Mariner Study and Ship Simulation Modeling of the Maritime Implications for the Port of Anchorage Modernization Project

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Questions, Comments and Requests for More Information

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Executive Summary

This study was conducted to identify and understand the maritime safety implications of the Anchorage Port Modernization Project (APMP). To achieve these goals, this study used the following methods of data collection and analysis: Seventeen interviews with stakeholders and subject-matter experts; Fifty-one simulations of five different vessel types docking and undocking under varying environmental conditions during construction phases of APMP; and a focus group with nine subject-matter experts and observers. Based on the results of this analysis, this report contains twelve recommendations for APMP construction.

Recommendation 1: The highest priority for mariners concerning the port modernization project is to cut back the present Northern Extension as soon as possible.

Recommendation 2: Name Petroleum Oil and Lubricants (POL) berths ‘POL North’ and ‘POL South’ to eliminate any confusion caused by the elimination of POL 1 and the construction of a new POL 1.

Recommendation 3: During construction APMP will be disruptive for ships and port activity due to the offset alignment of berths. The APMP construction phasing plan should not be initiated and then stopped without the capability for completion, due to the berths offset alignment. This means that funding for completion of construction should be secured prior to making the docks offset.

Recommendation 4: Make a third tugboat available during construction to assist vessels during the ice season.

Recommendation 5: Make a second tugboat assist available, with bollard pull equivalent to or greater than the Stellar Wind, during the construction process to minimize docking and undocking risks.

Recommendation 6: Place current meters where POL 1 and POL 2 are to be constructed to ascertain the current flow direction at various stages of the tide.

Recommendation 7: The POL 1 north dolphin installation should be delayed until POL 2 is brought out and made parallel with POL 1.

Recommendation 8: The north end of the newly constructed Terminal One during Phase Two will be difficult for Horizon when docking and undocking at their present berth. Developers may consider shortening Terminal 1 and using a temporary trestle in place of the north end of the actual berth during Phase Two to minimize this difficulty.

Recommendation 9: Propose an agreement of cooperation between TOTE and Horizon docking priority to assure the safety of all ships.

Recommendation 10: If feasible, construction barges utilized for the POA modernization project should be required to use spuds for mooring instead of anchors.
Recommendation 11: Provide ship simulation training to ship pilots prior to APMP in order to expose them to the port facilities.

Recommendation 12: Additional research should be conducted to further investigate the simulations that are identified as ‘moderate to high concern’ in this report. These include: the potential adjustment of the cutback of the Northern Extension, the variation in tugboat assists, and further investigation into port operations during Phase Two of APMP.
I. Introduction

The Port of Anchorage (POA) is essential to Alaska’s economy, serving both citizens and industry. The safe passage of ships in and out of the port is essential for the economic and environmental health of the state. A modernization project, known as the Anchorage Port Modernization Project (APMP), was designed to increase the sustainability and effectiveness of the POA by developing modern, safe, and efficient terminals. The APMP is undertaken by the engineering firm, CH2M Hill. Safeguard Marine LLC (SGM) is working in collaboration with CH2M Hill to identify aspects of the APMP that pose a marine safety concern, and to make recommendations that mitigate such concerns.

The data used to identify and analyze the aspects of APMP which concern mariners were collected from three sources of data collection and analysis. First, seventeen local maritime experts and POA stakeholders were interviewed on their opinions of the APMP design and construction, as well as their recommendations for simulation variables in SGM’s simulated analysis of the APMP process. SGM’s process of seeking input from the end users—mariners who possess local knowledge of ship operations within POA—was well received by all interview participants. Then, fifty-one simulations were conducted by expert mariners in which vessels were docked and undocked in varying environmental conditions during multiple phases of construction. Participating mariners were interviewed after each simulation, and asked to identify aspects of the APMP that made it difficult to safely dock and undock vessels in the simulated environmental conditions. These difficulties do not testify against the need for a POA modernization project, but rather reveal some areas of concern in APMP development. Finally, a focus group of six expert mariners, two CH2M Hill representatives, and the Director of the Port of Anchorage was organized to discuss simulation results, APMP plans, and make recommendations to mitigate maritime concern.

Data from stakeholder interviews, mariner simulations, and the focus group was collected, analyzed, and reported by SGM and more specifically the Co-Primary Investigators on this project, Jeff Pierce and Jonathan Pierce. From the data, SGM has determined twelve recommendations that will mitigate maritime concern. If these recommendations are implemented, APMP will more likely to develop a port that safely meets the State of Alaska’s and the City of Anchorage’s demands for economic growth and environmental protection.

This report is organized as follows: (1) discussion of the methods of data collection including interviews, simulations and focus group, (2) results of analysis, (3) recommendations, (4) conclusions, and (5) appendix, including simulation data.

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1 At this time Horizon has been renamed Matson, within this report we reference Horizon because we started this process with that name and it may create confusion if we attempt to substitute Matson for Horizon within the report.
II. Methods

A. Interviews

Interviews were conducted to utilize local mariners’ expertise in evaluating and discussing the practical implications of APMP construction, as well as to ascertain the value and viability of SGM’s APMP study simulations. Seventeen interviews were conducted with local stakeholders and maritime experts. The individual interviews are confidential, and results are reported in aggregate. Representatives from the following organizations were interviewed: Southwest Alaska Pilots Association (SWAPA), Totem Ocean Trailer Express (TOTE), Horizon, Cook Inlet Tug and Barge, Tesoro, U.S. Coast Guard, Cook Inlet Regional Citizens Advisory Council, and dredgers from Manson Construction Company. Interviews were conducted via the telephone by the co-primary investigators and notes were taken by designated recorders. The interview notes were then emailed to the interviewees to verify their accuracy and invite further comment.

The interviews gathered information about proposed APMP simulations, including: the quality and quantity of simulation participants, tugboat assist information, the range of environmental conditions (ice coverage, ice thickness, current, and wind direction and speed), characteristics and practicality of the model vessels, and descriptions of the six phases of construction. Interviewees were asked a series of questions based on this information. The complete interview protocol is found in Appendix 1. The aggregate answers to the interview questions are discussed in the results section of this report.

B. Simulations

SGM conducted fifty-one simulations with six mariner participants of various vessel approaches when docking and undocking at POA. These simulations were conducted by three simulators from Kongsberg’s “Polaris Ship’s Bridge Simulator” at the Alaska Vocational Technical Center (AVTEC) Marine Training Center in Seward, Alaska. This simulator has been certified by the U.S. Coast Guard for instruction and training. The simulations occurred over a period of two days. These simulations were supervised and administered with the assistance of Mike Angove, a maritime simulator technician who has been educated by Kongsberg to operate the simulator. A picture of the simulator can be found below in Figure 1.

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2 For more information about the simulator, please see the website for Kongsberg Maritime AS (http://www.km.kongsberg.com/). For more information about the specific simulator used in this study, please see Alaska Vocational Technical Center (http://www.avtec.edu/AMTC-Sim.aspx).
Figure 1. Photograph, actual bridge utilized for the simulation.

The simulations utilized both historical and current data. Historical data about environmental conditions in Upper Cook Inlet came from “Marine Ice Atlas for Cook Inlet”³ and Weather Source.⁴ Current data about tides and currents in upper Cook Inlet at the POA came from NOAA 2015 Current Table,⁵ local knowledge from mariners gathered during the interview process, and observations conducted for this study. Data about the various ships that may utilize POA included a Ro Ro vessel, a container ship, a handy bulker, a cruise ship, and a shuttle tanker. Data about tugboats that currently assist vessels at POA came from Cook Inlet Tug and Barge personnel. In addition to data about environmental conditions, vessels, and tugboats, data concerning APMP construction phases were provided by CH2M Hill to AVTEC. Input for the water depths were based upon March 2015 soundings of the port area. The most recent version of APMP construction phases (March 2015) was reconstructed on the simulator within a meter of accuracy to create a realistic and accurate depiction of the POA during APMP. The simulation database was created with explicit detail, to the point that even the lamp post in the port was reconstructed to within a meter.

To ensure the validity of the simulations, several experienced mariners participated in the simulations. Participants included current and former SWAPA pilots, a TOTE pilot, Cook Inlet Tug and Barge captains, and a master mariner. These participants operated simulated vessels in approaching, docking, and undocking maneuvers in various conditions of POA during APMP construction. In addition to the mariners, observers from CH2M Hill, Port of Anchorage, and the Municipality of Anchorage also attended the simulations.

Process

All fifty-one simulations were created with specific objectives to replicate the most extreme conditions that may be encountered at POA during specific construction phases. The simulation objectives were created based upon an overview of the data retrieved from the seventeen interviews conducted prior to the simulations. Each objective (tailored for particular vessel

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³ Mulherin et al., 2001
⁴ Weather Source, 2015.
⁵ NOAA, 2015.
types) was created to replicate scenarios that were realistic to the experiences of interview participants. Prior to the interviews, the interviewees were provided a PDF that was presented by CH2M Hill to the Anchorage City Assembly detailing the proposed construction phases. This document included extensive comments and questions created by SGM to stimulate their thoughts concerning the APMP process.

After the interview process was completed, responses were compiled to create simulations that replicated maneuvers of concern under the APMP. This was done to evaluate the areas of concern and consider end-user recommendations. Fifty-one simulations were then created and performed over a two-day period to evaluate the concerns of interviewees.

**Vessels**

The vessels modeled in the simulations were representative of the ships presently operating in the POA. These include TOTE, Horizon, Tankers, Bulkers, and Cruise vessels. TOTE and Horizon ships frequent the port twice per week, while Tankers have recently increased their port calls from only five in 2013 to fifteen in 2014. Bulk carriers calling at the POA are predominantly cement ships with infrequent bulk cargos. Cruise ships have frequented POA as regular callers with some annual variation.

Tugboat and barge traffic was not simulated because the vessels operate from the same POL berths that was used to simulate bulkers and tanker traffic. Tugboat and barge combinations have less tonnage and length, and thus their simulations are not required if ship traffic is simulated.

TOTE was simulated with a model SGM purchased for these simulations, the Kongsberg library’s ‘Texas Ro Ro’ with the following characteristics: length 864’, beam (width) 106’, draft (depth) 39’, gross tonnage 66,635 tons, diesel electric single propeller with two thrusters on the bow and stern, 2,560 horse power (HP) each. This model has a similar block coefficient as present TOTE ships yielding similar handling characteristics. The power plant was a single propeller instead of twin propellers (as it is for present TOTE ships), and therefore required an adaptation by the pilot during simulations. Due to the thrusters’ significant horsepower, a majority of the simulations were performed using thrusters and minimal tugboat assistance.

