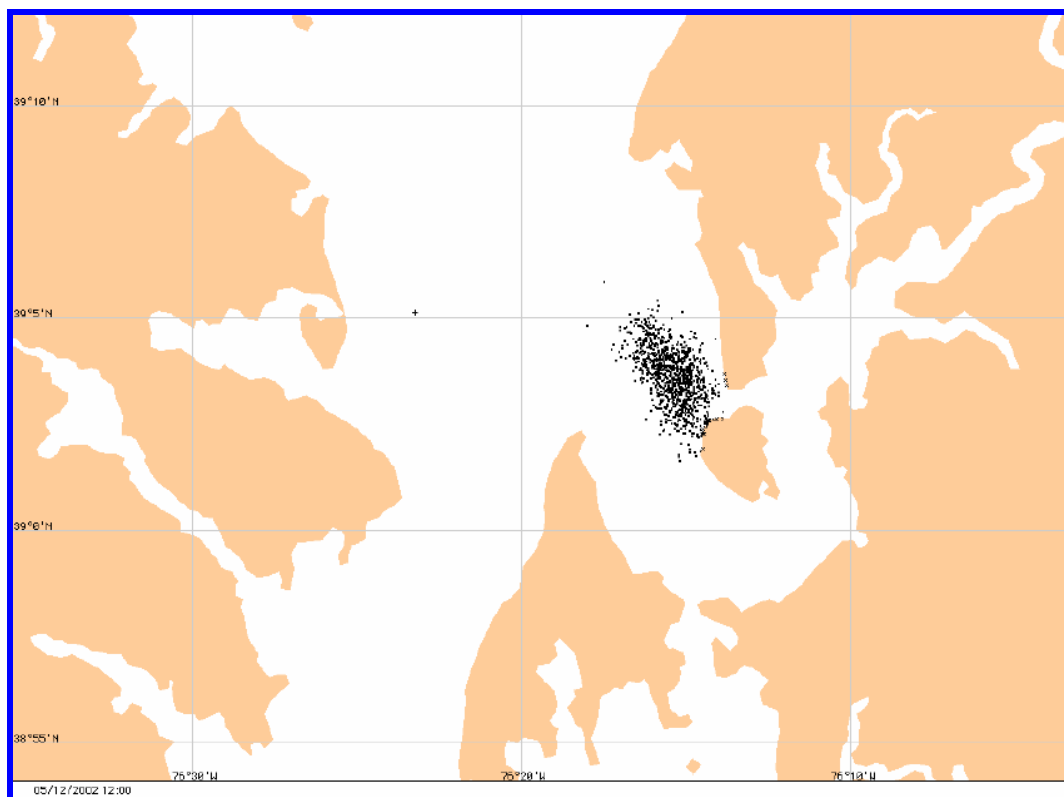

Ecological Risk Assessment: Consensus Workshop

Environmental Tradeoffs Associated With
Oil Spill Response Technologies

Maryland Eastern Shore



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**Environmental Tradeoffs Associated With
Oil Spill Response Technologies**

Maryland Eastern Shore

A Report to Commander, US Coast Guard
Activities Baltimore

Don Aurand (Compiler)
Ecosystem Management & Assoc., Inc.



**Ecosystem Management & Associates, Inc.
Report 02-02**

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CITATION

Suggested Citation:

Aurand, D. (Compiler). 2003. Ecological Risk Assessment: Consensus Workshop. Environmental Tradeoffs Associated With Oil Spill Response Technologies. Maryland Eastern Shore. A report to Commander, US Coast Guard Activities, Baltimore. Ecosystem Management & Associates, Inc., Lusby, MD 20657. Report 02-02, 36 pages.

SPONSOR

This report was prepared under Purchase Order No. DTCGG8-01-P-MER202 for US Coast Guard Headquarters (G-MP-2), 2100 2nd Street, SW, Washington, DC 21593.

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LIST OF ABBREVIATIONS, SYMBOLS, AND ACRONYMS

Term	Abbreviation, Symbol, or Acronym
Automated Data Inquiry for Oil Spills	ADIOS
Ecological Risk Assessment	ERA
Environmental Protection Agency	EPA
Environmental Sensitivity Index.....	ESI
National Oceanic and Atmospheric Administration	NOAA
Parts per million.....	ppm
Ramsar International Convention on Wetlands	RAMSAR
Regional Response Team.....	RRT
Scientific Support Coordinator	SSC
Square Kilometers.....	km ²
United States Coast Guard.....	USCG

ACKNOWLEDGEMENTS

Ecosystem Management & Associates, Inc. and the sponsors of this project extend their thanks to all those who participated in the risk assessment workshops. Special recognition is extended to LTJG Lisa Knopf (United States Coast Guard (USCG) Activities Baltimore), who served as the Assessment Coordinator, and to Mr. Alan Williams (Maryland State OSC) of the Maryland Department of the Environment, Mr. Rick Takacs of NOAA, and Mr. Gary Ott (NOAA Scientific Support Coordinator (SSC)), who served as the Assessment Planning Team during the planning of the workshops. We would also like to thank Mr. Tarik Adams and Mr. Marty Kaehny of the Eastern Neck National Wildlife Refuge for providing the outstanding meeting facility, and for their logistic assistance during the meeting. Contractor support to assist in the planning and facilitation of the workshops, and in the preparation of the report was provided by the Office of Response, Headquarters, USCG (G-MOR) under contract DTCG G8-01-P-MER202. The support and guidance of the Project Manager, LT Amy Cocanour, and of Mr. Robert Pond of that office is gratefully acknowledged.

Ecological Risk Assessment: Consensus Workshop

Environmental Tradeoffs Associated With Oil Spill Response Technologies

Maryland Eastern Shore

Executive Summary

In June and July of 2002, U.S. Coast Guard (USCG) Activities Baltimore sponsored a workshop to evaluate the relative risk to natural resources from various oil spill response options (on-water mechanical recovery with shore-line protection, on-shore *in situ* burning, on-shore mechanical recovery and dispersant application) in comparison to natural recovery. The spill scenario involved the release of 2,000 barrels of Number 6 Fuel Oil near the north end of Kent Island in Tolchester Channel under conditions which threatened the Eastern Shore of the Chesapeake Bay in the vicinity of the Eastern Neck Wildlife Refuge. The workshop involved two meetings during which participants received briefings on the expected results of the spill with and without response options, the relative effectiveness of the various response options, and the risks and benefits of these response options to the habitats and natural resources of the area. The participants were then divided into three focus groups and were asked to develop relative risk scores for the various alternatives, using standard analytical protocols outlined in the USCG guidebook entitled "Developing Consensus Ecological Risk Assessments: Environmental Protection in Oil Spill Response Planning. A Guidebook." The scores from the three groups were then compared and a composite risk matrix developed which represented the overall consensus of the entire group. At the conclusion of the second meeting, the group developed a list of lessons learned and recommendations for Regional Response Team (RRT) 3 and USCG Activities Baltimore which they felt would improve local response planning efforts.

