Ports and Waterways Safety Assessment

Workshop Report

Baltimore, Maryland

26 – 27 August 2025

Providing Navigation Safety Information

for America's Waterways Users

Released By:

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Executive Summary

Coast Guard Sector Maryland – National Capital Region sponsored a Ports and Waterways Safety Assessment (PAWSA) workshop in Baltimore, Maryland, from August 26, 2025, to August 27, 2025. Nineteen participants representing a range of waterway users, stakeholders, and federal, state, and local regulatory and public safety authorities met to collaboratively assess navigational safety on the waterways adjoining the port of Baltimore. This report provides a visual depiction of the study area and contains the full list of workshop participants and their associated organizations. The first day of the workshop included discussions about port and waterway attributes and vessel traffic in relation to the sixteen Waterway Risk Factors (WRFs) in the PAWSA Waterway Risk Model, which is described in more detail in this report. During this dialogue, participants identified specific port WRF issues to inform mitigations and facilitate the Focused Quantitative Risk Assessment (FQRA) conducted on the second day of the workshop. At the conclusion of WRF discussions, Risk Characterization for each WRF was established based on participants' survey responses. Risk Characterization assesses the potential consequence, risk trend, risk tolerance, and effectiveness of existing mitigation strategies for a specific WRF. The metrics from the Risk Characterization quantitatively prioritized WRFs to inform discussions during the next phase of the workshop. During the second day, participants conducted a FQRA to approximate adverse economic impacts of prioritized WRF issues and engaged in follow-on discussions to identify and develop risk mitigation strategies. The output of the FQRA is called a Risk Index Number (RIN), a numerical value designed to quantify an issue's adverse monetary impact on a port to guide resource prioritization and decision-making. A value of one RIN is equivalent to one million dollars in economic loss to a port. A higher RIN value is indicative of larger projected annual economic loss due to a specific event type or issue. FQRA results for the average annual frequency for each type of event and its associated RIN Value for the workshop study area is provided in the table below.

Event Name	RIN	Avg Frequency
Collision	46.67	12.35
Allision	12.04	10.68
Sinking	8.64	2.09
Traffic Restricted	5.10	9.26
Fire/Explosion	3.30	1.00
Grounding	2.10	7.01
Oil Spill	1.25	2.42
Infrastructure Failure	0.28	0.25
HAZMAT Release	0.00	0.00
Total	**79.39**	**45.04**

FQRA results for the five issues with the highest RIN value and the associated numerical value are presented in Chapter 2.C. The RIN results, recommended mitigation strategies, and participant observations documented in this report will meaningfully facilitate continued collaboration between the Coast Guard and waterway stakeholders to improve safe and efficient navigation within the Marine Transportation System (MTS). The Director of Marine Transportation Systems (CG-5PW), the Coast Guard's Navigation Center (CG NAVCEN), and CG Sector Maryland – National Capital Region extend their sincere appreciation to participants for their contributions to the Baltimore PAWSA workshop.

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CHAPTER 1. GENERAL

A. Background and Purpose

1. The Director of Marine Transportation Systems (CG-5PW) is responsible for developing and implementing policies and procedures that facilitate commerce, improve safety and efficiency, and maximize the commercial viability of the Marine Transportation System (MTS). In the late 1990s, the Coast Guard convened a national dialogue group (NDG) comprised of maritime stakeholders to identify the needs of waterway users with respect to Vessel Traffic Management (VTM) and Vessel Traffic Service (VTS) systems. A major outcome of the NDG was the development of the Ports and Waterways Safety Assessment (PAWSA) process, which the Coast Guard established as the formal model for facilitating stakeholder discussion to identify VTM improvements and determine candidate VTS waterways. The PAWSA methodology has been modernized several times by the CG NAVCEN and Office of Waterways & Ocean Policy (CG-WWM) since its original inception for purposes of creating a more adaptable tool available to Sector Commanders to engage the maritime community to monitor and improve the health of the MTS within their area of responsibility. The most recent PAWSA process update occurred in 2025.

2. The current PAWSA process convenes a select group of waterway users and stakeholders to facilitate a structured workshop agenda to meet pre-identified risk assessment objectives. A successful workshop involves the participation of professional waterway users with local expertise in navigation, waterway conditions, and port safety. Stakeholder involvement is central to ensuring that important environmental, public safety, and economic consequences receive appropriate attention as risk interventions are identified and evaluated. The workshop culminates in a written report that includes proposed risk mitigations developed by participants, which is made publicly available on the CG NAVCEN's website (https://www.navcen.uscg.gov/ports-and-waterways-safety-assessment-final-reports.)

3. The PAWSA process strives to achieve the following objectives:

   a. Gather stakeholder input to identify major waterway trends, safety hazards, and potential mitigation strategies.

   b. Bolster public-private partnership and enhance cooperation across the MTS.

   c. Generate a stakeholder driven report that captures data gathered from the PAWSA to prioritize future projects impacting the MTS.

B. Methodology

1. Waterway Risk Conditions and Waterway Risk Factors. The PAWSA process is designed to convert qualitative experience, observations, and opinions of participants into quantitative assessments. This method uses numerical comparison among sixteen WRFs to build consensus among participants to better inform conversations regarding risk mitigation strategies within an identified study area. The Waterway Risk Condition categories and associated WRFs are listed in Table 1 and further defined in Appendix B.

Navigation	Vessel Quality & Operation	Traffic	Waterway
Winds	Large Commercial Vessels	Volume of Commercial Traffic	Dimensions
Currents and Tides	Small Commercial Vessels	Volume of Recreational Traffic	Obstructions
Visibility Restrictions	Commercial Fishing Vessels	Waterway Use	Visibility Impediments
Bottom Type	Recreational Vessels	Congestion	Configuration

Table 1 – The four Waterway Risk Condition categories and sixteen WRFs.

2. PAWSA Workshop Structure. Each PAWSA workshop is a two-day facilitated process. The following sections detail the structure and goals for each day of a workshop. A maximum of 30 stakeholders divided into 15 two-person teams may participate.

   a. PAWSA Workshop - Day 1.

      (1) WRF Discussion. During the first day of a PAWSA, participants gain a comprehensive understanding of the workshop study area and are led through individual discussions for each WRF identified in Table 1. The purpose of these discussions is to provide a collaborative forum for stakeholders to generate a list of specific challenges unique to their respective port as related to each WRF. Participants identify and prioritize the top three issues for each WRF to facilitate

the Focused Quantitative Risk Assessment (FQRA) process and inform mitigation discussions during Day 2. These issues are documented in Appendix E.

(2) Risk Characterization Survey. Risk Characterization is a combined qualitative measure of the risk tolerance, risk trend, and effectiveness of existing mitigation strategies for a specific WRF. Surveys are completed at the end of Day 1 by the established two-person teams. The survey asks teams to evaluate the Current Risk Level, Current Risk Trend, and Current Risk Mitigations to characterize the risk associated with each WRF. Participants select from a set of qualitative descriptors that have weighted numeric values assigned to each answer to calculate Risk Characterization. Table 2 provides the available selections for each Risk Characterization question.

	Available Selections
Current Risk Level	We could accept more risk
	Balanced
	Unacceptable
Current Risk Trend	Decreasing
	Steady
	Increasing
Current Risk Mitigations	Acceptable
	Acceptable, but tenuous
	Unacceptable *(*If unacceptable select all that apply*)
	Not Effective
	Too costly
	Slow operations
	Causes other issues

Table 2 – WRF Survey, Risk Characterization categories.

After each team completes the Risk Characterization survey, their assessment of the Waterway Risk Factors is compiled into a Characterization Count. The Characterization Count is crucial because it reflects how each team perceives risk for each WRF. The selected values from the survey generate a color-coded classification that informs the overall WRF Risk Characterization for each team. The results from each team survey are then aggregated together to determine the Characterization Rating for each WRF that represents the average of the stakeholder group. The Characterization Rating informs the prioritization of

WRFs to guide mitigation development discussions and evaluation of WRF issues through the FQRA during Day 2 of the workshop.

(3) Characterization Count Color Designations. Individual team Characterization Count for a WRF is designated as red, orange, or green. For this scale, red represents high risk, orange represents intermediate risk, and green represents low risk. The following subsections outline the thresholds for each color-coded Risk Characterization designation for team Characterization Count.

(a) A WRF is designated with a red Risk Characterization when an individual team determines the WRF Current Risk Level is "unacceptable," or the Current Risk Mitigations are "unacceptable."

(b) A WRF is designated with an orange Risk Characterization when an individual team determines the Current Risk Trend is "increasing" and the Current Risk Mitigations are "weak."

(c) A WRF is designated with a green Risk Characterization when an individual team's combinations of answers do not meet the threshold for red or orange.

(4) Characterization Rating Color Designations. When the teams complete the Risk Characterization survey, their assessments are combined to calculate and assign the overall Characterization Rating for each WRF, as shown as an example in Table 3.

Category	RF Small	Characterization	Red	Orange	Yellow	Green
Traffic	Rec	Red	10	3		1
Vessel	Rec	Red	11	1		2
Vessel	Small	Red	9	3		2
Traffic	Congestion	Orange	6	6		2
Traffic	Usage	Orange	4	8		2
Navigational	Bottom	Green	1	1		12
Navigational	Tides	Green	2	4		8
Navigational	Vis	Green	1			13
Navigational	Winds	Green		1		13
Traffic	Commercial	Green		5		9
Vessel	Fishing	Green	1			13
Vessel	Large	Green	2	4		8
Waterway	Config	Green	4	2		8
Waterway	Dims	Green	4	2		8
Waterway	Obstr	Green	2	1		11
Waterway	Vis	Green	4	2		8

Characterization Count - Individual Team
Red. The Risk Level is Unacceptable OR the Mitigations are Unacceptable.
Orange. The Risk Trend is Increasing AND the Mitigations are Weak.
Green. All others.

Characterization Rating - Overall
Red. 60% or more teams rated as Red.
Orange. 50% or more teams rated Yellow or higher.
Green. 50% or more teams rated as Green.

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Table 3 – Example Risk Characterization survey results.