Horizon was simulated using the ‘Horizon Tacoma’ model, which was available through the AVTEC library. This model is representative of the three Horizon ships that frequent the POA. The model was an exact replica of the Horizon ship, however it lacked a stern thruster, and the bow thruster had less horse power. The majority of the simulations were performed utilizing tugboat assist due to this minimal thruster capability.

The Tanker was simulated with a 53,000 Dead Weight Ton (DWT) model from the AVTEC library. This model is representative of tanker vessels frequenting POA and has the following characteristics when loaded: 44’ draft, length 600’, beam 105’, small bow thruster, 1,632 HP, and a single propeller. Handling characteristics of the model were similar to the tankers that

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6 Whitt, 2015.
frequent the POA because the block coefficient was representative of other tankers frequenting Cook Inlet. Simulations were performed with two tugboats assisting.

The Bulker model simulation was conducted to replicate the Handy Max Bulkers with the following characteristics: 580’ long, 102’ beam, draft 39’, and 1,496 HP bow thruster with a single propeller. The Bulker was underpowered, similar to a typical Handy Max Bulker frequenting POA. The block coefficient was also representative of other Handy Max Bulkers. The vessel had a difficult time maneuvering in ice simulations, even with the two tugboat assists, because of low horse-power and the block coefficient of the hull.

The cruise ship model has the following characteristics: 855’ long, 106’ beam, 26’ draft to be representative of larger cruise ships frequenting POA. The block coefficient of the hull is similar to cruise vessels that use two propellers with significant horse power and two thrusters (each 6,118 HP) located on the bow and the stern. No tugboats were assigned to this vessel during simulations, which is representative of normal POA operations. The simulated vessel handled maneuvers very well, however the space for mooring was limited by simulated APMP construction phases.

**Assist tugboats**

Two ship assist tugboats were utilized during the simulations. One tugboat assist had 50 bollard pull tons while the other had 35 bollard tons. Both the POA harbor tugboats are azimuth drive—the *Stellar Wind* 3,500 HP and the *Glacier Wind* 2,200 HP. These models were available for vessels during simulations to represent the tugboats presently available at the POA. However, because three simulators were operating simultaneously, only four tugboats were available during any particular simulation. Simulator operators had to apply engine orders from the pilot for each tugboat, and could adequately manage up to two tugboats simultaneously. Tugboat forces were degraded manually by the simulator operators to create realistic simulations. For example, a maximum of 40 tons was applied to the *Stellar Wind*, which is a 50 ton bollard pull tugboat model, and the *Glacier Wind* had maximum 28 tons for 35 ton bollard pull, and proportionately less per pilot order. This degraded factor was based upon consultation with tugboat operators who presently operate assist tugboats in the POA.

**Environmental Conditions**

Wind: Simulated wind conditions were based upon several different factors, including interview responses about maximum wind speed in mariner experience, fifty-year historical wind speed and direction data from the Elmendorf Air Force Base, and worst-case scenario wind conditions for each particular simulation. All simulated vessels were affected by problematic wind conditions. The TOTE vessels were most affected due to the large amount of wind-sail area on the vessel. A majority of the TOTE vessel simulations were operated without tugboat assists.

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7 For more information about the tugboats at POA see the website for Cook Inlet Tug and Barge [http://www.cookinlettug.com/about/](http://www.cookinlettug.com/about/)

8 Weather Source, 2015.
because of available thrusters, however they were determined to be ineffective in any wind greater than 15 knots.

Current: Current calculations were created for the most difficult scenarios to include high water velocities and various current directions encountered within the limited area of the POA. These calculations were derived from different sources, including NOAA data from four different current stations⁹, and input from the mariners—including dredgers—during the interview process. Current maps were designed prior to the interview process, and every interviewed mariner was asked to evaluate the legitimacy of the proposed currents. Current maps were then altered to account for interview responses. Cook Inlet Tug and Barge volunteered their vessel to drift the location of proposed POL 1 dock to ascertain the actual current direction and velocity prior to construction. All of this information was integrated into five separate current maps representing five different current conditions. These conditions are: large ebb, small ebb, large ebb two and a half hours after low water, small flood, and large flood. Each of these specific current maps was represented with four different velocities and directions pertaining to the location from dock face outward into the harbor. These maps are identified below in Table 1.

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⁹ NOAA, 2015.
Table 1. Current Maps Used for POA Simulations

<table>
<thead>
<tr>
<th>Map Numbers</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Way Points from Current Map</td>
<td>Large Ebb/ Early Tide/ No back Eddy</td>
<td>Large Ebb/ Late Tide/ Flood Back Eddy Face Dock</td>
<td>Small Ebb</td>
<td>Large Flood (Fld)</td>
<td>Small Flood (Fld)</td>
</tr>
<tr>
<td>56 &amp; 58</td>
<td>4 knot ebb 200 degrees</td>
<td>4 knot ebb 200 degrees</td>
<td>2.1 knot ebb 200 degrees</td>
<td>5.1 knot Fld 020 degrees</td>
<td>2.7 knot Fld 020 degrees</td>
</tr>
<tr>
<td>57 &amp; 59</td>
<td>Slack water 200 degrees</td>
<td>Slack water 200 degrees</td>
<td>0.4 knot ebb 200 degrees</td>
<td>1.7 knot Fld 020 degrees</td>
<td>0.6 knot Fld 020 degrees</td>
</tr>
<tr>
<td>22 &amp; 60</td>
<td>5.3 knot ebb 200 degrees</td>
<td>5.3 knot ebb 200 degrees</td>
<td>2.7 knot ebb 200 degrees</td>
<td>5.9 knot Fld 020 degrees</td>
<td>3.2 knot Fld 020 degrees</td>
</tr>
<tr>
<td>Face of Dock out to 550’</td>
<td>2.5 knot ebb 200 degrees</td>
<td>1.5 knot Fld 020 degrees</td>
<td>1.0 knot Fld 020 degrees</td>
<td>3.0 knot Fld 020 degrees</td>
<td>1.0 knot Fld 020 degrees</td>
</tr>
</tbody>
</table>

All current directions are in degrees that the water moves toward the heading. Current direction was simulated parallel with dock faces for both new POL Docks.

Ice: Ice conditions are extremely difficult to accurately replicate in simulations. Creating an accurate simulation of ice for POA was difficult due to the various currents, velocities, and directions associated with ice flow. Ice does not move along with water flow during simulations, and thus separate ice maps that consider various current maps were required, as seen in Table 2.

AVTEC Seward is the first and only simulator in the United States to be certified by the U.S. Coast Guard to teach ice navigation classes. Designed and implemented by AVTEC’s nationally accredited maritime simulator and staff, the ice simulations conducted in this study most accurately demonstrated the ways in which ice can hinder a vessel’s movement docking and undocking at the POA.
Table 2. Ice Maps Used for POA Simulations

<table>
<thead>
<tr>
<th>Map Numbers</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of ice</td>
<td>Large Ebb/ Early Tide/ No back Eddy</td>
<td>Large Ebb/ Late Tide/ Flood Back Eddy Face Dock</td>
<td>Small Ebb</td>
<td>Large Flood (Fld)</td>
<td>Small Flood (Fld)</td>
</tr>
<tr>
<td>Face of docks outward to 550’ offshore</td>
<td>1.0 knots 200 degrees toward</td>
<td>1.0 knots 020 degrees toward</td>
<td>0.75 knots 020 Degrees toward</td>
<td>2.0 knots 020 degrees toward</td>
<td>0.75 knots 020 Degrees toward</td>
</tr>
<tr>
<td>From 550’ off dock to 865’ offshore</td>
<td>1.5 knots 200 degrees toward</td>
<td>0.0 knots</td>
<td>0.0 knots</td>
<td>2.5 knots 020 Degrees Toward</td>
<td>1.0 knots 020 Degrees toward</td>
</tr>
<tr>
<td>From 865’ off dock to 1,255’ offshore</td>
<td>2.0 knots 200 degrees toward</td>
<td>1.1 knots 200 degrees toward</td>
<td>1.0 knots 200 degrees toward</td>
<td>3.0 knots 20 Degrees toward</td>
<td>1.5 knots 020 Degrees toward</td>
</tr>
<tr>
<td>From 1,255’ off dock out into port continuous</td>
<td>3.3 knots 200 degrees toward</td>
<td>3.3 knots 200 Degrees toward</td>
<td>2.0 knots 200 degrees toward</td>
<td>4.0 knots 020 Degrees Toward</td>
<td>2.5 knots 020 Degrees toward</td>
</tr>
</tbody>
</table>

Ice thickness for all simulations was 0.5 meters, and coverage was 70%. Five separate ice maps were utilized for all ice simulations. Each map consists of four ice fields, all of which moved at different speeds and directions.

Construction Phases

CH2M Hill provided all information on the proposed construction phases of APMP, including dock alignments during construction. This information was integrated into the simulator by AVTEC, resulting in simulations that replicated each of the six different phases of construction, including completion. This information was forwarded to all interviewees prior to the interviews, along with notations concerning SGM’s evaluation of possible effects on vessel operations. During the interviews, participants were asked to comment on their concerns for each phase of the construction process. This feedback was then used to create the simulations based upon the mariners’ greatest concerns. TOTE personnel were most concerned with Phases Three and Four, while Horizon highlighted Phases Two, Three, and Four. Final phase simulations were requested by all mariners in order to determine the feasibility of the finished product.

Phase One of APMP, which involved the cut back and stabilization of the Northern Extension, the demolition of the port administration building, and the construction of POL 1, was not simulated because Phase Two simulations encompassed the ramifications of new POL 1 construction, and neither Horizon or TOTE were being affected by other Phase One alterations.
Phase Two was simulated using bulkers, tankers, cruise ships and Horizon. This was simulated to replicate the limited amount of sea room during the construction of Terminal 1, located south and offshore of Horizon ships, as well as the inset present at POL 2. Phase Three was simulated with TOTE to replicate scenarios during the construction of the new Terminal 2, located south of TOTE and seaward of their preset berth. Phase Four simulations involved moving TOTE to the newly constructed Terminal 2, with temporary trestles directly north of the Horizon berth. Phase Five simulations ran scenarios of operations around the new Terminal 2 for TOTE and the demolition of Terminal Three, located north of all the newly constructed docks. The final phase involves moving POL 2 outboard from shore to coincide with the other berths.