1.0 Objectives of the Maryland Eastern Shore Workshop

1.1 Background and Process

Since 1998, the U.S. Coast Guard (USCG) has been sponsoring efforts to develop a comparative risk methodology to evaluate oil spill response options. Interest in selecting response options based on a risk/benefit analysis goes back even further, but the current effort is different in that it emphasizes a consensus-building approach to evaluate risks and benefits.

Headquarters, USCG (G-MOR) has sponsored the development of a guidebook on this process. The document, entitled “Developing Consensus Ecological Risk Assessments: Environmental Protection in Oil Spill Response Planning. A Guidebook” is available from G-MOR, or can be downloaded from the contractor’s web site at www.ecosystem-management.net.

The process is designed to help planners compare the ecological consequences of response options, especially in nearshore or estuarine situations. This is particularly important for consideration of dispersants and in-situ burning, which present difficult analytical issues. It is focused on ecological “trade offs” or cross-resource comparisons. Through a structured analytical approach the participants find “common ground” for evaluation of impacts and develop a defensible logic to support their conclusions. This process is consistent with the U.S. Environmental Protection Agency’s (EPA) Ecological Risk Assessment (ERA) guidelines (US EPA, 1998), but emphasizes development of group consensus among stakeholders. The process uses a series of analytical tools specifically developed for use in a group environment. It is designed to be a planning tool, and should not be used during an actual event. The knowledge gained by participants in the process, however, will facilitate real-time decision-making.

The training usually involves two 2 or 3-day workshops led by a facilitator. The ideal size is 25 to 30 participants, including spill response managers, natural resource managers and trustees, subject matter experts, and non-governmental organizations. The goal is to achieve consensus interpretations of the potential risks and benefits associated with selected response options based on a scenario developed by the local participants. The time between the two workshops is used for the participants to research issues of concern before they develop their final conclusions. The process is heavily focused on achieving a consensus interpretation of the available technical information. It is very important to have a broad representation of the potential stakeholders in the decision process; otherwise the results may not be accepted by all of the groups who will be concerned if a spill occurs.

The workshop process includes three primary phases - **problem formulation, analysis, and risk characterization**. Details of the process are described in the Guidebook.

In the first phase, **problem formulation**, participants in the Maryland Eastern Shore workshop developed a scenario for analysis, identified resources of concern along with associated assessment thresholds, and prepared a conceptual model to guide subsequent analysis.

In the **analytical phase**, participants characterized exposure and ecological effects. The conceptual model, developed in the problem formulation phase directed the analysis using standard templates and simple analytical tools that define and summarize the analysis for each resource of concern and each response option.

Finally, the participants completed a **risk characterization**. During this phase, participants interpreted their results in terms of the costs and benefits of each response option to overall environmental protection as compared to natural recovery (i.e., baseline).

1.2 Sponsor’s Objectives

This series of workshops was sponsored by USCG Activities Baltimore in support of oil spill response planning by Regional Response Team (RRT) 3. The overall purpose of the project was to evaluate the ecological resource impacts of spilled oil and oil spill response operations on the Eastern Shore of Maryland.

The results of this ERA process are intended to improve oil spill response strategies and to enhance existing oil spill contingency planning. There are tradeoffs to every response decision. Exercises such as this are intended to help identify those natural resources at risk during a spill and to address the benefits and inherent tradeoffs associated with the different spill response tools.

Resource trustee consultation is essential to identifying those tradeoff priorities that drive spill response strategy. In the spirit of promoting as much pre-spill consultation and tradeoff dialogue as possible, an ERA training session was provided prior to the evaluation of the scenario. It has been the experience of the workshop organizers in earlier exercises that once participants are familiar with the ERA process and its methodology, resource and response agency stakeholders are better able to engage in effective risk assessment and tradeoff identification for pre-spill and spill-specific consultations. The result is a better understanding of resource trustee and response agency concerns, more timely and effective response decisions, and greater resource protection and recovery.

1.3 Participants and Responsibilities

A total of 23 individuals attended one or both of the workshop sessions. Their names and affiliations are provided in Appendix B. These 23 people represented a wide range of organizations and were divided into three focus groups for the purpose of the workshops, as indicated in the tables.

2.0 Overview of Workshop Events

The following is a summary of the activities that took place in the workshops for the Maryland Eastern Shore. Additional detail on the process itself is provided in the guidebook referenced in Section 1.1.

Two workshops were held, one in June and a second in July, 2002. They were sponsored by the USCG Activities Baltimore and the Upper Chesapeake Estuary Area Committee of RRT 3. The first workshop began with a presentation on the process, along with examples of its use in other locations. When that was completed, the participants reviewed the scenario, determined the risk factors associated with the response options, and identified the geographic area of concern and the habitats or ecological communities that were present. They used the latter information to build a table of habitats, subhabitats, and representative species that they needed to consider during their evaluation of the response options under consideration. When this was complete, they developed a risk ranking matrix, with scales based on recovery time and the proportion of the resource affected, to use to evaluate potential impacts.

When these initial tasks were completed, the participants were divided into smaller “focus groups” (in this case, three) and used the risk ranking matrix to evaluate their “level of concern” for potential impacts in each of the habitats for the “natural recovery” (i.e. no response) option. This option is always evaluated first because it establishes the baseline against which all other response options are compared. The focus groups independently used the alphanumeric designations to determine their level of concern, which was then summarized in a habitat/response option matrix. As the analysis for natural recovery was completed by the three focus groups, their results were compared and discussed to determine a group position on the potential risks and benefits. While the groups attempted to resolve as many differences as possible, they did not attempt to achieve total consensus, and so group scores are not identical. When the groups had significantly different initial conclusions, this comparison was used to make sure that areas of confusion or limited data were identified and addressed

Once this was completed, the participants reviewed the response options to be included and identified issues related to each that they wanted to discuss before completing the risk ranking. That was the final activity of the first workshop.