Characterization Rating for a WRF is designated as red, orange, or green. The color-coded scale for the Characterization Rating is the same as Characterization Count, but the thresholds for attributing the color designation are different. In Table 3, the numbers below each of the header columns labeled red, orange, and green represent the number of individual teams that attribute a certain risk level to that specific WRF. The Characterization Rating for a WRF is determined by plurality. The following subsections outline the thresholds for each color-coded Risk Characterization Rating designation.

(a) A WRF is designated with a red Characterization Rating if 60% or more of the teams select that specific rating.

(b) A WRF is designated with an orange Characterization Rating if 50% or more of the teams select that specific rating.

(c) A WRF is designated a green Characterization Rating if 50% or more of the teams select that specific rating.

(5) At the conclusion of Day 1, PAWSA facilitators present the Risk Characterization survey results and facilitate discussion among participants to determine and validate prioritization of WRFs for use in the FQRA and mitigation development.

b. PAWSA Workshop – Day 2. The second day of the workshop is focused on fulfilling two objectives. The first is to complete the FQRA to calculate the Risk Index Number (RIN) for the highest prioritized WRFs identified during Day 1. The second is to develop mitigations for issues associated with those WRFs. The following subsections provide more detail regarding the process and methodology for executing the FQRA and WRF mitigation development.

(1) Focused Quantitative Risk Assessment (FQRA). The FQRA is a process to conduct a normalized comparison between historical data and participant expertise to approximate the yearly adverse economic impact of individual WRFs on a port. The output from this calculation is called the RIN. The value of the RIN represents the annual average potential economic loss in millions of dollars based on the associated WRF. The FQRA uses existing historical data from Coast Guard vessel operational controls, waterways management operational controls, and incident investigation activities documented in the Coast Guard's Maritime Information for Safety and Law Enforcement (MISLE) database. The MISLE database is the centralized repository for capturing and reporting the information required to support Coast Guard marine safety, security, environmental protection,

and law enforcement programs and for ensuring compliance with statutory and regulatory record keeping requirements. The FQRA is a two-pronged method derived from combining the distribution of historical outcomes for a local area and the multiplication product of the likelihood and consequence for a specific scenario. Figure 1 depicts a flow chart that visually represents the process used in the FQRA.

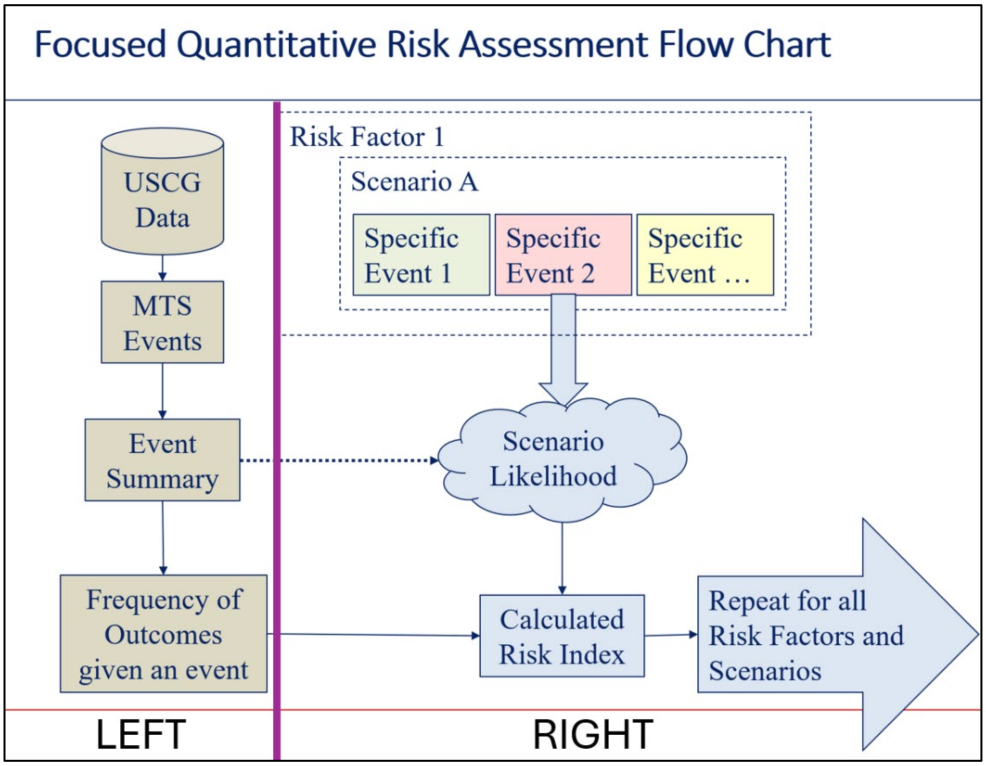

Figure 1 – FQRA Flow Chart.

(a) During the first step of the FQRA, represented on the left side of Figure 1, Coast Guard MISLE data is synthesized to determine the historical frequency of events and their outcomes. The outputs from this first step guide the calculations used in the second step to convert qualitative stakeholder input into a quantitative metric. In this model, outcomes are unwanted consequences that are classified as safety, environmental, or economic. For more information on the Coast Guard established consequence types, severity categories, and fiscal equivalence, please see Table 1 in section B.1 of Appendix B.

(b) During the second step of the FQRA, represented on the right side of Figure 1, participants provide qualitative data regarding the types and likelihood of an event occurring due to the issues identified for the top prioritized WRFs on

Day 1 of the workshop. To gather this information, facilitators provide participant teams with a Risk Event Form pre-populated with the prioritized WRFs and the associated top three issues for each factor that were determined during Day 1. The stakeholders use their local anecdotal knowledge of historical events to assign each issue up to three types of events that may occur due to the issue and the predicted frequency of the event. Available types of events on the Risk Event Form include allision, collision, fire/explosion, grounding, oil spill, sinking, or traffic restricted. For definitions of these event types, please see Appendix F. After selecting an event type, participants designate a predicted likelihood of the event, based on local knowledge and experience. Likelihood is the probability of an event based on local historical trends. Frequency thresholds for the likelihood designations used in the FQRA to calculate RIN are described in Table 4. The model standardizes the likelihood with incidents per fifty years to allow for easier understanding and comparison with historical numbers. The corresponding probability of each event is multiplied by the consequence value and normalized to millions of dollars, estimating the RIN to one million dollars in economic loss for an associated event.

Likelihood	Frequency	Probability
Very Unlikely	Once or twice in the history of the port / waterway	0.00055
Rare	Once every 50-100 years	0.006
Occasional	Once or twice every 10-20 years (2-20 every 50 years)	0.22
Probable	Once or twice every year or two (25-75 in 50 years)	1
Frequent	More than twice per year (100 in 50 years)	5

Table 4 – Likelihood designations, frequency thresholds, and probability values used to calculate RIN.

(c) The model uses MISLE data, including vessel operational controls, waterways management operational controls and incident investigation activities, to group historical investigations into consequence categories. This allows normalization of stakeholder inputs using historical data. It is important to note that the data used in this model was selected for its quality and availability and is therefore limited. It does not include reports or data from all types of events reported or investigated by the Coast Guard. The historically synthesized national and local data is used to pre-assign specific values for stakeholder qualitative input and create the frequency distribution used in the RIN calculation. During the FQRA, both the historical national events and local events are provided to stakeholders for review in handout form, prior to conducting the assessment. Please see Appendix F for the national and local event data provided to stakeholders during the PAWSA.

(d) For the FQRA, the stakeholders select a frequency for each event, which is then multiplied by the distribution of consequences. This is added together to calculate the RIN.

(2) FQRA Results. Facilitators use the qualitative data collected in the Risk Event Forms to conduct the FQRA. This generates a RIN and estimated annual frequency for each event type, which are sortable by WRF and issue. Table 5 and 6 provide examples of RIN results and data from the FQRA. A large volume of raw data is generated from the FQRA. To keep the report concise, only RIN results for all event types and the five issues with the highest RIN values are presented in this report and can be found in Chapter 2, Section C.3. Additional raw FQRA data, including the RIN results for all evaluated issues and associated event types, is available by request from the Coast Guard Navigation Center.

(a) The results summarized in Table 5 provide an example of the RIN and annual frequency for each event type as determined through the FQRA. The RIN represents a monetary quantification of identified risks. For the purposes of this assessment, a RIN value of '1' corresponds to a potential financial impact of $1 million (e.g., 2.5 RIN = $2.5 million). This quantification provides essential context for assessing the potential financial impact on the maritime system during an event.

Event Name	RIN	Avg Frequency
Collision	10.16	2.69
Traffic Restricted	7.72	14.01
Sinking	6.61	1.60
Infrastructure Failure	5.83	5.17
Allision	4.43	3.93
Grounding	1.08	3.60
Oil Spill	0.22	0.43
HAZMAT Release	0.04	0.08
Fire/Explosion	0.01	0.00
Total	**36.11**	**31.52**

EXAMPLE

Table 5 – Example RIN and annual frequency results by event.

(b) The results summarized in Table 6 provide an example of RIN values broken down by WRF, issue, and event type. Stakeholders can leverage the RIN to compare the costs associated with implementing mitigation measures against the potential cost of an incident and its subsequent cascading effects, thereby optimizing resource allocation for risk reduction. For example, in Table 6, if stakeholders reported that "Groundings throughout the study area can cause the waterway to shut down for an extensive amount of time," and associate a RIN of 1.02, this indicates that the issue is estimated to cost the local maritime system $1,020,000.

Risk_Factor	RIN	Avg Events
Bottom Type	**6.52**	**8.69**
Groundings throughout the study area can cause the waterway to shut down for an extensive amount of time.	**1.02**	**1.76**
Allision	0.09	0.08
Collision	0.00	0.00
Grounding	0.05	0.17
HAZMAT Release	0.00	0.00
Infrastructure Failure	0.10	0.08
Oil Spill	0.09	0.17
Sinking	0.00	0.00
Traffic Restricted	0.69	1.25

EXAMPLE

Table 6 – Example RIN by WRF, issue, and event type.

(c) Normalizing the impact value in dollars provides the ability to update and localize the model as needed or desired. This enables comparison between past and current results of the same port and comparisons between different ports. Port specific results generated during a workshop can be compared to existing Coast Guard data of historical events to highlight local mariner knowledge of events captured through the RIN process. Chapter 2, Section C.3. contains participant issues with the top five RIN values extracted from the FQRA results.

