APPENDIX D

Ship Simulator Scope of Work

D-1. Introduction. A checklist for navigation study design and a sample Scope of Work (SOW) for a case study are included. The SOW is an example of how a study plan can be prepared and what it would contain. The SOW should be designed to fulfill the specific needs and desires of the project design office for the navigation simulation study. The checklist may be helpful in the preparation of a new simulation study to ensure all items that should be considered in the study are included.

D-2. Checklist for Navigation Study Design.

a. When can a ship simulation study be used?

(1) Reconnaissance study.

(2) Feasibility study.

(3) General design memorandum.

(4) New construction design.

(5) Modification of existing channel, turning basin, anchorage area, etc.

(6) Federalization of a privately developed channel.

(7) Operational issues.

(8) Permitting decisions.

(9) Maintenance operations.

(10) Accident reconstruction.

b. What is the project purpose?

(1) Channel modification.

(a) Widening
(b) Narrowing
(c) Deepening

(2) Construction of new channel.

(3) Bend widening.

(4) Turning basin construction or modification.

(5) Anchorage construction or modification.

(6) Overhead bridge construction/replacement/ modification.

(7) Risk analysis.

(8) Alternative plan selection.

(9) Development of project design.

(10) Confirmation of project design.

(11) Navigation problem identification.

(12) Resolution of safety problems.

c. What should be modeled in the study?

(1) Existing conditions.

(2) Designs and alternative(s).

(3) Critical navigational conditions.

(a) Currents
(b) Wind
(c) Bank suction
(d) Channel geometry
(e) Traffic
(f) Tug assistance

(4) Navigational concerns.

(a) Increased vessel size
(b) Increased vessel draft
(c) New types of vessels in the channel
(d) Safety problems at specific locations
(e) Change in traffic operation
(f) Possible elimination of tidal restrictions
(g) Possible elimination of tug handling requirements

d. What information is required to perform a study?

(1) Environmental description of existing conditions.

(a) Channel bathymetry
(b) Wind data
(c) Currents – magnitude and direction
(d) Channel geometry and markers
(e) Existing vessel operational procedures

(2) Environmental description of new design conditions.

(a) New channel bathymetry
(b) Wind data
(c) Modified currents – magnitude and direction
(d) New channel geometry and markers
(e) Proposed vessel operational procedures

(3) Vessel(s) descriptors.

(a) Length overall (LOA)
(b) Beam (B)
(c) Draft (T)
(d) Handling characteristics
(e) Bow/stern thrusters.
(f) Special rudders
(g) Engine propulsion

e. What type of channel is being studied?

(1) Open water entrance.

(2) Fresh/saline/brackish water.

(a) Possible salinity wedge
(b) Vessel draft changes
(c) Three-dimensional currents

(3) Shallow draft.

(4) Deep draft.

(5) Turning basin.

(6) Anchorage.

(7) Canal.

(8) River.

(9) Lock approach.

(10) Bed material and geometry.

(a) Flat
(b) Natural alluvial
(c) Sand/sand waves
(d) Rock
(e) Coral

(f) Mud
(g) Fluff
(h) Hazardous material

f. What type of vessel traffic?

(1) One-way only.

(2) Two-way.

(3) Meeting and passing.

(4) Overtaking and passing.

(5) Tug assist.

(6) Other vessels: Recreational, ferries, small push-tows.

g. What is the project vessel type?

(1) Bulk carrier.

(2) Containership.

(3) Roll-on/roll-off (RO/RO).

(4) Car carriers.

(5) Tanker.

(6) Ferry.

(7) Etc.

h. Possible sources of information for design vessels?

(1) Tow tank tests.

(2) Sea trial data.

(3) Estimated model.

(4) Adjusted model from a geometrically similar ship.

i. Visual conditions to be used in testing?

(1) Daytime.

(2) Nighttime.

(3) Fog/Haze conditions.

(4) Radar-only navigation.

j. Are structures affecting the navigation conditions?

(1) Bridge(s).

(2) Lock.

(3) Anchorage/mooring cells.

(4) Dikes.

k. What pilotage should be used?

(1) Autopilot.

(2) Engineering/Scientists.

(3) Professional, licensed pilots.

(4) Local licensed pilots.