At the second workshop, the participants discussed the four response options selected for analysis (on shore in-situ burning, on water mechanical recovery, on shore mechanical recovery and use of dispersants), and then the three focus groups completed the risk ranking process for each one.

At the conclusion of the meeting, the entire group developed “lessons learned” and made a list of recommendations for implementation in future oil spill response planning options for the middle Chesapeake Bay.

3.0 Exercise Scenario and Basic Analytical Information

3.1 Exercise Scenario

The participants were presented with a spill scenario designed to focus on the environmental decisions that need to be made when an oil spill threatens the shoreline of the central Bay on the Maryland Eastern Shore, specifically the region of the Eastern Neck National Wildlife Refuge. The scenario involved a collision between an oil transport barge moving up bay and an outgoing cargo ship. The barge was holed and suffered a partial loss of cargo. A total of approximately 2,000 barrels of Number 6 fuel oil (Bunker C) was lost over a six-hour period, after which the vessel was secured. The collision occurred near the north end of Kent Island in Tolchester Channel. The release occurred in the early evening, at the beginning of ebb tide. The winds were at 12 knots from the west, changing to northwest after 12 hours.

3.2 Geographic Area of Concern

The general area of concern was the eastern shore of the middle portion of the Chesapeake Bay in the vicinity of the Chesapeake Bay Bridge. Specifically, the study included the shoreline and nearshore waters near Rock Hall, MD (39°07'N, 76°15'W), Eastern Neck, the mouth of the Chester River, the Kent Narrows, Crab Alley Bay, Prospect Bay and Eastern Bay.

3.3 Resources of Concern

The participants reviewed a summary of the resources at risk prepared by the National Oceanic & Atmospheric Administration (NOAA) Scientific Support Coordinator (SSC) (presented in Appendix A), and then revised a draft table prepared by the facilitators to create the habitat table presented in Table 3.1.

3.4 Conceptual Model

During discussions about the general analytical process, the participants decided that establishing a detailed model was not necessary for their purposes. They agreed to use the list of seven hazards developed in the San Francisco Bay workshop to evaluate each of the proposed response options (air pollution, aqueous exposure, physical trauma, oiling/smothering, thermal, waste and indirect). The list of response options, combined with the resource table, forms the basis for the cells of the conceptual model. The interactions between the two are defined by the hazards.

Table 3.1 Habitat Table for the Maryland Eastern Shore Risk Assessment

Habitat	Subhabitat	Resource Category	Example Organisms
Terrestrial	Upland and Supratidal	Vegetation	deciduous trees, shrubs, grasses agricultural crops
		Mammals	opossum, raccoon, red fox, deer, Delmarva fox squirrel
		Birds	bald eagle, cattle egret, rail, snipe, killdeer, woodcock, vultures, wood ducks, wild turkey peregrine falcon
		Reptiles/Amphibians	diamond back terrapins, black snake, frogs and toads, salamanders
		Insects	butterflies, damselflies
Water Surface		Mammals	otters, muskrat, dolphins
		Birds	osprey, black duck, mallard, tundra swan, mergansers, loon, bald eagle
		Reptiles/Amphibians	diamondback terrapins, northern water snake, loggerhead and Kemp's ridley sea turtles, frogs and toads, salamanders
Intertidal	Salt Marsh and Mud Flats	Vegetation	common three-square rush, salt meadow cord grass, salt meadow hay, big cord grass, common reed, groundsel, marsh elder, diatoms, blue green algae
		Mammals	muskrat, opossum, raccoon, red fox, deer, rice rat
		Birds	great blue heron, black duck, blue and green-winged teal, mallards, Northern harrier, osprey, rails, red wind blackbird, widgeon, shovellers
		Fish	killifish, mummichug, rockfish, perch, herring, bay anchovy, silversides
		Reptiles/Amphibians	diamondback terrapins, northern water snake, loggerhead and Kemp's ridley sea turtles, frogs and toads, salamanders
		Aquatic Arthropods	blue crab, mud crab, amphipods, grass shrimp
		Mollusks	snails, clams, mussels
		Polychaetes	worms
	Sea Walls/Pilings/Riprap	Mammals	rice rat, raccoons, domestic pets
		Birds	gulls, cormorants, terns, herons, killdeer, osprey
		Fish	killifish, mummichug, rockfish, perch, herring, bay anchovy, silversides, gobies, blennies
		Aquatic Arthropods	blue crab, mud crab, amphipods, grass shrimp, barnacles
		Mollusks	snails, clams, mussels
		Epifauna	sea squirts, bryozoans

Table 3.1 Habitat Table for the Maryland Eastern Shore Risk Assessment (*continued*)

Habitat	Subhabitat	Resource Category	Example Organisms
Intertidal (continued)	Sandy Beach	Mammals	opossum, raccoon, red fox, deer, domestic animals
		Birds	sandpipers, gulls, terns, plover, peregrine falcon
		Fish	killifish, mummichug, rockfish, perch, herring, bay anchovy, silversides
		Reptiles/Amphibians	diamondback terrapins, northern water snake, loggerhead and Kemp's ridley sea turtles, frogs and toads, salamanders
		Aquatic Arthropods	horseshoe crab
		Meiofauna	copepods, amphipods, nematodes
		Mollusks	snails
Subtidal Benthic Habitat	Shallow (0 to 10 feet)	Vegetation	macroalgae, benthic diatoms
		Mammals	otters
		Birds	diving ducks, loons, cormorants, canvasbacks, tundra swan
		Fish	killifish, mummichug, rockfish, perch, herring, bay anchovy, silversides, sturgeon, flounder, catfish, shad, eels, croaker, weakfish, skates and rays, menhaden
		Aquatic Arthropods	blue crab, mud crab, amphipods, horseshoe crab, barnacles, amphipods
		Mollusks	clams, mussels
		Polychaetes	worms
	Deep (10 to 20 feet)	Fish	rockfish, perch, herring, sturgeon, flounder, catfish, shad, eels, croaker, weakfish, skates and rays, menhaden
		Aquatic Arthropods	blue crab, mud crab, amphipods, horseshoe crab, amphipods
		Mollusks	clams
		Polychaetes	worms
		Vegetation	macroalgae, benthic diatoms
	Submerged Aquatic Vegetation	Vegetation	widgeon grass, redhead grass, milfoil, sago pondweed, horned pondweed
		Mammals	river otter
		Birds	tundra swan, dabbling and diving ducks
		Reptiles/Amphibians	loggerhead and Kemp's Ridley sea turtles
		Fish	killifish, mummichug, rockfish, perch, herring, bay anchovy, silversides, flounder, catfish, shad, eels, croaker, weakfish, skates and rays, menhaden
		Aquatic Arthropods	blue crabs, amphipods, isopods, grass shrimp
		Mollusks	clams, mussels, snails
	Epifauna	bryozoans, sea squirt	