(3) Mitigations. Following completion of the FQRA, facilitators present the Risk Characterization survey results and facilitate discussion among participants to determine prioritization of WRF for mitigation development. Stakeholders collaboratively determine the top WRFs to focus dialogue for mitigation development during the remainder of the workshop. The development of mitigation strategies is guided by facilitators using the key issues identified during discussions from Day 1. These issues are used as the starting point for participants to brainstorm mitigations to address concerns and are the same issues used in the FQRA. Facilitators assist participants in developing risk mitigation strategies that are both impactful and feasible, ideally capturing those that are well-developed

proposals with clear delineation of ownership and predicted timelines to enact change. Through this invaluable process, stakeholders make recommendations to improve safe and efficient waterways usage within the port study area, creating a comprehensive list of action items for future implementation or reevaluation.

CHAPTER 2. BALTIMORE PAWSA WORKSHOP

A. PAWSA Study Area

1. The geographical area for the Baltimore PAWSA included the Port of Baltimore and is depicted in Figure 2. The coordinates bounding the Baltimore study area were: 39.522°N, 076.641°W and 38.937°N, 075.969°W. Graphic representations of this study area were used to facilitate discussion with participants. Additionally, geographically referenced comments were collected during the workshop and are documented as chartlets in Appendix D.

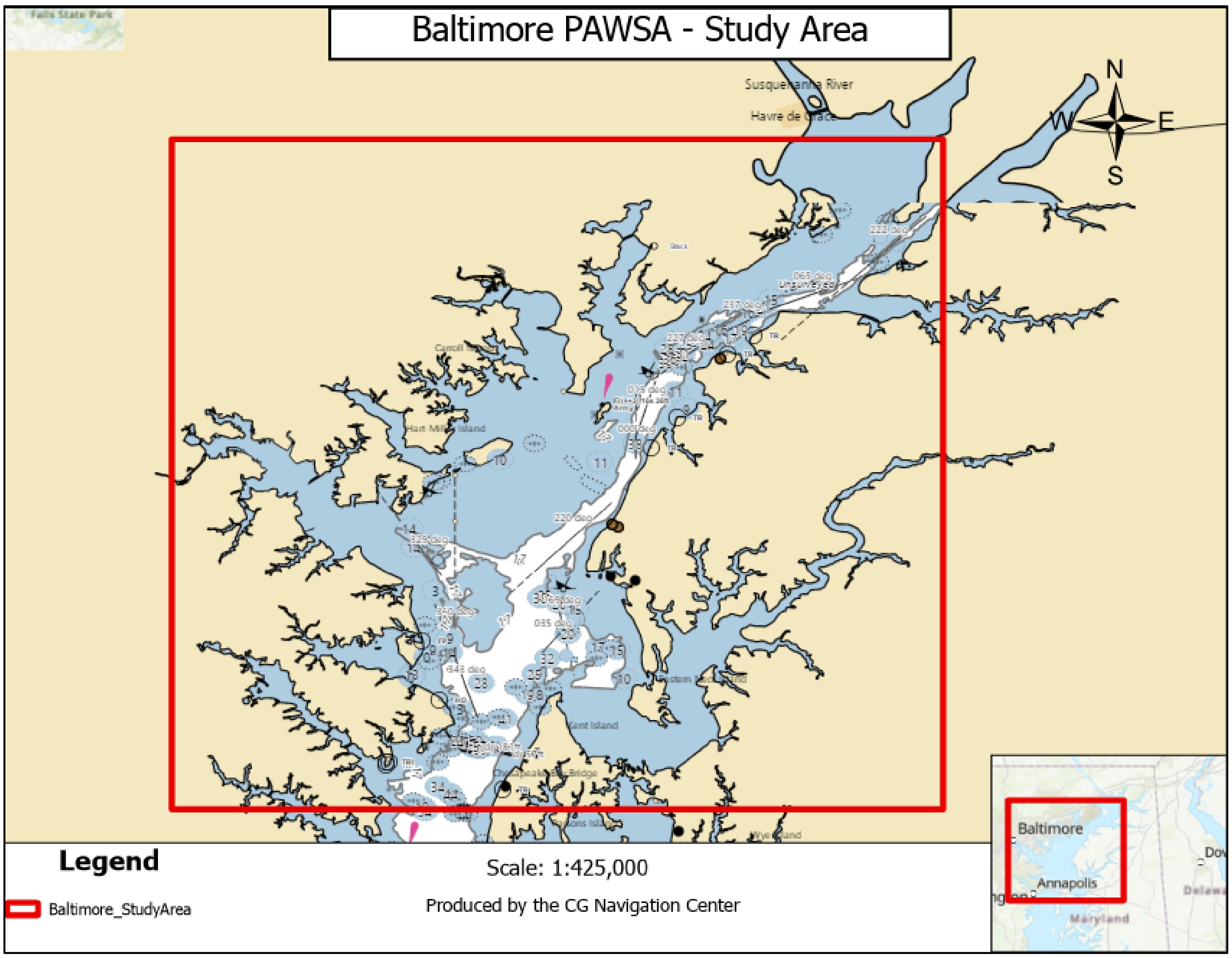

Figure 2- Baltimore PAWSA workshop study area.

B. Participant Validation of WRF Prioritization

1. The Risk Characterization survey results are depicted below in Figure 3. The results are grouped by Risk Characterization. These results were presented to participants to validate the prioritization order of WRFs to facilitate the FQRA and for mitigation strategy development.

2. Overall, stakeholders determined risk is increasing in the Port of Baltimore. Risk characterization results indicate that volume and density of recreational vessel traffic is the most concerning issue. During Day 1 of the workshop, participants described the waterways comprising the Port of Baltimore as complex. The configuration of waterways, growing volume and density of recreational and commercial vessel traffic, and the presence of increasingly larger commercial vessels in the Port of Baltimore creates complex navigational challenges that require careful management and risk mitigation from all waterway users.

Category	RF Small	Characterization	Red	Orange	Yellow	Green
Navigational	Bottom	Green	1	2		8
Navigational	Tides	Green	1	4		6
Navigational	Vis	Green	2	1		8
Navigational	Winds	Green	2	1		8
Traffic	Usage	Green	1	3		7
Vessel	Fishing	Green	1			10
Waterway	Obstr	Green	2	2		7
Waterway	Vis	Green	2			9
Traffic	Commercial	Orange	1	6		4
Traffic	Congestion	Orange	2	6		3
Traffic	Rec	Orange	5	3		3
Vessel	Large	Orange	3	4		4
Vessel	Small	Orange	1	5		5
Waterway	Config	Orange	2	5		4
Waterway	Dims	Orange	5	2		4
Vessel	Rec	Red	8	2		1

Characterization Count - Individual Team
Red. The Risk Level is Unacceptable OR the Mitigations are Unacceptable.
Orange. The Risk Trend is Increasing AND the Mitigations are Weak.
Green. All others.

Characterization Rating - Overall
Red. 60% or more teams rated as Red.
Orange. 50% or more teams rated Yellow or higher.
Green. 50% or more teams rated as Green.

Figure 3- Risk Characterization survey results for all WRFs.

3. Following subjective evaluation, participants selected Recreational Vessels, Volume of Recreational Traffic, Congestion, and Dimensions as the most significant WRFs that contributed to potential incidents in the Baltimore PAWSA study area. A consensus vote amongst participants determined the ranking of WRFs according to their level of concern. Table 7 presents WRFs in descending priority order from high to low.

Waterway Risk Category	**WRF**
Navigation	Recreational Vessels
Traffic	Volume of Recreational Traffic
Waterway	Dimensions
Traffic	Congestion

Table 7- Validated and prioritized WRFs listed from top to bottom.

C. Risk Index Number Results

1. RIN Results by Frequency. As detailed in Table 7, participants validated and prioritized WRFs within the Baltimore PAWSA study area. Based on this prioritization, stakeholders completed Risk Event Forms (as described in Chapter 1.B.2.b.(1)(b)) for the top four WRFs. Each form captured the top three validated issues that stakeholders deemed most pertinent for each of the four highest prioritized WRFs. Appendix E contains a full list of these participant-presented and validated issues. The issues presented in this appendix are edited for clarity and syntax.

2. The average annual frequency for each type of event with its associated RIN value listed from highest to lowest in Table 8.

Event Name	RIN	Avg Frequency
Collision	46.67	12.35
Allision	12.04	10.68
Sinking	8.64	2.09
Traffic Restricted	5.10	9.26
Fire/Explosion	3.30	1.00
Grounding	2.10	7.01
Oil Spill	1.25	2.42
Infrastructure Failure	0.28	0.25
HAZMAT Release	0.00	0.00
Total	**79.39**	**45.04**

Table 8- RIN by event type.

3. RIN Results by Issue. The five issues with the highest RIN values as identified from stakeholder surveys completed during Day 2 of the PAWSA workshop are ordered from highest to lowest in Table 9. The verbiage for the issues in Table 9 is presented as agreed upon and used by participants during the FQRA. It has not been altered for clarity. Additional data and information for the Sector Maryland – National Capital Region RIN results is available by request from the Coast Guard Navigation Center.

Issue #1	Maryland experiences a significant increase in recreational boating traffic during the season from April 1st to October 31st, driven by the state's 152,000 registered recreational vessels.			
Event Type	**RIN**	**Event Type**	**RIN**	**Total RIN**
Allision	3.48	Infrastructure Failure	0	**18.67**
Collision	9.45	Oil Spill	0.26	
Fire/Explosion	1.38	Sinking	3.10	
Grounding	0.45	Traffic Restricted	0.55	
Issue #2	Recreational vessels often demonstrate a poor understanding and application of navigation rules and proper use of navigation equipment, sometimes over-relying on it when available.			
Event Type	**RIN**	**Event Type**	**RIN**	**Total RIN**
Allision	3.38	Infrastructure Failure	0	**17.54**
Collision	9.77	Oil Spill	0.43	
Fire/Explosion	0.55	Sinking	2.76	
Grounding	0	Traffic Restricted	0.09	
Issue #3	Inadequate vessel enforcement across waterways is allowing drunk boating to increase, and stakeholders report a concerning decline in Coast Guard presence.			
Event Type	**RIN**	**Event Type**	**RIN**	**Total RIN**
Allision	2.63	Infrastructure Failure	0.19	**16.38**
Collision	10.40	Oil Spill	0.22	
Fire/Explosion	1.38	Sinking	0.69	
Grounding	0.65	Traffic Restricted	0.23	
Issue #4	Security zones are needed to manage the high volume of marine events (around 200 applications yearly), but information about these events and zones often doesn't reach recreational boaters.			
Event Type	**RIN**	**Event Type**	**RIN**	**Total RIN**
Allision	0.38	Infrastructure Failure	0.09	**9.75**
Collision	6.93	Oil Spill	0.04	
Fire/Explosion	0	Sinking	1.04	
Grounding	0.08	Traffic Restricted	1.19	
Issue #5	During Pier Six concerts, recreational boats often anchor haphazardly off the pier, creating potential obstructions; a designated anchorage should be established to ensure clear access for emergency vessels.			
Event Type	**RIN**	**Event Type**	**RIN**	**Total RIN**
Allision	1.22	Infrastructure Failure	0	**8.56**
Collision	5.99	Oil Spill	0.04	
Fire/Explosion	0	Sinking	0.35	
Grounding	0	Traffic Restricted	0.55	

Table 9- Highest five RIN values ranked by issue in descending order.