Construction barges were consistently referenced during the interviews as a possible problem for the ships, and thus numerous barges were placed in awkward positions during the majority of simulations. Other vessels were also placed alongside berths to create realistic worst-case situations in every simulation.

Objectives

The simulations were designed to replicate operations during multiple phases of APMP construction including the final port design. This was done to evaluate the legitimacy of the interviewed mariners’ greatest concerns in APMP construction and design. All of the simulations were based upon the worst and most extreme conditions that may be encountered in APMP, making simulations very difficult for the mariners. Exit interviews were conducted with mariners participating in the simulations immediately after they completed the simulated objective. A screen view of the simulation, which depicted exactly what occurred during the simulation every three minutes was immediately portrayed on a large screen in the debrief room where participants were interviewed. The mariner was thus able to immediately recall their thoughts and concerns at the time of the simulation. The post simulation interviews included debriefing comments along with a closed-ended survey question: “What is your level of concern for the completed simulation?” The scale was from 1 to 5 (1 = not at all concerned, 2 = slightly concerned, 3 = somewhat concerned, 4 = moderately concerned, and 5 = extremely concerned). A description of the objectives and conditions, result of the closed-ended survey question, and the screen shot of all fifty-one simulations is in Appendix 2.

The mariners performing the simulations were selected by SGM due to their known level of competency and regard as being highly proficient at the art of ship handling. Simulation participants were very intent on completing the objectives successfully, and approached the simulations with a serious and professional manner. Again, simulation objectives were based upon realistic conditions with extreme maximum velocity currents and winds from the worst direction. Vessels and construction barges were strategically placed at neighboring docks to create obstacles that compounded the extreme environmental conditions. The number of available assist tugboats were based on what is presently available at POA.

Regarding the simulation process, SGM worked in partnership with AVTEC to create the most accurate simulations possible, both in design and operation. This required extensive consultation with an AVTEC simulator operator and the evaluation of numerous test simulations prior to the simulations. Each simulation was based upon SGM’s extensive local knowledge of the
environmental conditions, ship specific maneuvering characteristics, and tugboat assist capabilities. Each simulation required the simulator to be adjusted and prepared by the simulator operator prior to the simulation. SGM knowledge of simulation procedures, in addition to the cooperation between AVTEC personnel and SGM coordinators, minimized the set-up process and allowed for the maximum amount of quality simulations during the two-day simulation period. Participant feedback during and after the simulations confirmed that the simulation process was both effective and efficient.

C. Focus Group

In order to validate and interpret the results of the simulations, as well as determine recommendations for improved safety, a focus group of expert stakeholders was conducted at the Port of Anchorage. The focus group included all simulation participants (four pilots and two mariners), as well as simulation observers such as Port of Anchorage Director Stephen Ribuffo, Captain Mark Daly (TOTE), and two representative from CH2M Hill, Lon Elledge and Elizabeth Calvit. During the focus group, a presentation was made by SGM about the purpose and goals of the research, the data collection process (including interviews and simulations), and the results of the simulations. Focus group participants were provided with a written draft of the simulation results prior to the meeting.

SGM developed nine questions for the focus group to discuss. These questions explored issues such as alterations to the Northern Extension, the number of tugboats necessary to safely assist traffic, and others. These questions were supported with visual evidence from simulation screen shots that can be found in Appendix 2. Notes were taken throughout the discussion and synthesized into multiple recommendations. These recommendations were then discussed with widespread support from the participants. The recommendations discussed during the focus group are outlined in the recommendations section of this report.
III. Results

A. Results of Interviews

The main results from the interviews were that the proposed simulations would be sufficient to determine the capability of vessels to safely dock and undock at the POA during APMP. In addition, interviewees agreed that the participants chosen to take part in the simulations were appropriate experts for this research. Some of the interviewees suggested specific conditions, such as current direction or wind speed for simulations. Interviewees were also asked specific questions about APMP. The responses from the interviewees included below are prior to the simulations.

1. During APMP construction process as portrayed within the attachment, do you foresee any difficulty maneuvering ships at the port?

Respondents consistently answered “yes.” They identified various reasons for this rationale including changes in currents and greater exposure of ships to ice (Interviews #3, 4, 5, 9, 10). In many cases, they specified detailed maneuvers such as “docking and undocking POL 2 during construction with offset berths” (Interview #6). In particular, mariners demonstrated a great amount of concern during Phase 2 of APMP (Interviews #4, 7, 8, 10, 11, 15).

2. Do you think any currents we presently encounter at the port will change due to the construction process?

Again, respondents consistently answered “yes” (Interviews #4, 5, 7, 9, 10, 11, 12, 13, 14, 15, 16). An example of an anticipated effect on currents is, “Presently on a flood the water stacks up behind TOTE and the dock face all the way up to Horizon Marine Building. This ‘cushion’ provides a comforting, slowing of the vessels inertia at the final phases of docking. I am anticipating that this cushion will be eliminated after Phase One of the construction process” (Interview #7). Another example is “Cutting back the Northend Extension will allow the water to flow less obstructed and will result in the decrease of the back eddies associated with the north end dock, TOTE. However, the docks further to the south will probably experience a back eddy with less velocity than previously experienced” (Interview #16). These changes in currents should be accounted for in future research and designs of POA.

3. Will the new POL 1 have an effect upon ice movement at the berths?

The respondents stated that ice movements would change at POL 1 (Interviews #4, 5, 7, 9, 10, 11, 13, 14, 15). More specifically, “because the new POL will be pushed offshore, the berth will pull shorefront ice and complicate ice movements around the berths. This will make it tough to wash the ice and clear it for navigation” (Interview #4). It is clear that changes in ice movements are a concern of mariners for vessels docked at POL 1. The cement bulkers will be the most widely effected by ice at POL 1. During the past seven years (2009-2015), there have been 12 movements of these bulkers at POL 1 during winter months (November – March) for an average of about two per year.10

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10 Please note that we have been informed that CH2M HILL is currently conducting a separate ice study of APMP. This study will evaluate the ice conditions at POL 1 and the entire project.
4. Will the new POL 1 affect their approach for starboard side to other berths at POA?

The majority of responses from mariners predicted that, though the starboard side approach would be more difficult, it would still be possible (Interviews #4, 5, 6, 7, 9, 10, 11, 14, 15). However, they warned that “ice during the winter months may be problematic” (Interview #7). Also, “Because of its new location, POL 1 will force mariners to take a more aggressive attack angle when approaching starboard side two” (Interview #9). The new POL 1 will change how mariners approach from starboard for docking vessels at POA.

5. Do you anticipate having to utilize assist tugboat(s) more frequently than presently done for docking and undocking during APMP?

The majority of respondents stated that due to construction, additional tugboats would be necessary during APMP (Interviews #3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15). This would mean that a third tugboat should be made available to assist. The reasons for this are due to the various phases of construction. For example, “By moving the new Terminal 1 further to the south, the current angle on vessels docking has changed. Vessels may no longer be directly stemming the current on their final approaches to the dock” (Interview #7). “With staggered docks, differing currents, and the new POL 1 sticking out, undocking will be a tight maneuver that will likely require additional support” (Interview #14). Also, during certain conditions, such as the presence of ice or during the ebb, multiple tugboat assists would be necessary (Interviews #4, 7, 9). Overall, additional tugboat assists should be made available during construction and for adverse environmental conditions.

6. Which phase of the construction project do you think simulations should be concentrated upon to best determine ability of the port to operate during construction?

Many interviewees expressed the deepest concern for operations during Phase Two (Interviews #4, 5, 7, 8, 11, 12, 13, 15). The rationale is that they want to see simulations of Horizon docking and undocking at the current dock during construction for both port and starboard. Particularly concerning are the changing conditions from the Northern Extension and Terminal One (Interview #5). Also, mariners wanted simulations to also concentrate on final construction in particular the placement of the new POL (Interviews #4, 6, 9, 14).

7. Finally, what are your general feelings concerning APMP?

The feedback on the final phase was positive and largely concluded that, while APMP construction may create some growing pains, the final product would be an improvement over the present POA (Interviews #1, 5, 7, 14). The interviewees also voiced an appreciation for the research (Interviews #6, 10, 11, 13, 14, 17), with one interviewee stating, “It is about time they listened to the mariner” (Interviews #13). The respondents were glad that mariner input was being considered for the project.

B. Results of Simulations

Preliminary results of the simulation data indicate that problematic situations, due to the necessary phasing of APMP construction, will create challenges for mariners in the POA. Specifically, the offset of dock alignments did not allow enough room for vessels to safely
manage the simulated environmental conditions with the present number of assist tugboats available within POA. Recommendations concerning some of the proposed construction phases were pursued during the focus group.

The tables below report the level of concern reported for the various simulations on a scale from 1 – 5 (1 = not at all concerned, and 5 = extremely concerned). Simulations with a reporting mean score of 4 (moderate concern) or higher are in bold.

