knots at buoy #9 to about six knots or less at the entrance to the middle basin. The shoreline realignment will allow the vessel to be brought down in speed much quicker and with more control than under the existing configuration.**

Cutoff at West Basin**The cutoff at the west basin will allow vessels to slow sooner before entering the west turning basin and begin the actual turn in to the basin much sooner than is now possible that will also ensure that vessels along the south side of the port in west cut are not caused to be too close to the stern of the Mariner with the obvious deleterious effects. The stern of the Mariner will be much better protected to possible grounding because at a slower speed it will be able to "climb" to the north.**

11) What in your opinion, should be a restricting upper limit wind condition (direction and speed) for operation of the Voyager Class vessel in the port. Be as specific as possible with reference to maintaining safe transit speeds and clearances to moored vessels, for both departure and arrival situations. This is only a recommendation for initial operations bearing in mind that experience gained with the actual vessel may require reevaluation of any limits or restrictions._**With north and south wind directions, I believe that 25 - 30 knots under the existing conditions without configuration #2 improvements would be**

appropriate. East or west winds of 40 Knots would be ok due to the channel headings.

12) Do you have any suggestions or recommendations not addressed above?

All pilots who are assigned to the vessel as control pilot should be required to see the vessel in transit under the direction of another pilot whether it be in Port Canaveral or at another port before he or she is allowed to handle the vessel solo.

Additional Comments:

I want to thank all the personnel who made it possible for my associates and I to attend the simulation and be able to provide comment on the safety aspects of bringing the Mariner in to Port Canaveral. Thank you: Dave, Victor, Howard, and Sandy and all the unnamed people who I have not met but who have worked behind the scenes to make the simulator so "real."

Please use additional sheets if necessary to complete your responses.

Thank you for your participation in this important project!

Port Canaveral Berth Access
Final Evaluation Form

Pilot #: 3 Date: 2-14-03

1) Were there any differences in the response of the simulated ship model(s) when compared to your experience with the actual ship(s)? (Indicate if no relevant experience.) Please indicate how any differences may have affected the results of the simulation study.

N/A

No Experience

2) Were there any differences in the effect on the vessel of the simulated wind and current when compared to your real-world experience, or with your expectations. If so, please indicate how this difference may have affected the results of the simulation study.

Less Set
More "weather vane" } than expected

therefore: Due to difficulty in controlling heading in strong crosswinds the actual (on real ship) performance may be different (better)

3) Of the conditions tested with the Voyager Class maneuvering model, which do you consider were the most challenging? Please explain.

Strong Cross winds (25 Kts plus) and especially from the south

Configuration Specific Comments

CONFIGURATION 1: Existing Port Conditions

4) In your opinion does the existing Entrance Channel configuration pose any difficulty for maneuvering the Voyager Class vessel for arrivals and departures? Please explain.

Arrival Due to the confines of the channel, ship speeds, in strong crosswinds, may need to be higher than 6 Kts & this will possibly cause surging of docked ships.

Departure Same as above

5) Do you feel that the unimproved Inner Reach to the West Basin portion of the transit poses any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, including specific conditions of wind, weather or time of day that would impact the transit.

(A) Clearance to vessels could be a problem if the ship, at a given speed, creates more "surge effects" than the present cruise ships in the port.

(1) North wind in vicinity of Rinker Dock (25 Kts +)

(2) South wind in vicinity of SCP #1 (20 Kts +)
south cargo pier

6) Is the existing, unimproved West Basin adequate in dimension and configuration to maneuver a vessel of the Voyager Class to/from the target berth (CT 10) under the normal range of conditions (wind and weather) experienced at the port? If not, please explain any deficiencies.

YES (except to say that the proposed widener just west of RINKER will provide a safer entrance/exit from the West Basin)

CONFIGURATION 2: Near-Term Improvements – Dredging (6 locations)

7) Under the second configuration that included the various near-term dredging projects, do you feel that the improved areas in the Inner Reach to the West Basin portion of the

port pose any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, specifying what deficiencies previously noted above would be corrected by these improvements.

1) Area just west of Rinker - Will enhance safer entry/exit to W/Basin
2) Area on south side of West Basin Access Channel will improve "surge prevention" @ Rinker and allow this larger ship to enter/exit West Basin Safer
3) Area by Navy Dock will be very important when ships are at South Cargo Piers

CONFIGURATION 3: Long-Term Improvements – Outbound Range, Channel Widening, Shoreline Re-alignments

8) Please comment on the usefulness of the Outbound Channel Range, including in what ways it improves the navigation for departure and/or arrival.

1) Outbound range for outbound traffic (especially night) is essential for these large ships

9) Please explain how the channel widening corrects any previously noted deficiencies or enhances navigability of the Inner Reach with respect to harbor transits of large vessels, and specifically with respect to the Voyager Class vessel.

~~The area~~ The 500' Channel will provide a first class safe channel as opposed to the present piece meal attempts to provide for safe transit of ships

This is a farsighted intelligent plan

10) In what way do the shoreline realignments along the Inner Reach (between the Trident Basin and the Middle Basin) and within the West Basin (cutoff of corner area) enhance the safety of navigation in general, and specifically as relates to ships of the Voyager Class? Please be as specific as possible.

Inner Reach Shoreline (north side) This is an important widening to alleviate surge of docked ships + eliminates the narrow area in vicinity of south cargo piers and navy dock which is always a tight area to navigate with even smaller ships

Cutoff at West Basin This will enhance the entry/exit of mega cruise ships into Basin as well as provide more underwater area to distribute the hydraulic effects (which creates surging at BINKER DOCK) that this ship will create. Slower speeds will be more possible.

11) What in your opinion, should be a restricting upper limit wind condition (direction and speed) for operation of the Voyager Class vessel in the port. Be as specific as possible with reference to maintaining safe transit speeds and clearances to moored vessels, for both departure and arrival situations. This is only a recommendation for initial operations bearing in mind that experience gained with the actual vessel may require reevaluation of any limits or restrictions.

NORTH WIND 30
SOUTH WIND 30
EAST WIND 35
WEST WIND 35

Note, I will not participate in specifics since this is a joint pilot/captain decision

12) Do you have any suggestions or recommendations not addressed above?

* Outside Turn at Buoy #9 should have a widener that reflects the area in the vicinity of buoy #11.

~~Additional Comments~~: SURGE

SURGE could not be addressed by the simulator & only experience will be able to evaluate this - improvements proposed however will improve this situation

Please use additional sheets if necessary to complete your responses.

Thank you for your participation in this important project!

Port Canaveral Berth Access
Final Evaluation Form

Pilot #: 4 Date: 2-14-03

1) Were there any differences in the response of the simulated ship model(s) when compared to your experience with the actual ship(s)? (Indicate if no relevant experience.) Please indicate how any differences may have affected the results of the simulation study.

THE VISUAL AND ENVIRONMENTAL EXPERIENCES ARE NOT AS YOU WILL SEE ONBOARD.

THIS PROBLEM CAN CAUSE SOME OVERUSE OF POWER AND/OR POD ANGLES.

2) Were there any differences in the effect on the vessel of the simulated wind and current when compared to your real-world experience, or with your expectations. If so, please indicate how this difference may have affected the results of the simulation study.

IT APPARES THAT THE MODEL SHIP TURNS MORE INTO THE WIND THAN THE REAL SHIP. MAKING IT NECESSARY TO USE MORE "RUDDER" POD ANGLE TO STAY ON COURSE.

3) Of the conditions tested with the Voyager Class maneuvering model, which do you consider were the most challenging? Please explain.

UNDOCKING WITH 40KN NORTH WIND. HAD TO USE ALL AVAILABLE POWER.

Configuration Specific Comments

CONFIGURATION 1: Existing Port Conditions

4) In your opinion does the existing Entrance Channel configuration pose any difficulty for maneuvering the Voyager Class vessel for arrivals and departures? Please explain.

Arrival

ENTRY TO AND FROM TURNING BASIN IS SOMEWHAT UNSAFE IN 25KNT WINDS FROM NORTH- OR SOUTH.
CHANNEL KEEPING ALSO IS MORE DIFFICULT AT 25 KN + WINDS.

Departure

SAME

5) Do you feel that the unimproved Inner Reach to the West Basin portion of the transit poses any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, including specific conditions of wind, weather or time of day that would impact the transit.

WINDS FROM NORTH OR SOUTH AT 25 KN. COULD POSE DIFFICULD.

6) Is the existing, unimproved West Basin adequate in dimension and configuration to maneuver a vessel of the Voyager Class to/from the target berth (CT 10) under the normal range of conditions (wind and weather) experienced at the port? If not, please explain any deficiencies.

NORMAL WIND CONDITIONS IN THE TURNING BASIN IS NOT DIFFICULT. THERE IS ENOUGH SPACE TO TURN AROUND AND TO MANOUVER.

THERE IS HOWEVER VERY LIMITED SPACE BEHIND THE STERN WHEN DOCKED.

CONFIGURATION 2: Near-Term Improvements – Dredging (6 locations)

7) Under the second configuration that included the various near-term dredging projects, do you feel that the improved areas in the Inner Reach to the West Basin portion of the

port pose any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, specifying what deficiencies previously noted above would be corrected by these improvements.

MORE CLEARANCE TO OTHE VESSELS IN THE CHANNEL + MORE SPACE ENTERING/LEAVING THE TURNING BASIN.

CONFIGURATION 3: Long-Term Improvements – Outbound Range, Channel Widening, Shoreline Re-alignments

8) Please comment on the usefulness of the Outbound Channel Range, including in what ways it improves the navigation for departure and/or arrival.

DELAYD SAILINGS MAKES FOR CHANNEL TRANSIT AT NIGHT WITH FEW MEANS FOR AIDS TO CHANNEL KEEPING. WITH THE RANGE IN PLACE, IT WILL BE SAFER.

9) Please explain how the channel widening corrects any previously noted deficiencies or enhances navigability of the Inner Reach with respect to harbor transits of large vessels, and specifically with respect to the Voyager Class vessel.

MORE ROOM TO MANOUVER / CRAB ANGLE IN THE CHANNEL.

10) In what way do the shoreline realignments along the Inner Reach (between the Trident Basin and the Middle Basin) and within the West Basin (cutoff of corner area) enhance the safety of navigation in general, and specifically as relates to ships of the Voyager Class? Please be as specific as possible.

Inner Reach Shoreline (north side) NO NEED TO BE AS WORRIED FOR SUCKTION IF YOU NEED TO HUG THE NORTH SIDE OF THE CHANNEL DUE TO WIND AND/OR VESSEL DOCK ON THE SOUTH SIDE.

Cutoff at West Basin MAJOR BENEFIT AS THIS IS A GREAT HELP FOR ENTRY AND LEAVING THE TUGHING BASIN.

11) What in your opinion, should be a restricting upper limit wind condition (direction and speed) for operation of the Voyager Class vessel in the port. Be as specific as possible with reference to maintaining safe transit speeds and clearances to moored vessels, for both departure and arrival situations. This is only a recommendation for initial operations bearing in mind that experience gained with the actual vessel may require reevaluation of any limits or restrictions.

1/ 30 KN WIND NORTH/SOUTH. DEPENDS ON OTER SHIPS IN THE PORT.

2/ 30 - 35 SAME

3/ 30 - Gust 40 - Same as above.

12) Do you have any suggestions or recommendations not addressed above?

Additional Comments:

Please use additional sheets if necessary to complete your responses.

Thank you for your participation in this important project!

Port Canaveral Berth Access
Final Evaluation Form

Pilot #: 5 EARL McMILLIN Date: 17 FEB 2003

1) Were there any differences in the response of the simulated ship model(s) when compared to your experience with the actual ship(s)? (Indicate if no relevant experience.) Please indicate how any differences may have affected the results of the simulation study.

I HAVE NEVER BEEN ABOARD A VOYAGER CLASS VESSEL.

2) Were there any differences in the effect on the vessel of the simulated wind and current when compared to your real-world experience, or with your expectations. If so, please indicate how this difference may have affected the results of the simulation study.

YES. THE SIMULATED SHIP APPEARED TO TURN INTO A BEAM WIND MUCH FASTER AND CORRECTIVE ACTIONS SEEMED MUCH MORE RADICAL THAN ANTICIPATED. ALSO THE SHIP DID NOT TRAVEL BODILY DOWNWIND AS QUICKLY AS ANTICIPATED.

(SEE PAGE 1-A)

3) Of the conditions tested with the Voyager Class maneuvering model, which do you consider were the most challenging? Please explain.

THE ONLY EXERCISE I DID PERSONALLY IN MANEUVERING MODE WAS DOCKING IN A 25 KT NORTH WIND. UNFAMILIARITY WITH THE CONTROLS AND EFFORTS TO USE A "LIGHT TOUCH" RESULTED IN A POOR PERFORMANCE.

WATCHING OTHERS ATTEMPT TO TRANSIT

(SEE PAGE 1-A)

Configuration Specific Comments

CONFIGURATION 1: Existing Port Conditions

4) In your opinion does the existing Entrance Channel configuration pose any difficulty for maneuvering the Voyager Class vessel for arrivals and departures? Please explain.

Arrival YES. WIDENING THE CHANNEL FROM MIDDLE TO WEST BASIN SEEMS TO ME TO BE ESSENTIAL. THIS IS TO BE DONE BY REMOVING MATERIAL ALONG THE SOUTH SIDE TO GIVE AN ADDITIONAL

Departure 87+ FEET. THIS WILL GREATLY IMPROVE THE SAFETY MARGIN FOR GETTING BY CEMENT SHIPS AT NORTH CARGO 4 INBOUND OR OUTBOUND AND TURNING IN OR OUT OF WEST BASIN.

5) Do you feel that the unimproved Inner Reach to the West Basin portion of the transit poses any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, including specific conditions of wind, weather or time of day that would impact the transit.

YES. CEMENT SHIPS AT NORTH CARGO 4 ARE OFTEN VERY DEEPLY LOADED. ALSO, NORTH CARGO 4 IS 400' LONG AND THE CEMENT SHIPS OVERHANG IT BOTH FORE AND AFT. FREQUENTLY THE ACCOMMODATION LADDERS OF CEMENT SHIPS ARE BARLELY ABLE TO REACH THE DOCK. FINALLY THE AUGER UNLOADER

<SEE PAGE 2-A>

6) Is the existing, unimproved West Basin adequate in dimension and configuration to maneuver a vessel of the Voyager Class to/from the target berth (CT 10) under the normal range of conditions (wind and weather) experienced at the port? If not, please explain any deficiencies.

YES.

CONFIGURATION 2: Near-Term Improvements – Dredging (6 locations)

7) Under the second configuration that included the various near-term dredging projects, do you feel that the improved areas in the Inner Reach to the West Basin portion of the

port pose any difficulty in maneuvering the Voyager Class vessel, within prescribed requirements (such as maximum transit speed, clearance to vessels), or with regard to safe distances from shoal areas or aids to navigation? Please explain, specifying what deficiencies previously noted above would be corrected by these improvements.

AS STATED ABOVE, IN MY VIEW, THE REMOVAL OF MATERIAL TO WIDEN THE CHANNEL 87+ FEET WILL MAKE TURNING INTO AND OUT OF WEST BASIN AND PASSING SHIPS AT NORTH CARGO 4 INBOUND AND OUTBOUND MUCH SAFER.

CONFIGURATION 3: Long-Term Improvements – Outbound Range, Channel Widening, Shoreline Re-alignments

8) Please comment on the usefulness of the Outbound Channel Range, including in what ways it improves the navigation for departure and/or arrival.

ALTHOUGH I WAS UNABLE TO REMAIN AT STAR CENTER AFTER DAY TWO AND DID NOT SEE THE LONG TERM IMPROVEMENTS USED IT IS MY OPINION THAT AN OUTBOUND RANGE IS DESIRABLE.

9) Please explain how the channel widening corrects any previously noted deficiencies or enhances navigability of the Inner Reach with respect to harbor transits of large vessels, and specifically with respect to the Voyager Class vessel.

NO COMMENT. UNABLE TO REMAIN AT STAR CENTER AFTER DAY TWO.

10) In what way do the shoreline realignments along the Inner Reach (between the Trident Basin and the Middle Basin) and within the West Basin (cutoff of corner area) enhance the safety of navigation in general, and specifically as relates to ships of the Voyager Class? Please be as specific as possible.

Inner Reach Shoreline (north side)

NO COMMENT. UNABLE TO REMAIN AT STAR CENTER AFTER DAY TWO.

Cutoff at West Basin

11) What in your opinion, should be a restricting upper limit wind condition (direction and speed) for operation of the Voyager Class vessel in the port. Be as specific as possible with reference to maintaining safe transit speeds and clearances to moored vessels, for both departure and arrival situations. This is only a recommendation for initial operations bearing in mind that experience gained with the actual vessel may require reevaluation of any limits or restrictions.

WITH THE HARBOR "AS IS" I BELIEVE 20 KTS CROSSWIND — NORTH OR SOUTH — IS THE LIMIT. IF THERE ARE SHIPS AT

(a) CRUISE TERMINAL 4
(b) SOUTH CARGO 1
(c) NORTH CARGO 3
(d) NORTH CARGO 4

12) Do you have any suggestions or recommendations not addressed above?

IT WOULD BE WELL IF CANAVERAL PILOTS COULD TRAIN ON VOYAGER CLASS VESSELS AT STAR CENTER AFTER THE PORT & VESSEL SIMULATIONS ARE FINE TUNED.

Additional Comments:

IT IS MY INTENTION TO RIDE NAVIGATOR OF THE SEAS IN AND OUT OF MIAMI AT LEAST ONCE.

ADDITIONALLY I MAY ASK RCI IF RIDING MARINER OF THE SEAS IS POSSIBLE.

Please use additional sheets if necessary to complete your responses. <SEE PAGE 4-A>

Thank you for your participation in this important project!

PORT CANAVERAL BERTH ACCESS
FINAL EVALUATION

PILOT 5 EARL McMILLIN

#2 I DO NOT BELIEVE THE FACT THAT THE SIMULATED SHIP BEHAVED DIFFERENTLY FROM WHAT I EXPECTED AFFECTED THE STUDY RESULTS.

#3 THE HARBOR IN 25 KT CROSSWINDS WHILE KEEPING SHIP'S SPEED WITHIN LIMITS THAT WOULD NOT CAUSE SURGING OF MOORED VESSELS WAS MOST INTERESTING. WHAT SEEMED TO HELP WAS USING MORE POWER ON ONE AZIPOD THAN THE OTHER — RPM SELECT. IN MY VIEW THIS WAS MOST CHALLENGING.

FEB 17 03 11:35a MCMILLIN 321 783 6027 p.3

PORT CANAVERAL BERTH ACCESS
FINAL EVALUATION

PILOT 5 EARL McMILLIN

#5 AT NORTH CARGO 4 IS OF CONCERN — A SURGING CEMENT SHIP COULD DAMAGE IT.

SOME YEARS AGO I RECEIVED AN URGENT CALL FROM RINKER ADVISING THAT THE UNLOADER WAS STUCK IN A SHIP'S HOLD AND IT WAS IMPERATIVE THAT APPROACHING INBOUND CRUISE SHIPS PASS BY AS SLOWLY AS POSSIBLE.

A NORTH WIND REQUIRES THAT CEMENT SHIPS BE PASSED CLOSELY AND THIS INCREASES THE POSSIBILITY OF SURGING.

PORT CANAVERAL BERTH ACCESS
FINAL EVALUATION

PILOT 5 EARL McMILLIN

ADDITIONAL COMMENTS.

ACCORDING TO THE INFORMATION PROVIDED BY RCI THE PODS CANNOT ——— OR SHOULD NOT ——— BE OPERATED ASTERN. THIS LIMITS MANEUVERABILITY AND MAKES DPS/JS OPERATION IMPOSSIBLE. SINCE THE SHIP CANNOT FUNCTION AS SHE WAS DESIGNED TO FUNCTION HARBOR IMPROVEMENTS TO ACCOMMODATE HER ARE REQUIRED.

Feb 17 03 11:56a McMillin 321 783 8834 p.8

Port Canaveral Section 203 Feasibility Study

Engineering Appendix

Attachment A

Port Canaveral 2007 STAR Center Report

RTM STAR Center
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4 June 2007

Port Canaveral 2007

1 STUDY OVERVIEW

This report describes the methodology and the results obtained from the simulation-based evaluation of the proposed channel improvements at Port Canaveral, Florida. The objective of the study was to examine vessel operations conducted in a widened channel and improved turning basin.

Improvements that were evaluated include:

- Dredging/widening the turn from the "Outer Reach" to "Middle Reach" at the harbor entrance east of the breakwater.
- Increased depth, 44 feet in the entrance channel and 41 feet in the within the harbor..
- Dredging areas to realign and widen the inner harbor channel, providing a 500-foot wide channel for commercial ship traffic.
- Excavating and dredging to expand the entrance to the West Basin to provide additional maneuvering room for very large passenger vessels.

This study was performed at the RTM STAR Center in Dania Beach, Florida in four, two-day sessions during the months of March and April 2007. The study was conducted in the STAR Center's 360º field-of-view, shiphandling simulator.

STAR Center's evaluation encompassed observations of passenger ship transits to and from one of the cruise ship piers in the West Basin and tanker vessel transits to and from various berths in the western end of the channel just beyond the Middle Basin. Transits were conducted during moderate to high wind conditions. Comments were solicited from the participants in the study. Their comments, recommendations, and observations made during the simulations, assisted in forming the basis for the conclusions expressed in this report.

Two test vessels were used in this study. The primary test vessel for this study was a vessel of extreme length and breadth that is yet to be launched, but is expected to be in service in the coming years. The *Genesis* class cruise ship has an overall length of nearly 1200 feet and a beam at the waterline of 154 feet. Though *Genesis* will be highly maneuverable, the existing channel width is anticipated to have a negative impact on this vessel's operational safety due to its extreme length and vulnerability to wind forces. The second test vessel represented a deep-

STAR Center admits students of any race, color, national and ethnic origin or sex.

draft tanker loaded to approximate the limiting draft for Port Canaveral. The response model used in this study, the *Jupiter*, has a draft of 39.4 feet, both forward and aft. It represents a generic tank vessel that was prepared in both partially loaded (deep draft) condition for inbound transits, and ballasted condition for outbound transits.

The simulated environmental parameters reflected normal daytime conditions known to exist at Port Canaveral, FL. The clear visibility and daylight conditions remained constant throughout the simulated runs. The variables included ship type, and load condition in the case of the tank vessel, direction of transit (arrival vs. departure), wind direction, wind speed, current direction (in the approach channel), and berth location. The test conditions were organized into a total of fourteen scenarios. Seven were run with the *Genesis*, and seven with the *Jupiter* ship response model). Each of the scenarios was repeated by a different test subject during one of four simulation sessions.

On each run, the simulated "Ownship" was controlled by the test subject, of which there were four for this study. The subjects were all experienced and currently practicing pilots at Port Canaveral.

The results of the simulation showed that the proposed widening and deepening of the channel, the West Basin, and the turn in the approach channel should provide the margin of safety necessary for the operation of very large passenger ships of 1000-1200 feet in length at Port Canaveral, FL. The results also indicate that other advantages to the operating efficiency of the port may ensue from the implementation of the widening and deepening project. These advantages include the possibility for two-way traffic for smaller vessels, and the ability to move deep-draft vessels through the port at nearly all stages of the tide, resulting in less port congestion, and the elimination or reduction of delays in berthing for deep-draft vessels.

2 PREPARATION

There are a number of steps involved in setting up a simulation study. The first step is to determine the study's goals and objectives. This is necessary to develop an efficient test plan within the scope of the simulation program. Consulting engineers, CH2M Hill, for Port Canaveral provided the data defining the proposed channel improvements and information on the operational procedures, expected environmental conditions, and the class of vessels to be tested were obtained from the port.

3 SIMULATION COMPONENTS

The next step in the process is to acquire all the data necessary to identify existing available simulation models or to generate new ones as required. The hydrodynamic model(s) representing the test vessel(s) are selected from the STAR Center's existing library of ship response models, or if the vessel model or a close approximation does not exist, models can be developed to the user's specifications. Finally, the geographical database that is required for a high-fidelity simulation study is generated. The components of the simulation project are described in the following sections.

3.1 Simulator Ship Models

The ship response model is a mathematical representation of the motion of the simulated vessel in response to aerodynamic, hydrodynamic and control forces. The vessel's hydrodynamic and aerodynamic characteristics are a function of hull form, load condition and draft, rudder size, and above-deck structures and appendages such as stacks, masts, cargo gear and deck cargo. External forces such as wind, waves, current, channel bank and bottom interactions, etc., are all considered with respect to the profile above the waterline (for wind) and the underwater hull form. Control forces include rudder, propeller (or azipod), bow and stern thrusters, assisting tugboats, and deployment of anchors or mooring lines. The equations of motion continuously calculate the acceleration of the vessel in three dimensions, which in turn is used to determine instantaneous velocity, position, and attitude. An individual ship model and its maneuvering performance are characterized by assigning a specific numerical value to each of the many coefficients in the equations of motion, and to the other coefficients that define the vessel's propulsion characteristics.

RTM STAR Center has an extensive library of vessel response models, representing a broad spectrum of the global maritime fleet. The library contains a large number of modern passenger vessels. One of the largest of these response models is the *Genesis* class cruise ship selected for the Port Canaveral study, which is yet to be built and launched. This vessel will be nearly 1200 feet in length and its size will provide numerous challenges to shiphanders navigating in many of the harbors at which this ship is intended to call.

The second ship response model was generated by the STAR Center to the dimensions specified by the client for a large tankship in two (2) different draft conditions: partially loaded to an even keel draft of 12 meters (39.4 feet), and a ballasted version drawing 8.3 meters Aft (27.2 feet) and 5.7 meters Forward (18.7 feet). Inbound transits with the tanker would utilize the partially loaded ship response model, while outbound transits would be conducted with the ballasted model.

Response models that represent actual in-service vessels are first constructed using towing tank and other design data, and are later fine-tuned from data generated during sea trials. Final validation of a model is usually performed with a pilot or shipmaster that is familiar with the actual vessel and its handling characteristics. The two ship response models used in this study have not been validated because no sea trial data exists, and since neither vessel is in service there are no experts who can comment on the maneuvering characteristics of the vessels. The tanker model is constructed using validated ship models of similar proportions as a baseline to generate a new model. The *Genesis* cruise ship model is likewise developed from a slightly smaller baseline model that is in service and has been validated. As a result of this procedure, there is a good degree of confidence in these models.

The particulars of the two ship response models used in this study are presented in Table 4.1.

3.2 Simulator Geographic Models

RTM STAR Center possessed an accurate computer model of Port Canaveral as it currently exists, which had been created for prior studies. The research staff prepared a modified model of

Port Canaveral using engineering drawings provided by the engineering firm of CH2M Hill for the proposed modifications to the navigation channel and turning basins. The changes included the widening and realignment of the navigation channel, widening and reconfiguration of the turn in the entrance channel, an increase in the channel and basin depths throughout the port, and widening the entrance to the West Basin. Information provided by the engineers was used to create a new model of the harbor that incorporates the vision for an enhanced waterway designed to accommodate the next generation of very large passenger cruise ships, as well as large, deep-draft commercial vessels such as tankers and bulk carriers, to a maximum draft of 39.5 feet.

The geographic model presents a realistic out-the-window visual display using Computer Generated Image (CGI) technology, and a corresponding radar image on the radar displays located on the simulator's navigation bridge. The visual and radar models incorporate landmass, terrain elevations, aids to navigation, piers, jetties, bridges, buildings, towers, and other characteristics of the modeled geographic area, and display other vessels and aircraft. Specific structures, buildings, stacks, key landmarks, and other prominent features that can be used as visual cues by the pilots when handling ships in the port are identified for inclusion in the 3-dimensional visual scene.

The accurate positioning of fixed and floating aids to navigation is an essential part of the visual database. This includes buoys, fixed beacons, lighthouses, and range structures with their correct height, shape, coloration, light characteristics, and dayshapes and color schemes, as may be applicable.

The visual database is generated starting with the latest editions of local navigation charts for the baseline information. Any available autoCAD engineering drawings are used to define proposed changes to the port area that are not featured on the latest navigation charts. Photographs of the harbor and additional information are gathered by the STAR Center staff or are provided by various sources, in order to produce a complete and reasonably accurate visual depiction of the harbor or waterway.

3.2.1 Channel Improvements

The objective of this study was to evaluate the effectiveness of proposed improvements to the Port Canaveral waterway to support the future operations of very large passenger ships and deep-draft cargo vessels. Modifications were made to the existing geographic database of Port Canaveral to represent proposed changes to the channel configurations and project depths. These changes include dredging to both deepen and widen the navigation channel, and excavation of land areas to increase the size of the West Basin.

Dredging and excavation of channel banks was modeled in the area on the north side of the channel from the entrance jetty to the southeast corner of Middle Basin, and on the south side of the West Access Channel from Tanker Berth 1 (TB1) to the western side of the entrance to West Basin. These modifications resulted in realigning the existing channel and creating a uniform, straight channel of 500 feet (152.4 meters) in width.

The inside of the entrance channel turn was dredged to provide a "widener" at the turn that would enable ships to make this turn more gradual, by starting the turn sooner. It has the effect

of increasing the radius of the turn. On the inbound transit the turn begins just past the "7" buoy.