4. Summary of RIN Results. The data indicates that collisions, which have the highest RIN, occur most frequently on average. This finding is unsurprising, as the FQRA identified collisions as the most prevalent event type, driven by waterway and port-specific factors that contribute to the elevated RIN value. In Baltimore, this concern is amplified by stakeholder observations regarding high recreational vessel traffic and congestion. The recent Francis Scott Key Bridge collapse, caused by a Neopanamax vessel, underscores the potentially catastrophic consequences of such incidents. Several key factors contribute to this heightened risk. First, the Port of Baltimore manages approximately 5,000 large ship movements annually, with volumes expected to increase, highlighting the need for infrastructure improvements such as the development of a new marine terminal to support larger vessels. Second, rising cargo volumes are driving the use of bigger ships, which reduces available pier space and narrows navigable channels. Finally, as commercial vessels continue to grow larger in size, the risk of collisions, allisions and groundings increases due to reduced vertical bridge clearances, underwater keel clearances, and space availability to maneuver in federal channels.

5. As detailed in Table 8, the total average frequency for all event types in the Port of Baltimore is 45.04 occurrences per year. The total estimated annual RIN cost associated with these events is $79.39 million.

D. Risk Mitigation Strategies

1. The validated list of WRFs was used to prioritize discussion and development of risk mitigation strategies. Facilitators directed participants to capture potential mitigation strategies on sticky notes, which were then consolidated and grouped to identify major themes. From this bank of action items, participants were encouraged to generate mitigation strategies. Recommended mitigation strategies documented in this section received consensus among workshop participants. Mitigation strategies are documented in the order of WRF priority as determined by participants.

2. Participant comments are listed in Appendix C of this report and are referenced throughout this subsection to provide support of documented developed mitigation strategies.

3. Appendix E of this report contains a full list of the issues that participants presented and validated, informing the development of mitigation strategies discussed below. The issues presented in Appendix E are edited for clarity and syntax.

4. <u>WRF – Recreational Vessels.</u>

   a. There is an increase in incidents related to impaired boating operators. Inadequate vessel enforcement throughout the waterways is contributing to an increase in incidents of impaired boating. Participants recommended the following mitigation strategies:

      (1) Coordinate and establish formal agreements with federal, state, and local agencies to increase law enforcement personnel and resource presence in the Baltimore PAWSA study area.

      (2) Reinstate the Baltimore City Police Department Marine Unit and other Baltimore City enforcement agencies to full-time patrol status.

      (3) Implement dedicated resources, including technologies such as cameras, specifically for detecting and deterring impaired boaters. This requires state and federal funding, training, and ongoing maintenance to ensure effective operation and enforcement.

      (4) A comprehensive public awareness campaign, led by the Port of Baltimore Harbor Safety Committee (HSC) in collaboration with the Coast Guard Auxiliary and

Maryland Department of Natural Resources (DNR), to educate boaters about the dangers and consequences of boating while intoxicated. This campaign will include efforts to design and implement a public awareness campaign, coordinate with local marinas and boating organizations to promote boating safety course attendance, evaluate outreach effectiveness, and provide regular progress reports to stakeholders.

b. Sailboat races and regattas at night frequently obstruct large commercial vessel traffic and pose a recurring impediment to safe navigation in the waterways. Participants recommended the following mitigation strategies:

(1) Leverage the Coast Guard Auxiliary to deliver targeted education to regatta participants on effective communication protocols and safe navigation practices to minimize risk of collisions with large commercial vessels.

(2) Mandate additional lighting for participating sailing vessels of less than 7 meters in length to include optional sidelights and stern light or combined lantern in addition to the electric torch, or lighted lantern prescribed by Rule 25 of the Navigation Rules.

(3) Mandate transmission of the positions of participating sailing vessels using Automatic Identification System (AIS) transponders.

(4) Encourage collaboration between the Port of Baltimore HSC and Maryland DNR to develop and distribute a boating safety handout that contains the following information: local hazards, radio etiquette with commercial vessels, AIS transponder usage, vessel lighting configurations compliant with federal navigation rules, and methods to access local marine event information.

(5) Expand efforts to encourage race organizers to share schedule with commercial operators.

c. Recreational vessels demonstrate a poor understanding and application of navigation rules and overly rely on available electronic navigation equipment. Participants recommended the following mitigation strategies:

(1) Advocate for the Coast Guard Auxiliary and Maryland DNR to collaborate and establish a multi-lingual boating safety outreach program, including Spanish,

Chinese, and Korean languages, that teaches information regarding navigation rules, basic seamanship, casualty response, and radio etiquette.

(2) Amend current boating safety outreach programs to include a dedicated module reviewing the potential dangers of over-reliance on electronic navigation equipment. The developed module will emphasize the importance of seaman's eye and maintaining heightened situational awareness even when electronic aids are available. The module will promote responsible equipment use of electronic navigation equipment and highlight the importance of visual observation to improve safe behavior by recreational boaters.

(3) Fund boating safety outreach programs using public-private cost shares. Leverage state and federal grant opportunities offered by Maryland, the Coast Guard, and the National Oceanic and Atmospheric Administration (NOAA). Explore private maritime foundations and corporate sponsorships as potential avenues for resourcing.

(4) Measure the success of boating safety outreach programs using pre- and post-program knowledge assessments. Track incident rates to measure the program's impact. Conduct follow-up participant surveys to gauge understanding and behavioral changes. Use these metrics to refine and improve the program's effectiveness over time, supporting iterative improvements and program sustainment.

5. <u>WRF – Volume of Recreational Traffic.</u>

a. With approximately 200 marine event applications processed annually, there is a critical need to improve communication and awareness of these events among the recreational boating community. Participants recommended the following mitigation strategies:

(1) Establish a standardized format for marine event announcements that incorporates precise geographic coordinates and clear visual representations for active security zones in the CG NAVCEN Broadcast Notice to Mariners (BNM) tool. Enable geo-fencing capabilities to deliver targeted notifications directly to boaters operating in impacted areas.

(2) Request the Coast Guard develop a user-centric mobile application that provides boaters with real-time alerts, interactive maps of security zones, and an easy-to-use system for reporting safety concerns.

(3) Provide the Coast Guard Auxiliary with comprehensive training on marine event procedures, detailed maps, and informational brochures to actively engage boaters at fuel docks and tackle shops. This training is vital for improving communication and awareness of marine events among the recreational boating community due to the quantity of marine events throughout Baltimore.

(4) Use the Port of Baltimore HSC to actively support and encourage marine event organizers to create and distribute press releases, through local media outlets and social media posts, that provide event details and potential waterway restrictions and impacts.

(5) Enhance awareness of marine event security zones by encouraging Maryland DNR to use its email distro-lists and social media outlets to disseminate event details and anticipated waterway restrictions.

Appendix A. Workshop Participants

Participant	Organization
1. Michael Snyder	American Sugar Refining
2. John Kinlein	Association of Maryland Pilots
3. Matt Wallach	Maryland Department of the Environment
4. Michael Lathroum	Maryland Department of Natural Resources
5. Scott Davis	Maryland Department of Natural Resources - Natural Resources Police
6. Cynthia Burman	Maryland Port Administration
7. Brian Miller	Maryland Port Administration
8. Ruel Sabellano	Maryland Transportation Authority
9. Mike Reagoso	McAllister Towing
10. Johnathan Steinberg	Moran Towing
11. Peter Stone	National Oceanic and Atmospheric Administration
12. Joseph Gowland	Ports America Chesapeake
13. Michael McGeady	Sail Baltimore
14. Nam Nawrocki	Sail Baltimore
15. Niels Veenema	Tradepoint Atlantic
16. Eric Lindheimer	United States Army Corps of Engineers
17. Garrett Dailey	United States Coast Guard
18. Peter Brown	United States Coast Guard
19. Timothy Walker	United States Coast Guard

Appendix B. Waterway Risk Model Terms, Definitions, and Focused Quantitative Risk Assessment (FQRA)

A. Waterway Risk Conditions and Waterway Risk Factor (WRF) Definitions. The Ports and Waterway Safety Assessment (PAWSA) Waterway Risk Model utilizes sixteen WRFs categorized under four Waterway Risk Conditions. Definitions for each Waterway Risk Condition and their associated WRF are defined in this section.

1. Waterway Risk Condition - Navigation. The environmental conditions that affect vessel navigation, such as wind, currents, and weather.

    a. WRF -Winds. The difficulty in maneuvering vessels resulting from increased and unpredictable winds, particularly if the wind is from abeam.

    b. WRF - Tides and Currents. The difficulty in maneuvering vessels caused by water movement flow and speed, often affected by seasonal variations and sustained winds. Tide rips and whirlpools can be created by strong currents and affect the maneuverability of smaller vessels. The frequency of occurrence and the location of the strongest currents in the waterway are critical considerations (e.g., if current speed can exceed vessel speed, timing is critical when transiting the area).

    c. WRF - Visibility Restrictions. The natural conditions that may prevent a mariner from seeing other vessels, aids to navigation, or landmarks, such as fog, severe rain squalls, etc.

    d. WRF - Bottom Type. The material on the waterway bottom or just outside the channel, such as hard rock, mud, coral, etc.