Simulations Based Upon Ship Type and Phase of Construction

Table 3. All Simulations Reporting Mean Level of Concern and Number of Simulations Performed

<table>
<thead>
<tr>
<th>Phase</th>
<th>TOTE</th>
<th>Horizon</th>
<th>Tanker</th>
<th>Bulker</th>
<th>Cruise</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0 Sim</td>
<td>3.25/ 8 Sim</td>
<td>2.0/ 5 Sim</td>
<td>3.5/ 2 Sim</td>
<td>4.0/ 2 Sim</td>
</tr>
<tr>
<td>3</td>
<td>2.8/ 5 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>4</td>
<td>3.0/ 4 Sim</td>
<td>2.0/ 2 Sim</td>
<td>3.3/ 4 Sim</td>
<td>4.33/ 3 Sim</td>
<td>1.0/ 1 Sim</td>
</tr>
<tr>
<td>Final</td>
<td>2.25/ 4 Sim</td>
<td>2.75/ 4 Sim</td>
<td>2.0/ 4 Sim</td>
<td>4.0/ 1 Sim</td>
<td>1.0/ 1 Sim</td>
</tr>
</tbody>
</table>

Table 4. All Ice Simulations Reporting Mean Level of Concern and Number of Simulations Performed

<table>
<thead>
<tr>
<th>Phase</th>
<th>TOTE</th>
<th>Horizon</th>
<th>Tanker</th>
<th>Bulker</th>
<th>Cruise</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0 Sim</td>
<td>2.5/ 4 Sim</td>
<td>2.5/ 2 Sim</td>
<td>4.0/ 1 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>3</td>
<td>3.5/ 2 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>4</td>
<td>2.5/ 2 Sim</td>
<td>2.0/ 2 Sim</td>
<td>3.3/ 4 Sim</td>
<td>4.33/ 3 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>Final</td>
<td>2.3/ 3 Sim</td>
<td>2.0/ 2 Sim</td>
<td>3.0/ 2 Sim</td>
<td>4.0/ 1 Sim</td>
<td>0 Sim</td>
</tr>
</tbody>
</table>

Table 5. All Flood Current Simulations Reporting Mean Level of Concern and Number of Simulations Performed

<table>
<thead>
<tr>
<th>Phase</th>
<th>TOTE</th>
<th>Horizon</th>
<th>Tanker</th>
<th>Bulker</th>
<th>Cruise</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0 Sim</td>
<td>3.2/ 5 Sim</td>
<td>2.5/ 2 Sim</td>
<td>3.5/ 2 Sim</td>
<td>4.0/ 2 Sim</td>
</tr>
<tr>
<td>3</td>
<td>2.8/ 5 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>4</td>
<td>3.0/ 4 Sim</td>
<td>2.0/ 2 Sim</td>
<td>3.3/ 4 Sim</td>
<td>4.33/ 3 Sim</td>
<td>1/ 1 Sim</td>
</tr>
<tr>
<td>Final</td>
<td>2.33/ 3 Sim</td>
<td>2.0/ 2 Sim</td>
<td>3.0/ 2 Sim</td>
<td>0 Sim</td>
<td>1/ 1 Sim</td>
</tr>
</tbody>
</table>

Table 6. All Ebb Current Simulations Reporting Mean Level of Concern and Number of Simulations Performed

<table>
<thead>
<tr>
<th>Phase</th>
<th>TOTE</th>
<th>Horizon</th>
<th>Tanker</th>
<th>Bulker</th>
<th>Cruise</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0 Sim</td>
<td>3.33/ 3 Sim</td>
<td>2.0/ 1 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>3</td>
<td>0 Sim</td>
<td>0 Sim</td>
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<td>0 Sim</td>
</tr>
<tr>
<td>4</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>Final</td>
<td>1.0/ 1 Sim</td>
<td>3.5/ 2 Sim</td>
<td>0 Sim</td>
<td>4.0/ 1 Sim</td>
<td>0 Sim</td>
</tr>
</tbody>
</table>
Table 7. All Docking Simulations Reporting Mean Level of Concern and Number of Simulations Performed

<table>
<thead>
<tr>
<th>Phase</th>
<th>TOTE</th>
<th>Horizon</th>
<th>Tanker</th>
<th>Bulker</th>
<th>Cruise</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0 Sim</td>
<td>2.83/ 6 Sim</td>
<td>2.66/ 3 Sim</td>
<td>3.5/ 2 Sim</td>
<td>4.0/ 2 Sim</td>
</tr>
<tr>
<td>3</td>
<td>2.66/ 3 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>4</td>
<td>2.0/ 2 Sim</td>
<td>2.0/ 2 Sim</td>
<td>4.5/ 2 Sim</td>
<td>5.0/ 2 Sim</td>
<td>1.0/ 1 Sim</td>
</tr>
<tr>
<td>Final</td>
<td>2.5/ 2 Sim</td>
<td>2.0/ 2 Sim</td>
<td>2.33/ 3 Sim</td>
<td>0 Sim</td>
<td>1.0/ 1 Sim</td>
</tr>
</tbody>
</table>

Table 8. All Undocking Simulations Reporting Mean Level of Concern and Number of Simulations Performed

<table>
<thead>
<tr>
<th>Phase</th>
<th>TOTE</th>
<th>Horizon</th>
<th>Tanker</th>
<th>Bulker</th>
<th>Cruise</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0 Sim</td>
<td>4.5/ 2 Sim</td>
<td>2.0/ 1 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>3</td>
<td>3.0/ 2 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>4</td>
<td>4.0/ 2 Sim</td>
<td>0 Sim</td>
<td>1.0/ 1 Sim</td>
<td>3.0/ 1 Sim</td>
<td>0 Sim</td>
</tr>
<tr>
<td>Final</td>
<td>2.0/ 2 Sim</td>
<td>3.5/ 2 Sim</td>
<td>1.0/ 1 Sim</td>
<td>4.0/ 1 Sim</td>
<td>0 Sim</td>
</tr>
</tbody>
</table>

The study simulations were all extreme cases, replicating difficult scenarios that do not allow for any miscalculations. Participants used the maximum available power for assist tugboats, thrusters and ships engines, and rudders.

Phase Two of APMP was problematic for Horizon due to the limited amount of maneuvering room available between TOTE’s bow and the construction of new Terminal 1. This was consistent for ebb fair current sailings and all docking maneuvers. POL 2 was difficult for both docking and undocking because of the inset berth compared to the other berths, frequently referenced as the “hole” or “pocket” during simulations and debriefings. Current direction being in line with the berth faces was crucial for docking and undocking, and emphasis was placed upon POL 1 and POL 2. Phase Three for TOTE was operational, though problematic, with the limited available horsepower because the Northern Extension was taken back. Bulkers had a very difficult time during all phases analyzed because of the limited amount of horsepower for the vessel, in comparison to the weight of the ship, and subsequently could not easily maneuver in complex environmental conditions. Tankers frequenting POL 2 during all phases in which POL 1 is constructed outboard and to the South experienced numerous difficulties.

C. Results of Focus Group

Mariners who performed the simulations were asked to outline their concerns in the focus group. Mariners explained, how they ranked the simulatations based upon their level of concern as asked during the exit interviews after the simulations. They stated that rating a simulation at a 3 or “somewhat concerned”, meant that it should not be considered an objective they would perform.

The results of the focus group were unanimous support for the twelve recommendations made by SGM and outlined below.
IV. Recommendations

Recommendation 1: The highest priority for mariners concerning the port modernization project is to cut back the present Northern Extension as soon as possible.

Recommendations to remove the Northern Extension were discussed in preliminary interviews, during the simulations, and again at the focus group. Mariners expressed that if removing the Northern Extension proved to be too costly, a partial removal should be explored.

The Northern Extension of the present port configuration has been problematic for several reasons. Under the current configuration, TOTE docking and undocking procedures are limited by space. There is minimal under keel clearance for ships because the TOTE berth is constantly being filled in by sedimentation, and the extension disrupts current flow and stacks ice up into the TOTE berth without any place for the ice to escape. Shoaling during winter months is significant and may be as great as three feet over a few weeks’ time. This process creates a shallow water effect where there is little water under the keel and the TOTE vessel responds slower. Presently, TOTE is incapable of moving vessels north in contrast to their berth or backing up when port side alongside due to the shallow water. The rudder and propeller damage is significant in this condition, and the port should attempt to rectify this problem as expeditiously as possible. The removal of the Northern Extension is of paramount importance to the operational success of the port during the construction process. This was emphasized by all focus group attendees who possessed professional maritime backgrounds.

However, the removal of the Northern Extension requires significant funding. Mariners agreed that even if developers removed a portion of the Northern Extension, the slight modification would reduce many challenging environmental conditions and greatly improve port safety. Instead of the whole extension being removed in one phase, the partial removal of the most southern portion of the extension would create less shoaling, allowing the current to move more freely, and minimize the ice damming effect which occurs during winter months. The partial removal would also minimize the counter-current effect, and reduce ice stacking on the north end of the TOTE berth.

Five simulations of Phase Three were performed with Texas Ro Ro (TOTE) with an average rating of concern of 2.8. This concern is due to the Northern Extension and the limited amount of space to safely maneuver ships during this phase; the close proximity of the Northern Extension to the north and Terminal Two construction to the south leaves minimal amount of space for docking and undocking. Two of these simulations were performed with ice conditions, and the corresponding average rating of concern increased to 3.5. The partial removal of the Northern Extension should be performed with maximum clearance to the northeast at an angled extension to allow current movement that will minimize dredging. Initial construction related dredging would be required to facilitate the newly created sea room between TOTE and the cut-back of the Northern Extension.

Recommendation 2: Name Petroleum Oil and Lubricants (POL) berths ‘POL North’ and ‘POL South’ to eliminate any confusion caused by the elimination of POL 1 and the construction of a new POL 1.
Presently, POL berths at the POA are designated as POL 1 and POL 2. POL 2, which is the most southern berth, was most recently constructed. When this berth was constructed, it was designated as a barge dock, and thus indicated that ships would not be utilizing the berth. However, ships have been calling upon POL 2 as per scheduling of the port traffic. Proposed construction development during Phase One includes the demolition of the existing POL 1, which is presently the northern POL berth and to construct the new POL 1 which will be located to the south of POL 2.

During the interview process, it was confusing to reference the different phases of construction and identify the POL berths as they are presently numbered. Simulations resulted in the same confusion due to the mariners’ knowledge of the present POL 1 being to the north of POL 2. The designation of the POL berths as being North and South would eliminate confusion during APMP, as one POL will always be north or south of the other POL berth.

**Recommendation 3:** During construction APMP will be disruptive for ships and port activity due to the offset alignment of berths. The APMP construction phasing plan should not be initiated and then stopped without the capability for completion, due to the berths offset alignment. This means that funding for completion of construction should be secured prior to making the docks offset.

Simulations of APMP indicated that offsetting dock faces during construction was a concern to mariners. Berth offset during construction results in vessels having minimal distances between the construction of other berths and ships. This close proximity was problematic during the simulations and was also identified during the interviews. The guideline for distance between ships should be 100 feet or 30 meters. This distance is a guideline based upon past experiences and other shipping companies requirements. For example, in a recent communication to SWAPA in June 2015 concerning the docking and undocking of vessels at POA, Kirby Offshore Marine requested the “Establishment of the minimum proximity distance between the cement ship and the DBL 185. Kirby is agreeable to 100’ minimum distance” (Personal communication with Louis Audette Kirby Marine Alaska operations manager, June 2015).