Table 3.1 Habitat Table for the Maryland Eastern Shore Risk Assessment (*continued*)

Habitat	Subhabitat	Resource Category	Example Organisms
Subtidal (continued)	Oyster Reef	Birds	oyster catcher, diving ducks, loons
		Fish	perch, rockfish, silversides, weakfish, juvenile flounder
		Aquatic Arthropods	blue crab, amphipods, isopods, oyster crabs
		Mollusks	oysters, oyster drills, other snails
		Epifauna	bryozoans, sea squirt
Water Column	Shallow Water (0 to 10 feet)	Mammals	otters, dolphins
		Birds	diving ducks, loons, cormorants
		Fish	rockfish, perch, herring, sturgeon, flounder, shad, eels, croaker, weakfish, menhaden
		Aquatic Arthropods	blue crabs
		Mollusks	squid
		Plankton	copepods, fish eggs and larvae, invertebrate larvae, jellyfish, diatoms, green algae, dinoflagelates
		Reptiles/Amphibians	loggerhead and Kemp's Ridley sea turtles
	Deep Water (10 to 20 feet)	Mammals	dolphins
		Birds	loons
		Fish	rockfish, perch, herring, sturgeon, flounder, shad, eels, croaker, weakfish, menhaden
		Aquatic Arthropods	blue crab
		Mollusks	squid
		Plankton	copepods, fish eggs and larvae, invertebrate larvae, jellyfish, diatoms, green algae, dinoflagelates

3.5 Modeling Results

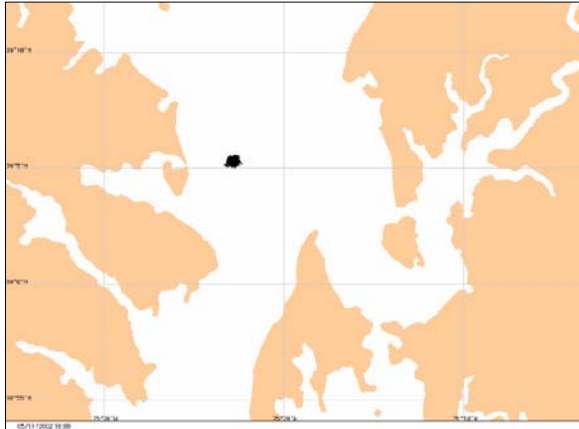
The NOAA HAZMAT Modeling Group used the basic information in the scenario to develop a surface trajectory and a dispersed oil trajectory analysis for the workshop. Basic weathering information was calculated using the Automated Data Inquiry for Oil Spills (ADIOS) II program

Under the conditions in this scenario, an untreated surface slick would rapidly move ashore in the vicinity of Eastern Neck National Wildlife Refuge, and continue to spread to the south towards Kent Narrows. Selected snapshots from the modeling results for the surface oil trajectory are shown in Figure 3.1. Under the prevailing winds the oil moves rapidly to the east and within 18 to 20 hours begins to contact the shoreline on the north side of the Eastern Neck Wildlife Refuge. Over the next 12 hours the oil moves steadily further south, continuing to oil the shoreline. Extensive shoreline oiling of significant areas of marshland would be expected.

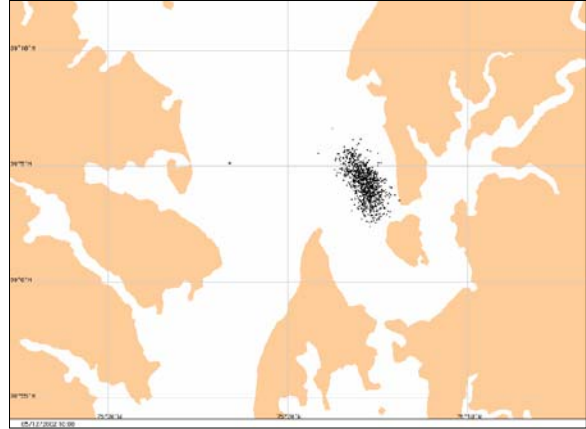
Snapshots from the dispersed oil modeling results (80% efficiency) are shown in Figure 3.2. The concentrations of dispersed oil in the entire vertical water column through time are shown in Table 3-2. Dispersants, if used, needed to be applied early on the morning of the first day after the spill, because the ADIOS II results indicated that dispersant effectiveness decreased significantly after 24 hours. The dispersed oil plume, assuming 80% efficiency, would remain in the vicinity of the dispersant application and move generally towards the eastern shore. Most predicted average concentrations were below 0.5 parts per million (ppm). Localized values up to 5 to 10 ppm, and a few above 10 ppm would probably be observed. It was explained that the increase which occurred six hours after dispersion was an artifact of the model, which cannot properly calculate dilution in model cells which are adjacent to the shoreline. In essence, the model moved dispersed oil into the most shoreward cells continuously and the concentration increased as a result, which could not occur.

Data available to the participants included the trajectory analysis for both surface and subsurface oil, oil budgets with and without dispersant use, habitat maps, information on species of concern, and toxicological information.

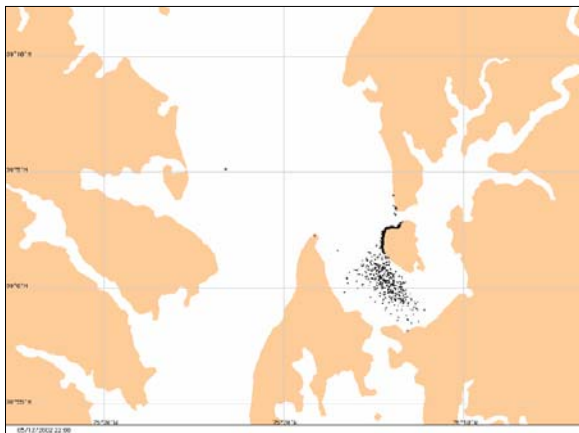
Areas and durations for lower concentration levels were also examined when estimating potential impacts to water column organisms. Based on a threshold of 1 ppm for the most sensitive organisms (planktonic early life history stages of fish and invertebrates), the maximum affected area would have been only a few square kilometers (the total area of the Chesapeake Bay is approximately 6,500 km²) for a period of approximately 24 hours. Based on a threshold value of 10 ppm (for other planktonic organisms), the area of concern would be limited to the surface layer and would last less than 24 hours.