2. Waterway Risk Condition - Vessel Quality and Operations. The quality of vessels and their crews that operate on a waterway. Each waterway has what are considered high risk vessels, such as old vessels, vessels with poor safety records, vessels registered in certain foreign countries, vessels belonging to financially strapped owners, vessels with inexperienced crews and operators, etc. When assessing risk, the following items should be considered (as appropriate) for each risk factor: maintenance, age, flag, class society, ownership, inspection record, casualty history, language barriers, fatigue related issues, and local area knowledge.

    a. WRF - Large Commercial Vessels. The quality of the large commercial vessel itself and the proficiency and quality of the crew. Large vessels are those ocean-going vessels, often in international trade, that usually are constrained by their draft to use dredged channels where such channels exist. Large vessels include such things as oil tankers, container ships, break bulk cargo ships, and cruise liners.

    b. WRF - Small Commercial Vessels. The quality of the small commercial vessel itself and the proficiency and quality of the crew. Small vessels include all other commercial craft EXCEPT commercial fishing vessels. Examples include tugs and towboats, offshore supply vessels, charter fishing boats, and small passenger vessels (inspected under 46 CFR Subchapters T and K), such as dinner cruises and ferries.

c. WRF - Commercial Fishing Vessels. The quality of the commercial fishing vessel itself and the proficiency and quality of the crew. These vessels are included because they are not required to undergo annual vessel inspections nor are the crewmembers required to hold USCG licenses; therefore, there may be a greater potential for increased incidents involving commercial fishing vessels.

d. WRF - Recreational Vessels. The quality of the recreational vessel itself and the proficiency and operating knowledge of the individuals who operate them. Recreational vessels include all boats used for noncommercial purposes (e.g., pleasure craft or craft used by indigenous people for transportation or subsistence fishing). They can be powered by an engine, the wind, or human exertion. Examples include yachts, personal watercraft (a.k.a., jet skis), and kayaks.

3. Waterway Risk Condition - Traffic Conditions. The number of vessels that use a waterway and their interactions.

   a. WRF - Volume of Commercial Traffic. The amount of commercial vessel traffic using the waterway (i.e., the more vessels there are on the water, the more likely that there will be a marine casualty). Deep draft and shallow draft commercial vessels as well as commercial fishing vessels are included in this risk factor. Shoreside infrastructure is also addressed in this risk factor (i.e., can it handle the volume of commercial traffic within the waterway).

   b. WRF - Volume of Recreational Traffic. The amount of non-commercial vessel traffic using the waterway. The volume may vary depending on the time of day, the day of the week, the season of the year, or during a major marine event.

   c. WRF - Waterway Use. The interaction between vessels or boats of different sizes using the same waterway and their maneuvering characteristics. Conflicts occur as risk increases with each type of vessel's maneuvering characteristics and actions that are often different and unpredictable (e.g. commercial mariners and recreational mariners using deep draft vessels and shallow draft vessels within the same waterway).

   d. WRF - Congestion. The ability of the waterway to handle the volume and density of traffic. Risk increases when a large number of vessels uses a small geographic area for an extended period of time. Risk also increases substantially when you get a larger than normal number of vessels together for a short time (e.g., fishing tournament or short season commercial fishery).

4. Waterway Risk Condition - Waterway Conditions. The physical properties of the waterway that affect vessel maneuverability.

    a. WRF - Visibility Impediments. The man-made objects (e.g., moored ships, condominiums, background lighting, etc.) or geographic formations (e.g., headlands, islands, etc.) that prevent a mariner from seeing aids to navigation or other vessels.

    b. WRF - Dimensions. The room available for two vessels to pass each other within the waterway.

    c. WRF - Obstructions. Floating objects in the water that impede safe navigation and could damage a vessel, such as ice, debris, fishing nets, etc. Fixed objects such as wrecks, pipelines, overhead wires, derelict piers, fixed bridges, and permanently moored vessels.

    d. WRF - Configuration. The arrangement of a waterway, including elements such as waterway bends, multiple and converging channels, and perpendicular traffic flow.

B. Focused Quantitative Risk Assessment (FQRA) Background. As described in Chapter 1 Section B.2.b.(1), the Risk Index Number (RIN) is calculated for participant prioritized WRF issues using the FQRA process. Details are provided in the following sections regarding the consequence component of the FQRA.

1. Consequence. Table 1, as referenced in Chapter 1 Section B.2.b.(1).(a), displays the Coast Guard established consequence types, severity categories, and descriptions. Each consequence category is quantified in dollar value to allow comparison between consequence types. The fiscal equivalence for each consequence category provides economic weight for the RIN.

		Severity Categories				
		Cat 1	**Cat II**	**Cat III**	**Cat IV**	**Cat V**
Consequence Type	**Safety**	Injuries up to permanent disability.	One to 5 Deaths	6 to 15 Deaths	16 to 50 Deaths	51 or more Deaths
	Environmental (Oil)	Minor releases (of less than 100 gal)	Medium releases (of 100 to 5000 gal) OR local marine resource stock collapse for 1 to 5 years.	Disruption of the ecosystem (of 5000 to 50k gal) OR local marine resource stock collapse for 5 to 10 years.	Serious disruption of the ecosystem (of 50k to 500k gal) OR local marine resource stock collapse for 10-50 years.	Catastrophic disruption of the ecosystem (of more than 500k gal) OR local marine resource stock collapse for more than 50 years.
	Economic	Vessel damage, structure damage, economic activity, or port disruptions that incur less than $50k economic losses in total.	Between $50k and $250k economic losses in total.	Between $250k and $5M economic losses in total.	Between $5M and $250M of economic losses in total.	More than $250M of economic losses in total.

Table 1 – Severity categories by consequence type.

a. The following subsections explain how monetary values for different consequences are derived for each consequence type.

(1) *Safety*. These estimates use the Department of Transportation value of statistical life. The guidance is intended for analyses assessing the benefits of preventing fatalities. Reflecting 2025 inflation, a single death is equivalent to $12.5 million.

(2) *Environmental*. These estimates use the Environmental Protection Agency's Basic Oil Spill Cost Estimation Model (BOSCM). This is an adaptable model that allows for customizable inputs regarding spill recovery methods and efficiency, oil type, cultural factors, and impacted ecosystem descriptors to predict cost of an oil spill. Each of these inputs modifies the cost calculation in a different way. Once customizations for the model are set, three functions are combined to get total cost. These consist of direct response costs, socioeconomic and secondary costs, and environmental damage costs. Due to the extensive prep work required to use BOSCUM, the FQRA does not customize the model for individual

ports. Instead, very conservative factors are selected with a bias towards over-estimating the cost and accounting for inflation adjusted to 2025. The primary limitation of this method is that not all environmental damage is caused by oil. An analysis of environmental damage costs from all maritime incident sources is difficult to estimate. Oil spill costs are the proxy that was selected until better models are found.

(3) *Economic*. This is the estimated dollar value for economic loss. It includes losses from vessel damage, facility damage, and economic activity.

Appendix C. Participant Comments

A. Background.

1. This appendix documents participant observations and recommendations expressed during the workshop with respect to specific issues of concern within the study area. Discussion during the first day of the workshop was recorded and subsequently transcribed using professional services. Comments were compiled and categorized by most applicable Waterway Risk Condition and WRF.

B. Waterway Risk Condition - Navigation.

1. WRF – Winds.

   a. Bridge operational limitations stem from vehicular traffic management and wind-related navigational restrictions. Scheduled bridge openings are curtailed when wind velocities surpass established safety thresholds, disrupting waterway transit.

   b. Real-time wind data is indispensable for maritime navigation. Pilots rely on accurate forecasts from NOAA's National Weather Service (NWS). Consistent funding for NWS is critical to ensure accurate wind predictions that may impact vessel maneuverability during high-wind events.

   c. Accurate wind predictions are challenged by altitude variations and underscores the need for strategically positioned sensors. The Baltimore region benefits from a network of weather stations, but the loss of the Key Bridge's primary sensor has impaired data availability, and the Hawkins Point replacement offers limited coverage.

   d. The increasing volume of vessel traffic with larger dimensions highlights the need for at least one additional high-altitude sensor in the port to avoid potential disruptions prior to winter weather.

   e. High winds pose a significant hazard to docking operations, due to the potential to disrupt vessel maneuvering, increase the likelihood of mooring failures, and contribute to operational delays or cancellations. Adequate tugboat availability is a critical mitigation factor for high winds. Modern vessels can require up to four tugs for safe maneuvering. Increased demand for tugs can cause potential delays for container ship operations.

   f. Terminal piers exposed to prevailing winter winds are particularly vulnerable to mooring line failures. Operations at the Coast Guard Yard are suspended when wind speeds exceed 15 knots.

   g. Summer squalls generate intense wind gusts, causing unpredictable port and bridge closures.

h. The erratic nature of summer squalls limits the availability of tugboats to assist large commercial vessels.

i. Persistent northwest winds from October through March create challenging navigation conditions for ultra large container vessels (ULCVs). Safe navigation of ULCVs in constrained channels requires a beam-to approach. During this maneuver, reduced vessel speed compromises maneuverability. This factor, compounded by beam-to winds, presents significant challenges for safe navigation.

j. Improperly secured cranes are susceptible to wind damage, potentially causing spills and area closures.

2. WRF - Tides and Currents.

a. Wind patterns significantly affect tidal ranges and create operational constraints in the Annapolis harbor. Sustained winds from specific directions can exacerbate or diminish tidal heights. Notably, northwest winds contribute to "blow-out tides," resulting in abnormally low water levels which limit the navigation of some vessels based on draft. Conversely, northeast winds drive significantly higher tides, impacting the air gaps under bridges and potentially affecting infrastructure. Although normal tidal range is approximately 17 inches, persistent winds can cause deviations of several feet and directly impact mooring and tug operations. Severe tidal "outs" can significantly reduce water levels and impact smaller vessels and tugs.

b. Accurate, up-to-the-minute information regarding tides and current is paramount for safe and efficient port operations. While current monitoring systems provide helpful data, unique conditions in this area make real-time information even more important. The water released from the Conowingo Dam creates unique tidal patterns that are typically seen only in ocean-facing ports. Precise, real-time data from sources like the NOAA port systems is recommended to ensure safety within the waterway.

c. Deep-draft vessels are susceptible to tidal fluctuations. Blow-out tides can render these vessels unable to safely navigate or depart from piers for extended periods lasting several days. These events occur several times annually resulting in scheduling disruptions and economic impacts.