The channel range markers for the inbound transit were shifted in this geographic model to align with the new centerline created by widening and straightening the channel. In addition, a new outbound range was created in the model to provide a visual cue for the new channel centerline when transiting the port outbound. The structures for the new outbound range are situated in the waters beyond the entrance jetty and just north of the turn. See Figure 1

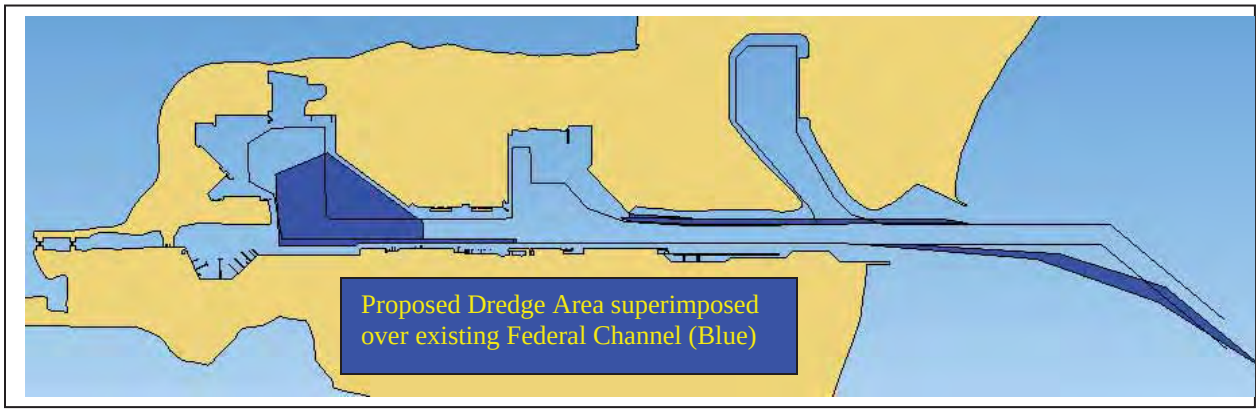


Figure 1 – Dredge Plan

3.3 Radar Database

The radar databases are developed in conjunction with the visual databases to ensure a realistic radar display that correlates to the visual depiction of the modified waterway. Features that are present in the visual database (landmass, aids to navigation, piers, and breakwaters, etc.) are represented in the radar image.

The RTM STAR Center utilizes authentic shipboard equipment in the full-mission bridge simulator. The simulator's wheelhouse is equipped with an integrated bridge console hosting two Radar/ARPA units that are identical to units installed aboard modern commercial ships.

3.4 Depth Modeling

The depth file used for harbor simulation represents the bathymetric definition of the waterway, including bottom contours and shoals, bottom composition, navigation channels and channel banks, turning basins, and berth dimensions. The bathymetric model includes important features that cause interactions with the ship response model, such as water depth (affecting underkeel clearance, "UKC"), the depth and slope of channel banks, and shoal areas.

Soundings depicted in the depth model for Port Canaveral and the entrance channel were modified from the existing data to produce a "model of the future" representation of the port. The inner harbor depths, including all navigation channels and basins were increased to a uniform project depth of 41 feet (12.5 meters), and the outer approach channel depth was increased to 44 feet (13.4 meters) extending to a point just east of the Trident Basin.

The resulting depths are more than adequate for the *Genesis* test vessel with a draft of 30.2 feet (9.2 m). Planned channel depths after dredging provide a maximum 1.6 feet of under-keel clearance for the tanker *Jupiter* at low water, which has a draft of 39.4 feet (12 m) when partially loaded.

3.5 Wind Modeling

Wind forces are automatically calculated on the simulator based upon wind speed and direction relative to the ship's heading, and the aerodynamic coefficients of the wind profile of each ship response model. The wind effects simulated during these exercises represented average to moderately high wind conditions for the Port Canaveral area.

Wind speeds in the range of 15 knots up to 25 knots were simulated in this study. The large profile presented by today's large passenger cruise vessels result in a substantial impact on shiphandling due to wind effects. The tanker is less affected by the wind in the partially loaded condition due to its deep draft, broad beam, low freeboard and minimal superstructure in comparison to the passenger ships. In ballast condition, the tanker would experience slightly more of the wind effect.

According to the comments solicited by the subjects during the sessions, the wind forces that were simulated in these scenarios were deemed to produce a very realistic effect on the handling of both of the response models during the harbor transits and slow speed maneuvers off the dock.

3.6 Current Modeling

Currents exist offshore in the approaches to Port Canaveral, but are minimal in the harbor itself. The only current simulated in this study was in the approach channel where it runs parallel to the shoreline. The pilots provided information on the expected velocity of currents and the area in which the current is prevalent.

4 ON-LINE SIMULATION TESTING PROCEDURES

The tests were conducted at RTM STAR Center in Dania Beach, Florida, using a state-of-the-art full-mission, 360° field-of-view shiphandling simulator. The tests consisted of a series of simulator-based transits where experienced mariners controlled the test vessel from the simulator's wheelhouse as they would in actual practice. The process of producing a final report of the simulator-based evaluation requires that:

- Each simulated maneuver be observed by RTM STAR Center personnel,
- A self-assessment be performed by each of the participating mariners,
- The mariners themselves comment on the project via a Final Evaluation questionnaire,

- An analysis of both the recorded vessel performance data and the mariner self-appraisals be conducted, and
- The results be condensed and summarized in a final written report that includes the recommendations and comments of the participating mariners.

4.1 Test Conditions

The Port Canaveral Channel Improvement Evaluation study was conducted with the participation of four (4) Port Canaveral pilots. The variables that were examined include environmental conditions (wind and current), ship type, and draft condition, direction of transit, and destination or departure berth. The test conditions are described in detail below.

4.1.1 Environmental Conditions

A variety of wind and current conditions were simulated. During each session, the first simulation run conducted with each of the ship response models exhibited no wind or current. These runs were considered "familiarization" with the vessel, its handling, its controls, and the simulator environment in general. Subsequent runs were made with a combination of wind and current as presented in the project Run Matrix listed in Appendix B.

Wind conditions simulated were calm (no wind), northwesterly winds of 15 knots and 25 knots, and gusting winds of 20-25 knots; southeasterly winds of 15 knots and 25 knots, and gusting winds of 20-25 knots.

Current conditions exist only in the entrance channel, seaward of the jetty, and are minimal. No current was simulated in the inner harbor channel beyond the entrance jetty. The current was simulated at a velocity of 0.3 knots setting to the north on some runs, and to the south on others.

All runs were conducted in daylight, with unrestricted visibility.

4.1.2 Ship Response Models

Two substantially different ship response models were examined in this study: a very large passenger cruise ship, and a medium-sized tank vessel. The latter simulated ship was developed to specific dimensions, representing some of the largest deep-draft bulk cargo vessels expected to enter the port subsequent to the proposed port configuration and channel improvements.

The *Genesis* class passenger cruise ship is 1185.7 feet (361.5 meters) in length. It is a highly maneuverable vessel, equipped with multiple bow thrusters, and azipod main propulsion that enables it to operate within a port routinely without the assistance of tugboats.

The second model employed in the study represents a generic single-screw tanker vessel, the *Jupiter*, which exhibited the draft, length and beam specified for a deep-draft bulk cargo test vessel. Three tugs were available for maneuvering assistance during channel transit, docking and undocking the tanker *Jupiter*. The tank vessel was modeled in two load conditions: partially loaded (deep-draft model), and ballasted. The primary difference between the two versions of the *Jupiter* ship response model is the draft, and the wind profile presented due to the resulting freeboard. Both ships' particulars can be found in Table 4.1 below.

Table 4.1 - Ship Response Model Particulars

Ship Math Model Name	*Genesis*	*Jupiter*
Type	Passenger Cruise Ship	Tanker
Displacement	103,252 m tons	97,200 m tons
LOA	1185.7 ft / 361.5 m	800.3 ft / 244.0 m
Beam at the waterline	154.2 ft / 47.0 m	137.8 ft / 42.0 m
Modeled Draft, forward and aft	Fwd 30.2 ft / 9.2 m Aft 30.2 ft / 9.2 m	Partially Laden Condition Fwd 39.4 ft / 12.0 m Aft 39.4 ft / 12.0 m
		Ballasted Condition Fwd 18.7 ft / 5.7 m Aft 27.2 ft / 8.3 m
Propulsion Type	Diesel Electric	Diesel
Propeller Type	Fixed Pitch (inward)	Fixed Pitch CW
Number of Propulsion Pods or propeller shafts	3 Azipods	1 shaft
Shaft hp (each shaft or pod)	26,820 hp	19,713 hp
Bow Thruster hp	4 x 7,376 hp	none

4.1.3 Direction of Transit and Destination

Simulation runs were conducted both inbound and outbound at Port Canaveral. During each session there were five (5) inbound runs and two (2) outbound runs.

The start position for inbound transits was generally at the beginning of the turn, near buoys numbers 7 and 8. The passenger cruise ship made a transit of the entire channel to the West Basin, where the vessel was turned around and backed into Cruise Terminal berths 9 and 10 (CT9/10) on the southwest side of the basin, to lay starboard side to the pier. Tank vessel *Jupiter* transited the channel inbound until it was abeam of the Middle Basin entrance, with three (3) tugboats made up to the ship to assist in slowing the vessel and turning it around. The tanker was turned at the Middle Basin and then backed into either the Tanker Berth 1 (TB1) on the south side of the channel, or North Cargo Pier 4 (NCP4) on the north side.

Outbound transits with the *Genesis* class passenger ship commenced with the vessel departing the West Basin (sailing from CT9/10) and turning into the West Access Channel. Outbound transits of the tank vessel were initiated alongside the pier at North Cargo Pier 3 (NCP3) on the north side of the channel. The tanker was positioned starboard side to the pier, necessitating a turning maneuver to proceed to sea. Depending on the wind direction, the ship was directed either to the Middle Basin or the West Basin in order to turn around, at the pilot's discretion. Refer to the project Run Matrix in Appendix B to this report.

4.2 Conduct of the Simulator-Based Evaluation

The simulation tests took place over four two-day sessions in 2007: March 3-4, March 10-11, March 31-April 1, and April 21-22. Each session was conducted with the identical simulation scenarios being run by a different pilot. Each day of the two-day session concentrated on a different ship response model. The first run of each day provided the pilot with the opportunity to become familiar with the simulated vessel and with the bridge simulator's equipment for that vessel.

A total of seven (7) runs were completed each day, with five (5) runs being inbound and two (2) runs being outbound transits. A list of all of the conducted simulation exercises and the test conditions applied to each of them can be found in the Run History Listing in Appendix B.

4.3 Participants

This simulation study was conducted with the active participation of Port Canaveral Pilots Stephen Gasecki, Ben Borgie, David Callan and Richard Grimison.

The simulation exercises were observed by representatives from the engineering firm of CH2M Hill, the Canaveral Port Authority, and Royal Caribbean International. RTM STAR Center staff members were also present as observers and facilitators of this project.

4.4 Simulator Configuration and Procedures

The simulation runs for the study were conducted on STAR Center's 360° full-mission bridge simulator. STAR Center's simulator bridge is a full-size replica of a commercial vessel's wheelhouse. The equipment on the simulator bridge can be configured to replicate the bridge arrangement of any merchant vessel.

The simulator presents a 360° panoramic out–the-window view from the wheelhouse. Wheelhouse instrumentation may include two ARPA/Radar displays and a CRT presentation referred to as the ship's "conning page" which provides information on rudder position, thruster setting, true and relative wind speed, fore and aft, and lateral speed of the vessel, in a single location. For docking maneuvers and turning around in the turning basin, a "bird's-eye view" display was provided on the console to compensate for the loss of depth perception and the difficulty in estimating distances in the simulator's visual scene. This display is similar in some respects to an ECDIS (Electronic Chart Data Information System), lacking only the detailed chart information.

A full range of communications devices is available in the wheelhouse, including ship-to-ship and ship-to-shore radios, sound-powered phones and intercom systems. Hand-held radios are provided to simulate portable short-range UHF equipment commonly used aboard ships.

The four participating shiphandlers each commanded the simulated vessels on a fixed number of runs into, and out of, Port Canaveral FL. The exercises were each under an hour in duration. Inbound transits began in the entrance channel in the vicinity of buoys 7 & 8, and depending on the ship type, finished in the West Basin at the passenger ship pier CT9/10, or at one of the bulk cargo berths on the south or north side of the channel, west of Middle Basin.

When commanding an azipod-equipped vessel such as a modern passenger ship, the shiphandler will usually take direct control of the combined steering-propulsion controls, so that a separate helmsman is unnecessary. On each run using the *Genesis* ship response model, the test subject controlled (conned) the vessel from a centerline console, where the azipod controls were located, and from which all indicators, radars and navigation equipment could be seen. When the simulator was configured as the tanker *Jupiter*, the test subject controlled the throttle and gave standard helm orders to a qualified helmsman, who steered the vessel from a separate steering stand at the rear of the wheelhouse.

The STAR Center provided support staff during this simulator-based study. The support staff included a technician, and a simulator operator who initializes the systems, ensures the collection and archiving of numerical data, and generates track plots for each exercise. The operator assists in "role playing" support, such as representing crewmembers during docking maneuvers to provide estimates of distances between the ship and pier structures, other vessels, buoys, etc. An observer/data collector is also present to brief/debrief the participants on the details and objectives of each exercise, to note any occurrences that might provide insights into the intentions or actions of the shiphandler, and to record the subject's verbal comments related to the simulated transits and maneuvers.

4.4.1 Use of Ship Assist Tugs

The ship response model of the tanker *Jupiter* required the assistance of tugboats to make the transit and for docking and undocking. Three (3) tugs were simulated, representing ship assist tugs that are available for use at Port Canaveral. Two (2) of the tugs were conventional twin-screw tugs of 3000 and 4000 hp. These were positioned on each shoulder of the vessel with lines made fast for the inbound transit. The third tug was a tractor tug of 4000 hp, made up at the tanker's stern on inbound runs for steering and braking.

The passenger vessel was maneuvered without tugboat assistance.

4.4.2 Special Simulator Procedures

Close quarters maneuvering such as docking and undocking vessels, turning them around, or navigating narrow channels, often requires the shiphandler to conn (operate) the vessel from the Port or Starboard bridge wing in order to assess the clearance from moored vessels or shoreside structures. The normal position of the eyepoint is in the center of Ownship's wheelhouse. When the subject needs to observe the Port or Starboard side of the ship, for example during a docking maneuver, he requests the view from the Port (or Starboard) wing, as appropriate. On the simulator the ability to view the operation from the bridge wing is facilitated by moving the eyepoint of the visual scene laterally to the outer edge of Ownship's side, or in the case of some vessels, to the extended bridge wing beyond the ship's beam. The simulator operator will immediately alter the eyepoint, which changes the perspective in the visual scene to a position as viewed from the desired bridge wing. This permits the subject to see the entire side of the vessel near the pier, to look around obstructions such as cranes or deck cargo on the foredeck, or to view objects that are astern of the ship.

The shiphandler can request by hand-held radio to the simulator operator to provide clearance distances from the ship's hull to various objects in the visual field. This compensates for the difficulty in estimating distance visually from the level of the wheelhouse. It also simulates the usual shipboard operation where ship's officers are stationed at the bow and stern to estimate distances from a better vantage point.

4.4.3 Data Collection Procedures

Prior to commencing each exercise, the shiphandler was briefed on the test conditions, including the vessel's position, starting speed, load condition if applicable, and the wind and current conditions to be expected. At the conclusion of each simulator exercise, the subject was asked to complete a quick self-evaluation of the run, the Run Evaluation Form. This form solicited his comments on any occurrences during the exercise, the controllability of the vessel, and a personal assessment of the safety of the maneuver, difficulty, and level of stress experienced. Copies of all of the completed Run Evaluation Forms can be found in Appendix D.

At the completion of all of the simulator runs during a session, each subject was requested to complete a Final Evaluation that solicited detailed comments related to the individual channel improvements and how the handling of the vessels was affected by the channel modifications/improvements that were tested. The pilots provided comprehensive comments about how the various channel improvements would be utilized and under what conditions they would enhance the safety of operations. Comments provided on these forms were used in the formulation of the conclusions appearing in this report. Copies of the completed Final Evaluation Forms can be found in appendix E.

The shiphandling simulator automatically records numerical data that represent the actual maneuvers made by the simulated vessel under the control of the subject (Ownship) during an exercise, including, but not limited to such elements as: rudder angle, throttle setting, heading, course, speed over ground, thruster power, under-keel clearance, rate-of-turn, etc. The simulator system also provides a graphical output of this data in the form of track plots, showing the relationship of Ownship to the navigation channel, to other vessels, and to piers and other important geographic features. These plots are printed at the conclusion of each run. Multiple plots may be generated if necessary at different chart scales to examine specific components of an exercise, for example, the port approach, channel transit, and final docking maneuver. Track plots depicting each of the test runs appear in Appendix C.

The combination of the track plots, observer notes, post-exercise evaluations, and final program questionnaires permit a thorough professional analysis of the simulation sessions. These procedures ensure the complete gathering of real-time simulation data necessary to describe the results of the study and to draw conclusions.

5 FINDINGS

Several strategies were noted while observing the exercises performed by the participating pilots. Speed control in the channel is important in order to minimize surging impacts on the any ships

that are berthed along the channel. Hydraulic effects caused by the displacement of a large volume of water during the passage of vessels transiting the channel can cause problems in the Trident Basin, home to Navy submarines and other support vessels. On transits involving the Genesis, the shiphandler reduces speed through the turn at the jetty, to make no more than 8 knots when abeam the Trident Basin. For the Jupiter, the speed was generally reduced to a maximum of 7 knots as the vessel approached the Trident Basin.

Speed limitations continue in the channel, so as to pass any passenger vessels moored at the outer cruise terminal docks (CT2 to CT4) at a targeted speed of about 6 knots or less. The shiphandler did not, on every inbound run, always achieve this targeted speed at this location, but it was readily apparent that this was the goal. The maximum speed that the subjects stated was acceptable in the inner channel was 6 to 6.5 knots.

The particular wind condition imposed during a simulation exercise had a significant effect on the strategy employed for navigating the improved waterway. This is more pronounced for the Genesis than for the Jupiter. The direction of the current outside the port had little discernable effect on the outcome of the simulation however, as it produced a minimal influence on the vessels. The current drift was 0.3 knots through most of the exercises and the set varied from North to South for different exercises. The current was sometimes opposed to the wind and sometimes in concert with the wind.

Vessels negotiating the channel in either direction will tend to navigate on the windward side of the channel whenever possible, in anticipation of being set to leeward. This is commonly used strategy was employed and was facilitated by the proposed dredged areas on the north side of the channel (from the jetty to the Middle Basin), and on the south side of the channel (along the West Access Channel) will be most useful. The dredged areas effectively widened the channel on the north side of the Inner Reach, and on the south side approaching the West Basin, allowing more adequate clearance when passing vessels berthed at the outer cruise terminal piers (CT2 to CT4), and at the bulk cargo piers (NCP3 and NCP4). The necessity for maximum passing distances from moored ships in the channel, is to minimize the surge resulting from the expected transit speeds.. Key elements in reducing surge effects as the ship transits the channel are speed reduction, and maximizing passing distances. However, in strong winds blowing across the channel, from the northwest and southeast directions, a reduction in speed means increased a greater "crab angle[1]", or the angle to the base course necessary to compensate for leeway.

Examination of the track plots recording the ship's position throughout the exercises may appear to indicate that the shiphandler did not often utilize the widened sections of the channel. It appears that Ownship rarely transits through the dredged areas. But a closer look shows that in most cases the cruise ship is tracking along the original channel boundary or just inside of it, where the dredged widener is present. This indicates that the pilot is utilizing the additional width provided by the dredged sections to minimize bank cushion and suction effects. Bank effects increase proportionately with the vessel's speed. The additional channel width enables the shiphandler to maintain a good distance from the channel bank, thus minimizing bank effects,

[1] Crab angle- or drift angle – difference between course steered and the course made good usually due to the action of current or wind. This effectively increases the footprint of a vessel lessening channel maneuver room.

while keeping the vessel's speed in the 5.5 to 6.5 knot range required both for adequate steering control and reducing the crab angle when making a transit in moderate to high winds.

The Jupiter, on the other hand, uses the middle of the channel and rarely if ever ventures into the area that has been widened by dredging, except perhaps in the entrance channel turn. The deep-draft ship is less affected by the wind, and has excellent directional stability. It can therefore track with a smaller crab angle at slower speeds in the harbor. Because of the deeper draft on the inbound transits, the pilot would want to eliminate the possibility of bank effects by keeping the vessel in the center of the channel.

5.1 Passenger Cruise Ship *Genesis*

It was observed that in strong winds, the *Genesis* was difficult to control with less than 6 knots of headway, although the selected propulsion/steering mode by the pilot may have contributed to this difficulty. The shiphandlers usually transited the entire channel from sea, using the *Combi* mode up to the point at which the ship entered the West Basin. *Combi* mode links the rotatable azipods so that they work in tandem to steer the vessel much like a conventional propeller-rudder system. Increased controlability may be achieved by using the bow thrusters to assist in steering and presumably, setting the propulsion system to *Azi* mode. *Azi* mode allows the azipods to be rotated independently, with the possibility of using one azipod for fore and aft propulsion and the other for transverse propulsion similar to a stern thruster.

Most often the shiphandler left the controls in *Combi* mode and did not use the bow thrusters during the transit, changing to *Azi* mode only when the *Genesis* was abeam of NCP3 or as the ship began to enter the West Basin.

The increased channel width substantially improves the margin of safety for a vessel of the *Genesis* class. When any ship is steered in a narrow channel so as to account for leeway due to wind and/or current, the result is an increase in the width of the channel that it occupies which we might call its "footprint". The leeway compensation angle from the base course measured in degrees is termed the "crab angle". The effective beam or width of the vessel is increased significantly by a crab angle of only a few degrees. The extreme length of the *Genesis* class ship, results in an effective beam that is over 60% greater than the ship's actual beam, when carrying a 5° crab angle. During some transits of the *Genesis* with 25-knot winds, crab angles of 10°-12° were noted. The effective beam of the *Genesis* class vessel moving down the channel is more than double its actual beam with a 12° crab angle. Therefore for a vessel whose actual beam is already 38% of the channel's width, minimizing the crab angle in the channel is a priority. Shiphandlers should, even with the widened channel, expect to use bow thrusters extensively through the transit to minimize this crab angle, and footprint.

An increase in speed will help to reduce the crab angle, however as has been discussed, any speed over 6 knots in the channel poses a danger to vessels at berth along the waterway and even in the turning basins due to hydrodynamic forces and the amount of water displaced by the moving vessel. The transit speed of 6 knots, with a maximum of 6.5 knots, has been identified as the balance between good steering control in the channel and the necessary reduction of the impact on other vessels in the waterway. The additional 100 feet of width in the channel permits

the increase in the crab angle, so that an increase in transit speed in not necessary in high wind conditions.

5.2 Tanker *Jupiter*

The shiphandlers experienced little difficulty with the transit of the tank vessel *Jupiter* into Port Canaveral in simulation. The 500 foot channel width provided by the improved channel minimizes bank effects because the tanker can navigate further from the channel banks. The increased width also helps to reduce the hydraulic impacts on other vessels in the channel and the turning basins that result from the displacement of water as the ship moves along the channel. The additional width allows more of the displaced water to pass around the sides of the vessel, resulting in less water being pushed ahead of the vessel.

Outbound Jupiter, in ballast, will experience greater crab angles than the loaded configuration under high wind conditions, because of their somewhat greater freeboard. As with the cruise ship, the increased channel width enables the vessel to safely carry a larger crab angle and thus travel at a lower speed. Yet the tanker is much shorter in length than the cruise ship *Genesis*, so that the crab angle is not as significant a factor and the "footprint" due to the crab angle is less.

The proposed channel improvement project would provide a depth of 41 feet throughout the inner channel and basins, and 44 feet in the entrance channel that is meant to facilitate deep draft vessels access the port. However, the 41-foot project depth will not be adequate for a ship drawing greater than 39 feet despite the 2 feet of "overdredge[2]" as this additional 2 feet cannot be guaranteed. The pilot association's criteria of 2.5 feet of water beneath the keel, is not met during low water (charted) conditions. If the goal is to enable deep draft vessels to navigate the port at all stages of the tide, this goal will not be achieved as presently planned.

The test vessel *Jupiter* in this study draws 39.4 feet when partially loaded. Low water was in simulations with a depth of 41 feet in the channel and a 2 foot "overage" totaling 43 feet. "Overage" dredging cannot be relied upon to accommodate vessels, and may disappear in time. The effects of "squat[3]" are very real on a vessel when transiting a narrow channel. Additionally, vessel draft can be increased by "list". Each of these factors independently, or in combination, could reduce under-keel clearance to an unsafe level. Tidal levels will be a factor for Jupiter, when loaded to 39.4 feet, and may preclude transits at specific periods of tide to insure safe passage. **Table 5.2** provides squat information calculated by a commonly used generic formula.

[2] Overdredge or maintenance dredge – normally an extra 2 feet of dredging depth added when possible to the specified depth to combat silting-in etc.

[3] Squat- the increase of a vessel's draft caused by movement through the water. A vessels draft is increased as ship speed through the water is increased.

Table 5.2 – Squat Table for *Jupiter*

Speed Kts	Open Water Squat m	Confined Squat m
2	0.03	0.07
3	0.08	0.15
4	0.13	0.27
5	0.21	0.42
6	0.30	0.60
7	0.41	0.82
8	0.54	1.08
9	0.68	1.36
10	0.84	1.68
11	1.02	2.03
12	1.21	2.42
13	1.42	2.84

6 CONCLUSIONS

6.1 Summary Conclusions

The proposed improvements to the Port Canaveral waterway evaluated in this study will enhance safety at the port for a new class of passenger cruise ships and existing large cruise ships. The benefits of dredging the harbor to a deeper project depth will be enjoyed by the deep draft commercial traffic and can reduce port congestion and wait times for ships to proceed to a berth. Widening and straightening the channel will not only enhance the safety of operations for all large vessels, but it may make it possible to open the channel to two-way traffic under certain circumstances.

With regard to the proposed deepening of the navigation channels to a 41 feet project depth, the criteria used by the Port Canaveral Pilots for under-keel clearance (UKC) is 2.5 feet (0.8 m). The tanker *Jupiter's* loaded draft in the simulation was 39.4 feet (12 m). Thus the *Jupiter* would not meet the criteria for harbor transit at low water with a project depth of 41 feet. Increasing the controlling depth of the navigation channel to greater than the existing 39 feet throughout the inner channel and turning basins would not be a significant benefit to the passenger ships, but a project depth of 41 feet would permit deep-draft vessels such as bulk carriers and tankers to transit the port at other stages of the tide..

For deep-draft vessels, the necessity of minimizing transit speed is a consideration to reduce hydraulic effects that will impact berthed vessels along the waterway, and to reduce the effect known as "squat" that causes the vessel's draft to increase. A balance must be achieved between controllability of the vessel, and permissible maximum speed, hence the necessity to employ tugs to assist in both steering and braking.

6.1.1 Widening of the Entrance Channel Turn

The dredged area proposed at the entrance channel turn was used most on outbound transits with southerly winds. Although the vessel may not have entered the dredged area on many of the runs, the additional room permitted the vessel to navigate on the side of the channel toward the inside of the turn, and this was taken advantage of in nearly every exercise. The significant benefit of the widener at the inside of the turn is to create a smoother, more gradual transition by increasing the radius of the turn, allowing a reduction of the rate of turn by half. For the *Genesis* vessel, reducing the rate of turn significantly diminishes the tendency to heel, which is a major safety issue on passenger ships. The simulation exercises showed reduction in turn rates to about 10°/minute, when up to 20°/minute are currently the norm when negotiating the turn as it exists today, according to the pilots participating in this study.

The reduced rate of turn also provides a greater margin of safety in controlling the vessel. Less effort is required to counter the swing rate when steadying up after the turn, and the chances of recovery from a steering or engine casualty are better with lower turn rates.

Dredging the inside of the turn enables the vessel to start the turn sooner, remain closer to the inside through the turn, and consequently keep the stern clear of the channel boundary on the outside of the turn.

6.1.2 Harbor Channel Widening

The large passenger cruise ships are expected to transit Port Canaveral at speeds of 6 knots, to a maximum of 6.5 knots, under moderate to high wind conditions in order to reduce crab angle, and to maintain adequate steering control. At speeds approaching and exceeding 6.5 knots, hydraulic forces in the channel cause surging effects that endanger ships moored along the waterway. Increasing the channel width to 500 feet permits the vessel to carry a larger crab angle, which would be the end result of reducing speed during the transit. The increased channel width also permits more water to pass around the moving vessel, and helps to mitigate the hydraulic effects that cause surging. A greater passing distance to moored vessels also reduces the surge effect, and the greater channel width contributes to maintaining a safe distance from other vessels.

The effect of widening the harbor channel in the two locations, north side from the jetty to Middle Basin and the south side from Middle Basin to West Basin, is the elimination of the constriction approaching the south cargo piers inbound. In addition, the navigation channel is realigned and straightened through nearly its entire length. Enhanced safety is a result whenever a navigation channel is straightened and widened.

6.1.3 Harbor Channel Deepening

The 41-foot project depth and 2 feet of “overdredge” will not be adequate for a ship drawing 39.5 feet at all stages of the tide. The additional 2 feet cannot be guaranteed and the safety criteria established by the pilot association for 2.5 feet under-keel clearance is not met. Furthermore, ship “squat” has to be considered. At a speed of 4 knots in the harbor, a deep-draft vessel similar to the test vessel *Jupiter* used in this study would experience an increase in draft of 0.9 feet (0.27 m); at 5 knots the increase would be 1.4 feet (0.42 m). Transit speeds of 4 to 5

knots would not be unusual in the channel, and would depend on the vessel's controllability at harbor maneuvering speeds. If the vessel must reduce speed and cannot be adequately controlled, tugs must be used to assist in steering at slow speeds, as they were used in this study.