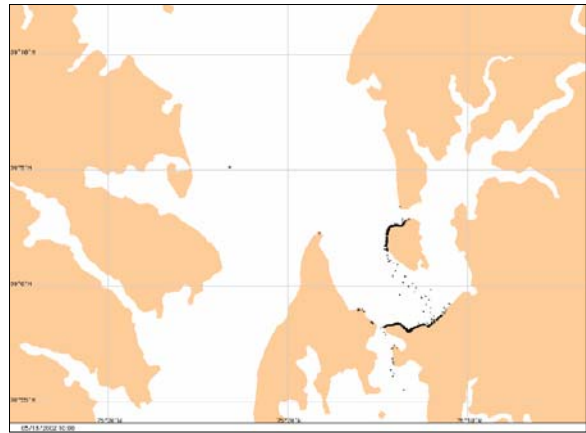
A: 1 Hour (End of Release)



B: 17 Hours (Initial Dispersion)

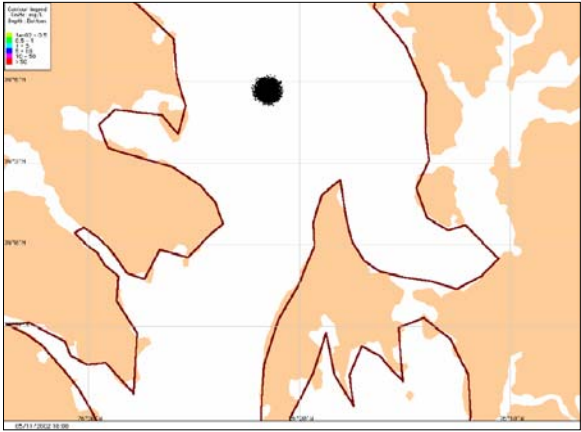


C: 29 Hours

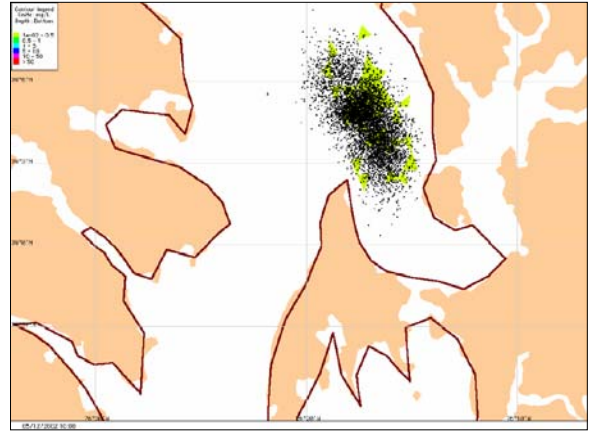


D: 41 Hours

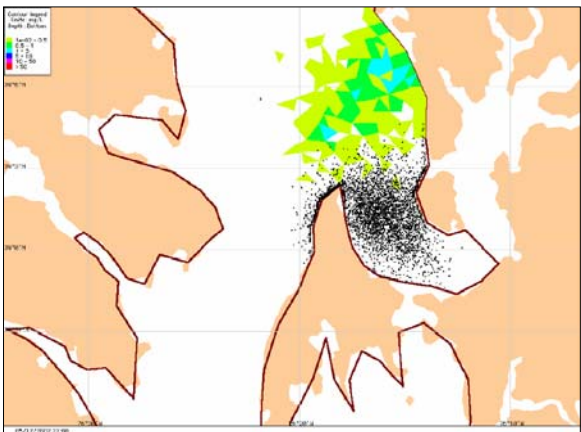
Figure 3.1 Results from the NOAA scenario modeling for the surface oil slick trajectory.



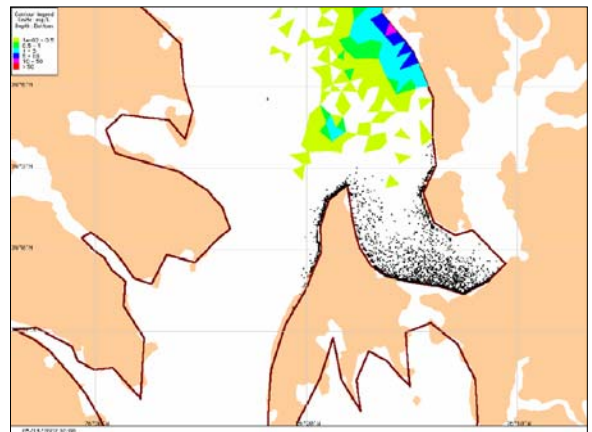
A: 1 Hour (End of Release)



B: 17 Hours (Initial Dispersion)



C: 29 Hours



D: 41 Hours

Key:

Light green	<0.5 ppm
Medium green	0.5 - 1 ppm
Light blue	1 - 5 ppm
Dark blue	5 - 10 ppm
Pink	10 - 50 ppm
Red	>50 ppm

Figure 3.2 Results from the NOAA scenario modeling for dispersant use at 80% efficiency (Surface oil remaining after application is also shown).

Table 3.2 Estimates of the Concentration of Dispersed Oil in the Water Column at Various Depths Over Time

Hours Since Dispersion	Estimated Concentration of Dispersed Oil Averaged Over Water Column (ppm)	
	Average	Maximum
1	< 0.5	0.5 - 1
3	< 0.5	0.5 - 1
6	< 0.5	1 - 5
12	0.5 - 1	1 - 5

4.0 The Results of the Risk Analysis Process

The risk analysis matrix used by the focus groups is presented in Figure 4.1. Each focus group was tasked with reviewing the scenario, the modeling results, information on exposure and sensitivity to oil and dispersed oil, and basic life history and distribution information to estimate the percent of each resource affected and the time of recovery. In the initial evaluation the groups used the various alphanumeric codes to rate the level of concern. At the end of the workshop the various color codes were used to develop summary levels of concern.

		RECOVERY			
		> 10 years (SLOW) (1)	5 to 10 years (2)	1 to 4 years (3)	< 1 year (RAPID) (4)
% of RESOURCE AFFECTED	> 50% (LARGE) (A)	1A	2A	3A	4A
	30 to 50% (B)	1B	2B	3B	4B
	10 to 30% (C)	1C	2C	3C	4C
	0 to 10% (SMALL) (D)	1D	2D	3D	4D

Legend: Red cells represent a “high” level of concern, yellow cells represent a “moderate” level of concern, and green cells represent a “limited” level of concern.