**Recommendation 4:** Make a third tugboat available during construction to assist vessels during the ice season.

During the winter ice season, one of the two tugboat assists will typically be clearing ice from the berth area to allow the ship to come alongside the berth. This process results in only one of the two tugboats being available to assist the ship during docking and undocking maneuvers. In study simulations, both tugboats were available for the mariner. Thus, the simulations were based upon the practical utilization of three tugboats during ice conditions, assuming one of them would be clearing ice, while the other two assisted the ship.

**Recommendation 5:** Make a second tugboat assist available, with bollard pull equivalent to or greater than the Stellar Wind, during the construction process to minimize docking and undocking risks.
Presently, POA berths act as if they are solid face docks during ice and non-ice conditions. There is a minimal amount of room for water to move behind the berths, resulting in a cushioning effect. This cushioning effect is exaggerated during lower level stages of the ebb tide due to the steep embankment which is presently behind the berth line. This results in the water having no place to move when a ship is coming alongside the berth.

When ships dock at any berth, they create a wall of water equivalent to the depth of the ship which is pushed toward the dock as they approach the dock. The depth of the ship, or draft, is the determining factor for how much water is being pushed towards the berth. This water is being displaced by the force of the ship moving into the berth replacing the water that existed at the berth with the ships mass. Larger and deeper ships will move, push, or displace more water from the inboard side of the ship than vessels with less draft or depth for the entire length of the ship. This creates more resistance against the deeper part of the ship, typically the stern. If a dock or berth has a sufficient amount of water behind it, then the cushion affect is less apparent upon the ship because the water can be more easily displaced over a larger area. POA docks have minimal room behind them (shoreward from the dock faces) due to years of dredging. This dredging was used to create sufficient water depth for ship docking, and created a steep embankment from inside the dock faces to the beach line inboard of the docks.

Docking a ship with this cushion effect requires the mariner to compensate by exerting force greater than the cushion effect to arrive at the dock. When the ship’s movement overcomes or breaks through this cushion effect, it is not immediately distinguishable until the vessel starts moving towards the dock. The cushion effect is a particularly difficult factor to overcome due to the inconsistency of the forces upon the bow and stern. This cushioning effect will continue until the berths are moved offshore.

Mariners expressed concern that the necessary tugboat assistance be made available to maneuver during construction due to dock alignments and construction barge locations. They illuminated the fact that the maximum bollard pull was consistently used during the simulations, and even with the tugboat assist, there was no margin for error. Without proper tugboat assists, damage to constructed piers may occur and would have significant economic consequences.

Tugboat assist for shipping during the construction phases was a variable that was highlighted through various simulations. Fifteen simulations (see Table 9 below) were highlighted as requiring greater tugboat assistance, however other simulations may also be identified as needing more tugboat assists. The Stellar Wind and Glacier Wind are the two tugboats for POA. Both are azimuth drive tugboats. Having only two tugboats available within the port has historically been sufficient, however the simulations analyzing the offset berths during Phases Two and Four indicate that either a greater bollard pull or another tugboat will be required to facilitate safe operations during the construction process. Typically, TOTE utilizes both of the tugboats for assistance while maneuvering for docking and undocking. Horizon will typically use only one tugboat, sometimes none, for undocking, and one or two for docking.

The fifteen simulations that resulted in the need for increased tugboat assistance during the construction process are reported below in Table 9. The corresponding screen shots of these simulations can be found in Appendix 2.
The commercial side of tugboat assistance would require analysis from both the ship operators and the POA. For example, at the Port of Seward industry, port operators, and tugboat companies previously worked together to resolve the economic issues of tugboat assist. Large cruise ships were frequenting the Port of Seward utilizing their thrusters until the wind became problematic, creating too much risk to dock without tugboat assist. The assist tugboat company was not being compensated for having “available” personnel and equipment, and was thus pursuing work outside of the port, making them unavailable for the cruise ships during situations where assistance was required. This issue was resolved when the industry, the port, and tugboat company reached an agreement to fix a set standby fee, remunerated to the tugboat company for having a tugboat available, as well as establishing assist tugboat fees based upon the use of the tugboat. This provided flexibility for the shipping company to utilize the assist tugboat when

### Table 9. Need for Increased Tugboat Assistance

<table>
<thead>
<tr>
<th>Simulation</th>
<th>Level of Concern</th>
<th>Additional Pilot Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2C2</td>
<td>5</td>
<td>Very unsafe maneuver!</td>
</tr>
<tr>
<td>3B2</td>
<td>2</td>
<td>Too much current; dock has too much going on and just missed the barge</td>
</tr>
<tr>
<td>4C2</td>
<td>4</td>
<td>Only potential viable solution would be to have a second tug on the stern</td>
</tr>
<tr>
<td>5A3</td>
<td>4</td>
<td>Can utilize tug for safer docking if north</td>
</tr>
<tr>
<td>5B2</td>
<td>2</td>
<td>At certain point, cannot bail out; have to commit, should not be maneuvering in or out on ebb</td>
</tr>
<tr>
<td>6B2</td>
<td>4</td>
<td>Difficult to maintain speed control in strong current; once committed very, risky maneuver</td>
</tr>
<tr>
<td>7A4</td>
<td>5</td>
<td>Forget it! The forces, conditions, and ship made it extremely difficult to be in control</td>
</tr>
<tr>
<td>7B4</td>
<td>4</td>
<td>Need someone or something to manage the ice; Although this tug doesn’t break ice he should have considered ice mitigation downstream of POL 1</td>
</tr>
<tr>
<td>7C4</td>
<td>4</td>
<td>Ice has negative effect when making the turn but is an advantage once the turn is completed; it was a little unnerving next to barge on approach right next to bridge</td>
</tr>
<tr>
<td>8A4</td>
<td>3</td>
<td>Losing all sleeve oil, thrusters are not enough; maneuver required tug boat, full to get ship to breast of the dock</td>
</tr>
<tr>
<td>8C4</td>
<td>5</td>
<td>Too little power to get away; need strong tugs, 25 knots too much</td>
</tr>
<tr>
<td>9A4</td>
<td>5</td>
<td>Dredging anchor is necessary; dredged starboard anchor to control bow and create better approach angle</td>
</tr>
<tr>
<td>12A2</td>
<td>4</td>
<td>Far too little horsepower; zero margin for operator/equipment error due to lack of available response in environmental conditions</td>
</tr>
<tr>
<td>13A2</td>
<td>5</td>
<td>Big current and wind on dock; used larger tug aft and had to use him at full power throughout maneuver; there was no reserve; we were at the limits of the available equipment</td>
</tr>
<tr>
<td>17B6</td>
<td>4</td>
<td>Underpowered ship fighting all the way</td>
</tr>
</tbody>
</table>
deemed necessary without questioning their availability. Port of Seward’s infrastructure was ultimately protected, and the tugboat company was compensated for their availability.

One point of information that is still required is to ask Cook Inlet Tug and Barge to give us the exact bollard pull of the tugboats presently used in the port. Current information provided to SWAPA has 44 tons and 18 tons respectively for the Stellar Wind and Glacier Wind. During simulations we used 50 tons for the Stellar Wind and 28 tons for the Glacier Wind. If this data has changed it should be updated and made available for public consumption.

**Recommendation 6:** Place current meters where POL 1 and POL 2 are to be constructed to ascertain the current flow direction at various stages of the tide.

Current alignment with the dock face is crucial to minimize risk associated when ships are docking and undocking during current movement. This is exemplified by Christy Lee, the Cook Inlet Pipe Line Company crude oil loading terminal on the west side of Cook Inlet. At this terminal the current is approximately thirty degrees different than the platform face or docking area, which creates a significant operating challenge.

Current meters can be utilized to create docks that are aligned with the current flow. Meters should monitor currents during different seasons of the year to differentiate current directions that exist in different dredging seasons. Obstructions placed in the water at POA will cause sedimentation to drop from the water column as the current is deflected or stopped at the obstruction. Shoaling may result when the berths are established. However, by placing meters in deeper water and into the stream, the water flow should be significant enough to create a self-scouring effect at the berths. This is indicative of current being significant at the berths. Dock platforms and cat walk alignments with this current is paramount for risk mitigation purposes. To demonstrate the importance of current direction, a simulation was performed where the current was purposefully offset thirty degrees from the dock heading. The result, as recorded in simulation 16B6 (see Appendix 2) was that the “maneuver could not be accomplished” due to the angle of the dock and the direction of the current. The current must be parallel with the dock face in order to safely dock a tanker under these conditions.

**Recommendation 7:** The POL 1 north dolphin installation should be delayed until POL 2 is brought out and made parallel with POL 1.

When the new POL 1 (POL South) is constructed in Phase Two, it will create a “pocket” or “hole” for ships and barges utilizing POL 2 (POL North). Phase Two stipulates Terminal 1 being constructed approximately 140’ off shore of the “existing” POL 1 North Berth line prior to demolition. This berth or dock alignment creates a risk for ships maneuvering into and out of the

---

11 Bollard pull in relation to horse power is generally 1.2 to 1.5 times the horse power equals the bollard pull. The Stellar Wind has 3,500 HP and the Glacier Wind has 2,200 HP see Cook Inlet Tug and Barge for more information about these tugboats [http://www.cookinlettug.com/about/](http://www.cookinlettug.com/about/).

12 CH2M HILL has notified SGM that as of July, 2015 that they are planning to place current monitors in the locations of POL 1 and POL 2.
POL 2. Increasing the size of this pocket is the emphasis of this recommendation, as increasing this hole will minimize the concern associated with offset docks.

Interviews underscored that the pocket effect was created during Phase Two construction for POL 2. Simulations highlighting this effect were conducted, and a summary of the results are based upon nine simulations reported below in Table 10. The corresponding screen shots can be found in Appendix 2.