6.1.4 Reconfiguration of the West Basin

The cutoff corner on the east side of the West Basin entrance allows for better control of the vessel and a slower speed upon entry. This reduces the hydraulic forces that are generated. This applies mostly to the cruise ships berthing in the West Basin, but also to large bulk carriers and tankers which may, occasionally, utilize this basin to turn around. The widening of the entrance to the West Basin allows a vessel to make a shallower approach from the channel, keeping the stern well away from vessels, marinas and ramps that are situated along the south sea wall opposite the basin, especially in strong northerly winds.

Increasing the width of the basin is necessary to support the maneuvering of very large passenger vessels such as the *Genesis* class that was simulated in this study. During the slow speed maneuver of turning around to back into the berth at CT9/10, the high sides of these large cruise ships are very vulnerable to strong winds when presenting their beam broadside to the wind direction. Adequate turning room must be provided to allow for the sideways set that the vessel may experience.

6.2 Comments and Recommendations

The subjects who participated in this study were very prolific in their comments on the proposed harbor improvement plan. This section comprises a summation of the comments that the pilots provided on their Final Evaluation Questionnaire.

6.2.1 Channel Widener in the Entrance Channel Turn

An increased margin of safety is provided by the reconfiguration of the turn, and is needed by a vessel as large as the *Genesis*. The widener permits an acceptable Rate of Turn (ROT) in comparison to what is currently required (up to 20°/min. ROT with southerly winds). The high Rate of Turn contributes to vessel heel, which is to be avoided on passenger ships. The ability of the pilot to make two gradual turns instead of one sharp turn reduced the ROT to 10°-15°/min.

The extreme dimensions of this vessel produce a much wider swept path when carrying a crab angle to compensate for the wind. The additional width provided by the cutoff turn leading up to the entrance jetty allowed the subject to navigate the channel using the *Combi* mode without requiring the use of the bow thrusters to steer. For the *Genesis* class, the additional width of the widener at the turn is essential when inbound in a strong southeasterly to southwesterly wind, to keep the vessel completely within the channel without swinging the stern outside the north channel limit on the 310° heading. Between buoy "10" and the jetty, the very shallow area outside the channel must be avoided. This widener enables the ship to track toward the inside of the turn, thus keeping the vessel's stern clear of this area.

The improved channel enables the vessel to be at a slower speed upon reaching the jetty when inbound, and therefore headway could be reduced even further by the time the vessel reached the

passenger ship berths (CT4). Passing berthed vessels at CT2 to CT4 was made safer because a speed of 6 knots or less could be easily achieved after coming onto the range.

There was ample width provided at the turn for the tanker *Jupiter* in both partly loaded and ballasted conditions. It is especially useful to have the added width near buoy "9" to enable the inbound loaded tanker to commence the turn earlier. Currently this turn requires that a tug put a line up to assist with the turn and to help in checking the turn in the Approach Channel Reach. Weather conditions often make this difficult if not impossible.

When the tanker was outbound in ballast, the widener enabled the vessel to remain close to the windward side of the channel without the risk of the stern tracking along the outside channel boundary. The widener at the turn will benefit high-windage vessels in southerly winds above 15 knots, both inbound and outbound.

6.2.2 Increased Channel Width to 500 Feet from the Jetty to West Basin

The dredging on the north side to the Middle Basin, and on the south side from Middle Basin to West Basin provides ample width, enabling large ships to be maneuvered at slower, safer speeds.

The increased channel width reduces hydraulic effects generated by deep-draft vessels that result in surging of vessels moored along the waterway. The width also provides for an increase in the safe passing distance from vessels at berth. The 500-foot wide channel enables the transiting vessel to carry a crab angle of up to 5° with strong winds. For the *Genesis* class vessel this effectively increases the ship's beam to over 250 feet, while providing adequate clearance distance for both the bow and stern.

The dredged area on the north side from the jetty to Middle Basin provides a greater safety margin for vessels that will be able to stay further to the right of the centerline when inbound due to the additional width. This added width enables the pilot to provide the additional clearance needed from the vessels moored on the south side berths at CT2 to CT4 to minimize or eliminate surging effects, and enables the vessel to transit at a reduced speed, enhancing this result.

Dredging the West Access Channel's south side, from the Tanker Berth to just opposite the entrance to West Basin, provides the additional room needed for the *Genesis* to swing its stern as it enters the basin. This becomes necessary as the vessel tracks to the left of the centerline just before the basin entry point on inbound transits in order to maintain appropriate clearance to vessels berthed at NCP3 or NCP4. On departures from West Basin the widener on the south side of the channel enables cruise ships to maneuver toward the south side of the channel in strong southerly winds, again to pass any ships moored at NCP3/4 at a distance that will minimize surge effects.

6.2.3 Increased Depths in the Navigational Channels and Turning Basins

The 41-foot depth is adequate for most but not all conditions. A deep-draft vessel drawing 39.5 feet (the maximum allowed) cannot be guaranteed passage at all stages of the tide with a controlling depth of 41 feet. These vessels would have to transit on a rising tide only. The Canaveral Pilots Association has established a safety margin of 2.5 feet under the keel, but UKC of only 1.5 feet is available. The further increase in draft due to ship squat must be taken into

account as well. At a speed of 5 knots for a vessel such as the tanker simulated in this study, the squat could reduce the UKC by up to 1.5 feet. Furthermore, the overdredge amount (2 feet) cannot be assured. At low water, and the occasional negative tide, the UKC for a vessel drawing 39.5 feet will be minimal or none at all with squat. One of the pilots' recommendations (see section 6.2.7) is that dredging to 42 feet as the controlling depth, should be considered for the inner channel, and for those basins that support deep-draft vessels.

A controlling depth of 41 feet will require tide restrictions for those ships arriving with draft of 38 feet or more. Under existing conditions, vessels with a draft of 36+ feet are required to take 3 tugs and to time the inbound transit for high water. These restrictions will simply be adjusted upwards for the increased depth in order to maintain the adequate UKC during transit.

6.2.4 Middle Basin

All respondents were in agreement that the Middle Basin as it exists is adequate for turning around a large bulk carrier or tanker. Vessels berthing at the Tanker Berth on the south side of the channel, or at NCP4 may use the mouth of the Middle Basin to turn around before docking. Vessels berthed "bow in" at NCP3 or NCP4 may opt to turn in the West Basin or in the Middle Basin before proceeding to sea.

6.2.5 West Basin

Because of the extreme dimensions of the *Genesis* class ship, it is necessary to implement the proposed dredge plan to support the transit of this vessel to and from the West Basin under possible adverse wind conditions. The excavation and dredging of the southeast corner of the West Basin is highly recommended because it enables the pilot to turn sooner into the basin with high winds present. Without this additional maneuvering room, it would be necessary to refrain from turning the vessel too soon because of the effect of the strong north wind when turning into the basin as it now exists. The extra room provided also enables the large vessel to turn around in a strong northerly wind keep its stern well away from vessels, marinas and ramps that are situated along the south sea wall opposite the basin. This additional width provided at the mouth of the basin also provides the needed room to take way off the vessel when combating high winds.

The wider entry to the basin allows the large passenger cruise ship to be positioned further to the south in strong southeasterly winds, and to remain well clear of other vessels in the West Basin while turning around. This is expected to be the choice of many cruise ship captains. A scenario can be envisioned where a *Genesis* class vessel can be turned 180° in the 1750+ feet wide entry to the West Basin in a strong southerly wind in excess of 30 knots, and then be allowed to drift sideways, downwind to the north, to a position from which it can be backed into the berth at CT9/10.

The dredged and excavated area on the southeast corner of the West Basin should also help to alleviate some of the hydraulic effects produced by large vessels in the channel, which have the potential to cause severe surging effects. Vessels berthed in the Rinker Dock (NCP4) are particularly susceptible to these surging effects.

The angled bulkhead on the east side of the basin is expected to provide berths for large vessels in the future. The additional width in the basin that would result from this dredging/excavation plan in the West Basin means that adequate room to turn large vessels of the length of the *Genesis* will also maintain adequate clearance from vessels berthed on the east side when these new berths are created.

6.2.6 General Benefits of the Widening and Deepening Plan

All of the subjects were in complete agreement that a significant increase in the margin of safety with respect to the operation of very large passenger cruise ships will result if the improvements to the channel and turning basin that were examined in this study are implemented. Channel widening to 500 feet will be adequate for the *Genesis* class and vessels of similar size (up to 1200 feet LOA).

The new channel width could enable two-traffic to be permitted in some areas of the channel, not with the passage of the largest cruise ships however, but with smaller vessels that operate at Port Canaveral. The additional width provided by reconfiguring and dredging the turn in the entrance channel may provide an "escape plan" for some vessels in the event of an emergency (steering or engine casualty for example). The extra width may allow smaller inbound vessels to be turned around before reaching the inner channel, upon departure.

The depth of water in the channel and basins will be adequate to support operation of these passenger vessels at all stages of the tide when squat is included in the calculation of draft. The increased controlling depth will enable vessels drawing more than 36 feet, such as tankers and bulk carriers, to transit the harbor 24/7 without tide restrictions, thereby improving port efficiency. NOTE: This is an open-ended comment. As discussed in section 6.2.3 above, the maximum draft that could be supported at low tide may be only 38.5 feet with the safety factor of 2.5 feet of UKC included. "Squat" must be considered as well due to the ship's speed.

Port Canaveral enjoys a high level of passenger ship traffic, and passenger ships are generally given priority over other commercial traffic. There are often periods of two to four days when the high tide coincides with the arrival or departure of cruise ships, and for this reason "tide jobs" which restrict the movement of deep-draft commercial vessels should be eliminated. Deep-draft vessels waiting for the high tide to proceed to berth incur delays at anchor, and further delays occur when passenger ship sailings prevent such movements. In addition to port congestion, this may result in loss of business as ships divert from Port Canaveral to avoid such delays.

6.2.7 Recommendations

It is strongly recommended that the channel improvements that were examined by this simulation study be implemented. Besides enhancing the operational safety for the largest of cruise ships, the proposed improvements will help to reduce port congestion by enabling deep-draft vessels to transit at nearly any stage of the tide, and by permitting two-way traffic for medium-sized vessels under certain circumstances.

Other recommendations include:

1. Modified Dredge Plan – Consider dredging to a uniform depth of 43 feet. This would

accommodate the standard UKC of 2.5 feet permitting a vessel at the maximum draft of 39.5 feet to transit at any stage of the tide, except unusually low tides. Should the tanker terminal be developed in the Middle Basin, the issue of vessels transiting the port drawing the maximum permitted draft at all stages of the tide will become a major one.

2. Outbound Centerline Range – In the simulation the STAR Center presented an outbound centerline range for the channel. It is recommended that a channel range be provide for vessels transiting outbound from the port.

3. As in simulation, reposition the existing inbound range to indicate the center of the new 500 foot inner channel.

SHIP PARTICULARS AZI / AZIMUTHING POD

SHIP NAME GENESIS *FILE NAME* CR186DE

SHIP TYPE cruise *LOAD COND* DESIGN

TONNAGE 103,252 *DWT* *DISPL* X *GRT* *Aero:* 15290

EYEBOW: 51 167 *Ft.* *Height Eye* 36 117 *Ft.* *EYESTERN:* 310.5 018 *Ft.*

Air Draft 57 186 *Ft.* *BEAM Bridge Wing* 53 173.8 *Ft.*
(If Wider than Beam)

LOA	361.5	1,185.7 *Ft.*	*Draft*		
LBP	330.0	1,082.4 *Ft.*	*FWD*	9.2	30.2 *Ft.*
W/L BEAM	47.0	154.2 *Ft.*	*AFT*	9.2	30.2 *Ft.*

PROPULSION DIESEL

AZIPOD NO. 3 *SHAFT HP* 26,820 *EACH*

PROPELLER DIRECTION inwar *TYPE* *FIXED* X *VARIABLE*

BOW THRUSTERS 4 *HP* 7,376 *EACH*

Shaft RPM and Speed

MANEUVERING

MAX_RPM 136 MIN_RPM: Max Speed: 24.7

Lever Position		RPM	Speed Shallow	Speed Deep
8	FULL AHD:	127	21	14
5	HALF AHD:	64	12	13
3	SLOW AHD:	34	6	7
1	DSLOW AHD	18	4	4
8	FULL ASTN	105	13	14
5	HALF ASTN	64	9	9
3	SLOW ASTN	33	5	5
1	DSLOW ASTN	16	3	3

Conventional Pilot Card

SHIP NAME JUPITER

SHIP TYPE tanker

FILE NAME TK110PD

LOAD COND Partly Loaded

TONNAGE 97,200 DWT DISPL X GRT

EYEBOW: 199 654 Ft. Height Eye 22 72 Ft. EYESTERN: 45 146 Ft.

Air Draft 31 100 Ft

BEAM Bridge Wing 0 0 Ft
(If Wider than Beam)

Aero: 2389

LOA	244.0	800.3 Ft.	Draft		
LBP	229.5	752.8 Ft.	FWD	12	39.4 Ft.
BEAM	42.0	137.8 Ft.	AFT	12	39.4 Ft.

PROPULSION Diesel

PROPELLERS 1 TYPE FIXED X VARIABLE

PROPELLER DIRECTION CW SHAFT HP 19,713 EACH

BOW THRUSTERS HP EACH

STERN THRUSTERS HP EACH

NO RUDDERS 1 RUDDER TYPE Normal

MAX_RUDDER 35

Shaft RPM and Speed

MANEUVERING

MAX_RPM 105 MIN_RPM: *Max Speed:* 15.6

Lever Position		RPM	Pitch	Speed SH	Speed DP
8	FULL AHD:	87		13.2	
5	HALF AHD:	70		10.6	
3	SLOW AHD:	53		7.9	
1	DSLOW AHD	34		5	
8	FULL ASTN	87			
5	HALF ASTN	70			
3	SLOW ASTN	53			
1	DSLOW ASTN	34			

Conventional Pilot Card

SHIP NAME JUPITER

SHIP TYPE tanker

FILE NAME Tk110BD

LOAD COND Ballasted

TONNAGE 54,260 DWT DISPL X GRT

EYEBOW: 199 653 Ft. Height Eye 22 72 Ft. EYESTERN: 45 148 Ft.

Air Draft 31 100 Ft

BEAM Bridge Wing 0 0 Ft
(If Wider than Beam)

Aero: 3548

LOA	244.0	800.3 Ft.	Draft		
LBP	229.5	752.8 Ft.	FWD	5.7	18.7 Ft.
BEAM	42.0	137.8 Ft.	AFT	8.3	27.2 Ft.

PROPULSION Diesel

PROPELLERS 1 TYPE FIXED X VARIABLE

PROPELLER DIRECTION CW SHAFT HP 19,713 EACH

BOW THRUSTERS HP EACH

STERN THRUSTERS HP EACH

NO RUDDERS 1 RUDDER TYPE Normal

MAX_RUDDER 35

Shaft RPM and Speed

MANEUVERING

MAX_RPM 105 MIN_RPM: *Max Speed:* 17.4

	Lever Position	RPM	Pitch	Speed SH	Speed DP
8	FULL AHD:	87			15
5	HALF AHD:	70			12
3	SLOW AHD:	53			9
1	DSLOW AHD	34			5
8	FULL ASTN	87			
5	HALF ASTN	70			
3	SLOW ASTN	53			
1	DSLOW ASTN	34			

Run Matrix

The contributing factor for the run matrix were one future plan of Port Canaveral to be tested, transit direction, two test vessels are to represent size of vessels in the future , two wind directions are to represent prevailing winter and summer conditions, wind speed to replicate realistic winds velocities, current replicates prevailing and counter current at entrance channel.

Run #	Scenario	Ship	irection	ind	Current	Start	End	Remarks
	1	Genesis	Inbound	0 kts	0 kts	Buoys 7&8	CT 9	Familiarization
	2	enesis D	Inbound	W NW 15kts	N 0.3kts	Buoys 7&8	CT 9	
	3	Genesis	Inbound	NW 25kts	S 0.3kts	Buoys 7&8	CT 9	
	4 G	Genesis	Inbound	SE 15kts	S 0.3kts	Buoys 7&8	CT 9	
	5	Genesis	Inbound	SE 25kts	N 0.3kts	Buoys 7&8	CT 9	
	6	Genesis	Outbound	NW 25kts	S 0.3kts	West TB	Buoys 7&8	
	7	enesis	Outbound	SE 25kts	N 0.3kts	West TB	Buoys 7&8	

Berth occupancy – G
Cruise vessel 216.3m x 28.4m at CT4, Cruise vessel 152m x 23.1m, Reefer 106.7m x 16.8m at SCP2
Tanker 244m x 42m at Tanker berth 1&2, bulker 234m x 32.2m at NCP3 and NCP4

Run #	Scenario	Ship	irection	ind	Current	Start	End	Remarks
	8	Tanker / Ld	Inbound	0 kts	0 kts	Buoys 7&8	TB 1	Familiarization
	9	Tanker / Ld	Inbound	W NW 15kts	N 0.3kts	Buoys 7&8	TB 1	
	10	Tanker / Ld	Inbound	NW 20/25kts	S 0.3kts	Buoys 7&8	TB 1	
	11	Tanker / Ld	Inbound	SE 15kts	S 0.3kts	Buoys 7&8	NCP 3	
	12	Tanker / Ld	Inbound	SE 20/25kts	N 0.3kts	Buoys 7&8	NCP 3	
	13	Tanker / Bal	Outbound	NW 20/25kts	S 0.3kts	NCP4	Buoys 7&8	
	14	Tanker / Bal	Outbound	SE 20/25kts	N 0.3kts	NCP4	Buoys 7&8	

Berth occupancy -
Cruise vessel 216.3m x 28.4m at CT4, Cruise vessel 152m x 23.1m, Reefer 106.7m x 16.8m at SCP2
Tanker 244m x 42m at Tanker berth 1&2, bulker 234m x 32.2m at NCP3

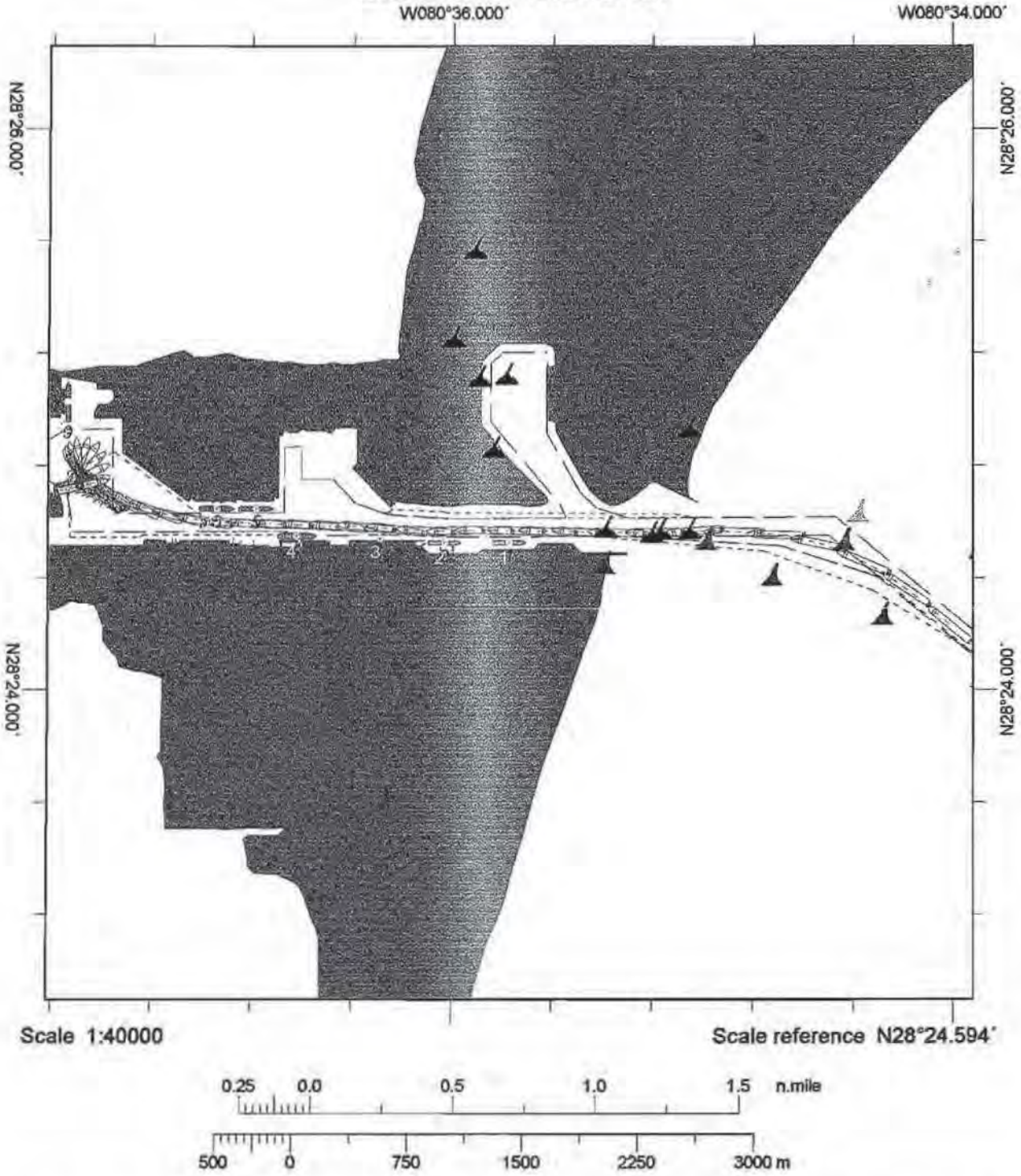
Port Canaveral Channel Improvement Study

Exercise Run History

RUN #	SCENARIO	SHIP	WIND (kn)	CURRENT (kn)	DIRECTION	START	END	REMARKS
1	**1**	GENESIS	one	one	nbound	Buoys 7&8	CT 9/10	Familiarization 03/03/07
2	**2**	GENESIS	NW 15	N 0.3	Inbound	Buoys 7&8	CT 9/10	
3	**3**	GENESIS	NW 25	S 0.3	Inbound	Buoys 7&8	CT 9/10	
4	**4**	GENESIS	SE 15	S 0.3	Inbound	Buoys 7&8	CT 9/10	
5	**5**	GENESIS	SE 25	N 0.3	Inbound	Buoys 7&8	CT 9/10	
6	**6**	GENESIS	NW 25	S 0.3	Outbound	CT 9/10	Buoys 7&8	
7	**7**	GENESIS	SE 25	N 0.3	Outbound	CT 9/10	Buoys 7&8	Bad start - incomplete
8	**7**	GENESIS	SE 25	N 0.3	Outbound	CT 9/10	Buoys 7&8	Re-start Run 7
9	**8**	JUPITER	one	one	nbound	Buoys 7&8	TB 1	Familiarization 03/04/07 grounded at bad depth pt
10	**9**	JUPITER/L	NW 15	N 0.3	Inbound	Buoys 7&8	TB 1	
11	**10**	JUPITER/L	NW 20/25	S 0.3	Inbound	Buoys 7&8	TB 1	
12	**11**	JUPITER/L	SE 15	S 0.3	Inbound	Buoys 7&8	NCP 3	
13	**12**	JUPITER/L	SE 20/25	N 0.3	Inbound	Buoys 7&8	NCP 3	
14	**13**	JUPITER/B	NW 20/25	S 0.3	Outbound	NCP 4	Buoys 7&8	
15	**14**	JUPITER/B	SE 20/25	N 0.3	Outbound	NCP 4	Buoys 7&8	
16	**1**	GENESIS	one	one	nbound	Buoys 7&8	CT 9/10	Familiarization 03/10/07
17	**2**	GENESIS	NW 15	N 0.3	Inbound	Buoys 7&8	CT 9/10	
18	**3**	GENESIS	NW 25	S 0.3	Inbound	Buoys 7&8	CT 9/10	
19	**6**	GENESIS	NW 25	S 0.3	Outbound	CT 9/10	Buoys 7&8	
20	**4**	GENESIS	SE 15	S 0.3	Inbound	Buoys 7&8	CT 9/10	
21	**5**	GENESIS	SE 25	N 0.3	Inbound	Buoys 7&8	CT 9/10	
22	**7**	GENESIS	SE 25	N 0.3	Outbound	CT 9/10	Buoys 7&8	
23	**8**	JUPITER/L	None	one	nbound	Buoys 7&8	TB 1	Familiarization 03/11/07
24	**9**	JUPITER/L	NW 15	N 0.3	Inbound	Buoys 7&8	TB 1	
25	**10**	JUPITER/L	NW 20/25	S 0.3	Inbound	Buoys 7&8	TB 1	
26	**14**	JUPITER/B	SE 20/25	N 0.3	Outbound	NCP 4	Buoys 7&8	
27	**11**	JUPITER/L	SE 15	S 0.3	Inbound	Buoys 7&8	NCP 3	
28	**13**	JUPITER/B	NW 20/25	S 0.3	Outbound	NCP 4	Buoys 7&8	

RUN #	SCENARIO	SHIP	WIND (kn)	CURRENT (kn)	DIRECTION	START	END	REMARKS
29	**12**	JUPITER/L	SE 20/25	N 0.3	Inbound	Buoys 7&8	NCP 3	
30	**1**	GENESIS	one	one	nbound	Buoys 7&8	CT 9/10	Familiarization 03/31/07
31	**2**	GENESIS	NW 15	N 0.3	Inbound	Buoys 7&8	CT 9/10	
32	**3**	GENESIS	NW 25	S 0.3	Inbound	Buoys 7&8	CT 9/10	
33	**7**	GENESIS	SE 25	N 0.3	Outbound	CT 9/10	Buoys 7&8	
34	**4**	GENESIS	SE 15	S 0.3	Inbound	Buoys 7&8	CT 9/10	Speed too fast on entry
35	**5**	GENESIS	SE 25	N 0.3	Inbound	Buoys 7&8	CT 9/10	
36	**6**	GENESIS	NW 25	S 0.3	Outbound	CT 9/10	Buoys 7&8	
37	**8**	JUPITER/L	None	one	nbound	Buoys 7&8	TB 1	Familiarization 03/11/07
38	**9**	JUPITER/L	NW 15	N 0.3	Inbound	Buoys 7&8	TB 1	
39	**12**	JUPITER/L	SE 20/25	N 0.3	Inbound	Buoys 7&8	NCP 3	
40	**13**	JUPITER/B	NW 20/25	S 0.3	Outbound	NCP 4	Buoys 7&8	
41	**10**	JUPITER/L	NW 20/25	S 0.3	Inbound	Buoys 7&8	TB 1	
42	**11**	JUPITER/L	SE 15	S 0.3	Inbound	Buoys 7&8	NCP 3	
43	**14**	JUPITER/B	SE 20/25	N 0.3	Outbound	NCP 4	Buoys 7&8	
44	**1**	GENESIS	one	one	nbound	Buoys 7&8	CT 9/10	Familiarization 04/21/07
45	**2**	GENESIS	NW 15	N 0.3	Inbound	Buoys 7&8	CT 9/10	
46	**3**	GENESIS	NW 25	S 0.3	Inbound	Buoys 7&8	CT 9/10	
47	**6**	GENESIS	NW 25	S 0.3	Outbound	CT 9/10	Buoys 7&8	
48	**4**	GENESIS	SE 15	S 0.3	Inbound	Buoys 7&8	CT 9/10	
49	**7**	GENESIS	SE 25	N 0.3	Outbound	CT 9/10	Buoys 7&8	
50	**5**	GENESIS	SE 25	N 0.3	Inbound	Buoys 7&8	CT 9/10	
51	**8**	JUPITER/L	None	one	nbound	Buoys 7&8	TB 1	Familiarization 04/22/07
52	**9**	JUPITER/L	NW 15	N 0.3	Inbound	Buoys 7&8	TB 1	
53	**14**	JUPITER/B	SE 20/25	N 0.3	Outbound	NCP 4	Buoys 7&8	
54	**10**	JUPITER/L	NW 20/25	S 0.3	Inbound	Buoys 7&8	TB 1	
55	**11**	JUPITER/L	SE 15	S 0.3	Inbound	Buoys 7&8	NCP 3	
56	**12**	JUPITER/L	SE 20/25	N 0.3	Inbound	Buoys 7&8	NCP 3	
57	**13**	JUPITER/B	NW 20/25	S 0.3	Outbound	NCP 4	Buoys 7&8	