Figure 4.1. Definition of levels of concern for the Maryland Eastern Shore assessment

The participants added one additional analytical element. During the initial discussion of the ranking process, they decided that some of the differences between the focus groups were due to the use of different baseline areas for the interpretation of the percentage of the resource affected. For example, if the population of bald eagles resident in the immediate vicinity of the spill was used as the baseline, the percentage affected would be much higher than if the baseline were assumed to be all of the eagles in the middle Chesapeake Bay. It was decided that an additional line would be added to the preliminary ranking table, which would allow each focus group to indicate what area was assumed for the baseline population. Four such levels were defined: local (immediate area) (L), middle Chesapeake Bay (M), entire Chesapeake Bay (C), or Mid-Atlantic region (R). These designations are included in the preliminary tables, but are not shown in the final summary table.

The risk results for natural recovery are shown in Figure 4.2. Impacts to the Eastern Neck National Wildlife Refuge would be of significant concern to the response given its federally protected status and international recognition regarding wetlands importance (RAMSAR site). Seasonal changes will affect population impacts, especially for submerged aquatic vegetation, horseshoe crabs, and birds (especially since the Mid-Chesapeake Bay is a large

fall/winter flyover). During this initial evaluation, terrestrial upland (bird and overall) scores ran the gamut of low, medium, and high levels of concern. The specific reason for this difference was the possibility of bald eagles bringing contaminated food back to their nests and adversely affecting young eaglets. Osprey were also included in the discussion, but to a lesser extent. Overall, the bald eagle drove the level of concern for the bird category, and terrestrial upland habitat as a whole. The range in scores was clearly influenced by the viewpoint of what population was impacted, and it was this discussion that led to the designation of the four habitat areas. Once the concern for upland species was resolved, the participants focused on the high level of risk for organisms using the water surface, especially birds, and to a lesser extent the Diamondback terrapin. Given the high seasonal usage of the Bay by waterfowl, this was a serious concern to all participants. Salt marsh and sandy beaches were felt to be at moderate risk.

On shore in-situ burning was discussed at length (Figure 4.3) and the participants felt it would offer the best response option for salt marshes, provided it was used judiciously. This discussion was strongly influenced by the difficulties encountered in cleaning marshes during the Chalk Point oil spill in 2000.

Dispersant use was evaluated (Figure 4.4) and found to reduce the level of concern for the water surface habitat, without any significant increase in level of concern for exposure to organisms in the water column. This latter conclusion was based primarily on the assumption of dispersant effectiveness, limited area affected by the dispersed oil plume, and its rapid dilution to levels which were not felt to represent a significant risk.

Under the given scenario there would be no detectable changes from on-water mechanical recovery with shoreline protection (Figure 4.5) in comparison to natural recovery. Under the best conditions, these mechanisms would provide very minimal improvements over the natural recovery scenario. This is due to the lack of local resources and the speed with which the bulk of the oil moved ashore. Any small improvement in score was the result of protective booming limiting the amount of shoreline that might be impacted. Despite this, these efforts should be a part of the response effort. If nothing else, protective booming is strongly recommended for highly sensitive areas, such as the salt marshes, where this type response could be very instrumental in preventing oil from entering. Additionally, some type of protective booming plan should be developed for Kent Narrows.

Likewise, the benefits of on-shore mechanical recovery (Figure 4.6) were very limited, and concern was expressed that, given the sensitivity of marshes to most recovery techniques, any such response in that habitat might do more harm than good. Two focus groups raised their levels of concern from moderate to high on this basis.

Except for dispersant application, none of these techniques lowered the level of concern for the effects of the surface slick. One group did feel there would be some protection for the surface resources from on water mechanical recovery and on shore recovery because reoiling would be reduced.

Habitats		Terrestrial					Water Surface			Intertidal																				
Sub-Habitats		Upland & Supratidal								Salt Marsh and Mudflats					Sea Walls/Pilings/RipRap					Sandy Beach										
Resources	Group	Vegetation	Mammals	Birds	Reptiles/Amphibians	Insects	Mammals	Birds*	Reptiles/Amphibians	Vegetation	Mammals	Birds	Fish	Reptiles/Amphibians	Aquatic Arthropods	Mollusks	Polychaetes	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Mammals	Birds	Fish	Reptiles/Amphibians	Aquatic Arthropods	Meiofauna	Mollusks
		1		4D	4D	4D	4D	4D	3C	3A	4D	3B	3D	3C	4D	4C	3D	3D	4C	4D	4D	4D	4D	4D	4D	4D	3B	NA	3B	3C
2		L	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	M	L	L
3		4D	4D	3D	4D	N/A	3D	3A	2B	4A	3C	3B	4D	4D	4C	3C	3D	4D	4D	4D	4C	4D	4C	3D	3B	NA	3B	3D	4D	4D

Habitats		Subtidal Benthic Habitat															Water Column																								
Sub-Habitats		Shallow (0 to 10 feet)					Deep (10 to 20 feet)					Submerged Aquatic Vegetation					Oyster Reef					Shallow Water (0 to 10 feet)					Deep Water (10 to 20 feet)														
Resources	Group	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Polychaetes	Fish	Aquatic Arthropods	Mollusks	Polychaetes	Vegetation	Vegetation	Mammals	Birds	Reptiles/Amphibians	Fish	Aquatic Arthropods	Mollusks	Epifauna	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles/Amphibians	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton		
		1		L	L	R	M	M	L	L	M	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	M	L	L	L	L	L	L	L	L	L	L
2		4C	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	3C	4D	4C	4C	4D	4C	4D	4D	4D	4D	4D	4D	4D	4C	4C	4C	4D	4D	4A	4D	4D	4D	4D	4D	4D	4D	4D
3		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Figure 4.3 Detailed focus group risk analysis results for on shore in situ burning