Table 10. Pocket Effect of Phase Two and Phase Four Construction for POL 2

<table>
<thead>
<tr>
<th>Simulation</th>
<th>Level of Concern</th>
<th>Additional Pilot Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>3B2</td>
<td>2</td>
<td>Too much current; dock has too much going on and just missed the barge</td>
</tr>
<tr>
<td>4B2</td>
<td>3</td>
<td>Concern if there is enough bells to get in there; need enough speed and power to get in there; concern with strong flood current and number of engine starts a strip of the configuration will have as the final approach is made</td>
</tr>
<tr>
<td>6B2</td>
<td>4</td>
<td>Difficult to maintain speed control in strong current; once committed very, risky maneuver</td>
</tr>
<tr>
<td>7A4</td>
<td>5</td>
<td>Forget it! The forces, conditions, and ship made it extremely difficult to be in control</td>
</tr>
<tr>
<td>7B4</td>
<td>4</td>
<td>Need someone or something to manage the ice; Although this tug doesn’t break ice he should have considered ice mitigation downstream of POL 1</td>
</tr>
<tr>
<td>8A4</td>
<td>3</td>
<td>Losing all sleeve oil; thrusters are not enough; maneuver required tug boat; full to get ship to breast of the dock</td>
</tr>
<tr>
<td>9A4</td>
<td>5</td>
<td>Dredging anchor is necessary; dredged starboard anchor to control bow and create better approach angle</td>
</tr>
<tr>
<td>11B4</td>
<td>5</td>
<td>Bulk carrier seriously underpowered for conditions; ship was nearly overcome by in “the hole”</td>
</tr>
<tr>
<td>12A2</td>
<td>4</td>
<td>Far too little horsepower; zero margin for operator/equipment error due to lack of available response in environmental conditions</td>
</tr>
</tbody>
</table>

SGM is not knowledgeable of the length of the dock if north dolphin is eliminated. This may initially appear to be an unsuitable recommendation based upon the dock being insufficient to support ships due to the north end of the dock being incapable of providing a moorage structure.

If the north dolphin is eliminated, then mooring line provisions are the problem and temporary mooring arrangement requires further investigation. SGM proposes a resolution that temporarily minimizes the risk created from POL 1 (South) north dolphin elimination. Endeavoring to create a berth that is effective with the north dolphin eliminated until the POL 2 can be brought in line with POL 1 (South) requires a mooring line provision with a northern lead for this temporary solution.
A ship’s stern or bow line, depending on which side alongside the ship is moored, could be deployed to a mooring rope or wire from the most southern dolphin POL 2, or from the beach and attached to a fixed structure ashore. If a shore structure was utilized a temporary mooring on the beach would be required with a chain or wire lead for the initial distance required to span shore line or rock areas. A wire or synthetic mooring line could be attached to this lead from the beach or southern dolphin POL 2 with a swivel and shackle arrangement. The other end of the mooring line attached to the shore based chain or wire or POL 2 south dolphin would have the same arrangement of swivel and shackle, which is connected to the ship’s mooring lines from the north end of POL 1.

Synthetic mooring lines have evolved to yield extremely high strength capabilities and weigh less than traditional mooring wires. Several different manufactures have developed synthetic mooring lines which include different compositions such as plasma, spectra, polyester and nylon. Chaffing is a concern with these materials, however a protective shielding could be placed around the rope to mitigate chaffing.13

When out of use, this wire or synthetic rope, could be attached to the causeway of POL 1. The attachment to the causeway would be at least three-quarters way seaward down the causeway, in water deep enough for the tugboat to maneuver. This attachment point is just a storage point from the shore mooring. The mooring line would be attached to the causeway by a shackle to a pelican hook located upon the causeway. Longshoreman would release the pelican hook and lower the shackle attached to the end of the line from the causeway to the deck of the tugboat. The tugboat would already have the mooring lines from the ship on deck, and would attach them to the shackle on the back deck of the tugboat. The ship can then heave in their mooring lines, which will then lead directly to POL 2 southern dolphin or the shore, eliminating the storage point upon the causeway from the mooring arrangement.

Upon letting go or departing from the berth, the ship’s mooring lines that are attached to the shackle from the mooring ashore or POL 2 southern dolphin would need to be slackened onto the back deck of the tugboat. The shackle and mooring lines’ eyes will be on the deck of the tugboat. The tugboat crew would release the mooring lines from the shackle and then take the mooring line and shackle back to that causeway where the longshoreman would hoist the shackle back up onto the causeway and reattach the shackle to the pelican hook for the next arrival.

North mooring lines from the ship moored at POL 1 attached to POL 2 southern dolphin or the shore mooring upon the beach could be temporarily disconnected and stored to allow a ship to maneuver for POL 2. This would minimize the amount of time the ship moored at POL 1 would have exposure to insufficient mooring capability from the north end.

PMO Response: Another temporary solution during construction is restrict POL 2 to barge-only berthing during the period when POL 2 is has not yet been moved out. And yet another option would be to move new POL 2 construction forward in the construction sequences to the access challenge is minimized. This is great and could be added in as stated without PMO response…

13 The handling of the portion of the mooring arrangement should always be overseen or administered by the tugboat’s crew instead of the ship’s crew to prevent mishandling of this line.
**Recommendation 8:** The north end of the newly constructed Terminal One during Phase Two will be difficult for Horizon when docking and undocking at their present berth. Developers may consider shortening Terminal 1 and using a temporary trestle in place of the north end of the actual berth during Phase Two to minimize this difficulty.

This is due to the offset docks, Terminal One construction being built approximately 140’ offshore of the existing dock line, and the configuration of TOTE docking north of Horizon with insufficient maneuvering room between them. Multiple simulations were performed with the Horizon ship during Phase Two, with the objective of maneuvering within this area based upon the interviews. These eight simulations are reported below in Table 11. The corresponding screen shots are available in Appendix 2.

**Table 11. Simulating Horizon during Phase 2**

<table>
<thead>
<tr>
<th>Simulation</th>
<th>Level of Concern</th>
<th>Additional Pilot Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B2</td>
<td>3</td>
<td>Not much room for AA; job requires care taking act of all available tools</td>
</tr>
<tr>
<td>1C2</td>
<td>3</td>
<td>TOTE overlaps Horizon position; tight fit</td>
</tr>
<tr>
<td>2C2</td>
<td>5</td>
<td>Very unsafe maneuver!</td>
</tr>
<tr>
<td>3C2</td>
<td>4</td>
<td>Tight berth – little room forward and aft, big forces make small adjustments difficult because it causes little leeway</td>
</tr>
<tr>
<td>4C2</td>
<td>4</td>
<td>Only potential viable solution would be to have a second tug on the stern</td>
</tr>
<tr>
<td>6C2</td>
<td>5</td>
<td>Tight margins force off; learning curve for pilot</td>
</tr>
<tr>
<td>12C2</td>
<td>4</td>
<td>Heavy ice makes entry into the berth risky; the job is challenging in the simulator, but would be unpleasant in real life; the job would be much safer without TOTE berthed directly astern</td>
</tr>
<tr>
<td>13A2</td>
<td>5</td>
<td>Big current and wind on dock; used larger tug aft and had to use him at full power throughout maneuver, there was no reserve; we were at the limits of the available equipment</td>
</tr>
</tbody>
</table>

This recommendation would create more room for the berthing of Horizon during the construction phase of Terminal 1. The length of Terminal 1, utilizing a temporary trestle, would need to be analyzed to determine if the Horizon ships would still be able to reach all of the hatches of the ship with the shore side cranes after shifting to Terminal 1. If feasible, this would help mitigate the concern involved with the close proximity between the north end of Pier 1 and the Horizon docking and undocking operations.

**Recommendation 9:** Propose an agreement of cooperation between TOTE and Horizon docking priority to assure the safety of all ships.

Cooperation between TOTE and Horizon was discussed during the focus group meeting based on the simulations below in Table 12. If the Northern Extension was cut back prior to the construction of Terminal 1 during Phase Two, this would allow TOTE more maneuvering room. Horizon, attempting to dock in the space between TOTE and new construction of Terminal 1, is
problematic. Evidence of this issue is demonstrated below in Table 12 presenting the eight simulations during Phase 2 where TOTE and Horizon were in close proximity to each other. Therefore, cooperation between the two companies is highly encouraged.

### Table 12. Cooperation between TOTE and Horizon

<table>
<thead>
<tr>
<th>Simulation</th>
<th>Level of Concern</th>
<th>Additional Pilot Comments</th>
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<tr>
<td>1B2</td>
<td>3</td>
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<tr>
<td>13A2</td>
<td>5</td>
<td>Big current and wind on dock; used larger tug aft and had to use him at full power throughout maneuver, there was no reserve; we were at the limits of the available equipment</td>
</tr>
</tbody>
</table>

**Recommendation 10:** If feasible, construction barges utilized for the POA modernization project should be required to use spuds for mooring instead of anchors.

Throughout a majority of the simulations, a construction barge was positioned in construction areas which were highlighted as areas of concern during the interview process. The placement of these barges during simulations were intended to model the most awkward and realistic configuration for each particular objective.

Due to the significant large tides and currents experienced within POA, the amount of anchor cable required to hold a barge in position would be significant. Anchor wires from barges will make maneuvering a vessel in or out of dock difficult due to the possible fouling of the anchor wire with the maneuvering vessel’s propeller. The anchor wires from barges will create concern for the maneuvering vessel due to the limited space that is available and further obstructions such as the barge anchor cables should be eliminated if possible.

**Recommendation 11:** Provide ship simulation training to ship pilots prior to APMP in order to expose them to the port facilities.

This would provide an opportunity for pilots to be exposed to the difficult possible scenarios during the APMP construction process. This exposure would benefit not only the pilots, but also the City and Port of Anchorage by creating general awareness of what will be required to safely maneuver the ships during this process. If a ship does damage to a dock during the construction
phase, it would result in significant expense to the city and construction delays. The probability of this would be decreased if training were to occur prior to the construction process.

Port parameters may need to be evaluated on the implementation of the proposed construction phases. These parameters would be created during the same ship simulations that would be used for pilot training. Also, the determination of what recommended horse power or bollard pull, and the number of assist tugboats that may be required to facilitate ship safety at the POA should also be considered.

Pilots’ initial response to the proposed construction phases may initially be negative due to the increased hazards (construction barges, offset docks). The State of Alaska requires all state licensed pilots to, “safely navigate vessels under the pilots direction and control and to protect life and property and the marine environment while engaged in the provision of pilot services.”14 SWAPA members take this charge seriously, and are justifiably proud of their fine safety record and of the time honored traditions of professional pilotage. If a pilot believes that the task is contrary to this mandate, they probably will not perform the job. Without proper exposure to APMP construction phases in the simulator, some pilots may refuse to operate without sufficient risk mitigation procedures and trainings.

**Recommendation 12:** Additional research should be conducted to further investigate the simulations that are identified as ‘moderate to high concern’ in this report. These include: the potential adjustment of the cutback of the Northern Extension, the variation in tugboat assists, and further investigation into port operations during Phase Two of APMP.