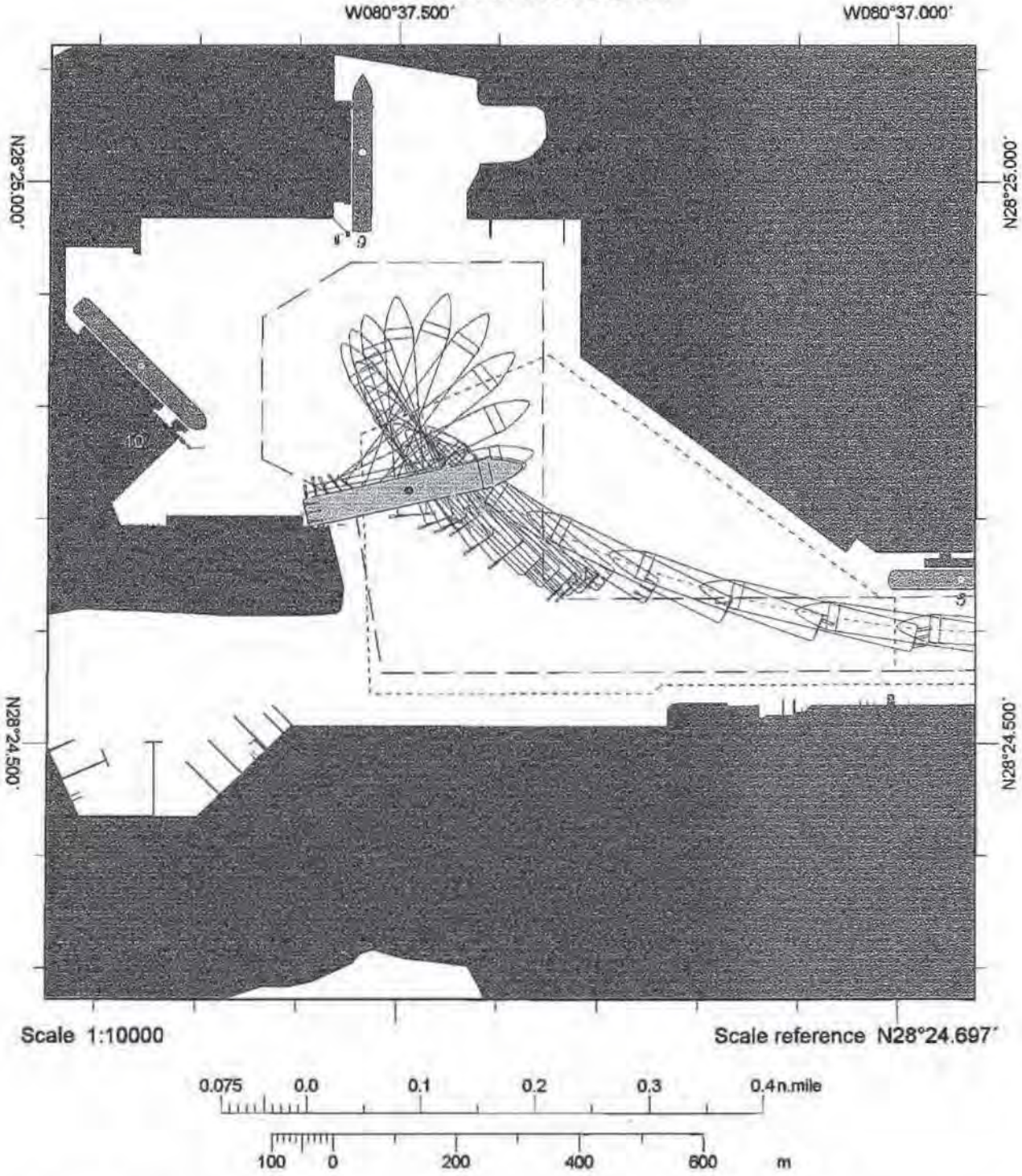
Canaveral Research



Comments: Wind: 0
Current: 0

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

Canaveral Research

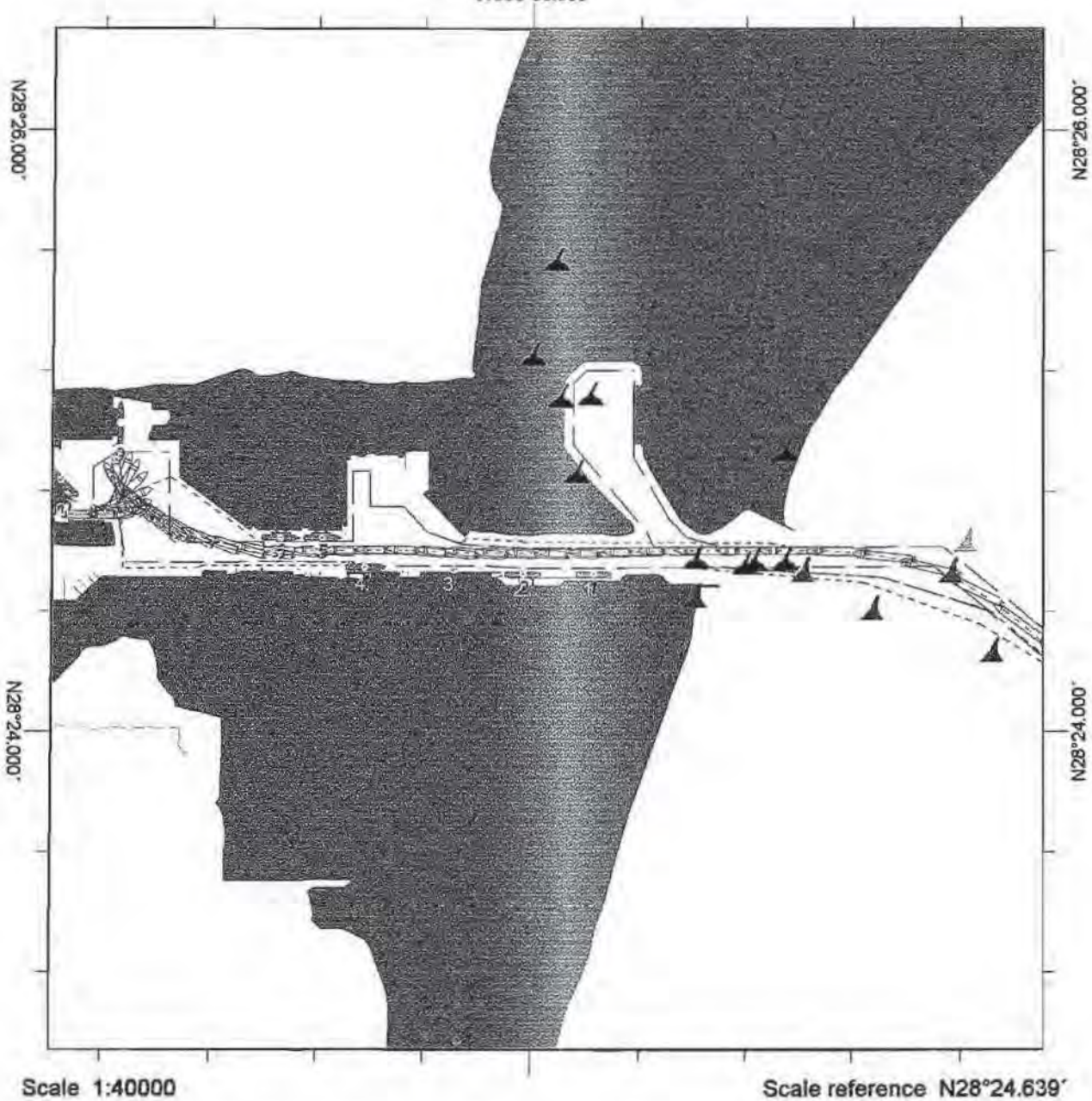


Comments: Wind: 0
Current: 0

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

Canaveral Research

W080°36.000'



Scale 1:40000

Scale reference N28°24.639'

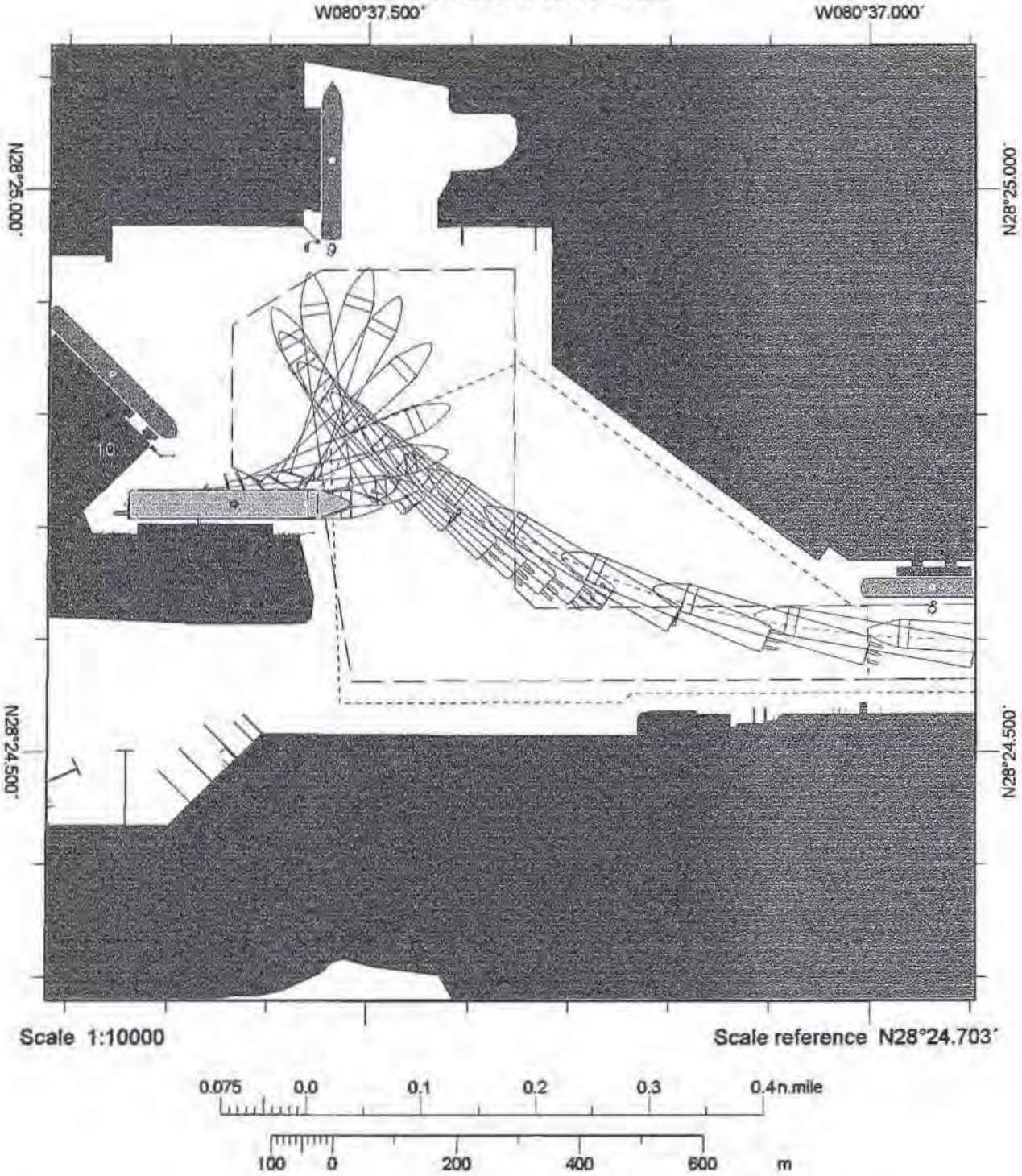
0.25 0.0 0.5 1.0 1.5 n.mile

500 0 750 1500 2250 3000 m

Comments: Wind: NW 15kt
Current: N0.75

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

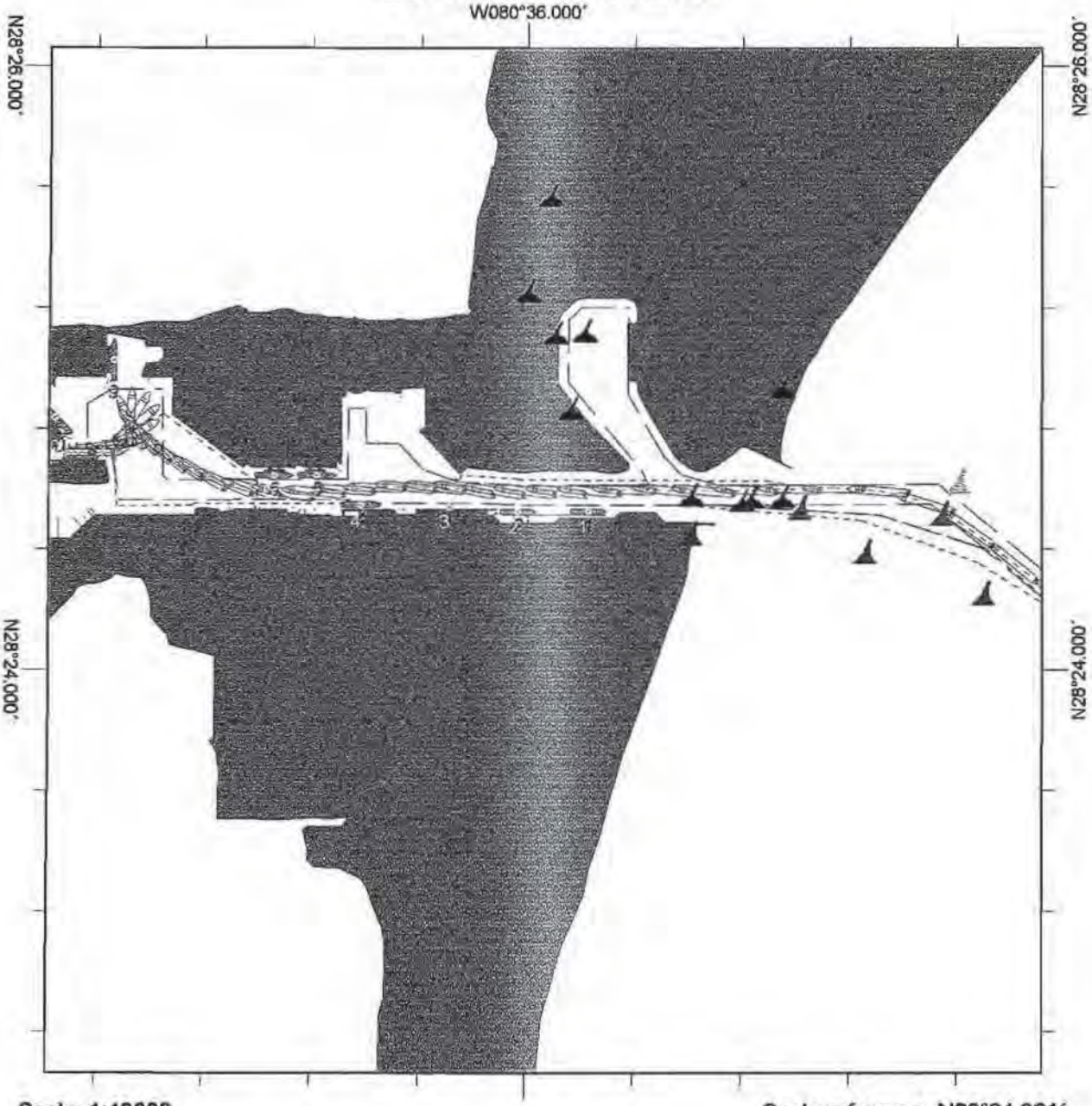
Canaveral Research



Comments: Wind: NW 15kt
Current: N0.75

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

Canaveral Research



Scale 1:40000

Scale reference N28°24.361'

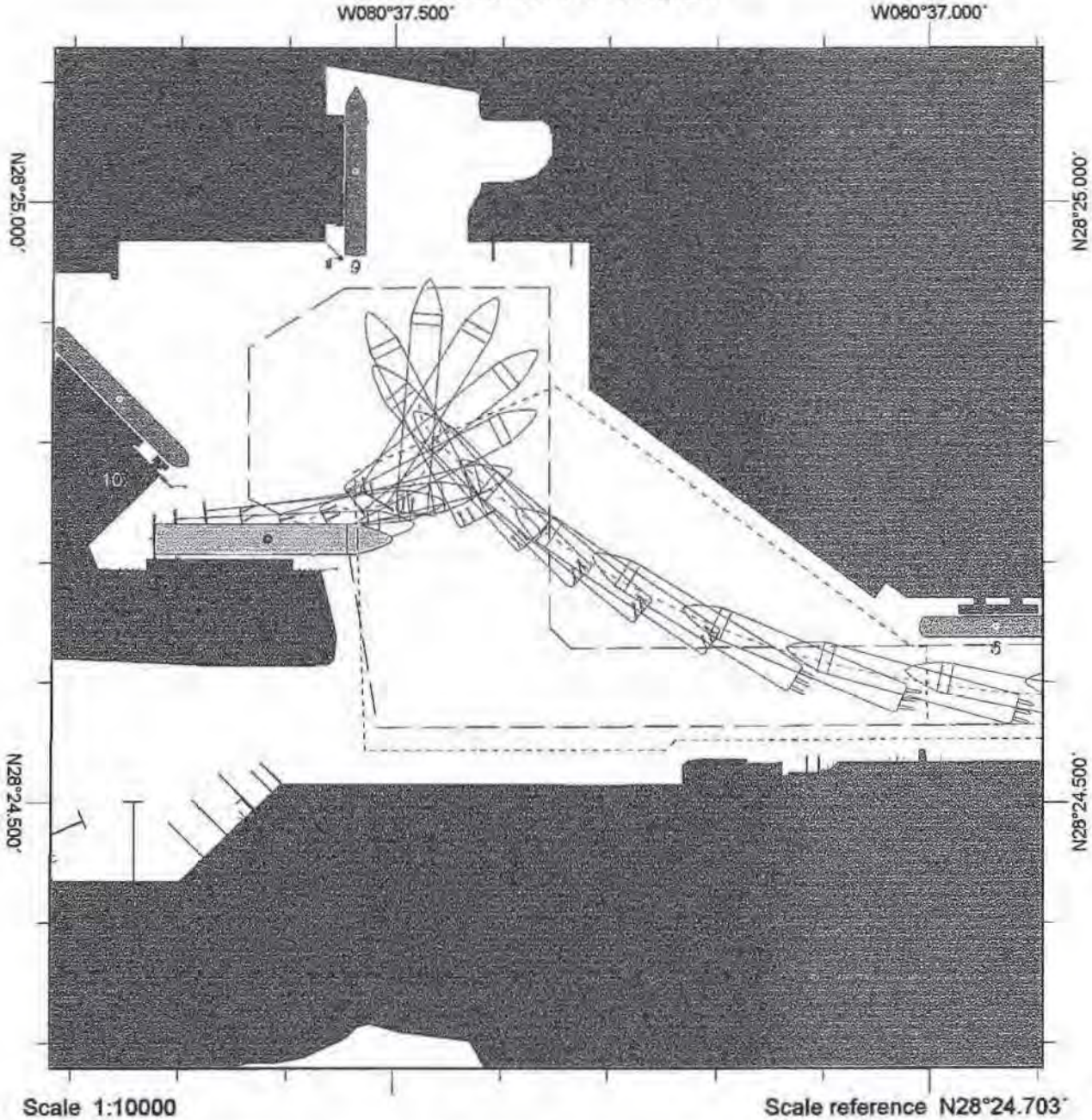
0.25 0.0 0.5 1.0 1.5 n.mile

500 0 750 1500 2250 3000 m

Comments: Wind: NW 25kt
Current: S 0.75

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

Canaveral Research



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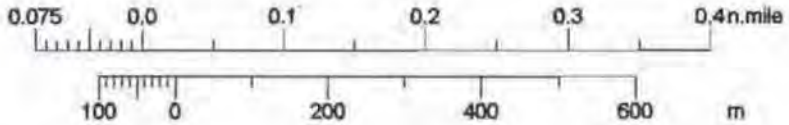
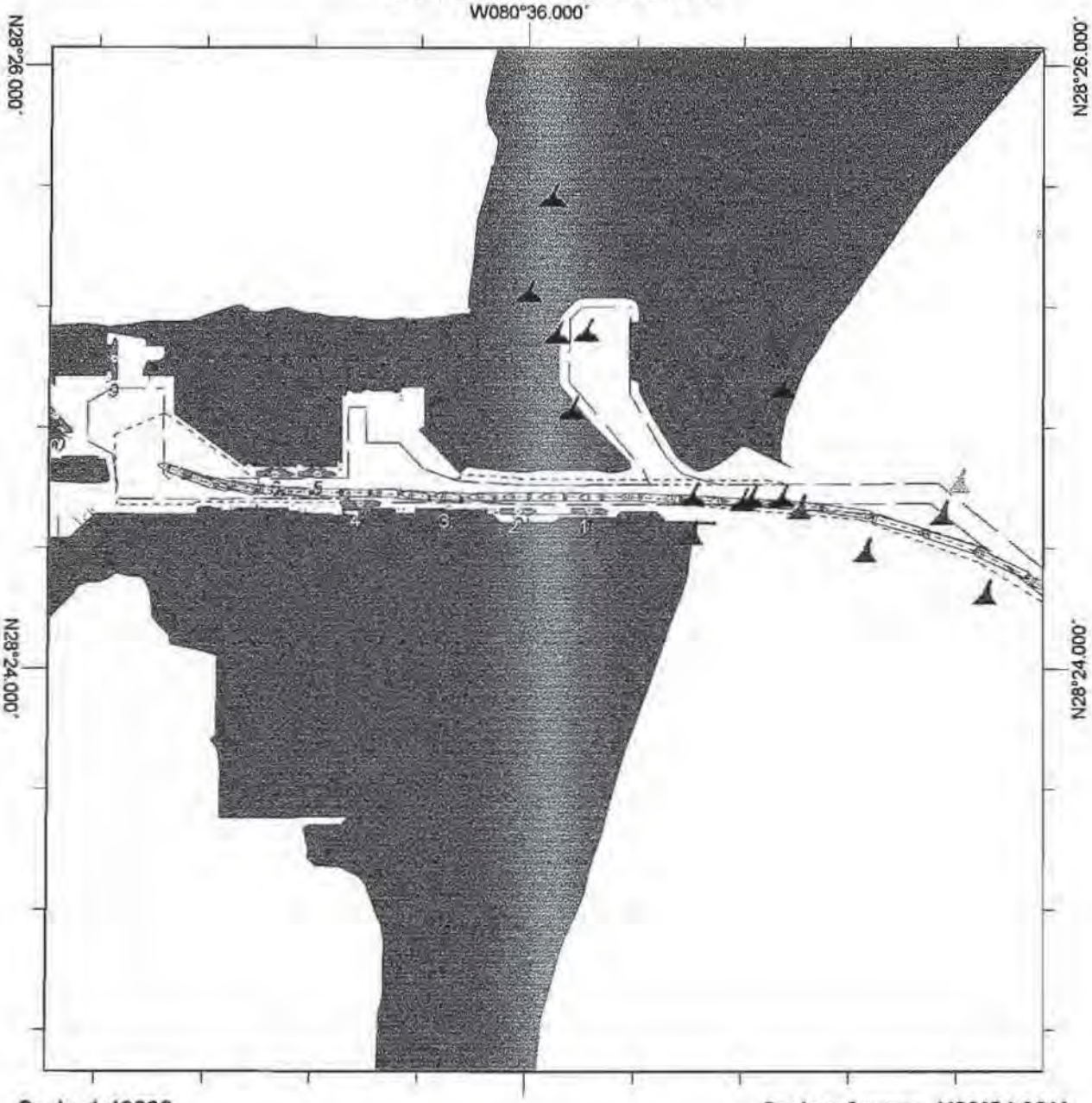
Scale reference N28°24.703'



Comments: Wind: NW 25kt
Current: S 0.75

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

Canaveral Research



Scale 1:40000

Scale reference N28°24.361'

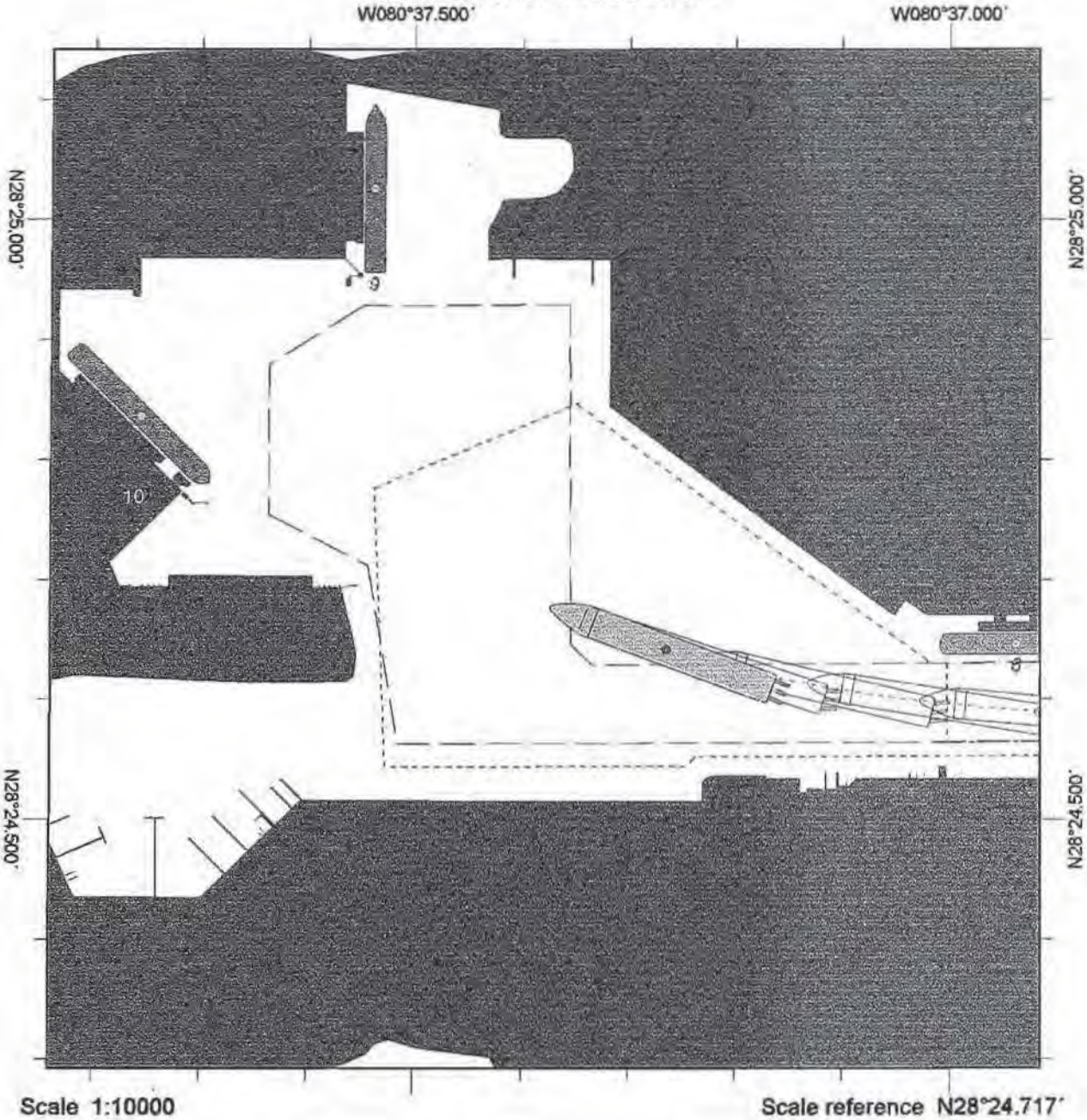
0.25 0.0 0.5 1.0 1.5 n.mile

500 0 750 1500 2250 3000 m

Comments: Wind: SE 15kt
Current: S 0.75

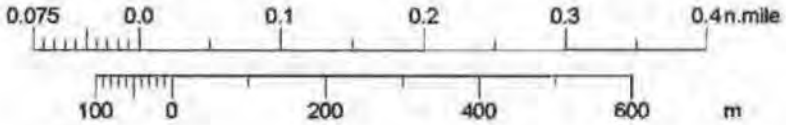
Line sample period (s)	30
Course marker every	N/A
Heading marker period (s)	60
Shape outline every	01:00

Canaveral Research



Scale 1:10000

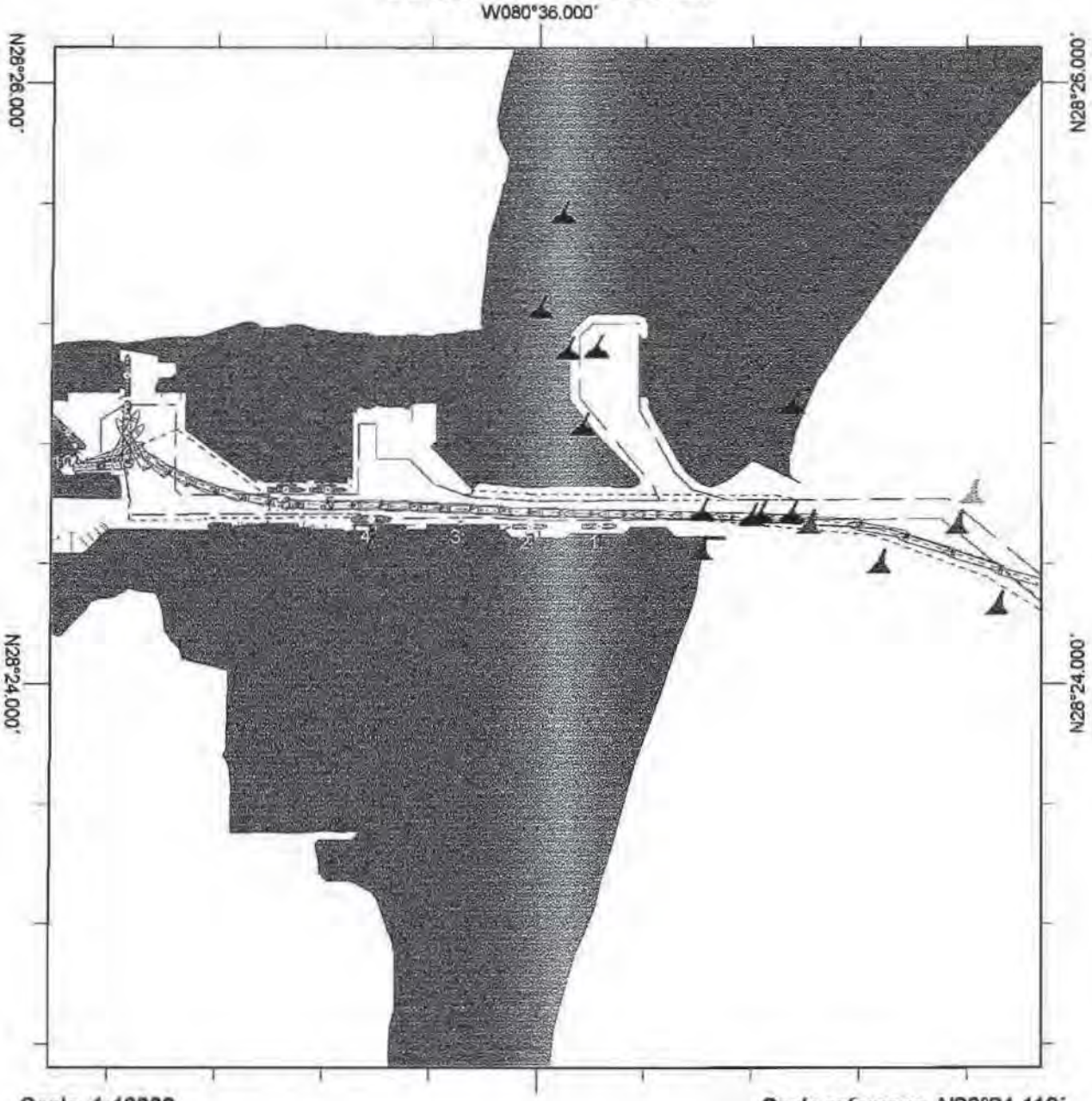
Scale reference N28°24.717'