3. WRF – Visibility Restrictions.

a. Gyrocompass errors significantly impact navigational accuracy and pose risks when using virtual Automated Identification System Aids to Navigation (vAIS ATON). When gyrocompass errors are present, they can cause any AIS-transmitted position, including those of vAIS ATON marking bridge openings and gated buoy sets in a channel to be inaccurate. These inaccuracies, even if relatively small (ranging from four to five degrees), can falsely present the channel opening's location when overlaid on radar displays. This creates a significant risk of allision with bridge stanchions or grounding outside of a channel. There are reports of these types of incidents in the vicinity of the Bay Bridge in Maryland and the Chesapeake Bay Bridge Tunnel in Virginia. To minimize the risk of accidents stemming from gyrocompass-induced inaccuracies impacting AIS positioning, the Association of Maryland Pilots recommended the immediate discontinuation of vAIS use for marking bridge openings and gated buoy sets to prevent future accidents.

b. The Port of Baltimore is vulnerable to weather-related visibility limitations caused by fog, rain, snow, and smoke. Reduced visibility slows vessel speeds and can directly impact schedules by disrupting mooring operations. This can have a cascading effect causing back-ups and congestion in the port.

c. Navigation under foggy conditions is challenging. Visibility varies considerably between the Port of Baltimore and areas south of the Chesapeake Bay Bridge.

d. The lack of radar or AIS transponders aboard small recreational and commercial fishing vessels heightens risk of collision during foggy conditions. Commercial fishermen frequently deploy fishing pots in the channel during foggy conditions and are often unaware of approaching large container or cruise ships.

e. Risk of allision due to fog near the Chesapeake Bay Bridge is a major concern.

f. Fixed ranges are critical for radar navigation during fog and snow. Piloting techniques that utilize an Electronic Bearing Line and range finding by interpreting shipboard radar signature returns are essential for safe navigation during periods of restricted visibility.

g. The existing visibility sensor on the Chesapeake Bay Bridge provides valuable data. However, to enhance maritime safety across the entire 17-mile transit, it is recommended that an additional visibility sensor be installed in Baltimore Harbor.

h. The nearest weather sensor to the Inner Harbor is located several miles away at Fort McHenry. Additional strategically placed sensors are needed throughout the area to provide ships a more accurate and comprehensive understanding of weather conditions along the entire channel.

4. WRF – Bottom Type.

   a. The Port of Baltimore has a soft channel bottom, primarily composed of mud and sand. USACE has observed frequent changes in bottom composition revealing rock at greater depths.

   b. Effective management of dredged material outside the federal channel in the Inner Harbor is a primary concern. Proper disposal of dredged material is critical because disposal areas can pose a danger for deep draft vessels. Baltimore harbor sediment disposal is restricted within city limits. Additionally, the "hump" at the bottom of the Jones Falls regularly accumulates silt and impedes deep draft vessel movement. There is concern regarding shoaling around the main navigation channels due to sediment buildup.

   c. The Conowingo Dam significantly contributes to shoaling in the channel system. The dam contains an abundance of silt that affect channels downstream. The dam is the largest contributor of water to the area and is considered the primary contributor to shoaling problems.

C. Waterway Risk Condition – Vessel Quality and Operations.

1. WRF – Large Commercial Vessels.

   a. The diverse range of ships and crew backgrounds present communication and coordination challenges.

   b. Deficient material condition of vessels entering port leads to frequent machinery failures that pose a significant risk. Steering and engine failures are key contributors to operational delays.

   c. There are concerns regarding increasing vessel size and potential impact on port infrastructure, such as bridges.

   d. Current trends for international shipbuilding prioritize reduction of vessel emissions. New ships often lack sufficient horsepower to counteract forward or aft movements and increase the risk of grounding and collision in the Chesapeake Bay.

2. WRF - Small Commercial Vessels.

   a. Commercially Coast Guard inspected passenger, and towing vessels have been observed obstructing deep-draft vessel traffic near container ship piers.

   b. Water taxi operators have been observed routinely disregarding navigation rules.

c. Many operators demonstrate a lack of situational awareness during nighttime navigation. This is exacerbated by operator training deficits and highlights the need for enhanced education on navigation rules and safe operating practices.

3. WRF - Commercial Fishing Vessels.

a. Commercial fishing vessels occasionally suffer propeller entanglement with fishing floats and traps requiring divers to remove entangled cables and lines.

4. WRF - Recreational Vessels.

a. Recreational vessels ignore speed restrictions and are a challenge in the 6-knot no-wake zone. There is limited boater awareness of no-wake zone boundaries from Fort McHenry to the Inner Habor. Enforcement of speed restrictions primarily falls to DNR due to reduced funding for the Baltimore City Police Department Marine Unit.

b. Marinas in the vicinity of Fort McHenry to the Inner Harbor, experience wake damage resulting from vessels exceeding speed limits.

c. The Baltimore City Police Department Marine Unit has experienced reduced funding. The DNR and Coast Guard are taking on a greater role in boating under the influence enforcement near Pier Six.

d. Autopilot use on recreational boats is a concern due to tendencies of operator complacence.

e. Sailboat races at night in Chesapeake Bay pose a significant safety concern. Boaters participating in races are unaware that a high percentage of large commercial vessel traffic occurs at night in the main shipping channel.

f. The presence of unlit recreational vessels is a recurring dangerous issue that creates a significant collision hazard.

g. Recreational boaters often lack sufficient proficiency in operating essential navigation tools, such as radios and radar.

h. There is an increase in recreational boaters transiting during periods of low visibility that over rely on and do not know how to properly operate electronic navigation equipment.

D. Waterway Risk Condition - Traffic.

1. WRF - Volume of Commercial Traffic.

a. The Port of Baltimore experiences approximately 5,000 large ship movements annually. There is concern, as this number rises, that existing infrastructure cannot accommodate increased traffic volume. There is a need for increased channel depths and an enhanced physical ATON network.

b. Increased volume and size of commercial vessels elevates the probability of collisions and allisions.

c. There are concerns regarding the ready availability of towing vessels due to scheduling issues. The Port of Baltimore tug fleet is comparable in size to ports with similar vessel traffic metrics. Offshore wind industry growth may drive a need to increase the port's towing fleet size.

2. <u>WRF - Volume of Recreational Traffic.</u>

a. Approximately 200 marine event applications are received annually. A key challenge is ensuring that all mariners receive timely and accurate information regarding security zones and event details. Recreational boaters often lack awareness of available resources and necessary information pertaining to marine events. There is a need for more effective dissemination strategies to bridge this communication gap.

b. Sail250, a major maritime festival celebrating America's 250th birthday, is anticipated to generate a significant increase in vessel traffic. There is concern regarding the anticipated strain on pilots and towing vessels to facilitate safe and efficient event operations.

c. The typical recreational boating season in Maryland spans from April 1st to October 31st. Increased summer recreational traffic is generally observed during this period.

d. Recreational boats often anchor haphazardly off Pier Six during concerts creating waterway obstructions.

e. There is concern that larger marine events with higher attendance create potential safety hazards associated with large-scale, post-event vessel movements. The increased number of boats attending these events, combined with the concentrated outflow from the area afterwards, creates specific challenges. There is demand for a comprehensive strategy to manage traffic flow and mitigate potential safety hazards.

3. <u>WRF - Waterway Use.</u>

a. One-way traffic patterns imposed in Craighill Channel during ULCV transits effectively suspend inbound and outbound vessel movements for approximately three and a half hours.

b. Increased vessel traffic due to Tradepoint Atlantic's development as a wind hub creates potential waterway usage conflicts.

c. The Dominion Energy wind farm project in Virginia requires shipping large components through Maryland. This has raised concerns about potential traffic conflict throughout Chesapeake Bay.

d. There is ongoing testing of autonomous vessels by the Department of Defense (DoD) in Chesapeake Bay. Operations are well-managed and there is excellent communication between DoD and relevant stakeholders. Current activities do not pose issues to the federal channel.

4. WRF – Congestion.

a. Maintaining open channels, particularly in Curtis Bay, is important to avoid conflicts with Coast Guard cutters and other vessels. Proactive communication is also important to prevent congestion.

b. Current federal channel width restricts two-way traffic due to the increasing size of commercial vessels. "Texas Chicken" maneuvers (intentionally delayed meeting arrangements which result in vessels passing very closely abeam of one another) are routinely performed with large commercial vessels.

c. ULCVs operating in the Fort McHenry and Brewerton Channel require a one-way traffic pattern due to their size.

d. Widening the Fort McHenry and Brewerton Channels will enable more consistent and reliable two-way commercial vessel traffic.

e. Congestion is a key concern due to coordination issues. This is because vessels tend to arrive and depart simultaneously, underscoring the importance of time distribution.

f. The federal government's established role in defining anchorage rules makes it challenging for state and county governments to enforce their own regulations for Inner Harbor to Fort McHenry West.

E. Waterway Risk Condition – Waterway.

1. WRF – Dimensions.

a. A wider channel is needed to accommodate ULCV two-way traffic. The Fort McHenry Federal Channel is 700 feet wide by 50 feet deep and is nearing operational capacity for two-way traffic. The channel should be widened to 1200 feet, to eliminate a constant reliance on range lights.

b. Widening the channel to accommodate ULCVs requires comprehensive environmental impact studies, navigating the funding process, and securing disposal sites for dredged material.

c. Maintaining smaller channels requires investments in ATON, such as two-piece ranges.

d. Attainment of property for land-based ATON platforms to support navigation in the Port of Baltimore is challenging. Statutory authorities, including the use of eminent domain, should be analyzed as potential mechanisms to secure property to ensure long term sustainability and availability of land-based ATON sites.

2. WRF – Obstructions.

a. Efforts are underway to assess the potential benefits of increasing the Chesapeake Bay Bridge's vertical clearance. Raising the clearance to 230 feet will enable passage of larger cruise ships that are currently restricted by the bridge's 186-foot vertical clearance.

b. Derelict piers and vessels pose hazards to the waterways in the Inner Harbor. The process for removing derelict vessels is lengthy and complex.

c. Towing vessels operating near the Conowingo Dam frequently encounter wood, pilings, and other debris that can lodge in their propellers. Opening the dam's floodgates increases the amount of debris in the water. Additionally, submerged, decommissioned utility wires endanger these vessels.

d. Concerns exist regarding the maintenance and proximity of privately maintained navigational markers in the vicinity of the maneuvering area near the Fort McHenry Channel. Delays in marker maintenance and their proximity to the maneuvering area hinder safe vessel navigation. Some markers are misplaced; others are missing. Immediate correction is required, and authorities must relocate or replace markers as needed.