(5) Bar pilots.

(6) Docking.

(7) Tug pilots.

l. What analysis of the data is required?

(1) Track plots.

(2) Pilot survey, questionnaires, and comment.

(3) Ship control parameters.

(a) Rudder
(b) Shaft RPM
(c) Heading
(d) Rate of turn
(e) Speed
(f) Drift Angle

(g) Tugs
(h) Bow/Stern Thrusters

(1) Channel Parameters.

(a) Vessel clearance: Port and starboard
(b) Swept path of vessel
(c) Percent of channel used by vessel
(d) Heading of vessel relative to channel bearing

m. What reporting requirements are desired?

(1) Monthly progress.

(2) Financial.

(3) Special problem.

(4) Preliminary results.

(5) Draft final.

(6) Final.

(7) Executive summary.

D-3. Example Scope of Work. Figure D-1 provides the table of contents for the following example SOW, with page numbers in the table of contents referring to pages in this example.

Kill Van Kull and Newark Bay Channels
New York and New Jersey

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Figure D-1.

KILL VAN KULL AND NEWARK BAY CHANNELS
NEW YORK AND NEW JERSEY
SCOPE OF WORK
SHIP SIMULATION MODELING

Introduction

1. The study area, consisting of the Kill Van Kull, Newark Bay Channels, and a section of the Arthur Kill Channels, is located west of the Upper New York Bay along the border of New York and New Jersey. The Kill Van Kull, an 800-ft-wide channel approximately 4 miles in length, extends from Constable Hook to Bergen Point, New Jersey, connecting the Upper New York Bay to Newark Bay. The Newark Bay Channels, stemming north from the junction of the Kill Van Kull and Arthur Kill at Bergen Point, service the busy port authority terminals at Port Newark/Port Elizabeth and continue farther north, connecting with the Passaic and Hackensack River Channels. The North of Shooters Island, Elizabethport and Gulfport reaches of the Arthur Kill Channel, 500 to 600 ft wide and approximately 3.2 miles in length, extend west and south from the western end of the Kill Van Kull in Newark Bay.

Problem Identification

2. The problems associated with vessel navigation within the existing projects are related to the existing available channel depths. The existing 35-ft channel depth requires that the larger vessels enter the channel less than fully loaded, forcing tankers to perform costly lightening operations in the deeper areas within the Upper New York Bay and containerships to arrive at port underloaded, thereby increasing the shipping costs. The predicted trend is not for larger ships, but for an increasing number of the existing vessels deeper laden. The increased traffic in the already congested channels, combined with complex currents, sharp bends, and limited maneuvering areas have dictated the need for modifying the existing Federal navigation projects. The recommended modifications to the existing projects are developed in the “General Design Memorandum, Kill Van Kull and Newark Bay Channels, New Jersey and New York,” June 1986, (Reference 1) and the “Feasibility Study, Arthur Kill Channel, Howland Hook Marine Terminal, Staten Island, New York,” March 1986 (Reference 2), and shown in Figures D-2 and D-3. These modifications include deepening the Kill Van Kull and Newark Bay channels to 44-ft MLW and the Arthur Kill to 40-ft MLW. In addition to deepening the channels, critical locations of historical trouble spots will be widened. However, since there is a possibility that the Kill Van Kull channel will not be constructed to the authorized depth, but may be left at the Phase I depth of 40 ft, the channel dimensions should be determined for this condition. The ship handling conditions will likely be more difficult for this condition, since the velocities in the channel will probably be higher and the underkeel clearance will be minimum, assuming containership drafts do not change significantly. Thus, this more critical condition (Phase I) will be evaluated in the simulation study, and these results will also be applied to the 44-ft depths in the Kill Van Kull.