Comments: Wind: SE 15kt
Current: S 0.75

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

Canaveral Research



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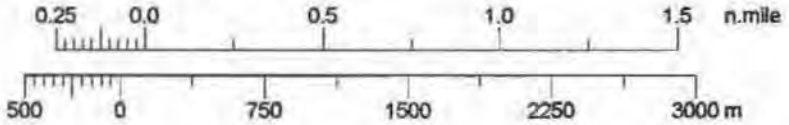
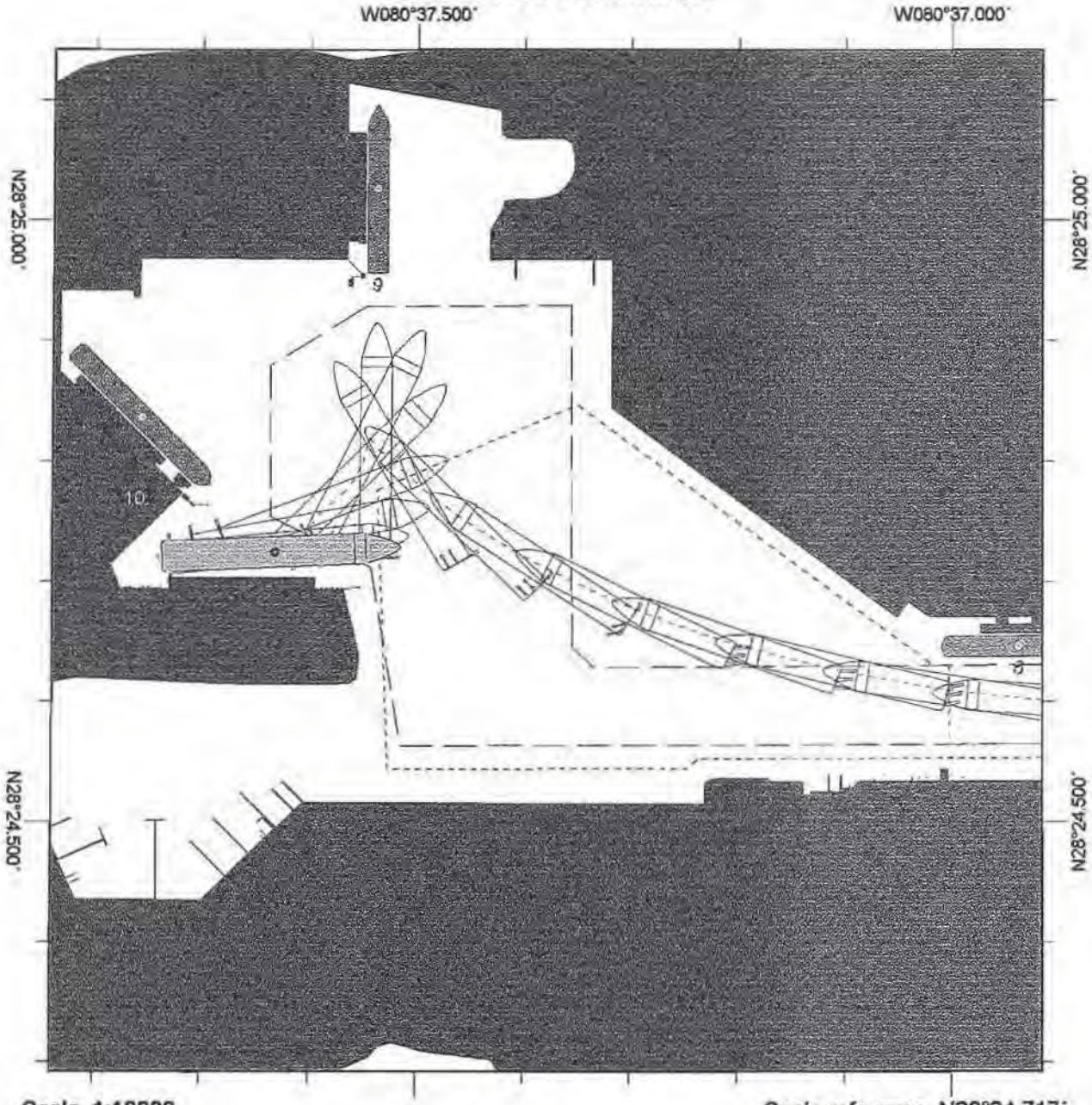
Scale reference N28°24.419'



Comments: Wind: SE 25kt
Current: N 0.75

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

Canaveral Research



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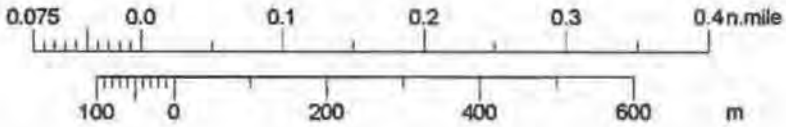
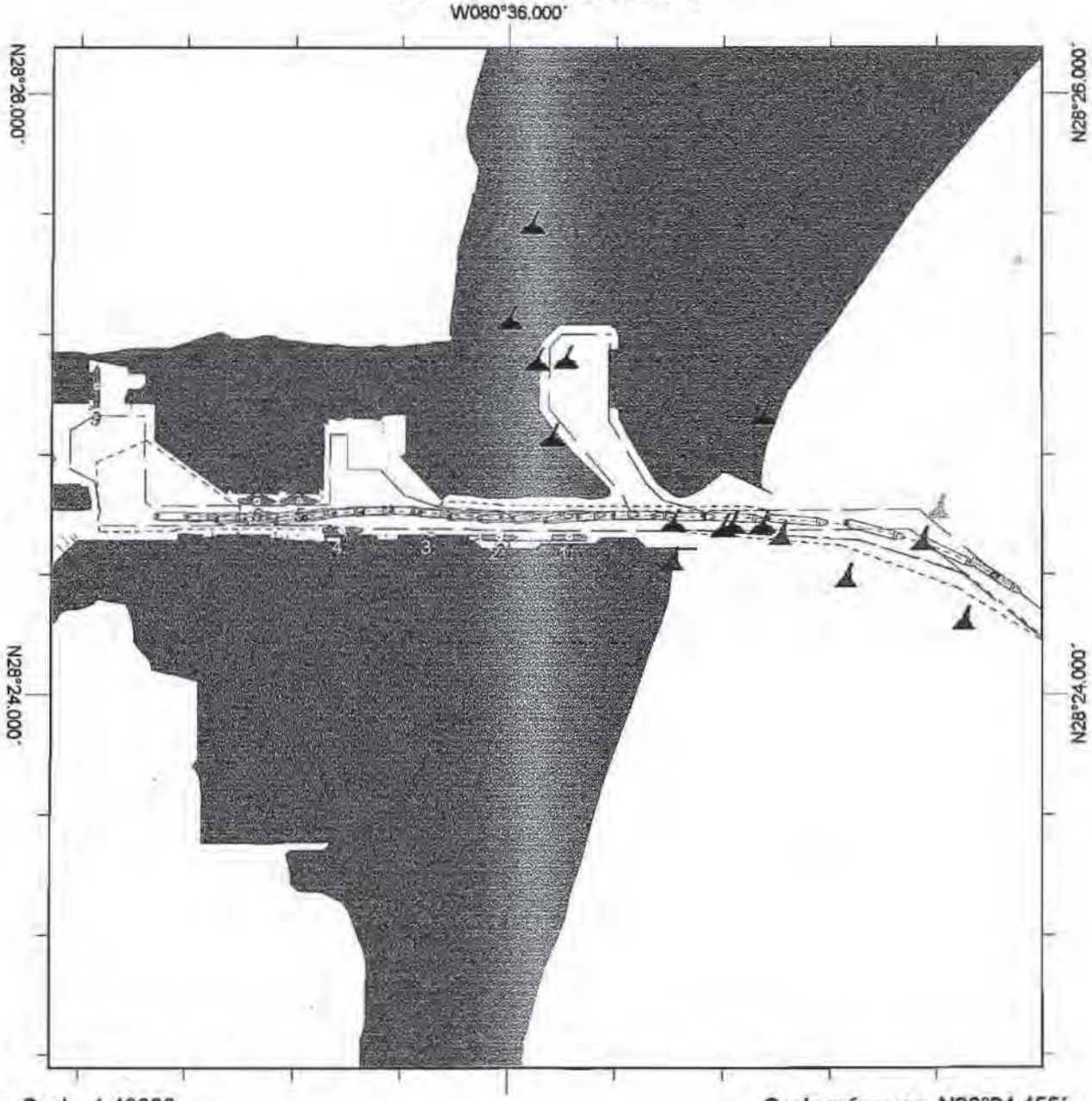


Comments: Wind: SE 25kt
Current: N 0.75

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

Canaveral Research



Scale 1:40000

Scale reference N28°24.455'

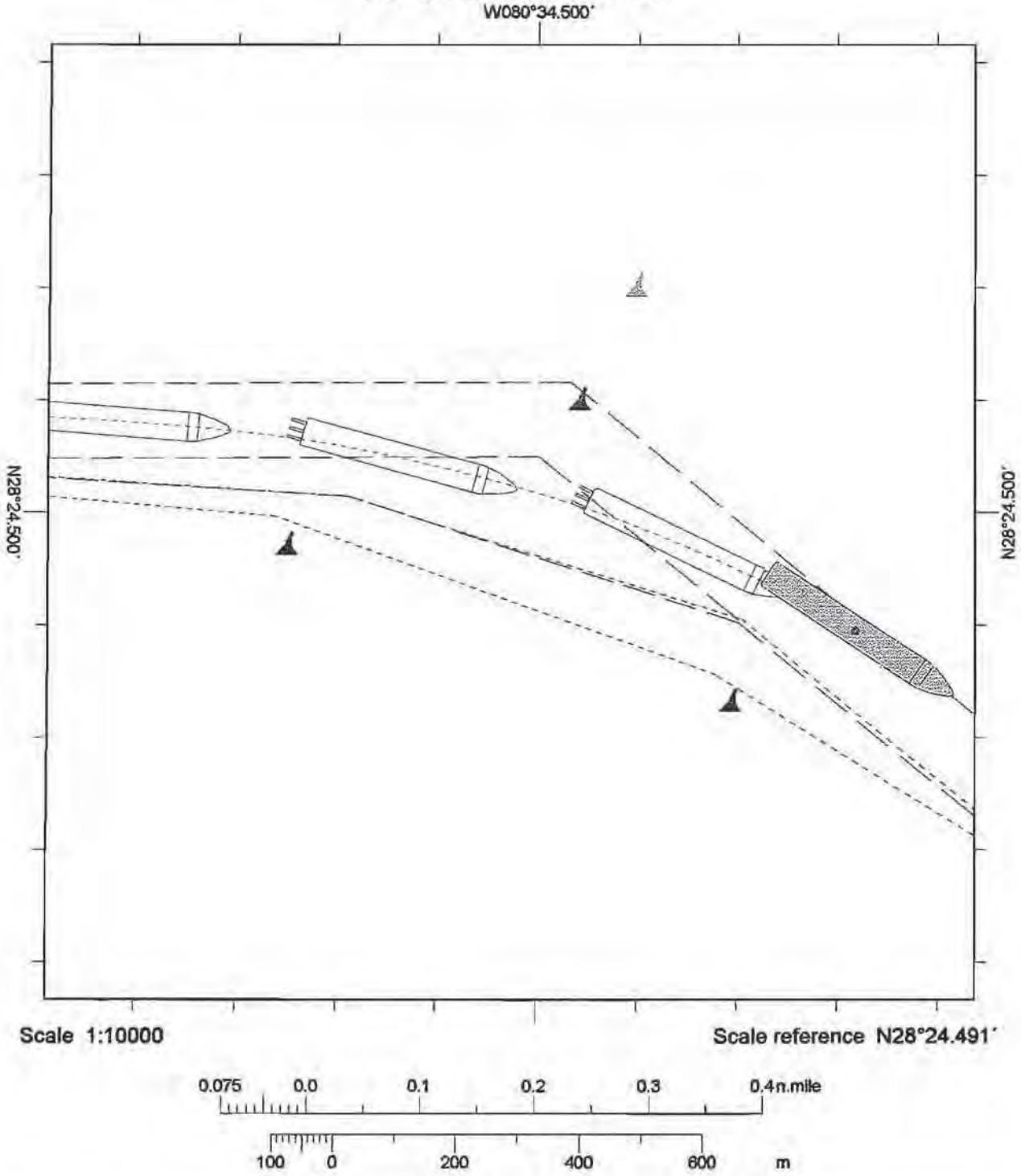
0.25 0.0 0.5 1.0 1.5 n.mile

500 0 750 1500 2250 3000 m

Comments: Wind: NW 25kt
Current: S 0.75

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

Canaveral Research

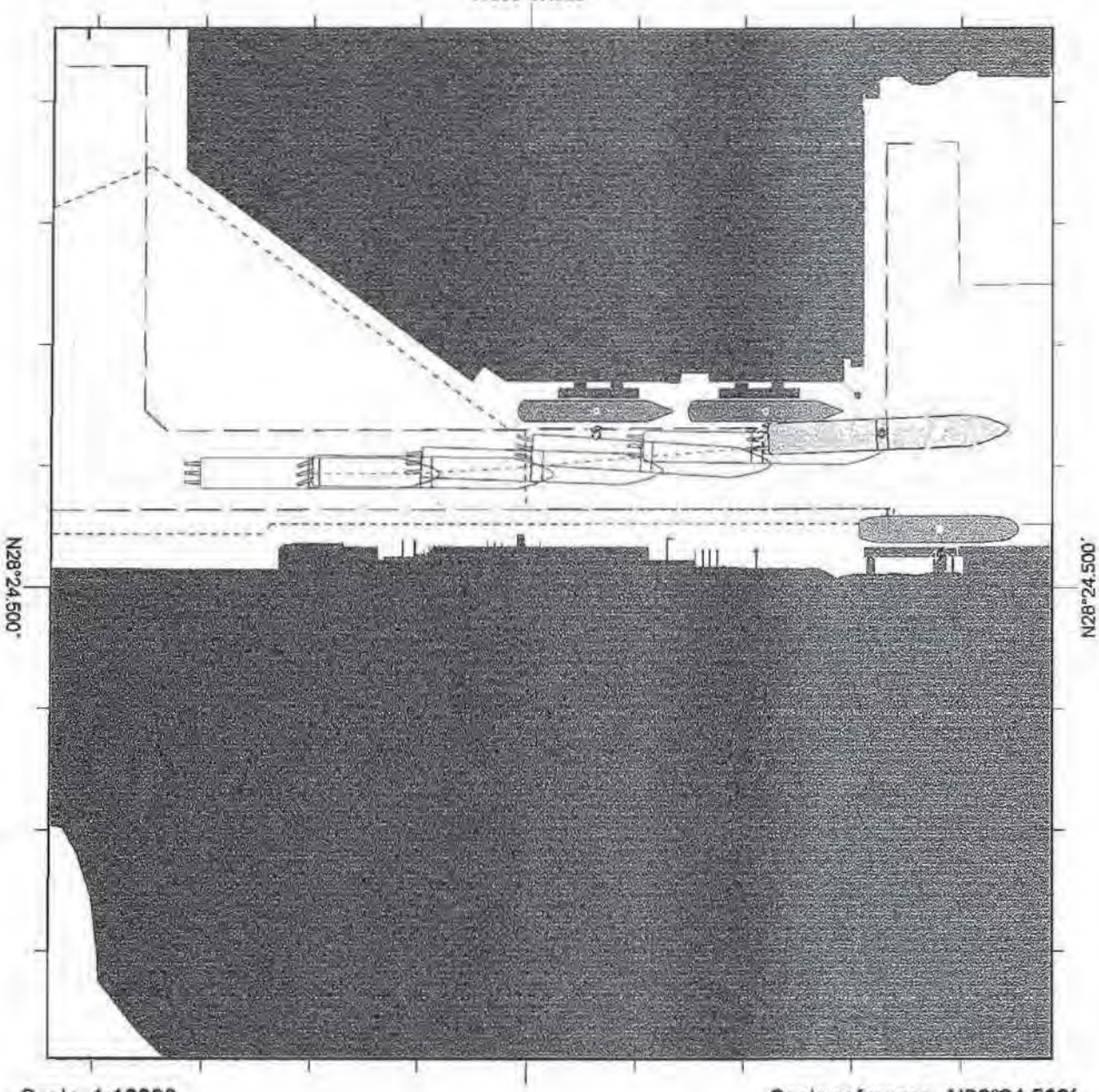


Comments: Wind: NW 25kt
Current: S 0.75

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

Canaveral Research

W080°37.000'



Scale 1:10000

Scale reference N28°24.536'