3. WRF – Visibility Impediments

a. Background lighting caused by urban development and shoreside construction around Fort Howard threatens mariner safety and impairs vessel operator ability to identify and correctly interpret vessel navigation lights.

4. WRF – Configuration.

a. Brewerton, Fort McHenry, and Craighill Channel navigational ranges are critically important to facilitate safe one-way traffic in the Port of Baltimore. Range degradation would compromise transit safety and cause an immediate suspension of all incoming and outgoing vessel operations.

Appendix D. Geospatial Participant Comments

Facilitators captured participant observations that made specific geographic references. Those observations were then transferred to an ArcGIS online web-application to generate the chartlets reflecting the location and specific context of each comment. The chartlets are included below and represented as Figures 1-3.

Geospatial Comments	
Point	**Comment**
1	Establishment of a designated anchorage at the South End of Pier 6 is immediately needed to optimize harbor operations.
2	The Harbor East Marina area requires routine maintenance due to consistent silting.
3	There are frequent violations of navigation rules by water taxi operators in this area.
4	Physical ranges are essential for maintaining safe two-way navigation of large vessels in the federal channel. Loss of these navigational aids is predicted to severely restrict vessel traffic and economically devastate the port.
5	Upon approach to the terminal, container ships and roll-on/roll-off vessels are vulnerable to strong seasonal northwesterly winds which can significantly impact maneuverability.
6	The functionality of the Curtis Creek Lift Bridge is significantly affected by weather. Wind speed limitations, combined with the presence of fog and snow, often necessitate bridge closures. These closures create navigational hazards for vessels transiting the waterway due to increased congestion.
7	Bascule bridge operation is subject to wind speed restrictions. Knowledge of these limitations is critical to prevent disruptions and ensure navigational safety.
8	Sparrows Point Channel range lights are frequently obscured by bright lights erected for construction purposes and pose a hazard to navigation.
9	The Chesapeake and Delaware Canal’s current checkpoint location does not offer ample maneuvering space to ensure safe and efficient management of vessels denied entry and should move to another location.

Table 1- Geospatial Comments.

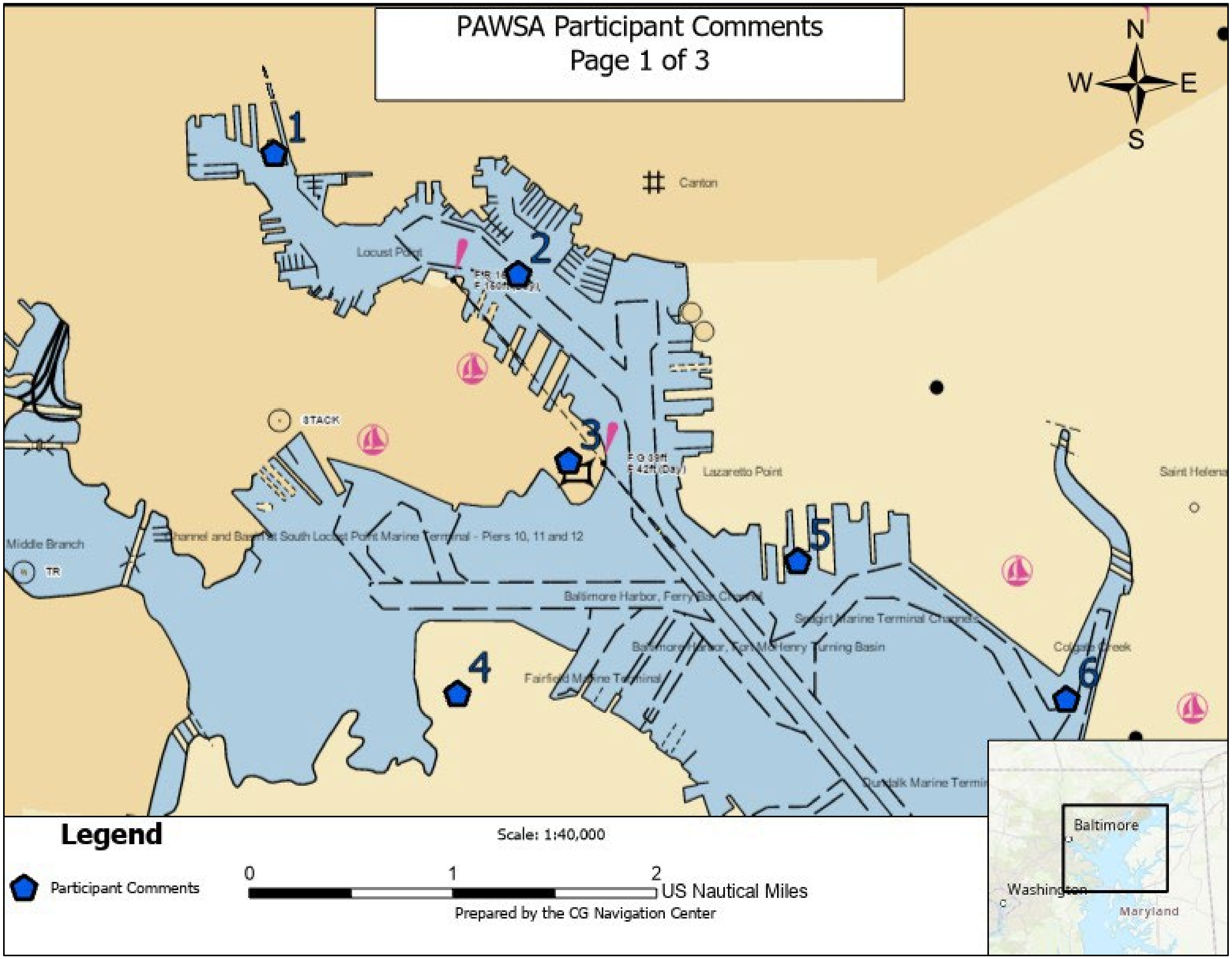

Figure 1- Mapped location of geospatial participant comments 1-6.

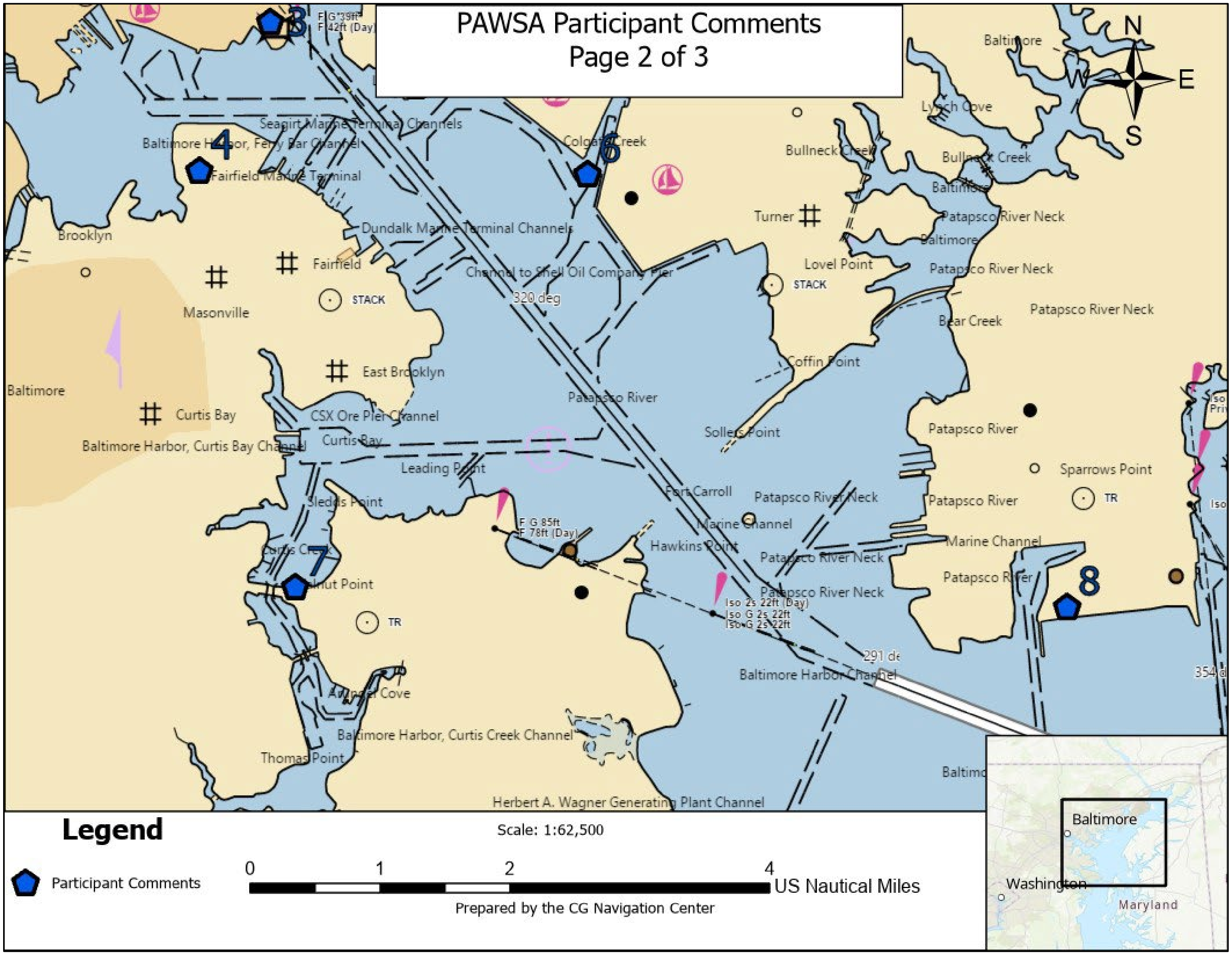

Figure 2- Mapped location of geospatial participant comments 3-8.