Habitats		Terrestrial						Water Surface			Intertidal																			
Sub-Habitats		Upland & Supratidal									Salt Marsh and Mudflats					Sea Walls/Pilings/RipRap					Sandy Beach									
Resources		Vegetation	Mammals	Birds	Reptiles/Amphibians	Insects	Mammals	Birds*	Reptiles/Amphibians	Vegetation	Mammals	Birds	Fish	Reptiles/Amphibians	Aquatic Arthropods	Mollusks	Polychaetes	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Mammals	Birds	Fish	Reptiles/Amphibians	Aquatic Arthropods	Metofauna	Mollusks
Group																														
1	1	4D	4D	3C	4D	4D	3D	3D	4D	2D	3D	3C	4D	4C	3D	3D	3C	4D	4D	4D	4D	4D	4D	3C	NA	3D	3D	4D	4D	
	3C																													
	3D																													
2	1	L	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	M	L	L
	2	4D	2D	3D	4D	4D	3C	3C	3C	3C	3C	3C	4B	3B	4A	3B	4A	4D	3D	4B	4B	3D	4B	4C	3C	4D	3C	3D	4C	4D
	2D																													
3	1	L	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L
	2	4D	4D	3C	4D	N/A	3D	3C	2D	3D	3D	2D	4D	4D	4D	3D	3D	4D	4D	4D	4D	4D	4D	3D	3C	NA	3C	3D	4D	4D
	3C																													

Habitats		Subtidal Benthic Habitat																		Water Column																						
Sub-Habitats		Shallow (0 to 10 feet)						Deep (10 to 20 feet)						Submerged Aquatic Vegetation						Oyster Reef						Shallow Water (0 to 10 feet)				Deep Water (10 to 20 feet)												
Resources		Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Polychaetes	Fish	Aquatic Arthropods	Mollusks	Polychaetes	Vegetation	Vegetation	Mammals	Birds	Reptiles/Amphibians	Fish	Aquatic Arthropods	Mollusks	Epifauna	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles/Amphibians	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton			
Group																																										
1	1	4D	3D	3C	3D	3D	3B	3B	4D	4D	4D	4D	NA	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	3D	4C	4C	4C	4C	4D	4D	4D	4D	4D	4D	4D	4D	4D	
	3C																																									
	4D																																									
2	1	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
	2	4C	4D	4D	3B	4B	3B	4A	4D	4D	4D	4D	4D	4C	4D	4C	3B	4C	4A	4D	4A	4D	4C	4C	4C	4D	4D	4C	4C	3B	4A	4D	4A	3B	4D	4D	4D	4D	4D	4D	4B	
	4B																																									
3	1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	2	4C	4D	4D	4C	4D	4C	4C	4C	4D	4C	4C	4D	4D	NA	4D	4C	4D	4C	4C	4C	4C	4D	4C	4C	4C	4C	4D	4D	4C	4C	4C	4C	4D	4D	4C	4C	4D	4D	4D	4D	4D
	4C																																									

Figure 4.4 Detailed focus group risk analysis results for dispersant application at 80% effectiveness

Habitats		Terrestrial						Water Surface		Intertidal																				
Sub-Habitats		Upland & Supratidal								Salt Marsh and Mudflats						Sea Walls/Pilings/RipRap				Sandy Beach										
Resources	Group	Vegetation	Mammals	Birds	Reptiles/Amphibians	Insects	Mammals	Birds*	Reptiles/Amphibians	Vegetation	Mammals	Birds	Fish	Reptiles/Amphibians	Aquatic Arthropods	Mollusks	Polychaetes	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Mammals	Birds	Fish	Reptiles/Amphibians	Aquatic Arthropods	Meiofauna	Mollusks
		1		3D	4D	3C	4D	4D	3C	3A	4D	2B	3D	3B	4D	4C	3D	3C	3C	4D	4D	4C	4C	3C	4C	4D	3C	NA	3C	3C
2		L	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	M	L	L	
3		3C	2D	3C	4C	4D	3B	3A	3A	3B	3C	3C	4C	3C	4B	3B	4D	4D	3D	4C	4C	3D	4A	4D	2D	4C	3C	3D	4A	4D
		3C						3A						4C				3C												
		L	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	
		3D	4D	3C	4D	N/A	3D	3A	2B	3A	3C	2B	4D	4D	4C	3C	3D	4D	4D	4D	4C	4D	4C	3D	3B	NA	3B	3D	4D	4D
		3D						1A		3A						4D				3B										

Habitats		Subtidal Benthic Habitat														Water Column																												
Sub-Habitats		Shallow (0 to 10 feet)						Deep (10 to 20 feet)				Submerged Aquatic Vegetation				Oyster Reef		Shallow Water (0 to 10 feet)					Deep Water (10 to 20 feet)																					
Resources	Group	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Polychaetes	Fish	Aquatic Arthropods	Mollusks	Polychaetes	Vegetation	Vegetation	Mammals	Birds	Reptiles/Amphibians	Fish	Aquatic Arthropods	Mollusks	Epifauna	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles/Amphibians	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton					
		1		L	L	R	M	M	L	L	M	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
2		4C	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	3C	4D	4C	4C	4D	4C	4D	4D	4D	4D	4D	4D	4D	4D	4C	4C	4C	4D	4D	4A	4D	4D	4D	4D	4D	4D	4D	4D		
3		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
		4D						4D				4D				4D		4D					4D																					
		4D						4D				3C				4D		4A					4D																					
		4D						4D				4D				4D		4D					4D																					

Figure 4.5 Detailed focus group risk analysis results for on shore mechanical recovery

Habitats		Terrestrial						Water Surface			Intertidal																			
Sub-Habitats		Upland & Supratidal						Salt Marsh and Mudflats						Sea Walls/Pilings/RipRap					Sandy Beach											
Resources	Group	Vegetation	Mammals	Birds	Reptiles/Amphibians	Insects	Mammals	Birds*	Reptiles/Amphibians	Vegetation	Mammals	Birds	Fish	Reptiles/Amphibians	Aquatic Arthropods	Mollusks	Polychaetes	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Mammals	Birds	Fish	Reptiles/Amphibians	Aquatic Arthropods	Meiofauna	Mollusks
		1		4D	4D	3C	4D	4D	3C	3A	4D	2C	3D	3B	4D	4C	3D	3D	3C	4D	4D	4D	4D	4D	4D	4D	3B	NA	3B	3C
		3C					3A		3C						4D					3C										
2		L	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	M	L	L	L	L
		4D	2D	3C	4D	4D	3B	3A	3A	3C	3C	3C	4D	3C	4C	3C	4D	4D	3D	4C	4C	3D	4B	4C	2C	4B	3B	3B	4A	4D
		3C					3A		3C						4C					3B										
3		L	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	
		4D	4D	3C	4D	N/A	3D	3A	2B	3C	3C	2C	4D	4D	4C	3D	3D	4D	4D	4D	4C	4D	4C	3D	3C	NA	3C	3D	4D	4D
		3C					1A		3C						4D					3C										