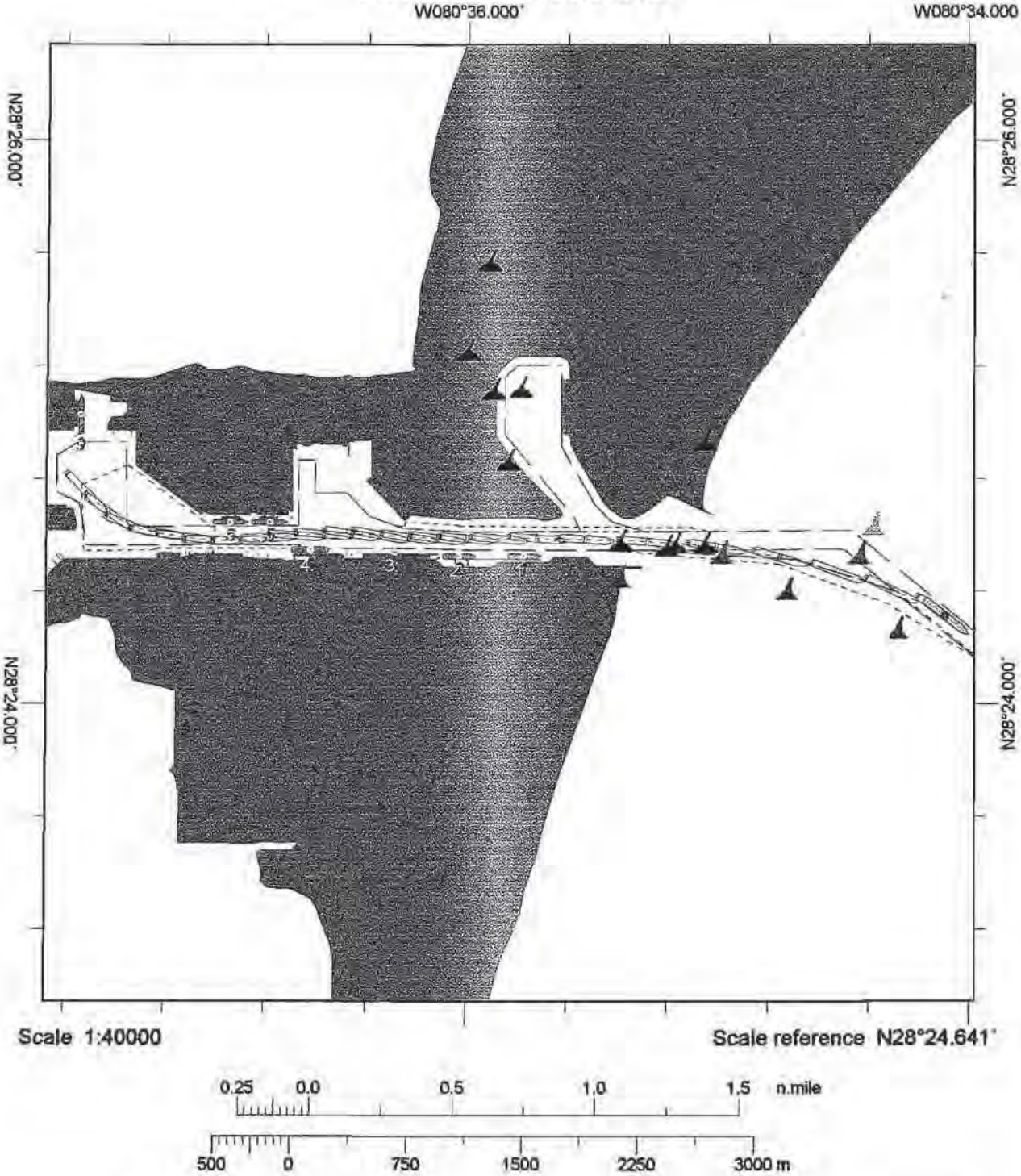
0.075 0.0 0.1 0.2 0.3 0.4 n.mile

100 0 200 400 600 m

Comments: Wind: SE 25kt
Current: N 0.75

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

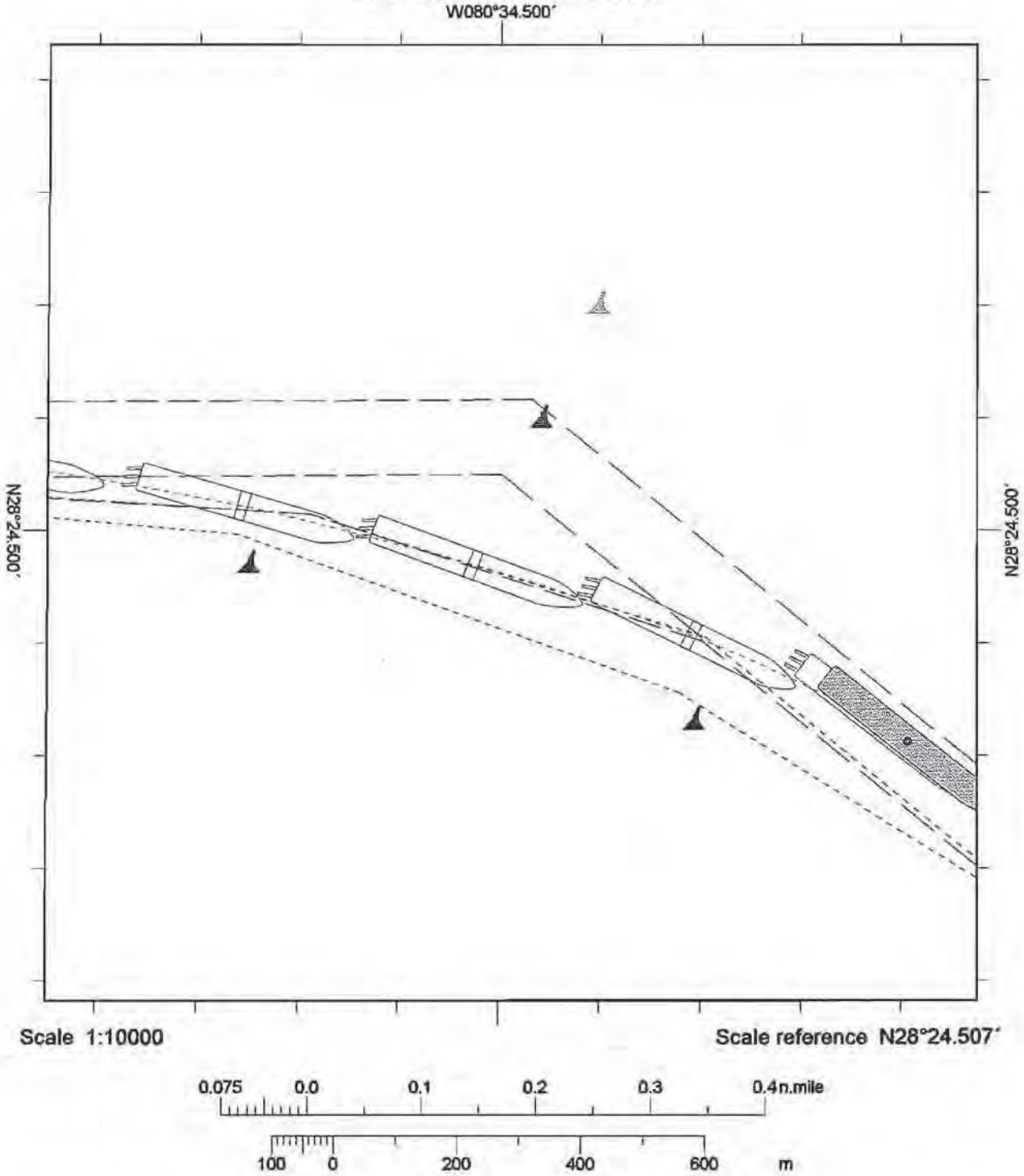
Canaveral Research



Comments: Wind: SE 25kt
Current: N 0.75

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

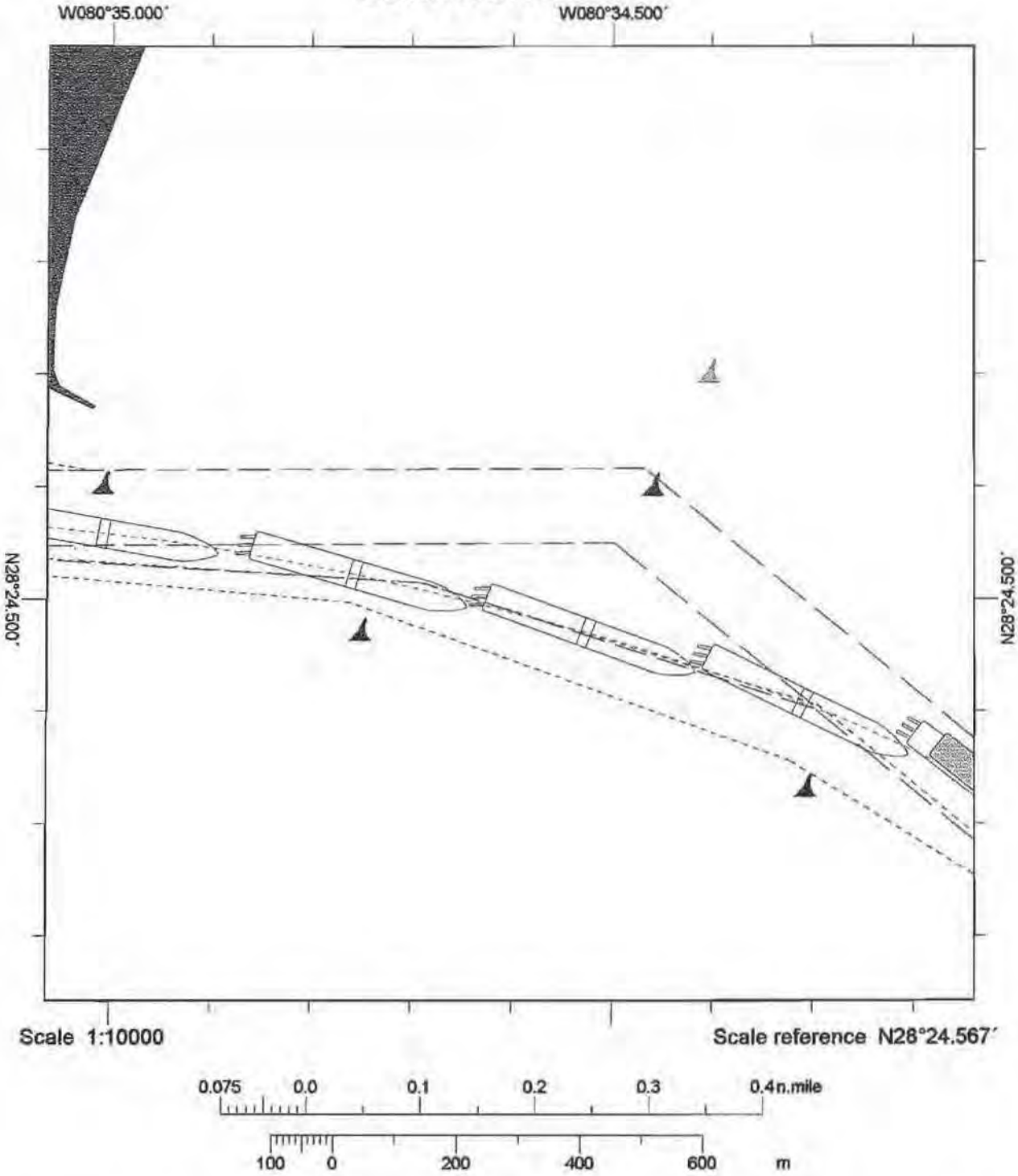
Canaveral Research



Comments: Wind: SE 25kt
Current: N 0.75

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

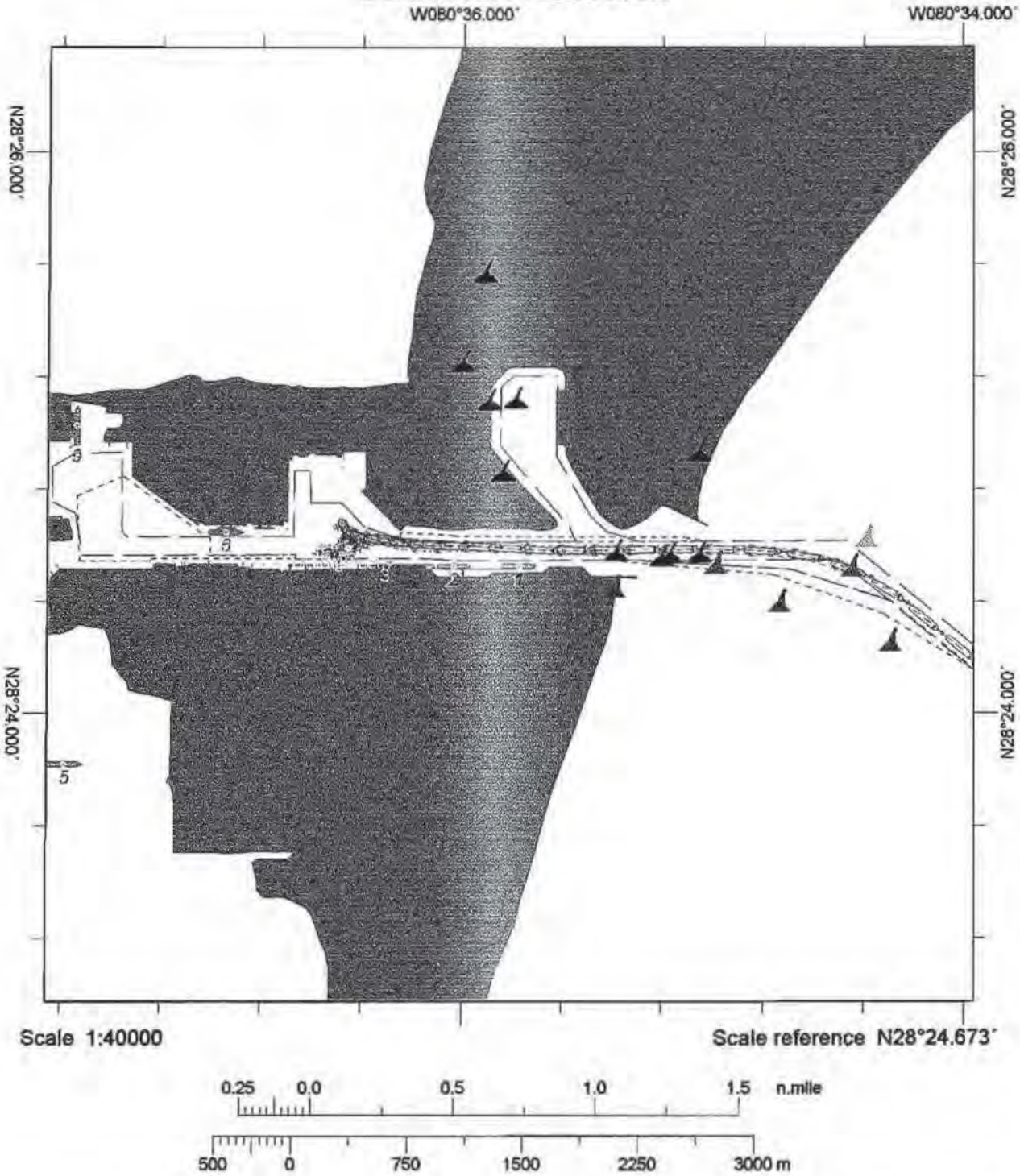
Canaveral Research



Comments: Wind: SE 25kt
Current: N 0.75

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

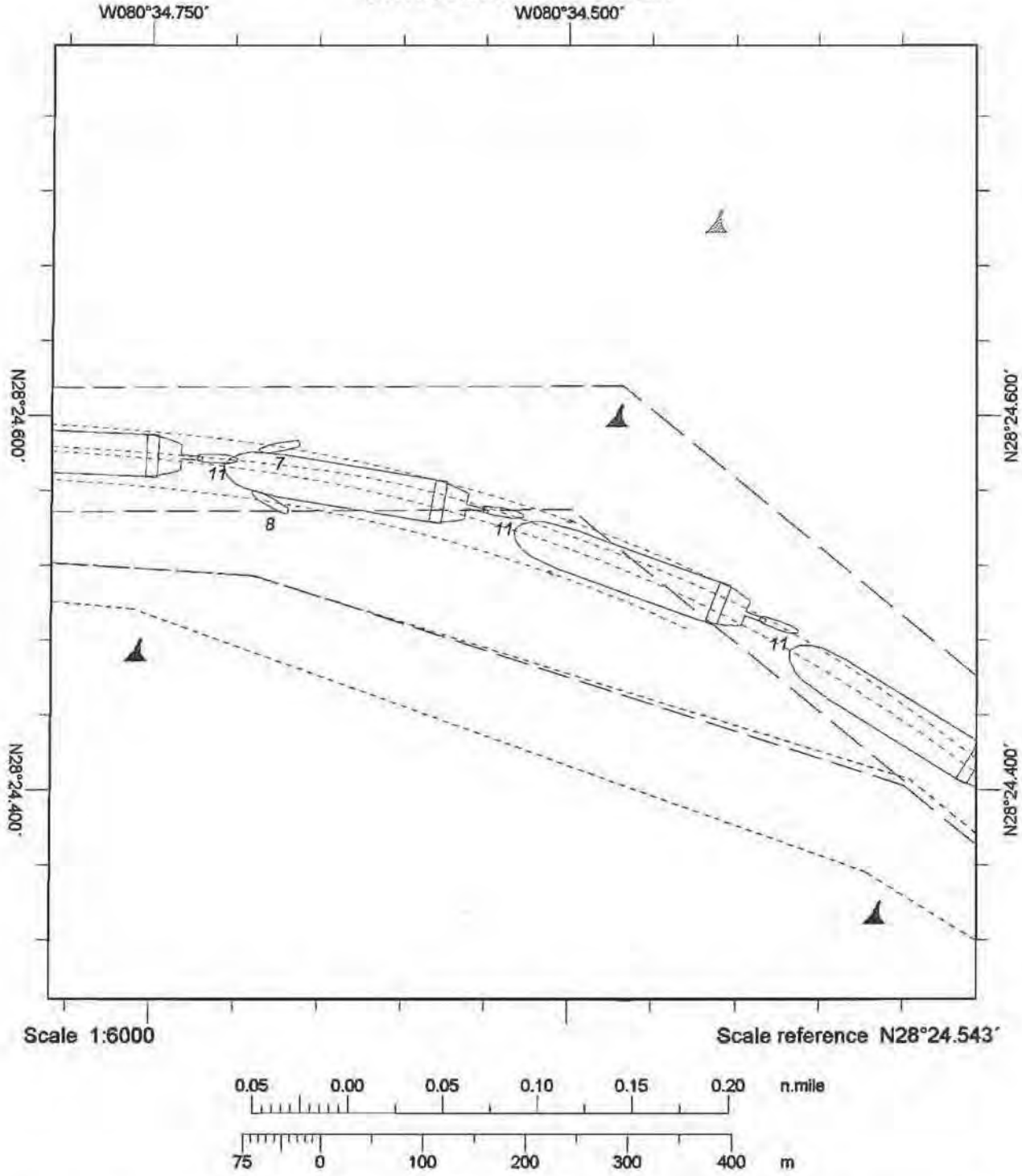
Canaveral Research



Comments: Wind: 0
Current: 0

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

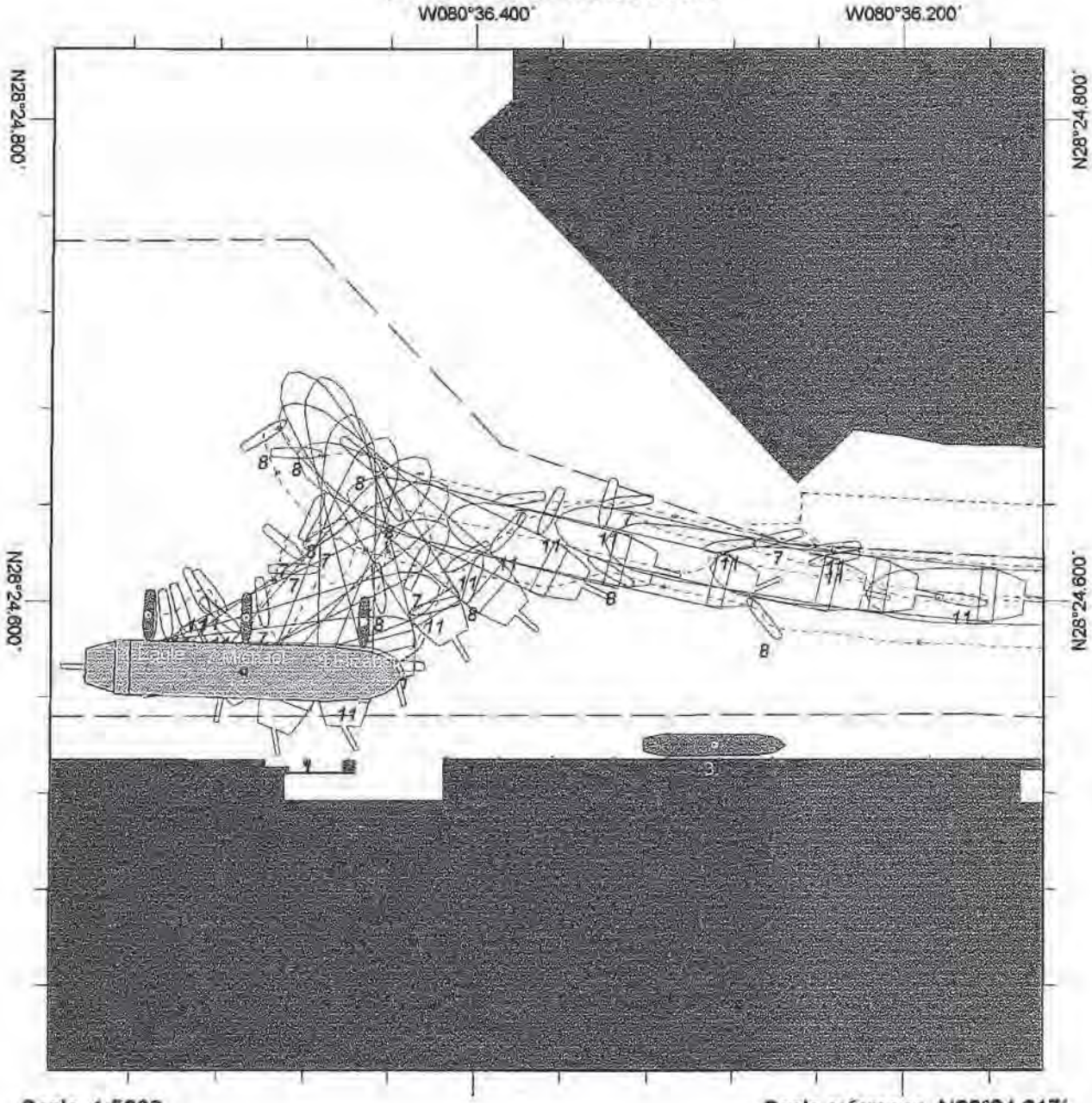
Canaveral Research



Comments: Wind: 0
Current: 0

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

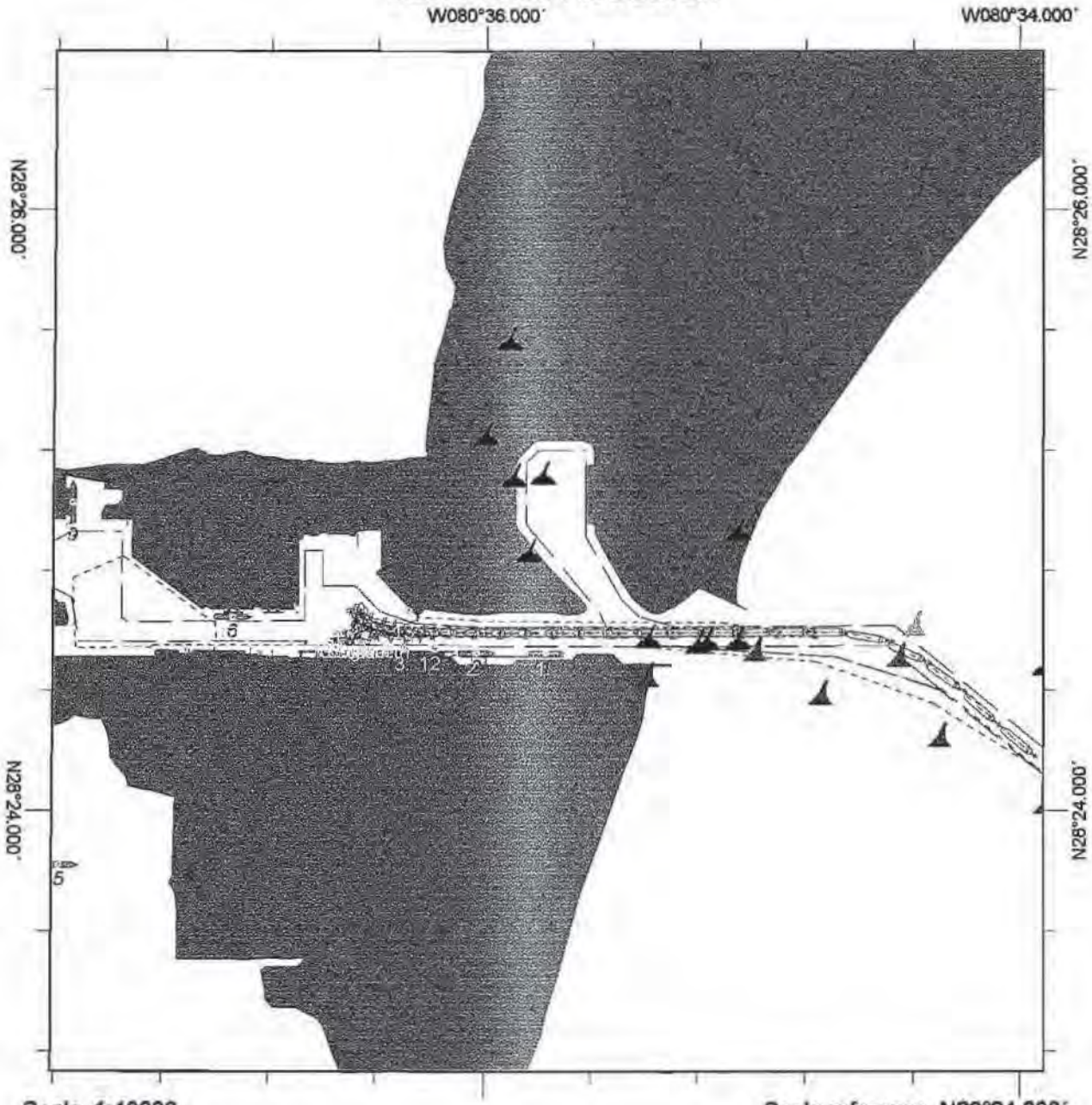
Canaveral Research



Comments: Wind: 0
Current: 0

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

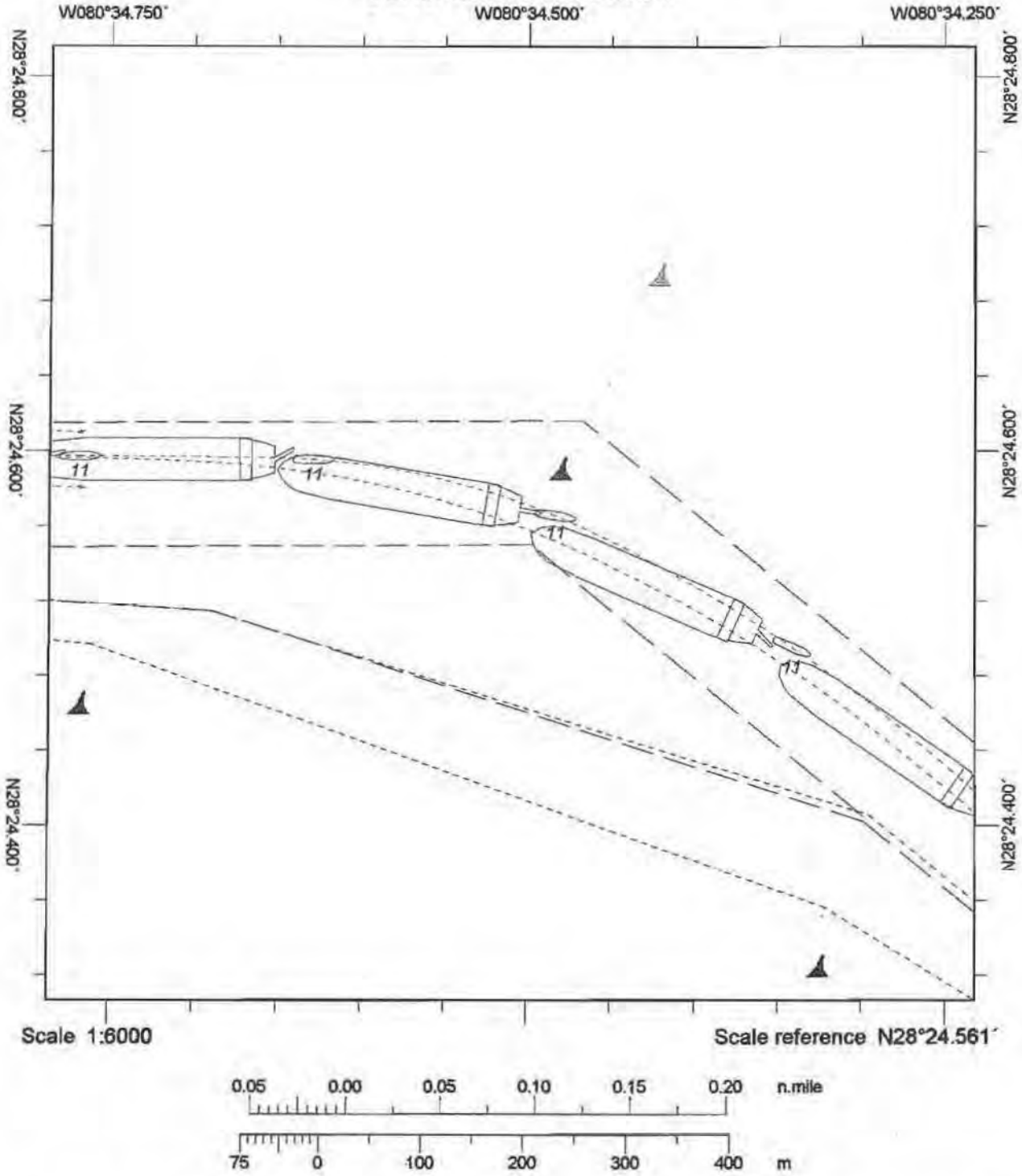
Canaveral Research



Comments: Wind: NW 15 kts
Current: N .75

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

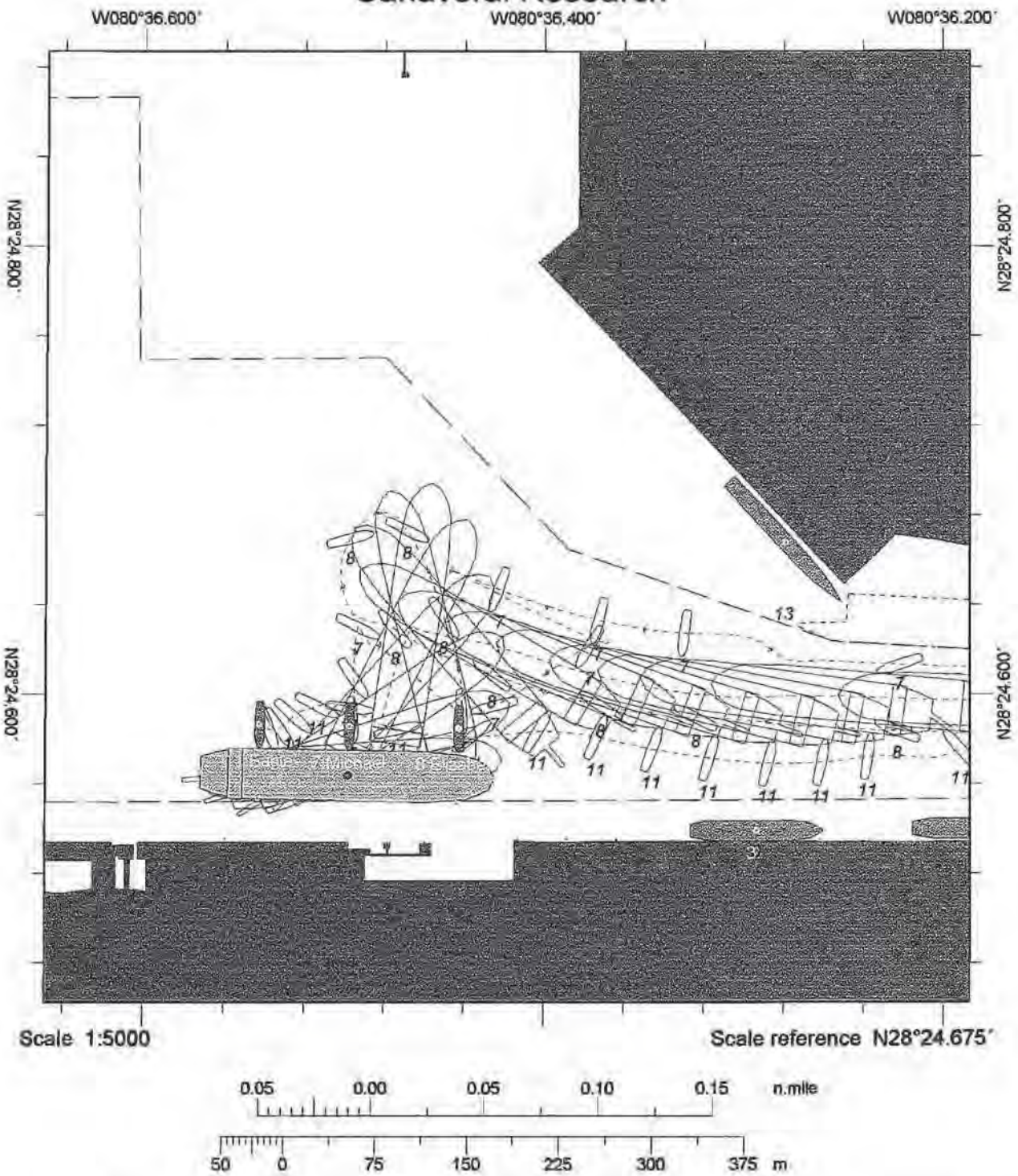
Canaveral Research



Comments: Wind: NW 15 kts
Current: N .75

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

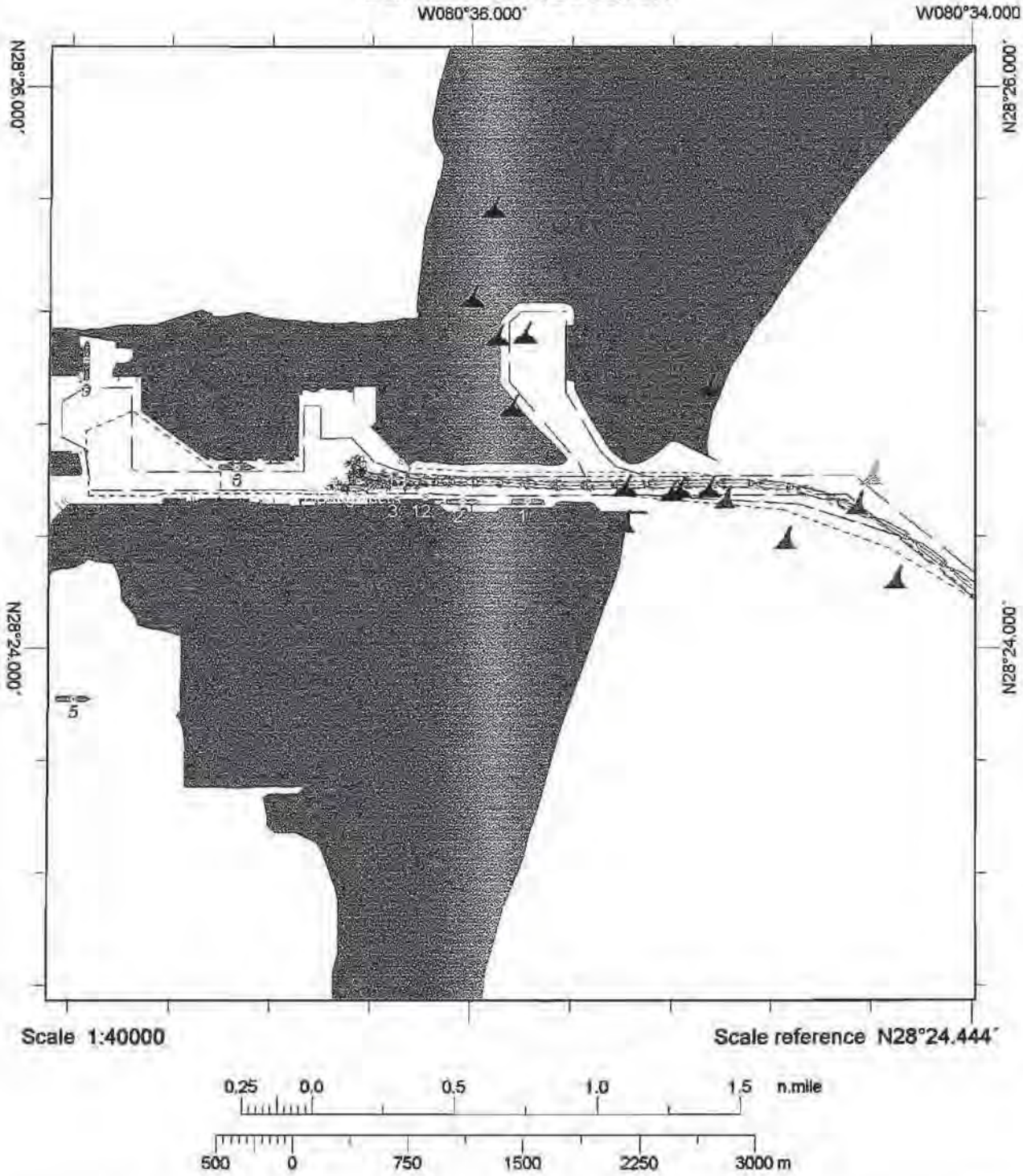
Canaveral Research



Comments: Wind: NW 15 kts
Current: N .75

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

Canaveral Research



Scale 1:40000

Scale reference N28°24.444'