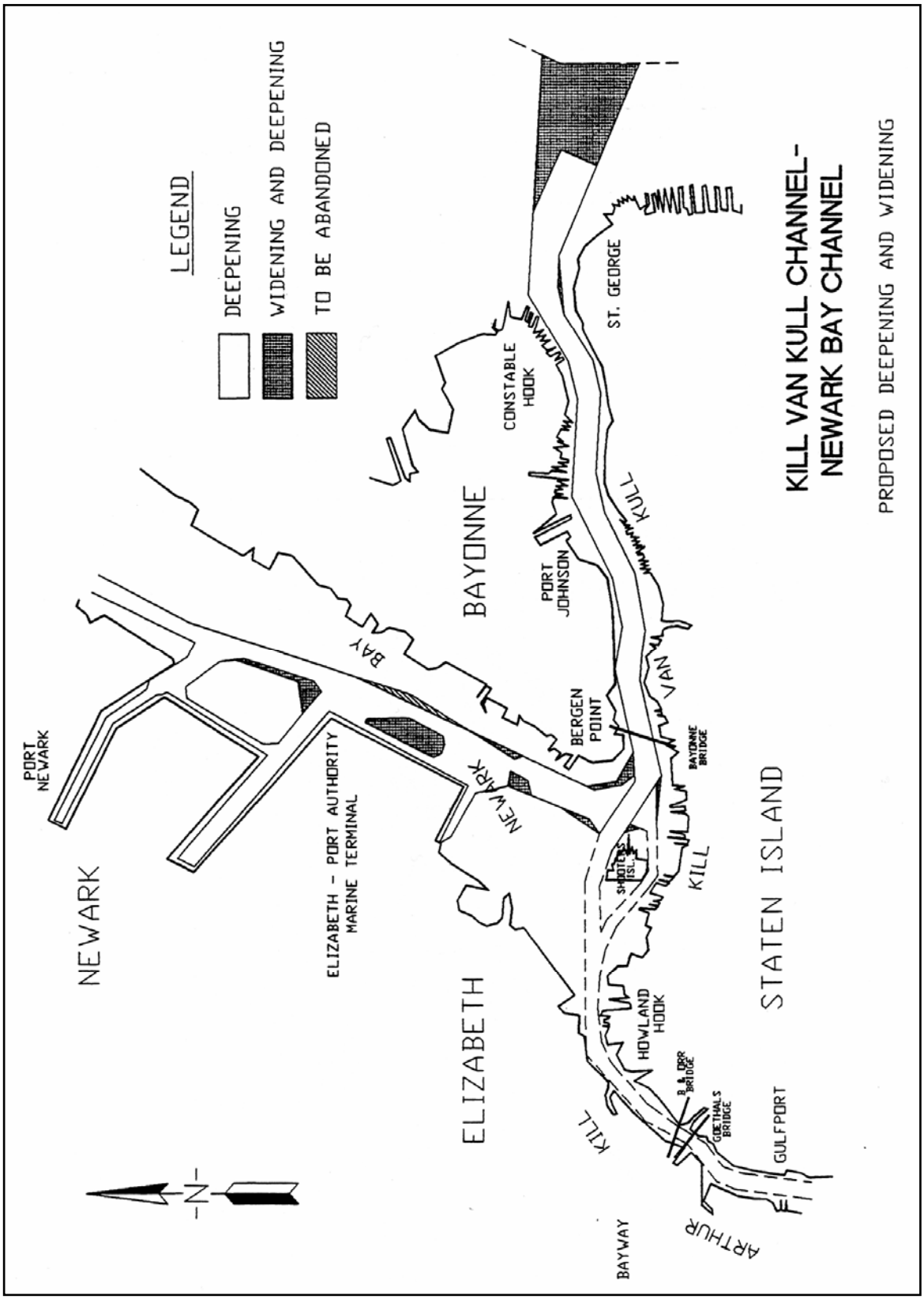

Figure D-2. Kill Van Kull and Newark Bay Channels – Study Area

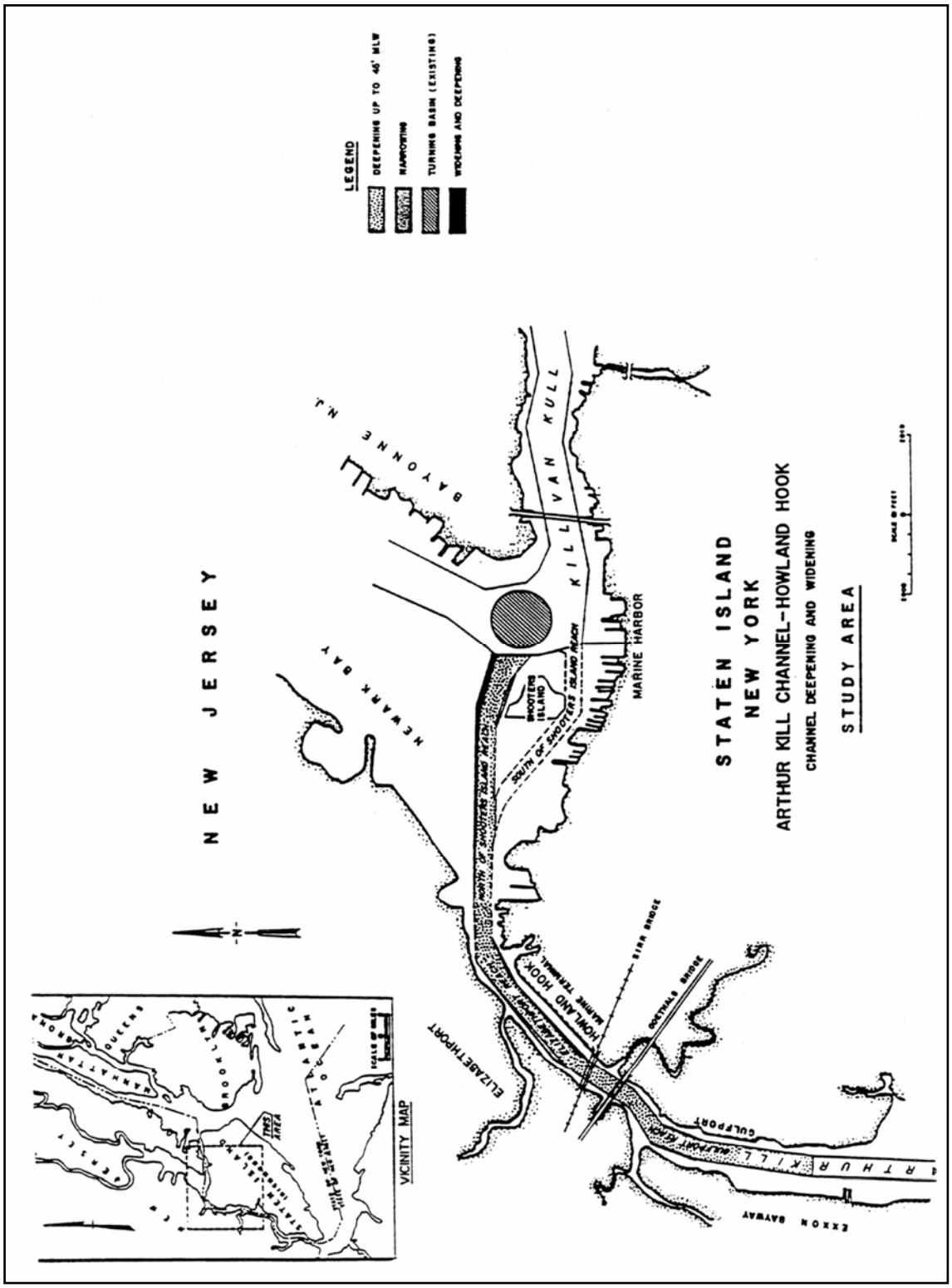

Figure D-3. Arthur Kill Channel and Howland Hook Terminal – Study Area

Objective

3. The objective of this simulation study is to aid in the refinement of the widths of the recommended channel improvements and also to assess the impact of the proposed improvements on the safety and efficiency of the deep-draft waterborne commerce within the study area. In order to obtain these objectives, the ship simulation study will evaluate vessel movement throughout the entire study area with particular concentration on the following locations:

a. The entrance to Kill Van Kull.
b. The Bergen Point Bend.
c. The Port Elizabeth Maneuvering Area.
d. The Newark Bay Channels.
e. The North of Shooters Island Reach.
f. The Staten Island R.R. and Goethals Bridge.

4. The entrance to the Kill Van Kull is the site of complex traffic patterns where two-way deep draft traffic is combined with crossing ferry traffic and shallow-draft tug/barge units through a 60-deg bend forming a complex three-way traffic situation. Deep-draft vessels reduce speed when entering the Kill Van Kull; some vessels pick up their tug escort at this location. The proposed improvements in this reach require widening the entrance of Kill Van Kull to a maximum of 2,000 ft. Simulation at this location should simulate two-way tanker traffic through the bend with the center lane blocked to simulate the presence of a shallow-draft tug/barge combination and crossing ferry traffic. Normal rules of the road will be observed in the test procedure.