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14 Southwest Alaska Pilots Association, 2015.
V. Conclusions

The final configuration of the APMP is an overall improvement of the present POA. There will be difficult time periods for shipping port calls during construction phases where berths are offset, creating pockets and obstructions for ships maneuvering at the port. Proposed dock structures of APMP will ultimately minimize dredging requirements because the current will be able to flow freely amongst the docks. This will have several beneficial effects upon docking and undocking at POA.

All mariners emphasized the importance of cutting back of the Northern Extension as a priority for risk mitigation. If financial consequences are a concern for this segment of APMP, a partial cut back would still benefit ships frequenting the port. TOTE is obviously effected by this segment, however all ships calling upon POA are affected due to inconsistent currents and sedimentation that reduces the depths of the berths.

Under the present POA configuration, ice is packed against the dock face. The current moves ice parallel to the dock face, thus requiring ships to utilize their assist tugboats to create a lee or an open area alongside the berths for docking purposes. If a lee is not created, the ship will be unable to lay flat alongside the berth. Offshore open piling docks will minimize this problem.

During the construction phases, SGM simulations indicated that another assist tugboat would help minimize the concern from offset docks and construction barges. If implemented, this recommendation, along with the others listed in this report, would mitigate risk and assist in the creation of a safe, effective, and efficient POA.
VI. References


Appendix 1. Interview Protocol Draft Questions for Port of Anchorage Modernization Project

Co-Principal Investigators: Jeff Pierce and Jonathan Pierce

Report Title: Ship Simulation Modeling and Mariner Study of the Maritime Implications of the Port of Anchorage Modernization Project

Version Date: April 6, 2015

Introduction

Safeguard Marine LLC (SGM) is conducting approximately 15 interviews regarding the Port of Anchorage Modernization Project (APMP) with local maritime experts. The purpose of this interview is to better understand the specific parameters that will create accurate ship simulations to help determine the safety for docking and undocking of ships during the five phases of construction at the Port of Anchorage, and to identify additional concerns about the capability of the Port of Anchorage to operate during APMP. The lead researchers on this study are Captain Jeff Pierce and Jonathan Pierce, Ph.D.

Your participation in this study is voluntary. If you decide to take part in the study, the interview will take approximately 20-30 minutes and will be conducted by telephone. Your name and position will be confidential and not connected to specific statements instead reporting will be done using “Interview #1”. We will report that someone from your organization was interviewed in the report such as: U.S. Coast Guard, Southwest Alaska Pilots Association, etc. There are expected to be no risks to participation in this study. To ensure accuracy, a written description of the interview will be completed and sent to you for your review before it is deemed to be complete.

Information about Simulations

To help facilitate this interview, a pdf file providing information about APMP is attached, containing the proposed construction phases of the port.

SGM will conduct approximately 48 ship simulations over a two-day period (May 2 and 3) using the three Kongsberg ship simulators at the AVTEC simulator in Seward, Alaska. The personnel operating the simulators will include technicians and multiple experienced local mariners. They are listed below in Table 1.
Table 1. Mariners participating in the simulations

<table>
<thead>
<tr>
<th>Mariner (position)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Captain Ed Kelly (Pilot)</td>
<td>Past Horizon pilot and presently TOTE pilot</td>
</tr>
<tr>
<td>Captain Josh Weston (Pilot)</td>
<td>Southwest Alaska Pilot</td>
</tr>
<tr>
<td>Captain Pete Garay (Pilot)</td>
<td>Southwest Alaska Pilot</td>
</tr>
<tr>
<td>Captain Nick Garay (quarter master)</td>
<td>Unlimited Master Mariner</td>
</tr>
<tr>
<td>Brad Kroon (quarter master)</td>
<td>Extensive assist tugboat experience Anchorage</td>
</tr>
<tr>
<td>Tugboat or USCG licensed operator</td>
<td>Tugboat or USCG licensed operator experience</td>
</tr>
<tr>
<td>experience (quarter master)</td>
<td></td>
</tr>
<tr>
<td>Mike Angove (simulator operator)</td>
<td>Lead simulator technician; many years’ experience</td>
</tr>
<tr>
<td>Rob Chadwell (simulator operator)</td>
<td>1600 ton master license</td>
</tr>
</tbody>
</table>

Table 2. Tugboat Assist Information

<table>
<thead>
<tr>
<th>COMMANDS</th>
<th>50 TON TUGBOAT (STELLAR)</th>
<th>35 TON TUGBOAT (GLACIER)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HANG</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>DEAD SLOW</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>ONE THIRD</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>SLOW/ EASY</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>HALF</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>TWO THIRDS</td>
<td>33</td>
<td>23</td>
</tr>
<tr>
<td>FULL</td>
<td>40</td>
<td>28</td>
</tr>
</tbody>
</table>

Simulations will be based on most extreme conditions normally encountered for wind current and ice with tugboat assistance or thrusters available for all the maneuvers. Table 3 below describes the range of conditions that will be used in the simulator including ice coverage and thickness, current, and wind speed. Model responses were tested using various ice conditions and thickness, they performed most realistically with 7/10 coverage and half meter thick ice.

Table 3. Range of Conditions

<table>
<thead>
<tr>
<th>Ice</th>
<th>Ice thickness</th>
<th>Current</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 percent coverage</td>
<td>0.50 meter</td>
<td>Large floods</td>
<td>NW 25/ 40</td>
</tr>
<tr>
<td>70 percent coverage</td>
<td>0.50 meter</td>
<td>Large Ebbs</td>
<td>NE 25/40</td>
</tr>
<tr>
<td>70 percent coverage</td>
<td>0.50 meter</td>
<td>Small for both</td>
<td>SW 25/ 40</td>
</tr>
</tbody>
</table>

Any of these conditions may be mixed with each other to create extreme simulations. Currents will be based on NOAA tables, Nobel Tech calculations, local knowledge and Cook Inlet Tug and Barge drifts in the vicinity of the proposed new petroleum POL docks.

Simulations will be conducted using the following models of target vessels in Table 4 below.
Table 4. Characteristics of Model Vessels

<table>
<thead>
<tr>
<th>Target Vessel</th>
<th>Gross Tonnage/ Deadweight</th>
<th>Length</th>
<th>Beam</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midnight Sun TOTE</td>
<td>65,314 GT</td>
<td>258 m</td>
<td>36 m</td>
<td>Actual ship dimensions</td>
</tr>
<tr>
<td>TOTE MODEL</td>
<td>66,635 GT</td>
<td>262 m</td>
<td>32 m</td>
<td>Texas Ro Ro Model, similar block coefficient, diesel electric model</td>
</tr>
<tr>
<td>Horizon D7</td>
<td>20,695 GT</td>
<td>216 m</td>
<td>24 m</td>
<td>ACTUAL Horizon D7 Vessel</td>
</tr>
<tr>
<td>Loaded Tanker</td>
<td>53,000 Deadweight</td>
<td>600’</td>
<td>105’</td>
<td>deep draft 44’, single propeller and rudder w/ bow thruster</td>
</tr>
<tr>
<td>Cruise Ship</td>
<td>Fantasy Class 71,000 GT</td>
<td>261 m</td>
<td>31 m</td>
<td>two engines, twin propeller w/ two rudders, bow and stern thrusters</td>
</tr>
<tr>
<td>Handymax m</td>
<td>37,000 Deadweight</td>
<td>580’</td>
<td>102’</td>
<td>deep draft 44’, single propeller and rudder</td>
</tr>
</tbody>
</table>

These target vessels represent ship traffic frequenting Port of Anchorage (POA). We are utilizing models representing these vessels’ approximate length width and weight and, more importantly, handling characteristics.

The maneuvers will include docking and undocking at the POA during all phases of construction, and will be separate and distinct within the harbor area, as each simulator can be operating utilizing different models. Information about the construction phases during APMP are described below in Table 5.

Table 5. Description of each phase of APMP

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>Cut back and stabilize North extension and construction New POL 1</td>
</tr>
<tr>
<td>Phase 2</td>
<td>Construction of new terminal 1 immediately south of present Horizon berth</td>
</tr>
<tr>
<td>Phase 3</td>
<td>Horizon moved to new Terminal 1 construction of terminal 2 north of Horizon</td>
</tr>
<tr>
<td>Phase 4</td>
<td>TOTE moved to new Terminal 2 using temporary trestles</td>
</tr>
<tr>
<td>Phase 5</td>
<td>Demolish Terminal 3 (old TOTE dock)</td>
</tr>
<tr>
<td>Phase 6</td>
<td>New POL 2 dock constructed replacing old POL 2 berth</td>
</tr>
</tbody>
</table>

Simulations are being conducted as research thus the starting points will be just off the docks and ending points will be when the vessel is in close proximity to the berth and the pilot feels they have good control of the vessel. The environmental conditions wind, current and ice will be
extreme cases with the assumption that less extreme can executed safely. Tugboat assist will be based on present tugboats bollard pull available in the port at this time. Tugboat and or thrusters will be available for TOTE, tankers, bulkers and some of the Horizon simulations. One of the three simulators will not have tugboat assist available due to limitations of the simulator, thus thrusters will be utilized instead of tugboats during some simulations. Simulations will be divided up between the various target ships with emphasis upon the most difficult maneuvers possible.

**Interview Questions**

1) Do you think the simulations described above will be sufficient to determine the capability of vessels to dock and undock at the Port of Anchorage safely during the construction process?
   a. Vessels
   b. Ice coverage
   c. Ice flow
   d. Wind speed
   e. Current
   f. Simulation operators

2) Do you have any specific simulations you wish to see performed based upon the phases of construction?
   a. Specific wind, current, ice combinations that may be problematic?

3) During APMP construction process as portrayed within the attachment do you foresee any difficulty maneuvering ships at the port?
   a. If yes, what would you recommend for operational procedures?

4) The attached file portrays the phases of construction during APMP, do you think any currents we presently encounter at the port will change due to the construction process?
   a. If yes, what would you anticipate changing and will it be a hindrance or helpful for maritime operations?

5) Will new POL 1 have an effect upon ice movement at the berths?

6) Will new POL 1 affect your approach for starboard side alongside to other berths at the port?

7) Do you anticipate having to utilize assist tugboat(s) more frequently than presently done for docking and undocking during APMP?