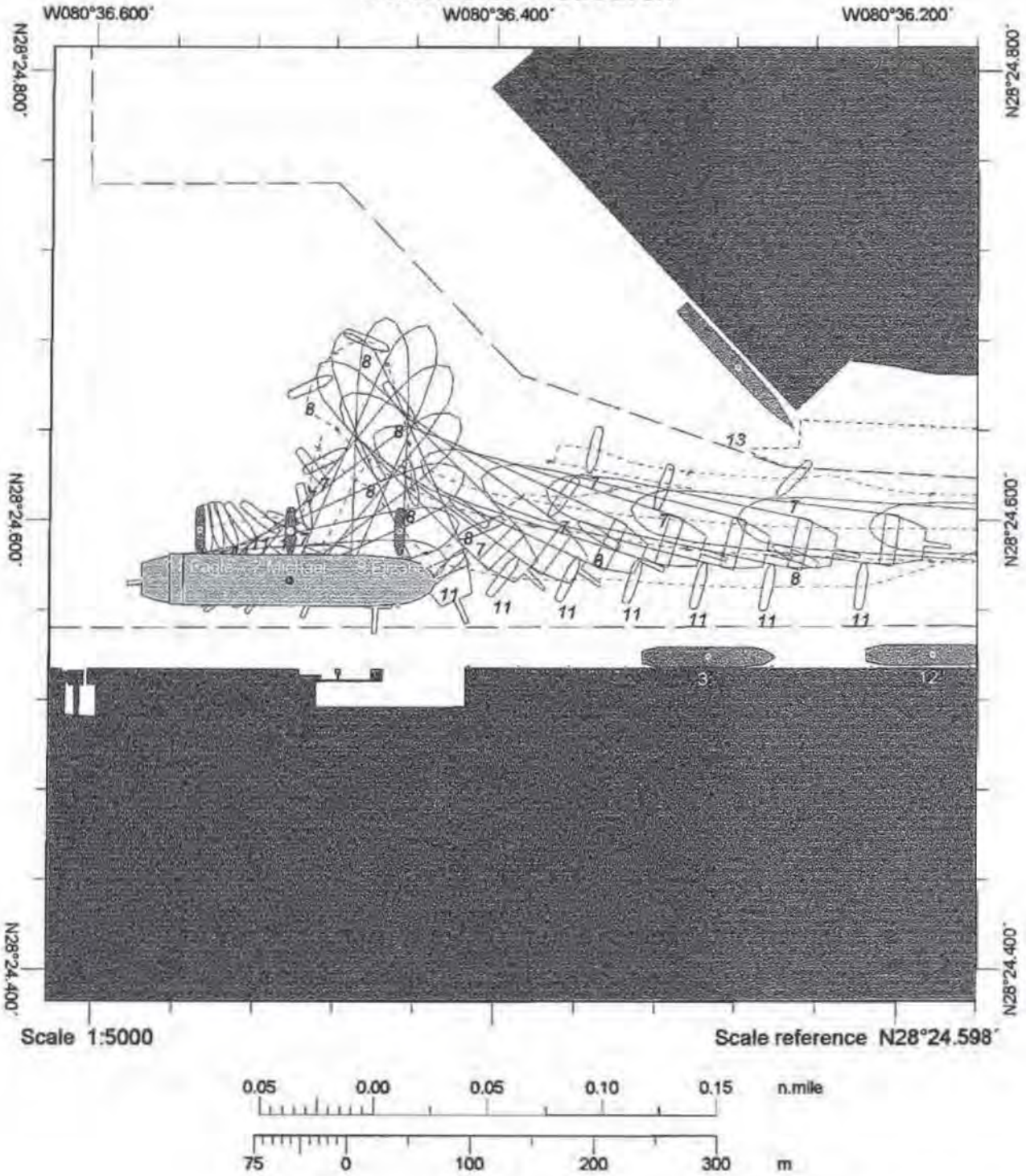
0.25 0.0 0.5 1.0 1.5 n.mile

500 0 750 1500 2250 3000 m

Comments: Wind: NW 20-25 kts
Current: S .75

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

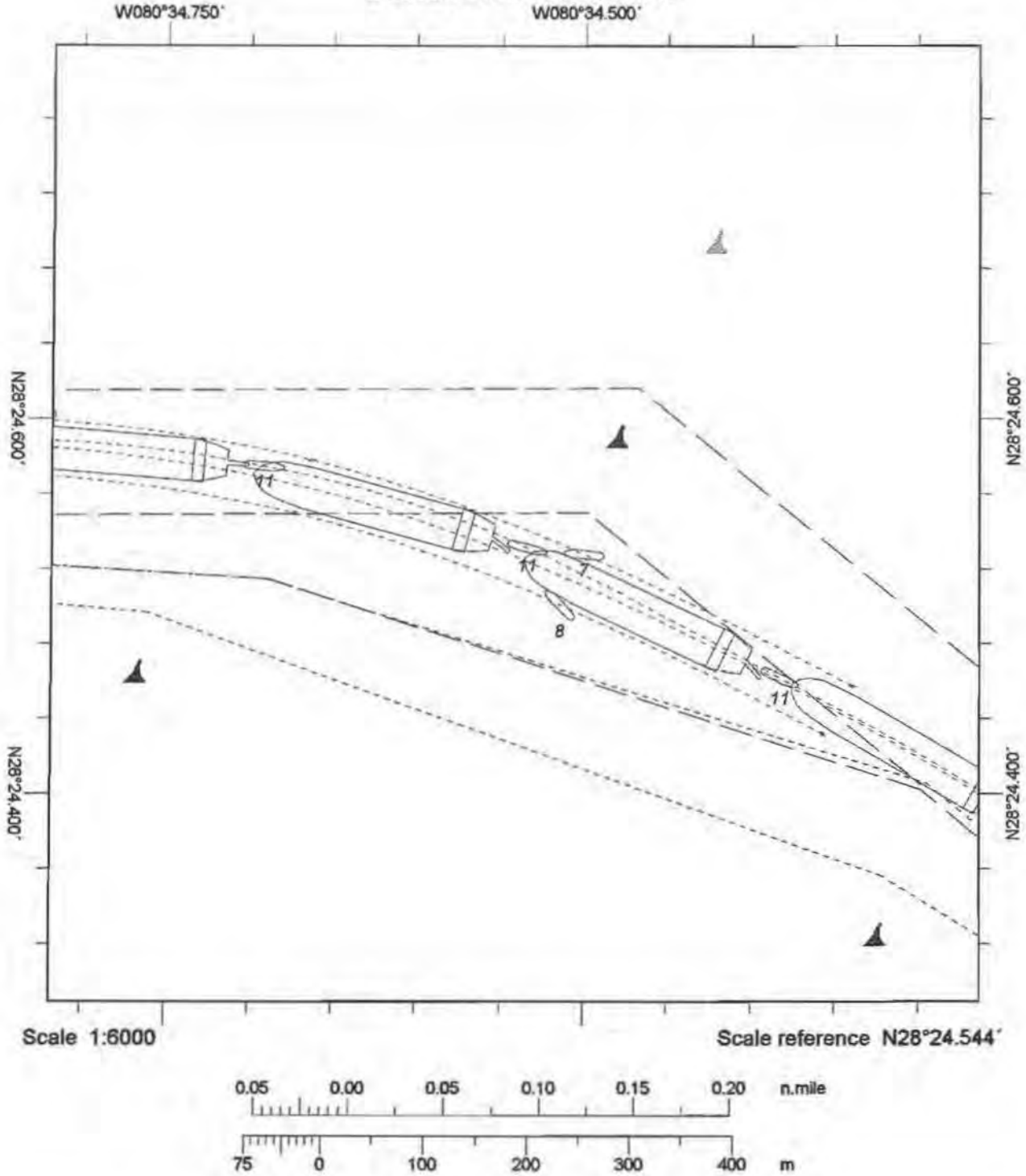
Canaveral Research



Comments: Wind: NW 20-25 kts
Current: S .75

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

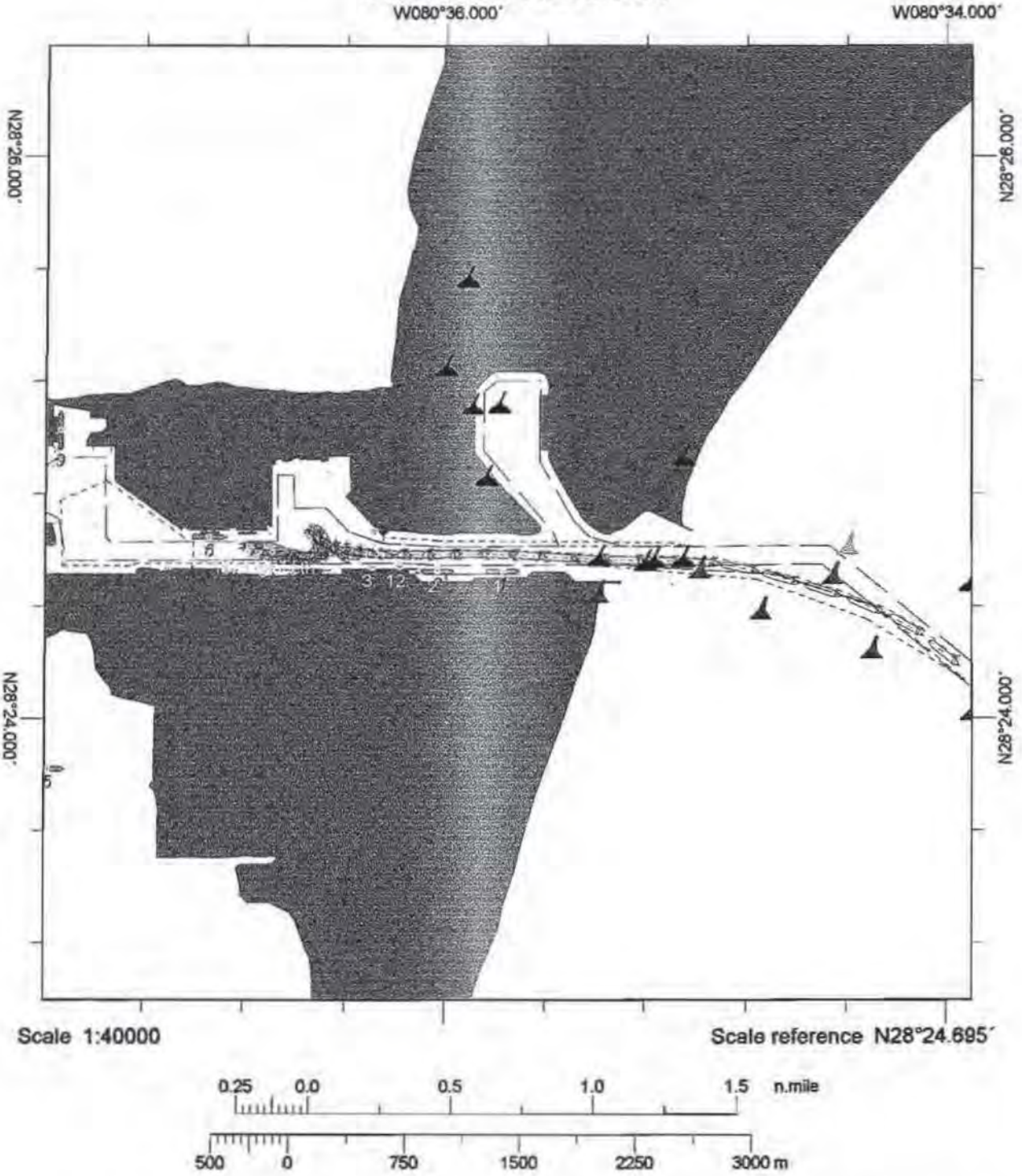
Canaveral Research



Comments: Wind: NW 20-25 kts
Current: S .75

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

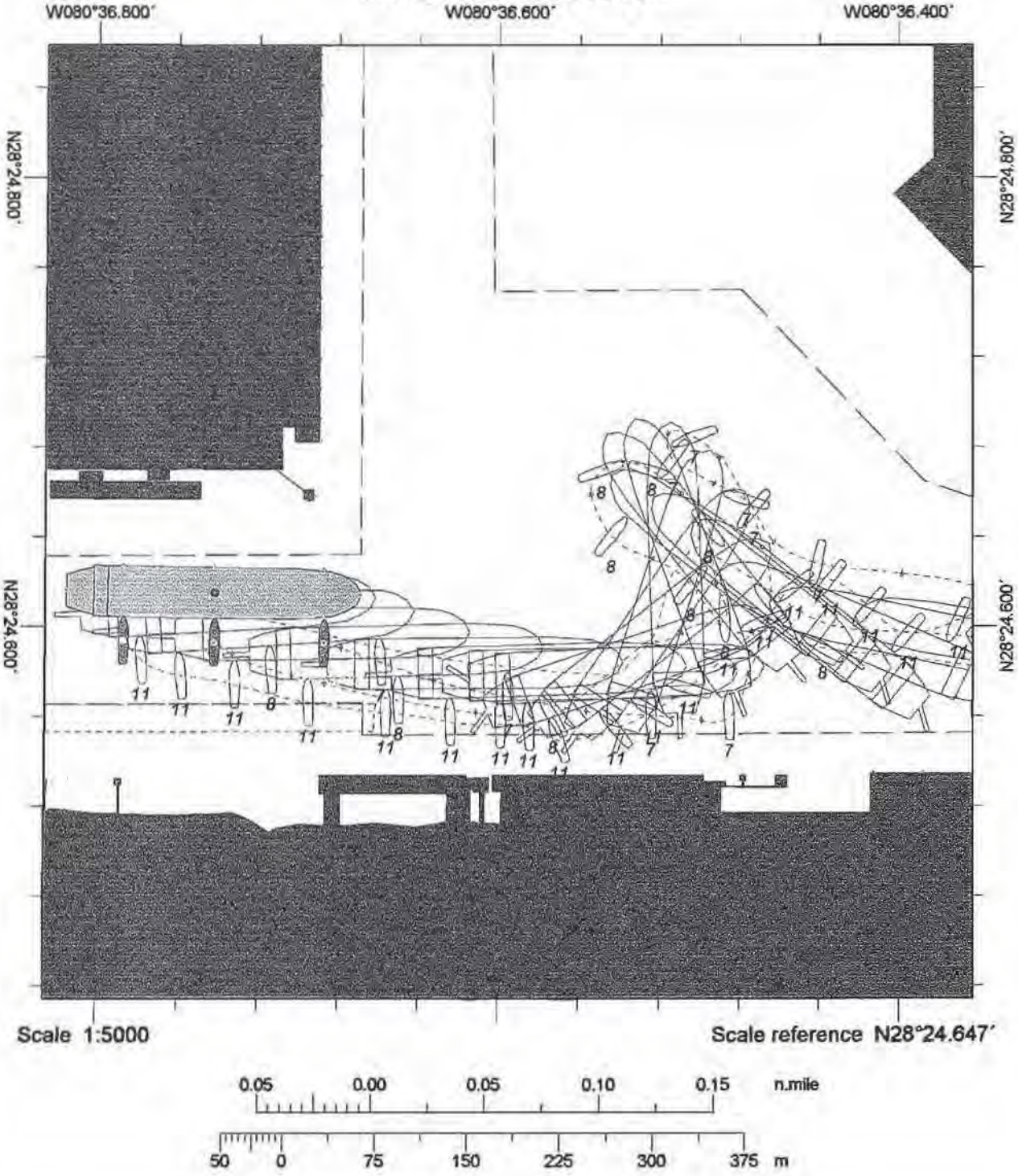
Canaveral Research



Comments: Wind:SE 15 kts
Current: S .75

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

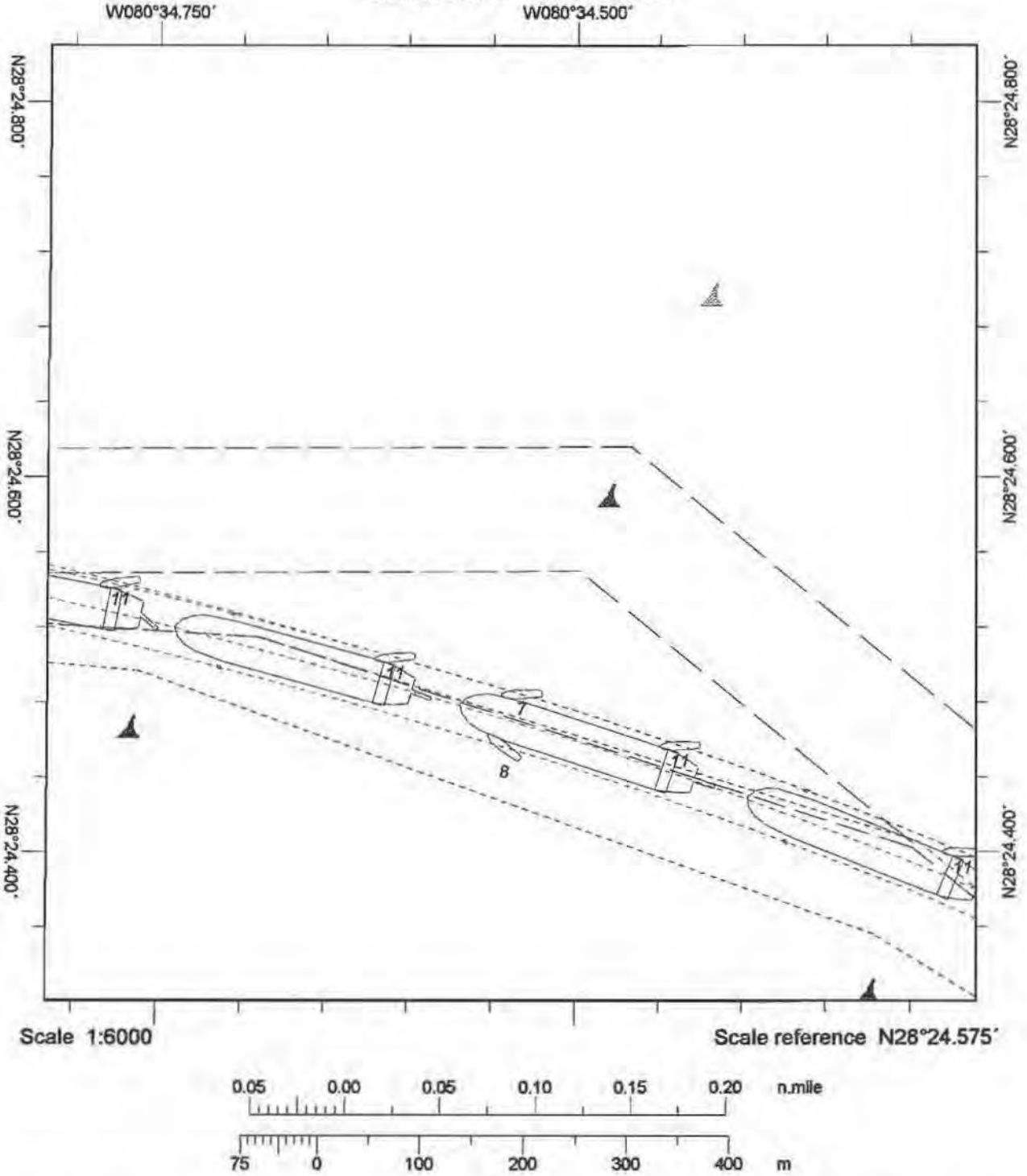
Canaveral Research



Comments: Wind:SE 15 kts
Current: S .75

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

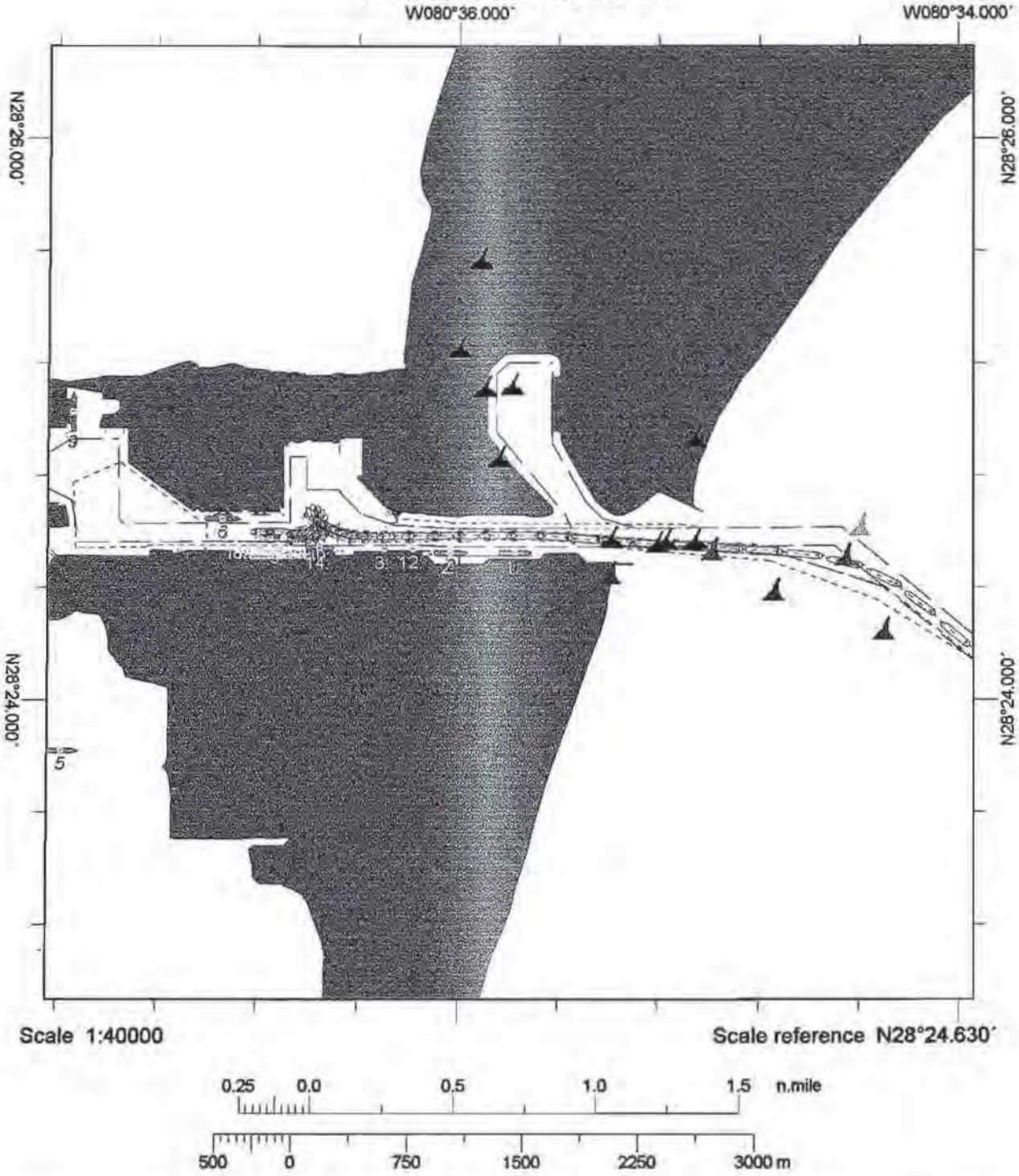
Canaveral Research



Comments: Wind:SE 15 kts
Current: S .75

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

Canaveral Research



Scale 1:40000

Scale reference N28°24.630'

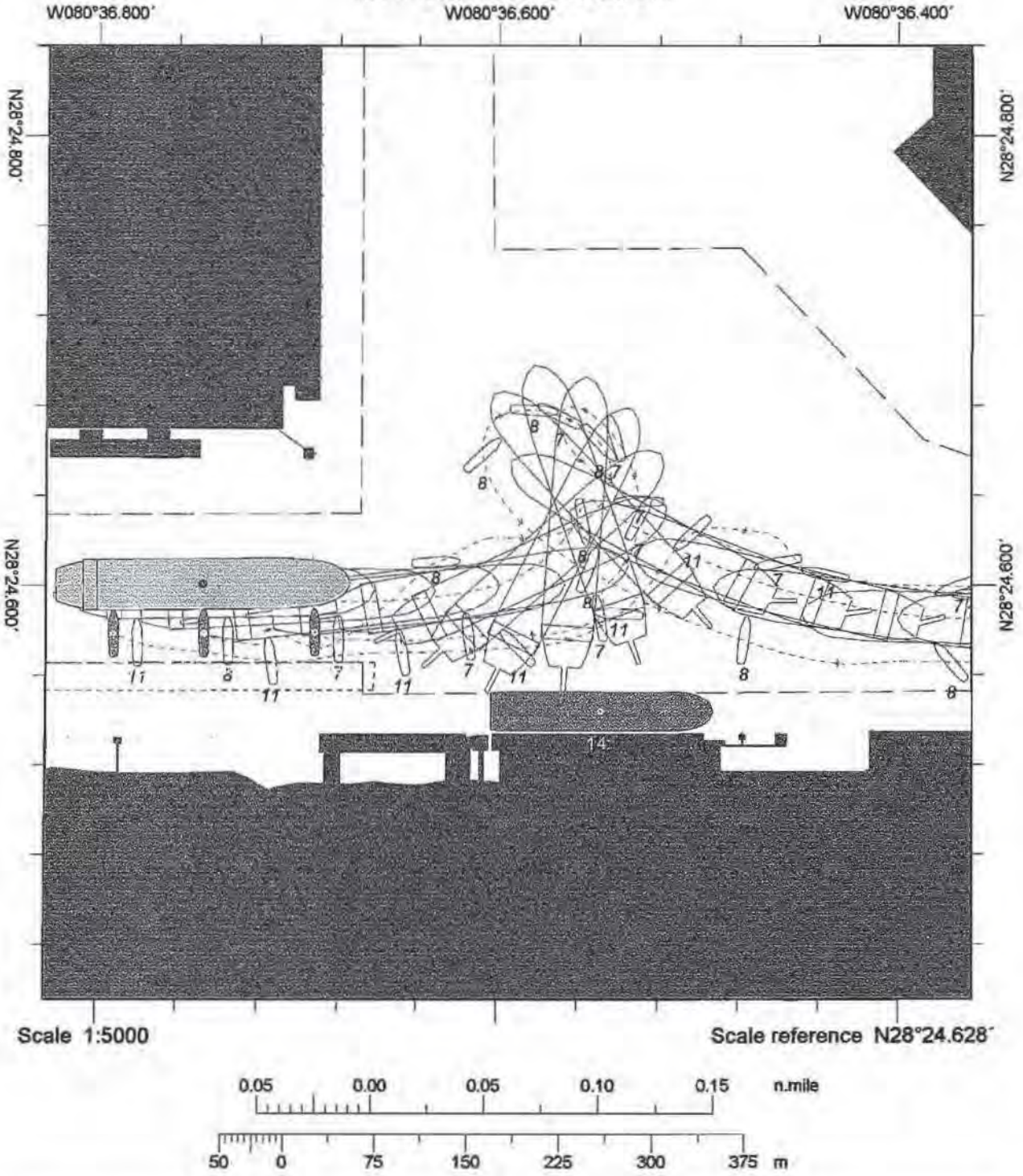
0.25 0.0 0.5 1.0 1.5 n.mile

500 0 750 1500 2250 3000 m

Comments: Wind:SE 20-25 kts
Current: N .75

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

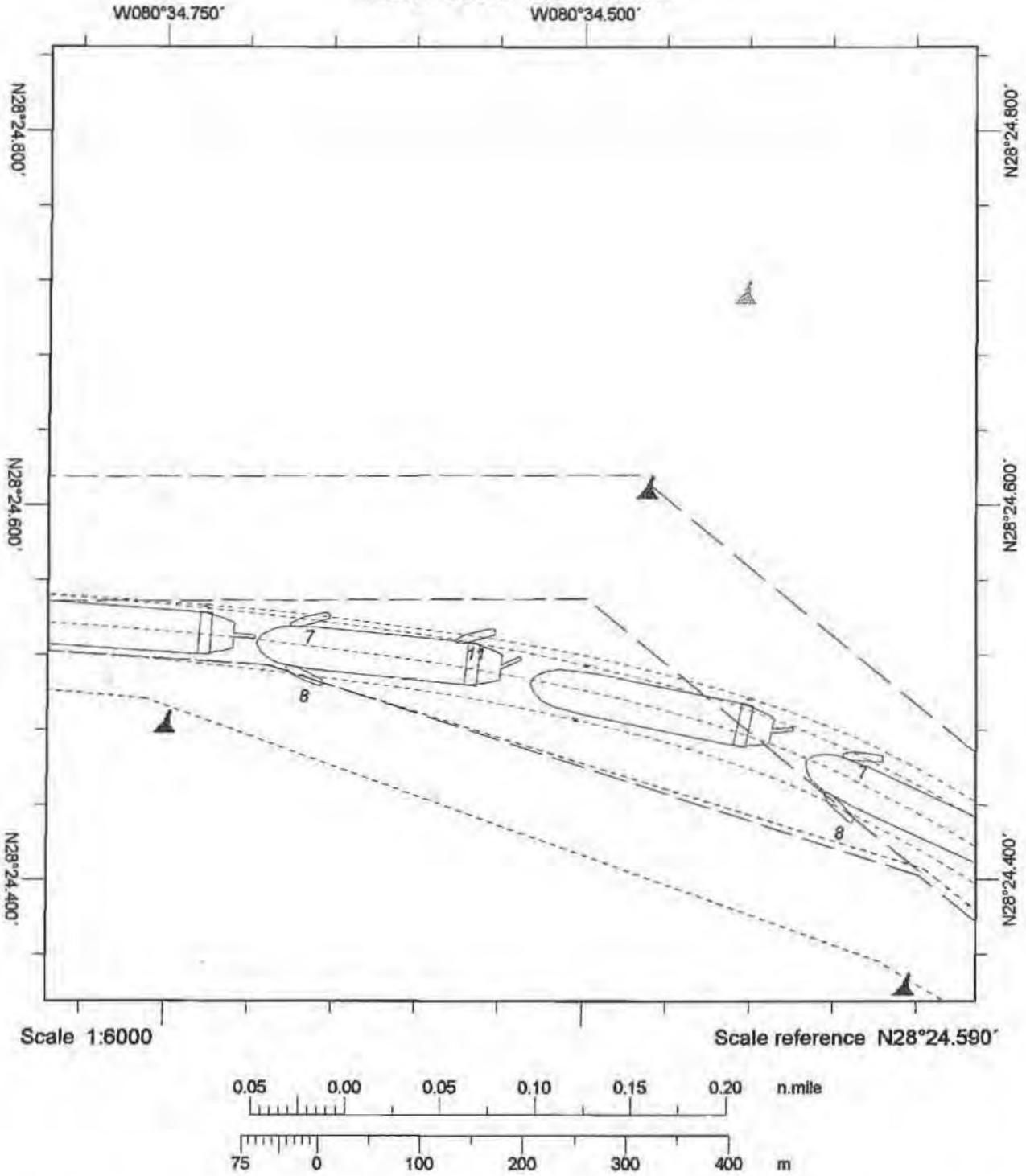
Canaveral Research



Comments: Wind:SE 20-25 kts
Current: N .75

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

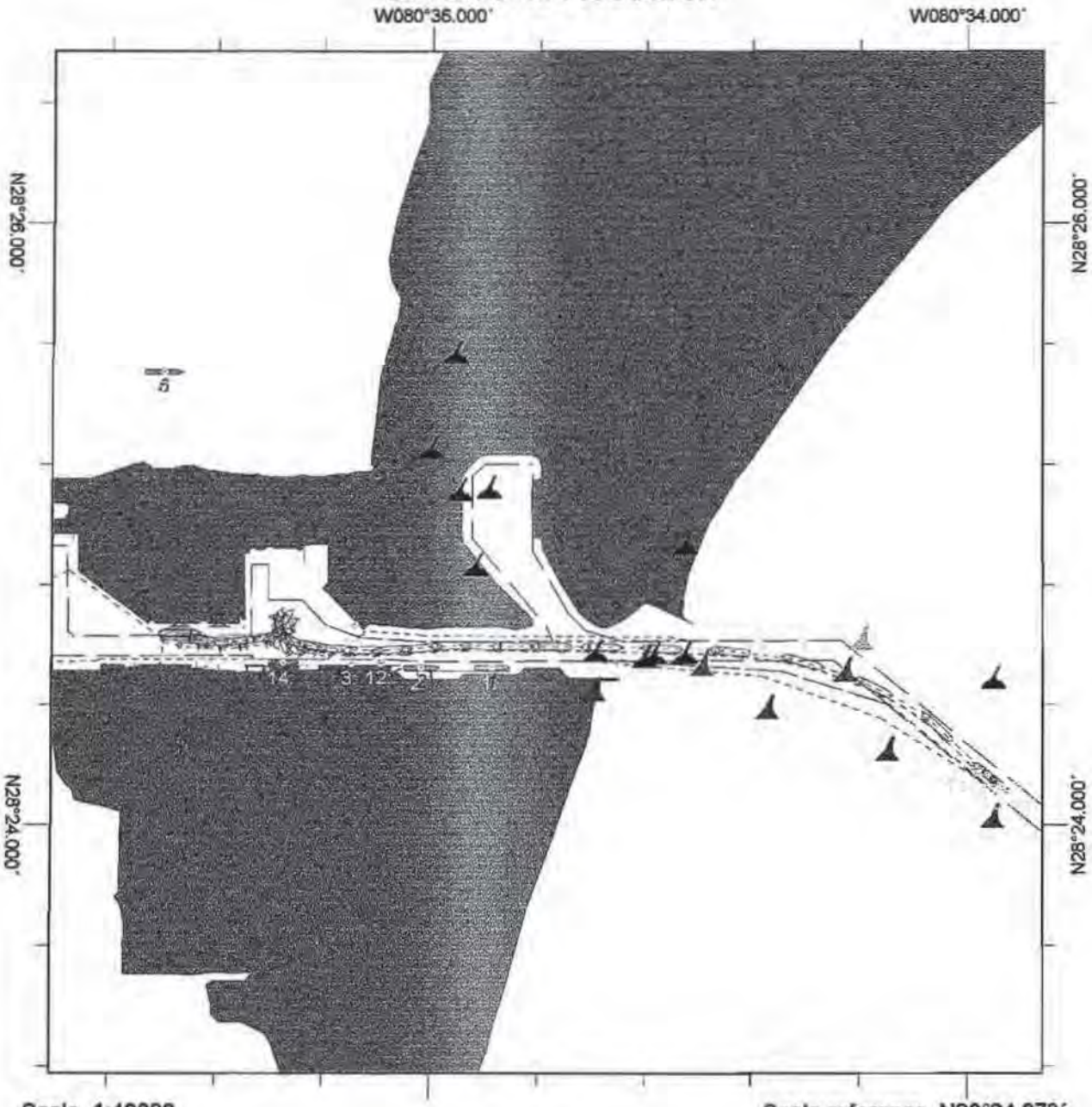
Canaveral Research



Comments: Wind:SE 20-25 kts
Current: N .75

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

Canaveral Research



Scale 1:40000

Scale reference N28°24.873'