5. The Bergen Point bend at the junction of the Kill Van Kull and Newark Bay channels is a sharp 127-deg bend hampered by complex and varying currents formed by the confluence of three channels. The existing channel width is inadequate for two-way deep-draft traffic, forcing an oncoming vessel to hold in the channel until the bend is clear. As a result, this bend has historically been the site of many accidents. In addition to through traffic, the Bergen Point bend also serves as a turning basin for containerships to turn and back down the Arthur Kill. The proposed improvements require widening the bend to a maximum of 2,200 ft to accommodate two-way (deep/shallow) traffic. Simulation at the Bergen Point bend should include the following scenarios: two-way traffic (container and tug/barge), two-way container traffic with one vessel holding just outside of the bend until the bend is clear, and a containership and/or tanker entering the bend from Kill Van Kull turning around and backing into the Arthur Kill.

6. The Newark Bay channels serve the busy Port Newark/Port Elizabeth terminals and the Passaic and Hackensack Rivers. Two-way deep-draft traffic is common throughout most of the channels where channel dimensions permit. In addition to the two-way traffic, many vessels turn around and back into the Port Newark and Port Elizabeth Channels when docking. The proposed improvement of the main channel includes widening to 800 ft. Simulation in the Newark Bay Channels should include a container vessel entering the Bay from Kill Van Kull, passing an outbound vessel near the Newark Bay Middle Reach and turning into the Port Newark Channel.

7. The construction of the Port Elizabeth maneuvering area (maximum width 1,570 ft) would permit vessels to turn around within the Port Elizabeth Pierhead area, and create a safe area for

vessels to hold within Newark Bay while awaiting berth. Simulation within this area should include turning a containership and backing the ship into the Port Elizabeth Channel.

8. The Arthur Kill is a narrow confined channel whose dimensions are dictated by the existing width between the banks of the waterway. Traffic patterns in this channel vary with the width of the channel. The North of Shooters Island reach of the Arthur Kill experiences two-way deep-draft traffic, often with one of the vessels backing down from Bergen Point to the Howland Hook Marine Terminal. The remainder of the Arthur Kill experiences two-way traffic (deep-draft or shallow/deep) along the straight sections. One-way traffic is the general rule in the sharper bends. The proposed improvements include widening of the North of Shooter Island reach to 600 ft (800 ft at the junction of Kill Van Kull). Simulation in the Arthur Kill should include an inbound tanker proceeding from the Anchorage Channel through the Kill Van Kull and Bergen Point to the Gulfport terminal, meeting the various passing situations as described above.

9. The Staten Island R.R. Bridge and the Goethals Bridge span a 500-ft- wide section of the Gulfport reach of the Arthur Kill. Immediately south of the bridges, two sharp bends (19 and 45 deg) create a hazardous approach to the bridges. North of the bridges and south of the bends, the channel widens to 600 ft. Simulation of one-way traffic (tanker) might identify possible realignment of the approach sections to lessen the severity of the bend-bridge combination.

Model Components

10. Hydrodynamics. In order to determine the hydrodynamic forces affecting vessel navigation, a two-dimensional (2-D) vertically integrated, finite element model will be developed. The grid will have sufficient resolution within the channel areas to define lateral as well as longitudinal currents. The hydrography/ topography should be based on current hydrographic/topographic data such as channel sounding, NOAA navigation charts, etc. These data have previously been developed for the New York Harbor model study at U.S. Army Engineer Research and Development Center (ERDC)/U.S. Army Engineer Waterways Experiment Station (WES). The model will be verified for tidal propagation and current velocities throughout the numerical grid using available field data as well as physical model data. Field data have been collected for the previous New York Harbor and Kill Van Kull model studies. No additional hydrodynamic field data collection is expected.

11. To represent the improved conditions with the proposed channel, the existing hydrography above the project depth will be deepened to the project depth. Those areas naturally deeper will remain so. Bank conditions along the existing and proposed channels will be defined so that bank effects on vessels will be modeled.