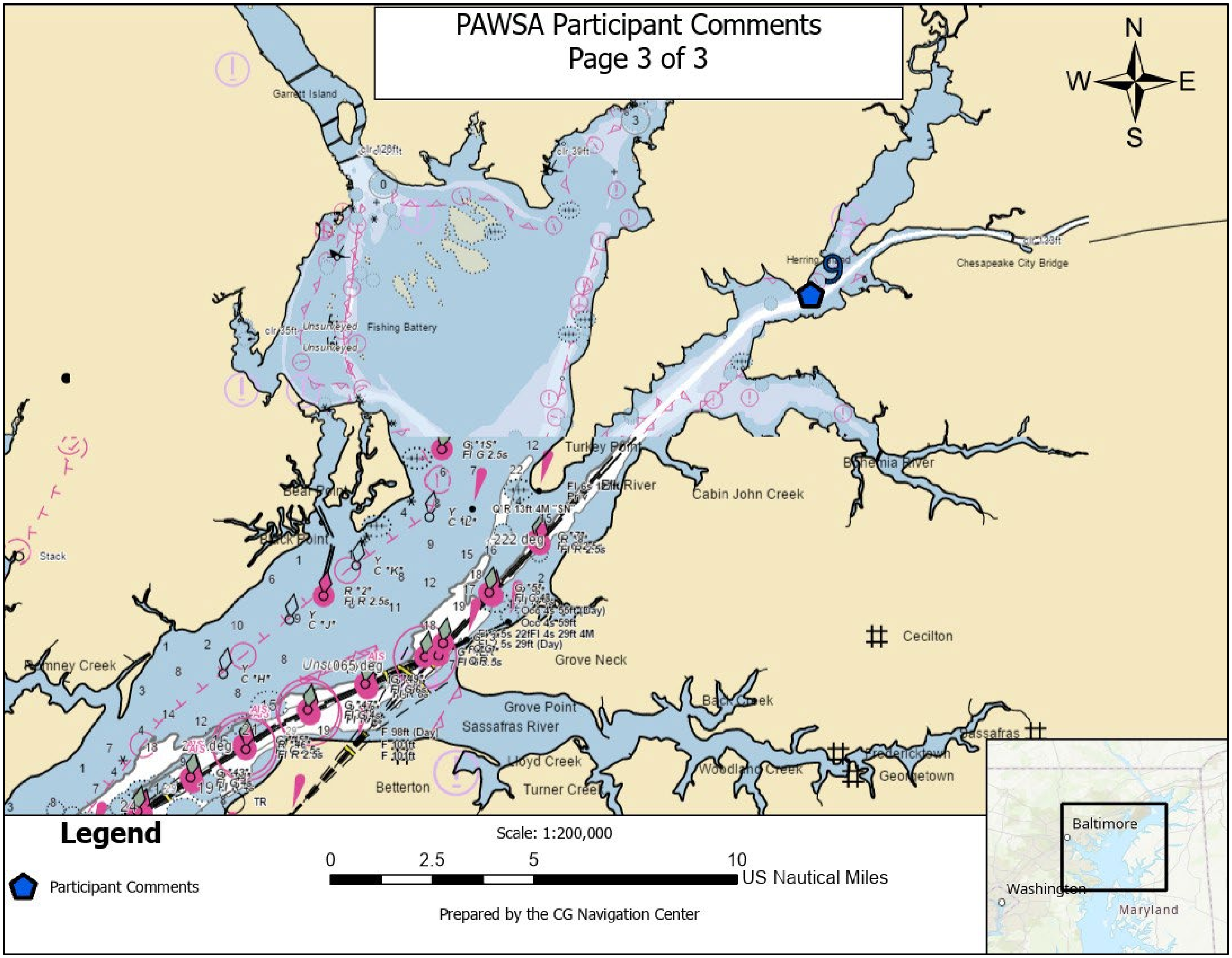

Figure 3- Mapped location of geospatial participant comment 9.

Appendix E. Waterway Risk Factor Issues

Following Day 1 workshop discussions, participants were asked to identify the most concerning issues for the highest prioritized and validated WRFs from the Risk Characterization survey. The following is a summary of the prioritized issues as selected by the participants. These issues are not listed in priority order and are also documented in Chapter 2.C preceding each mitigation strategy.

1. WRF – Recreational Vessel Quality

    a. There is an increase in incidents related to impaired boating operators. Inadequate vessel enforcement throughout the waterways is contributing to an increase in incidents of impaired boating.

    b. Sailboat races and regattas at night frequently obstruct large commercial vessel traffic and pose a recurring impediment to safe navigation in the waterways.

    c. Recreational vessels demonstrate a poor understanding and application of navigation rules and overly rely on electronic navigation equipment when available.

2. WRF – Volume of Recreational Traffic

    a. With approximately 200 marine event applications processed annually, there is a critical need to improve communication and awareness for these events amongst the recreational boating community.

    b. Recreational boats often anchor haphazardly off Pier Six during concerts and creating waterway obstructions.

    c. There are concerns for increased accidents and general waterway safety from April 1st to October 31st due to the significant increase in recreational boating traffic.

3. WRF – Congestion

    a. The width of the Fort McHenry Channel restricts two-way traffic for large commercial vessels and cannot accommodate increasingly larger ships.

    b. When multiple large commercial vessels are conducting inbound or outbound transits simultaneously, competition for available towing vessels creates delays and logistical challenges.

4. WRF – Dimensions

   a. Fort McHenry Channel's current dimensions and depth are inadequate to support two-way traffic for the predicted increasing volume of ULCVs transiting to the port.

Appendix F. National and Local Event and Consequence Data

A. National and Local Event and Consequence Data. As referenced in Chapter 1 Section B.2.b.(1)(c), the following section displays the tables and definitions for event types included in the handout provided to stakeholders prior to conducting the FQRA. The model uses national and local Coast Guard MISLE data that are both updated as appropriate. The national event data in Table 1 contains information through September 2025. Table 2 and 3 contain the local event data for Sector Maryland – National Capital Region that was derived prior to the workshop.

1. Event Types. During the FQRA process on the second day of the PAWSA, participants complete Event Forms that are pre-populated with issues validated during the first day of the PAWSA to enable RIN value calculations. An example of an event form completed by participants for this workshop is included below as Figure 1.

PAWSA Location: Baltimore **Risk Factor:** Rec Vessel Traffic Volume
Team Number: 1

Issue	Event	Frequency
With approximately 200 marine event applications processed annually, there is a critical need to improve communication and awareness for these events amongst the recreational boating community.	Collision	Probable
	Grounding	Probable
	Sinking	Probable
Recreational boats often anchor haphazardly off Pier Six during concerts and creating waterway obstructions.	Collision	Probable
	Traffic Restricted	Probable
There are concerns for increased accidents and general waterway safety from April 1st to October 31st due to the significant increase in recreational boating traffic.	Collision	Probable
	Allision	Probable
	Grounding	Probable
	Sinking	Probable

Populated by PAWSA facilitators based on Day 1 | Completed by Participants on Day 2

Figure 1 – Example event form from the Sector Maryland – National Capital Region PAWSA.

2. For each issue listed, participants select up to three event types that may occur due to the associated issue. For example, if "Groundings throughout the study area can cause the waterway to shut down for an extensive amount of time," then allision, grounding, or traffic restricted are examples of three event types a participant may select that could occur because of this issue. Definitions for the nine event types available during the FQRA are provided below:

   i. **Allision**: Vessel runs into stationary structure.

ii. **Collision**: Vessel runs into another vessel.
iii. **Fire/Explosion**: Fire or explosion.
iv. **Grounding**: Vessel draft exceeds water depth.
v. **HAZMAT Release**: Hazardous Material container breached or no longer working as designed (tank, package, pipe, etc.)
vi. **Infrastructure Failure**: Infrastructure stops working or damaged from non-vessel source.
vii. **Oil Spill**: Oil container breached or no longer working as designed (tank, pipe, etc.)
viii. **Sinking**: Vessel stops floating as designed. Capsizing is a sub-type of sinking.
ix. **Traffic Restricted**: Traffic not flowing normally; NOT from any event listed.

3. National Events. Table 3 provides data capturing the record of the yearly average of national events used in the FQRA process.

National Events

Event	Total Events	Yearly Avg
Allision	11,179	429.96
Collision	3,118	119.92
Fire/Explosion	2,442	93.92
Grounding	14,794	569.00
Oil Spill	77,603	2,984.73
Sinking	4,457	171.42
Traffic Restricted	6,816	262.15
Total	**120,409**	**4,631.12**

Table 1 – Total and yearly average of national events.

4. Local Events. The data capturing the record of local events used in the FQRA process is specific to the port for the PAWSA. Table 2 and 3 provide the local event and consequence data provided to stakeholders prior to conducting the FQRA for the Sector Maryland – National Capital Region PAWSA workshop.

Local Events

Event	Total Events	Yearly Avg
Allision	136	5.2
Collision	42	1.6
Fire/Explosion	40	1.5
Grounding	158	6.1
Oil Spill	1463	56.3
Sinking	100	3.8
Traffic Restricted	5	0.2
Total	**1944**	**74.8**

Table 2 – Total and yearly average of local events for the Sector Maryland – National Capital Region PAWSA workshop study area.

Local Event Consequences

Type	Allision	Collision	Fire/Explosion	Grounding	Oil Spill	Sinking	Traffic Restricted
⊟ **Economic**							
Ec0	Probable	Probable	Probable	Frequent	Frequent	Frequent	Rare
Ec1	Frequent	Probable	Occasional	Occasional	Occasional	Probable	Occasional
Ec2	Probable	Occasional	Occasional	Occasional	Occasional	Occasional	Occasional
Ec3	Occasional		Occasional		Rare	Rare	
⊟ **Environmental**							
En0	Frequent	Probable	Probable	Frequent	Frequent	Probable	
En1			Occasional		Frequent	Frequent	
En2	Rare		Occasional		Frequent	Rare	
En3					Occasional		
⊟ **Safety**							
Sa0	Frequent	Probable	Probable	Frequent	Frequent	Frequent	
Sa1	Occasional	Occasional	Occasional	Occasional	Occasional	Rare	
Sa2	Rare	Occasional				Occasional	

Table 3 – Local event consequences and likelihood for the Sector Maryland – National Capital Region PAWSA workshop study area.