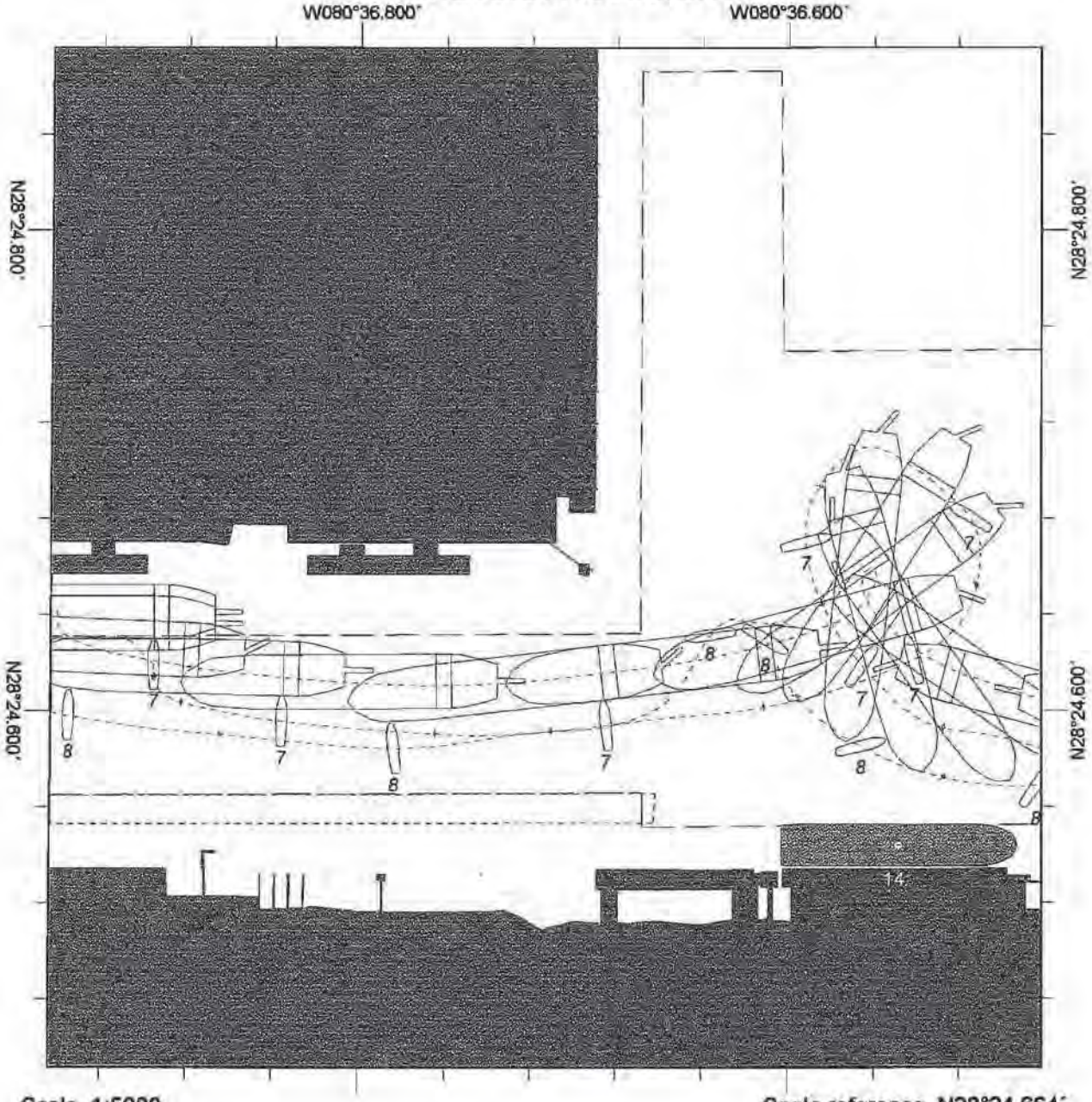
0.25 0.0 0.5 1.0 1.5 n.mile

500 0 750 1500 2250 3000 m

Comments: Wind: NW 20-25 kts
Current: N .75

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

Canaveral Research



Scale 1:5000

Scale reference N28°24.664'

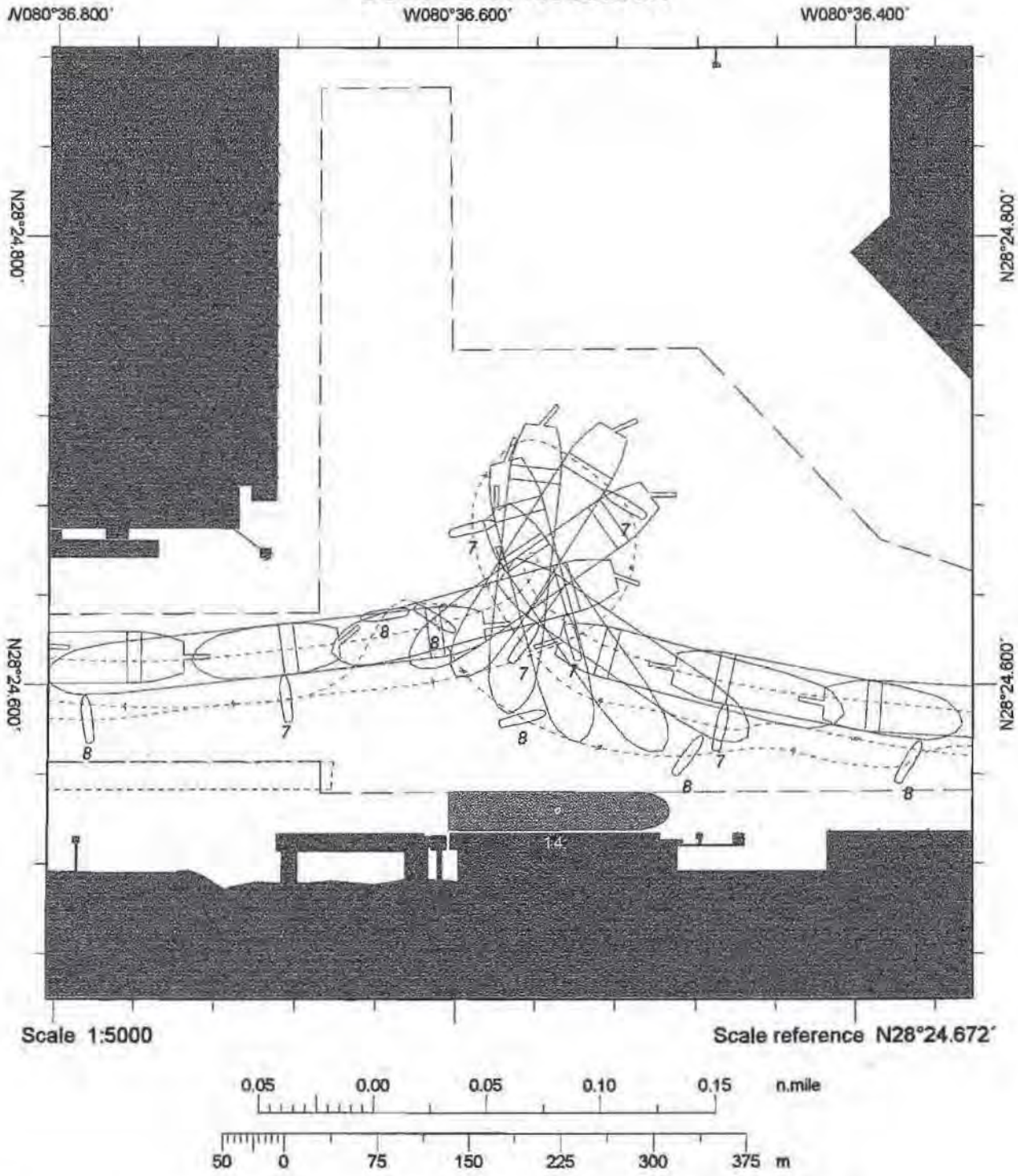
0.05 0.00 0.05 0.10 0.15 n.mile

50 0 75 150 225 300 375 m

Comments: Wind: NW 20-25 kts
Current: N .75

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

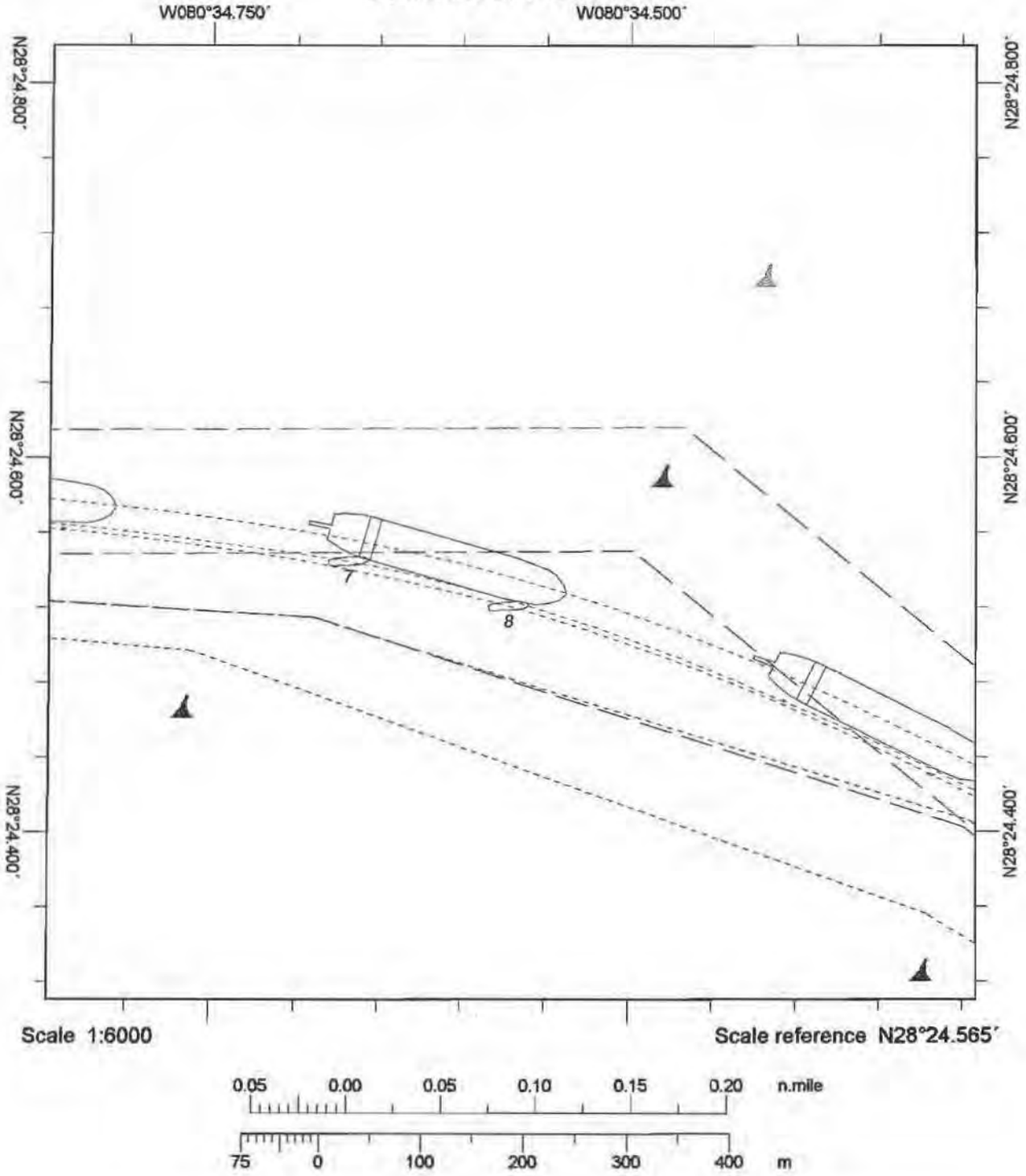
Canaveral Research



Comments: Wind: NW 20-25 kts
Current: N .75

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

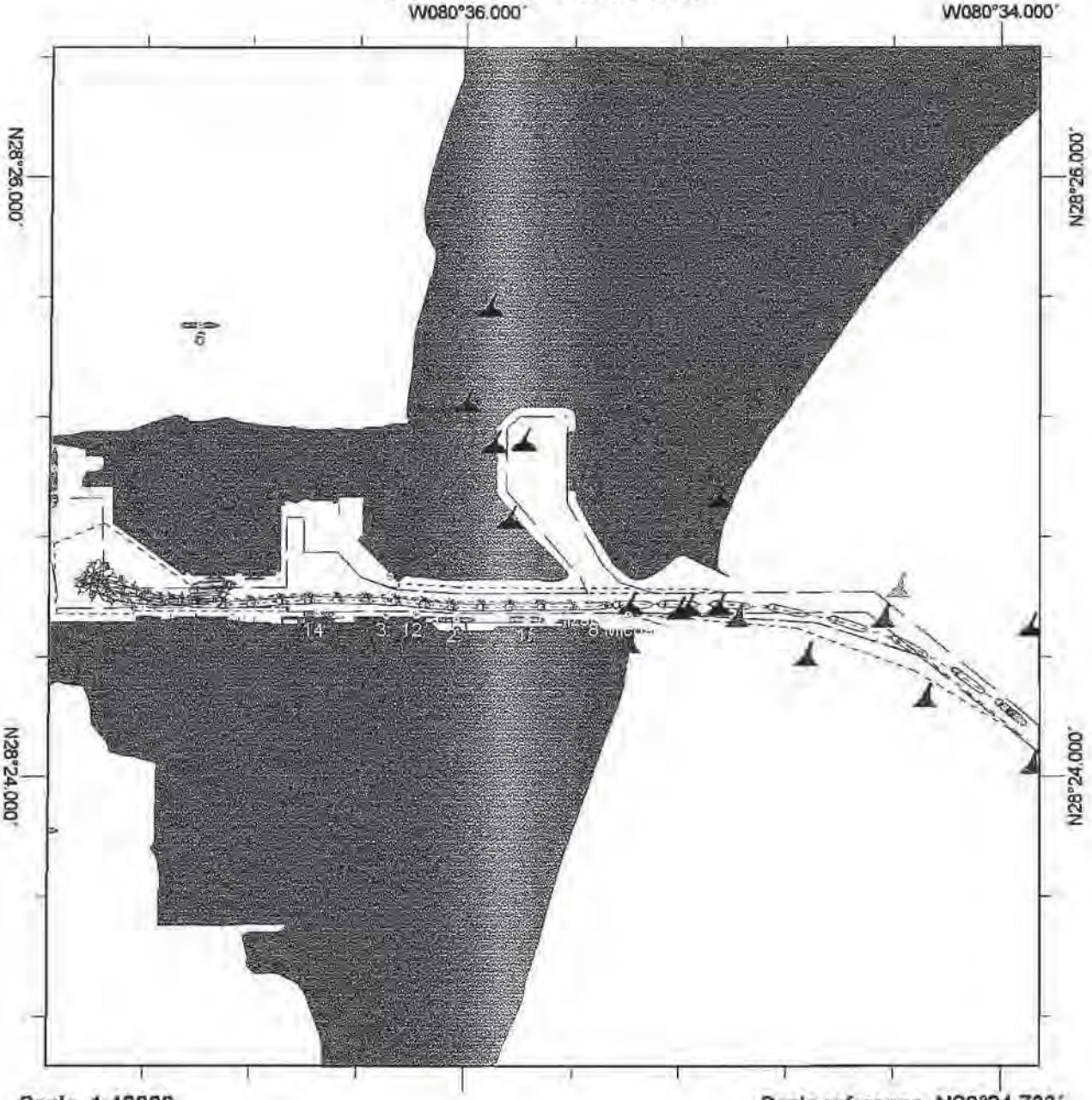
Canaveral Research



Comments: Wind: NW 20-25 kts
Current: N .75

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

Canaveral Research



Scale 1:40000

Scale reference N28°24.733'

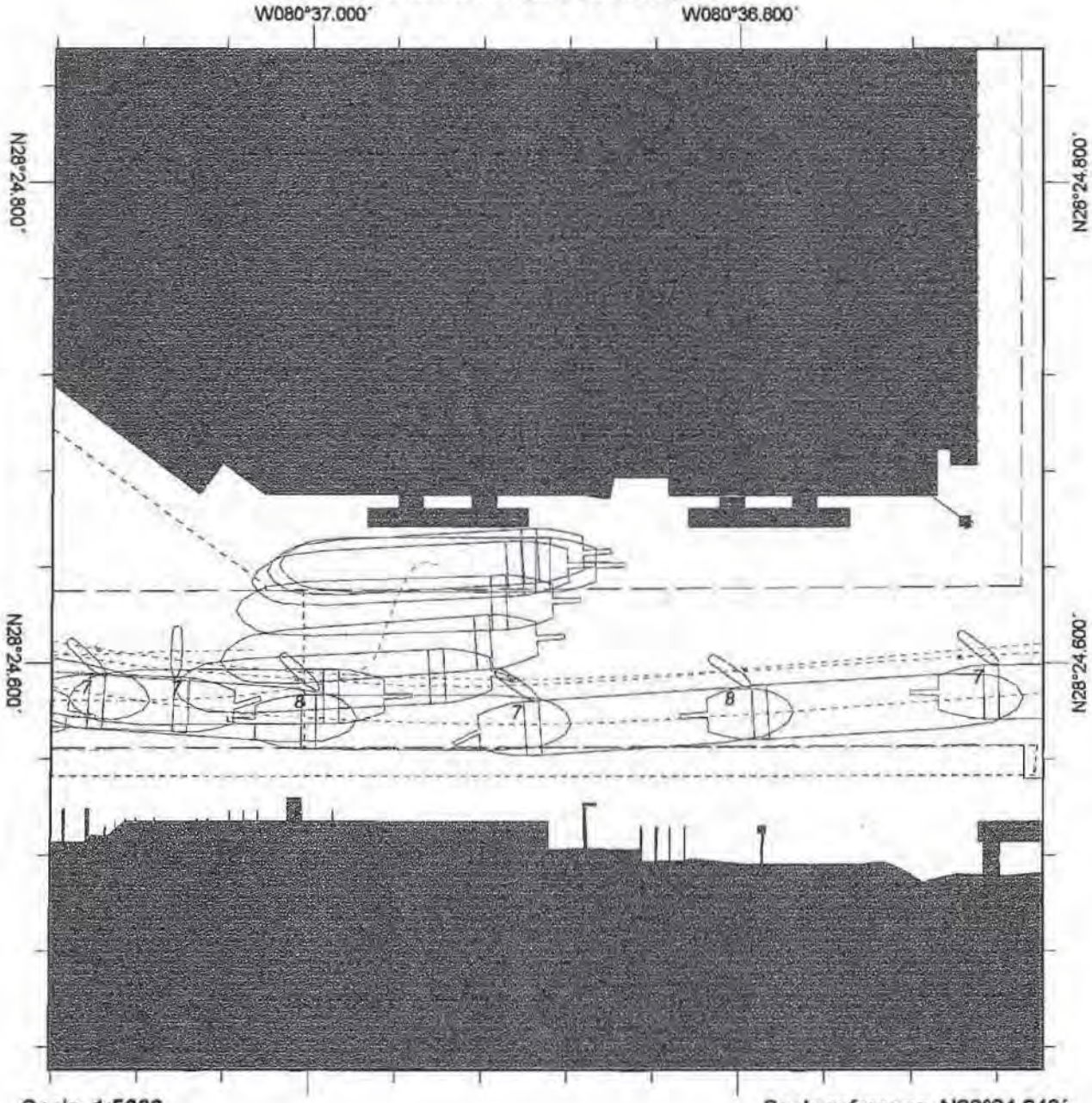
0.25 0.0 0.5 1.0 1.5 n.mile

500 0 750 1500 2250 3000 m

Comments: Wind: SE 20-25 kts
Current: S .75

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

Canaveral Research



Scale 1:5000

Scale reference N28°24.643'

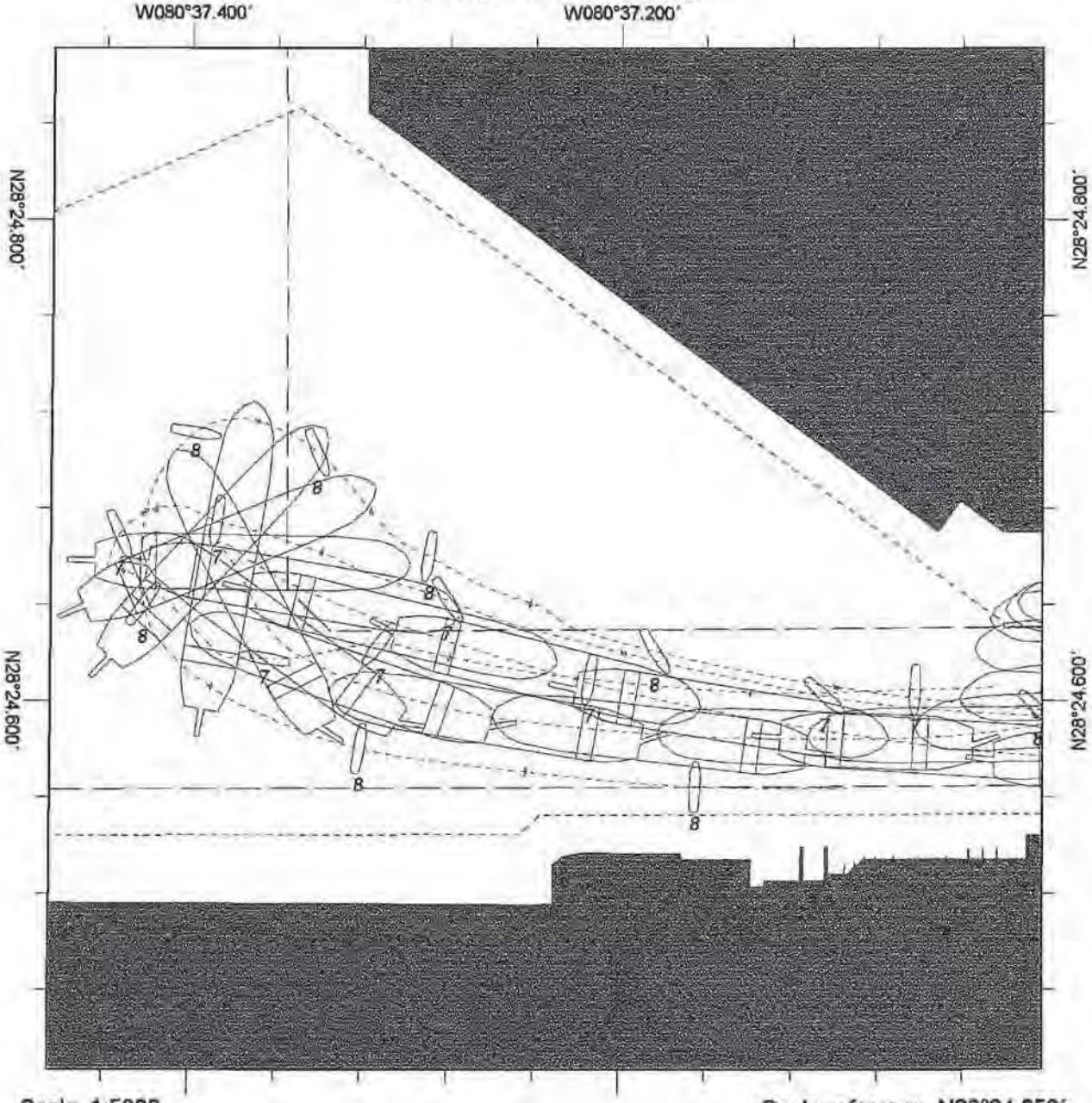
0.05 0.00 0.05 0.10 0.15 n.mile

50 0 75 150 225 300 375 m

Comments: Wind: SE 20-25 kts
Current: S .75

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

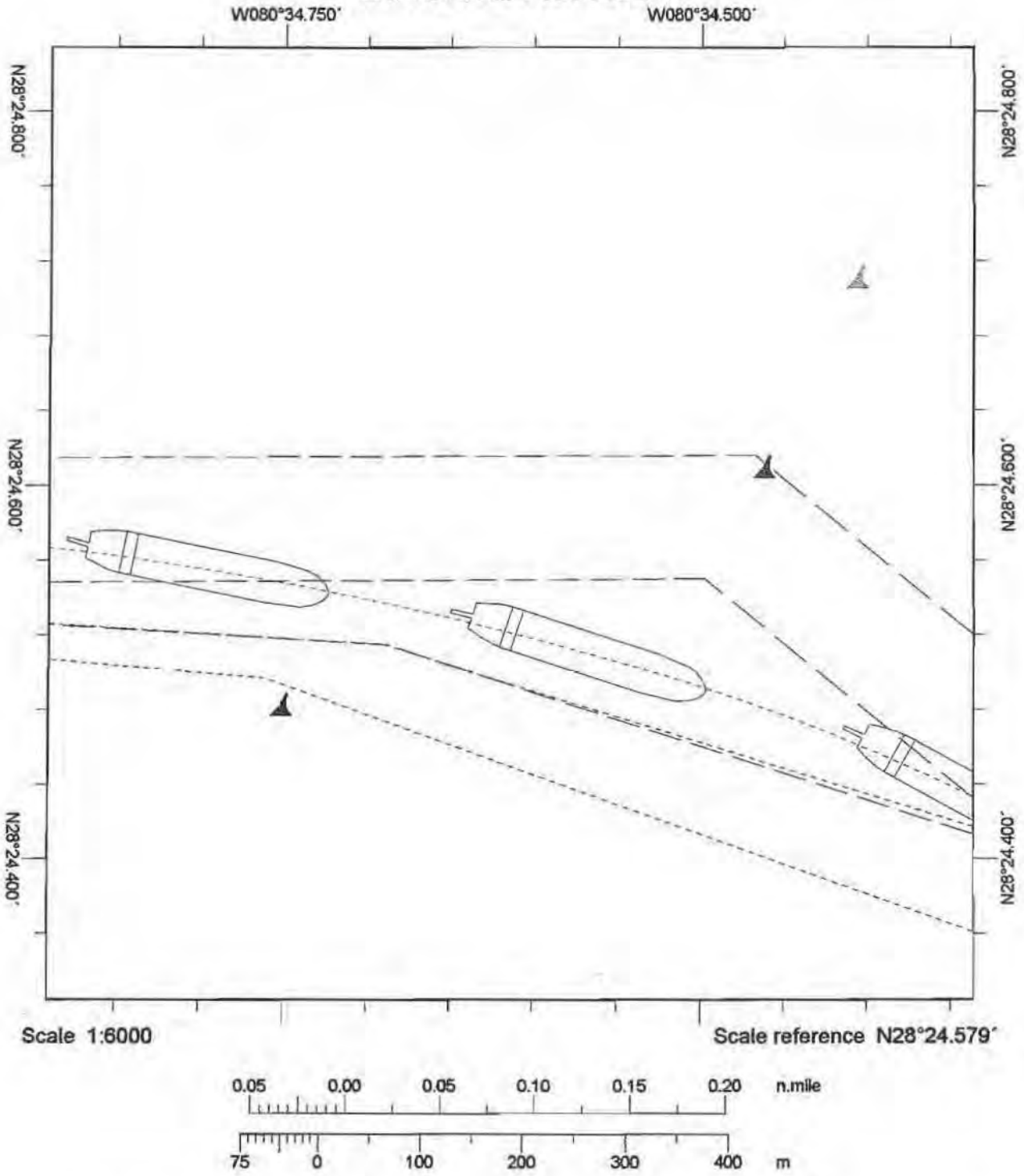
Canaveral Research



Comments: Wind: SE 20-25 kts
Current: S .75

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

Canaveral Research



Comments: Wind: SE 20-25 kts
Current: S .75

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