12. Visuals and Radar. In addition to the hydrodynamics, a physical representation consisting of a visual scene and radar image will be developed to guide the pilots through the real-time simulation of the vessel transits. The visuals and radar should display all buoys, ranges, landmarks, prominent channel features, and obstructions normally used by pilots as aids-to-navigation. Traffic ships will also be displayed in the visual scene and radar image.

13. Vessels. The deep-draft design vessels to be modeled in the study are containerships and tankers in the “Pan-Max” class with a maximum beam of 106 ft. In addition to the deep-draft

vessels, a tug/barge combination is to be modeled to represent shallow-draft traffic. The dimensions of the three design vessels are presented in Table D-1 below.

Table D-1

			Static Draft	
Type	Length, ft	Beam, ft	Existing	Improved
Container	944	106	30	36
Tanker	880	106	30	35
Tug/barge	330	75	20	20

The actual loaded drafts should include the appropriate underkeel clearances (trim, density, and squat) as defined in References 1 and 2.

14. In addition to the individual vessels above, the study should model the tankers and containerships with tug assistance when required. The number, placement, type, and size of tugs will be coordinated with the local pilots. Tug assistance may be modeled as a force on the ship with controlled direction and magnitude.

15. It is understood that models of these vessels have been previously developed and are currently available. Modifications required are expected to include variation in draft.

Modeling Approach

16. The scope of testing is being limited to two project channels. The existing channel will be the base condition. The plan condition will include both Kill Van Kull and Arthur Kill projects deepened to the Phase I depths of 40 ft as designed and approved by the New York District. In addition, the hydrodynamics of the Kill Van Kull deepened to 44 ft will be evaluated. No testing of a channel condition in which only one project is completed and the other is not, e.g., build Kill Van Kull and not Arthur Kill, is included in this scope of work. Any consideration of these options may require additional testing.

17. Preliminary Simulation Tests. Because of time and cost limitations, preliminary tests will be limited to checking out the simulator setup. In order to identify the most critical conditions to be used in the real-time simulations, discussions with the local pilots will be conducted to determine the appropriate tide stages, wind conditions, and vessel traffic conditions that create the most severe navigation conditions. These preliminary simulations will be conducted in lieu of auto-piloted fast-track analyses since auto-piloted tests are not practical for the high degree of maneuverability required in the project channels.

18. Real-time Simulation. Upon determination of the worst conditions, the selected conditions will be tested using real-time simulations piloted by local pilots, with a visual “view-out-the-window” scene, a simulated radar image, and operating with the ship's console with appropriate ship controls and instruments. It is expected that these tests will include piloting by experienced New York Harbor pilots (Sandy Hook Pilots and/or McAllister Tugboat Pilots). The tests will determine if the proposed channel is too small, too large or near the optimum dimension and proper alignment. This will be based upon being able to maintain adequate control of the vessel, sufficient clearance from

the channel edges and distance between the ships being passed. Passing situations will be set up to occur at several places, including bends and straight sections. The passing situations will be evaluated based on positions and orientations obtained from individual transits through the channel reacting to a meeting traffic ship by maintaining location within a passing lane. It is anticipated that the above test procedure will be refined, based on pilot consultations.

19. Scenarios. Tests will be conducted for both existing and improved channel dimensions (width and depth). In general, simulations should reflect existing traffic situations discussed briefly above and in detail in U.S. Army Engineer District, New York, "General Design Memorandum, Kill Van Kull and Newark Bay Channels, New Jersey and New York," June 1986, and U.S. Army Engineer District, New York, "Feasibility Study, Arthur Kill Channel, Howland Hook Marine Terminal, Station Inland, New York," March 1986. It is expected that the tests can be divided into two sets - Kill Van Kull/Newark Bay and Kill Van Kull/Arthur Kill. Runs for the Kill Van Kull/Newark Bay tests should include but not be limited to a containership entering the Kill Van Kull from New York proceeding north through Newark Bay and turning into Port Newark; a containership transiting Kill Van Kull, holding at the Bergen Point bend for an outbound vessel to pass, proceeding into Newark Bay, turning around in the Port Elizabeth maneuvering area and backing into Port Elizabeth Channel; and an outbound container vessel leaving Port Elizabeth through the Bergen Point bend into Anchorage Channel. To simulate emergency conditions, a run should be made with a containership loosing power entering the Bergen Point Bend and being guided through the bend using tug assistance only.