8) Which phase of the construction project do you think simulations should be concentrated upon to best determine ability of the port to operate during construction?

9) What are your general feelings concerning APMP?
Appendix 2. Screenshots of Simulations
• Simulation Map: 1A 3
• Objective: Docking TOTE Port
• Phase: 3
• Current: Large flood
• Wind: 15 knots NW
• Level of Concern: 3
- Simulation Map: 1B 2
- Objective: Docking Tanker Port POL 2
- Phase: 2
- Current: Large Flood
- Wind: 15 knot NNW
- Level of concern: 3
• Simulation Map: 1C 2
• Objective: Docking Horizon Port
• Phase: 2
• Current: Large Flood
• Wind: 15 knots NNW
• Level of Concern: 3
• Simulation Map: 2A 3
• Objective: Docking TOTE Port
• Phase: 3
• Current: Small Flood
• Wind: 15 knots NW
• Level of Concern: 2
- Simulation Map: 2B 2
- Objective: Undocking Tanker Port POL 2
- Phase: 2
- Current: Large Flood
- Wind: 20 knots NNW
- Level of Concern: 1
- Simulation Map: 2C 2
- Objective: Undocking Horizon Port
- Phase: 2
- Current: Large Flood
- Wind: 20 knots NNW
- Level of Concern: 5
- Simulation Map: 3A 3
- Objective: Undocking TOTE Port
- Phase: 3
- Current: Large Flood
- Wind: 10 knots NNW
- Level of Concern: 2
- Simulation Map: 3B 2
- Objective: Tanker Docking Starboard POL 2
- Phase: 2
- Current: Large Ebb
- Wind: 20 knots NNW
- Level of Concern: 2
• Simulation Map: 3C 2
• Objective: Docking Horizon Starboard
• Phase: 2
• Current: Large Ebb
• Wind: 20 knots NNW
• Level of Concern: 4
Simulation Map: 4A 3
Objective: Docking TOTE Port
Phase: 3
Current: Large Flood
Ice Map: 4
Wind: 15 knots NW
Level of Concern: 3
- Simulation Map: 4B 2
- Objective: Docking Bulker Port POL 2
- Phase: 2
- Current: Large Flood
- Wind: 15 knots NW
- Level of Concern: 3
• Simulation Map: 4C 2
• Objective: Undocking Horizon Port
• Phase: 2
• Current: Large Ebb
• Wind: 15 knots NW
• Level of Concern: 4
• Simulation Map: 5A 3
• Objective: Undocking TOTE Port
• Phase: 3
• Current: Small Flood
• Ice Map: 5
• Wind: 10 knots NW
• Level of Concern: 4
• Simulation Map: 5B 2
• Objective: Docking Horizon Port
• Phase: 2
• Current: Small Flood
• Ice Map: 5
• Wind: 15 knots NW
• Level of Concern: 2
- Simulation Map: 5C 2
- Objective: Docking Cruise Ship Port POL 2
- Phase: 2
- Current: Small Flood
- Wind: 15 knots NW
- Level of Concern: 3
• Simulation Map: 6A 3
• Objective: Docking Horizon Port
• Phase: 3
• Current: Large Flood
• Ice Map: 4
• Wind: 15 knots NW
• Level of Concern: 2
• Simulation Map: 6B 2
• Objective: Docking Tanker Port POL 2
• Phase: 2
• Current: Large Flood
• Ice Map: 4
• Wind: 15 knots NW
• Level of Concern: 4
- Simulation Map: 6C 2
- Objective: Docking Cruise Ship
  Port Horizon Berth
- Phase: 2
- Current: Large Flood
- Wind: 15 knots NW
- Level of Concern: 5
- Simulation Map: 7A 4
- Objective: Docking Bulker Port POL 2
- Phase: 4
- Current: Large Flood
- Ice Map: 4
- Wind: 15 knots NW
- Level of Concern: 5
- Simulation Map: 7B 4
- Objective: Docking Tanker Port POL 2
- Phase: 4
- Current: Large Flood
- Ice Map: 4
- Wind: 15 knots NW
- Level of Concern: 4
- Simulation Map: 7C 4
- Objective: Docking TOTE Port north end Terminal 2
- Phase: 4
- Current: Large Flood
- Ice Map: 4
- Wind: 15 knots NW
- Level of Concern: 4
• Simulation Map: 8A 4
• Objective: Undocking Bulker Port POL 2
• Phase: 4
• Current: Small Flood
• Ice Map: 5
• Wind: 25 knots NW
• Level of Concern 3
- Simulation Map: 8B 4
- Objective: Undocking Tanker Port POL 2
- Phase: 4
- Current: Small Flood
- Ice Map: 5
- Wind: 25 knots NW
- Level of Concern: 1
• Simulation Map: 8C 4
• Objective: Undocking TOTE port north end Terminal 2
• Phase: 4
• Current: Small Flood
• Ice Map: 5
• Wind: 25 knots NW
• Level of Concern: 5
• Simulation Map: 9A 4
• Objective: Docking Tanker Port POL 2
• Phase: 4
• Current: Large Flood
• Ice Map: 4
• Wind: 15 knots NW
• Level of Concern: 5
- Simulation Map: 9B 4
- Objective: Docking Horizon Port
- Phase: 4
- Current: Large Flood
- Ice Map: 4
- Wind: 15 knots NW
- Level of Concern: 3
• Simulation Map: 9C 4
• Objective: Docking Cruise Ship Port
• Phase: 4
• Current: Large Flood
• Wind: 15 knots NW
• Level of Concern: 1
• Simulation Map: 10A 4
• Objective: Docking TOTE Port
• Phase: 4
• Current: Small Flood
• Ice Map: 5
• Wind: 20 knots NW
• Level of Concern: 2
- Simulation Map: 10B 4
- Objective: Docking Horizon Port
- Phase: 4
- Current: Small Flood
- Ice Map: 5
- Wind: 20 knots NW
- Level of Concern: 1
• Simulation Map: 10C 4
• Objective: Undocking Tanker POL 1
• Phase: 4
• Current: Small Flood
• Ice Map: 5
• Wind: 20 knots NW
• Level of Concern: 1
Simulation Map: 11A 4
Objective: Docking Horizon Port
Phase: 4
Current: Large Ebb
Ice Map: 2
Wind: 15 knots NW
Level of Concern: 2
• Simulation Map: 11B 4
• Objective: Docking Bulker Port POL 2
• Phase: 4
• Current: Large Flood
• Ice Map: 4
• Wind: 15 knots NW
• Level of Concern: 5
• Simulation Map: 11C 4
• Objective: Docking Tanker Port POL 1
• Phase: 4
• Current: Large Flood
• Ice Map: 4
• Wind: 15 knots NW
• Level of Concern: 1
• Simulation Map: 12A 2
• Objective: Docking Bulker Port POL 2
• Phase: 2
• Current: Large Flood
• Ice Map: 4
• Wind: 20 knots NW
• Level of Concern: 4
- Simulation Map: 12B 4
- Objective: Docking TOTE Port
- Phase: 4
- Current: Small Flood
- Ice Map: 5
- Wind: 20 knots NE
- Level of Concern: 2
• Simulation Map: 12C 2
• Objective: Docking Horizon Port North of Terminal 1
• Phase: 2
• Current: Large Flood
• Ice Map: 4
• Wind: 20 knots NW
• Level of Concern: 4
- Simulation Map: 13A 2
- Objective: Undocking Horizon Port
- Phase: 2
- Current: Large Ebb
- Ice Map: 1
- Wind: 20 knots NW
- Level of Concern: 5
• Simulation Map: 13B 4
• Objective: Undocking TOTE Port North end Terminal 2
• Phase: 4
• Current: Small Flood
• Ice Map: 5
• Wind: 20 knots NW
• Level of Concern: 3
- Simulation Map: 13C 4
- Objective: Undocking Tanker Port POL 1
- Phase: 2
- Current: Small Flood
- Ice Map: 5
- Wind: 20 knots NW
- Level of Concern: 1
- Simulation Map: 14A 6
- Objective: Docking TOTE Port
- Phase: 6
- Current: Large Flood
- Wind: 20 knots NE
- Level of Concern: 2
- Simulation Map: 14B 6
- Objective: Docking Tanker POL 2
- Phase: 6
- Current: Large Flood
- Wind: 20 knots NE
- Level of Concern: 1
• Simulation Map: 14C 6
• Objective: Docking Horizon Terminal 1
• Phase: 6
• Current: Large Flood
• Wind: 20 knots NE
• Level of Concern: 2
- Simulation Map: 15A 6
- Objective: Undocking TOTE Port
- Phase: 6
- Current: Large Ebb
- Ice Map: 1
- Wind: 0 knots
- Level of Concern: 2
• Simulation Map: 15B 6
• Objective: Undocking Tanker POL 2
• Phase: 6
• Current: Small Flood
• Ice Map: 5
• Wind: 20 knots NE
• Level of Concern: 1
- Simulation Map: 15C 6
- Objective: Undocking Horizon Terminal 1
- Phase: 6
- Current: Small Flood
- Ice Map: 5
- Wind: 20 knots NW
- Level of Concern: 2
- Simulation Map: 16A 6
- Objective: Docking TOTE Port
- Phase: 6
- Current: Large Flood
- Ice Map: 4
- Wind: 15 knots NE
- Level of Concern: 3
• Simulation Map: 16B 6
• Objective: Docking Tanker POL 1
• Phase: 6
• Current: Large Flood, 5 knots midstream and 3 knots at dock
• Wind: 15 knots NE
• Level of Concern: 5
• Simulation Map: 16C 6
• Objective: Docking
• Cruise Ship POL 2
• Phase: 6
• Current: Large Flood
• Wind: 15 knots SW
• Level of Concern: 1
• Simulation Map: 17A 6
• Objective: Docking Horizon Starboard
• Phase: 6
• Current: Large Ebb
• Ice Map: 1
• Wind: 20 knots NW
• Level of Concern: 2
• Simulation Map: 17B 6
• Objective: Docking Bulker POL 2
• Phase: 6
• Current: Large Ebb
• Ice Map: 1
• Wind: 20 knots NW
• Level of Concern: 4
- Simulation Map: 17C 6
- Objective: Undocking TOTE
- Phase: 6
- Current: Large Flood
- Ice Map: 4
- Wind: 20 knots SW
- Level of Concern: 2