20. Runs for the Kill Van Kull/Arthur Kill tests should include but not be limited to a containership entering the Bergen Point bend, turning around and backing down the Arthur Kill to Howland Hook; a containership exiting from Howland Hook through Kill Van Kull straight through Bergen Point; a tanker entering Kill Van Kull, proceeding straight through Bergen Point and continuing through the Arthur Kill to Gulfport with the appropriate passing situations; and a tanker exiting from Gulfport through Bergen Point and out Kill Van Kull.

21. Tug assistance would be required to be available for all transits, turning and backing maneuvers.

22. Location of critical passing situations will be identified by the local pilots.

23. Environmental conditions, such as winds and visibility, will be determined upon discussions with pilots and analysis of available data.

Study Outputs

24. In order to determine the effectiveness of the proposed channel improvements, the data outputs of the model study should include but not be limited to the following:

a. Vessel position relative to the channel boundaries, bridges, and passing vessels.
b. Vessel control measures, e.g., rudder used, drift angles, etc. for various tests.
c. Pilot's assessment of the test conditions.

25. The format of the output, method of analysis of output data, and the specific variables to be evaluated will be determined prior to the initiation of the study.

Study Management

26. Schedules. The preliminary results for the Arthur Kill reaches are required by 30 December 1987; results for the Kill Van Kull and Newark Bay reaches are required by 30 September 1988. Changes in the proposed schedule must be approved by the New York District in advance.

27. Monitoring Study Tasks. It is the intention of the New York District to carefully monitor the hydrodynamic and simulation modeling described in this SOW. Monthly progress reports will be submitted through the first of each month due 15 calendar days later. The monthly progress reports will cover:

a. Accomplishments since the previous report.
b. Progress to date.
c. Preliminary study results.
d. Expected accomplishments for next month.
e. Existing and adherence to schedule.
f. Anticipated problems and consequences.
g. Recommendation for study changes, if necessary.
h. Funding allotted and spent to date.

28. Coordination meetings will be held as agreed upon by the New York District and ERDC/WES. It is anticipated that approximately three meetings will be held; however, this is dependent upon study needs.

29. Contract Work. The ship simulation portion of this study will be conducted by Tracor Hydronautics, Inc., using the Computer Aided Operations Research Facility (CAORF) under the guidance of ERDC/WES. Tracor is a partner in the privatized operation of CAORF. Contracting will be performed under an existing contract with Tracor. This facility was chosen because a model of New York Harbor exists and can be readily modified and because it is located near the project site and the local pilots that would be involved in the study.

Report Requirements

30. Management Plan. Prior to the initiation of work, a management plan will be submitted to detail the procedures and methodologies, assumptions, and test schedule.

31. General. Reports on the ship simulation model studies will present study results, explanations of study procedures used, and interpretations of study results. Published formal reports, except routine progress reports, will conform to requirements of ER 1110-1-6 relating to identification of proprietary matters, key sheets, and statement prohibiting use of the report for promotional purposes.

32. Interim Reports. In an effort to reduce costs and save time, separate interim reports will not be required. However, the information normally presented in these reports (a brief description of

study results and problems encountered, one to two typed pages written in a form that will be of use to lay personnel with supporting documentation) will be included in the Monthly Progress Report following the completion of each subtask of Tasks 1, 2, and 3.

33. Summary Report. A draft summary report will be prepared for use by the New York District in a form that will be of use to both technical and lay personnel. Its purpose is to provide the District with sufficient information to be incorporated into the documentation to both higher authority and interested private organizations. The report will clearly describe the study aspects such as, methodology and procedures, hydrodynamic model verification, ship simulation study results, and conclusions. The draft summary report need not be more than 20 pages and will be completed 2 months after completion of the testing. The District will review the report and return the draft for revisions (if required) within 30 days from receipt of District's comments.

34. Final Report. A final report will be prepared for the ship simulation model study. The document will contain a complete discussion and analysis of the technical studies. A draft of this report accompanied by a suggested distribution will be submitted to the New York District Engineer for approval prior to publication.