Habitats		Subtidal Benthic Habitat															Water Column																									
Sub-Habitats		Shallow (0 to 10 feet)					Deep (10 to 20 feet)					Submerged Aquatic Vegetation					Oyster Reef					Shallow Water (0 to 10 feet)				Deep Water (10 to 20 feet)																
Resources	Group	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Polychaetes	Fish	Aquatic Arthropods	Mollusks	Polychaetes	Vegetation	Vegetation	Mammals	Birds	Reptiles/Amphibians	Fish	Aquatic Arthropods	Mollusks	Epifauna	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles/Amphibians	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton			
		1		L	L	R	M	M	L	L	M	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	M	L	L	L	L	L	L	L	L	L	L
		4D	3D	3B	3D	3D	3C	3C	4D	4D	4D	4D	NA	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	3B	4C	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D
		3C							4D					4D					4D				4D																			
2		L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
		4C	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	3C	4D	4C	4C	4C	4C	4C	4D	4D	4D	4D	4D	4D	4D	4D	4C	4C	4C	4D	4D	4A	4D	4D	4D	4D	4D	4D	4D	4D
		4D							4D					3C					4D				4A				4D															
3		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
		4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	NA	4D	4D	4D	4D	4C	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D
		4D							4D					4D					4D				4D				4D															

Figure 4.6 Detailed focus group risk analysis results for on water mechanical recovery and shoreline protection

5.0 Summary Risk Analysis Results and Lessons Learned

Figure 5.1 presents the summary results for this workshop. Five response options were analyzed, natural recovery, on-shore in situ burning, dispersant application at 80% effectiveness, on-shore mechanical recovery and on-water mechanical recovery with shoreline protection. The summary conclusions of the participants were developed in a group session at the end of the meeting and represent the consensus of the participants. These are listed below.

Response Options	Habitat Type											
	Upland and Supratidal	Water Surface	Intertidal			Subtidal				Water Column		
			Salt Marsh and Mudflats	Seawalls/Pilings/Riprap	Sandy Beach	Shallow (<10')	Deep (>10')	Submerged Aquatic Vegetation	Oyster Reef	Shallow Water (<10')	Deep Water (>10')	
Natural Recovery	Yellow	Red	Yellow	Green	Yellow	Green	Green	Green	Green	Green	Green	Green
On Shore <i>In Situ</i> Burning	Green	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Dispersant Application (80%)	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
On Shore Mechanical Recovery	Yellow	Red	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green
On Water Mechanical Recovery and Shoreline Protection	Yellow	Red	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green

Legend: Red cells represent a “high” level of concern, yellow cells represent a “moderate” level of concern, and green cells represent a “limited” level of concern. A + indicates an improvement within the broad risk category, while a – indicates an increased concern within the category.

Figure 5.1 Final relative risk matrix for the Maryland Eastern Shore risk assessment

At the conclusion of the workshop, the participants developed the following suggestions for improving oil spill response planning for the middle Chesapeake Bay. These suggestions relate to three topics of interest to the response community. The Coast Guard intends to present these results to the Area Committee for further consideration.

5.1 Planning and Process

- There are two types of emergency all-hazard response planning; development of detailed site specific plans, and “just in time” site-specific crisis plans. This area does not have the resources or commitment to prepare detailed plans, so by default are in the “just in time” mode. Therefore, response agencies need to participate in the development, training, and exercise of all-hazard response planning. Agency participants and responsibilities should be identified.
- Improvement in information transfer might contribute to better response.

- Oil spill response is perceived as a low risk issue in the Chesapeake Bay, so there are not a lot of dedicated resources to do planning. It would be useful to investigate low cost options for education, training, system development, and information systems.
- Regional Response Team (RRT) 3 has implemented an ongoing program to provide technical information at low cost and impact to RRT members. State agencies need to pursue opportunities to attend such training.
- The use of relative risk planning is useful for technical staff, but would be difficult to communicate to the public.
- Continuity of staffing is important.
- These recommendations are partially based on the experience of participants at the April 2000 Chalk Point response. Implementation will make future responses more efficient.

5.2 Response Options

- There is a consensus that marsh burning could have benefits, but that the resources and planning are not in place to achieve this at present. This option is potentially cheap and relatively quick to set up, and could yield significant benefits.
- The common perception of the probability of success with on water mechanical recovery is overly optimistic.
- There was a consensus that the selective use of dispersant should be investigated further before a final recommendation on its potential use can be made.
- There was a consensus that response managers must be careful when recommending response options for use in marshes. The no response option may be less damaging than using mechanical recovery techniques.
- The window of opportunity to implement a specific response is limited. Decisions must be made in a timely fashion, which implies pre-planning.

5.3 Information Needs

- For dispersants, the participants still had concerns about potential chronic impacts from short-term exposures. It would be useful to have chronic and acute toxicity data on regional species.
- Participants also had concerns about the lack of information on shallow water dispersant application. The generally shallow water of the Chesapeake Bay and limited mixing of water layers could limit the true effectiveness of dispersant application.
- National standards on toxicity and efficiency of chemical counter-measures should be developed and an approved list of the chemical counter-measure products that meet these standards should be published.

- The surface currents in Chesapeake and Delaware Bays are largely wind driven. A need exists to ensure that oil spill trajectory models effectively model this process.
- ESI maps need to be updated and digitized. Overlays of staging areas and booming strategies need to be integrated into Environmental Sensitivity Index (ESI) maps.

Appendix A

Resources at Risk Summary (Prepared by Gary Ott, NOAA SSC)

Resources at Risk for Chesapeake Bay, Maryland Eastern Shore

Spill Source Information

This report was prepared for a spill drill during which the spill scenario begins on May 11 in Chesapeake Bay near the Maryland shore community of Rock Hall. Information in this report is based on the assumption that a mid-channel collision above the Chesapeake Bay Bridge resulted in a release of persistent oil.

Geographic Region Covered

The area covered by this report includes the shoreline and nearshore waters near Rock Hall, MD (39_07'N, 76_15'W), Eastern Neck, the mouth of the Chester River, the Kent Narrows, Crab Alley Bay, Prospect Bay, and Eastern Bay. This area does not necessarily correspond to actual or potential oil locations. Consult other Hotline reports for oil location information.

Expected Behavior of the Spilled Material

The exact oil type is not known, but is described as a "persistent oil", and therefore is likely to be a medium or heavy weight crude. Persistent oils may coat shorelines, intertidal areas, and biological resources at the water surface, and be very difficult to clean up. Due to relatively low concentrations of water soluble and acutely toxic compounds, impacts to water column and subtidal resources tend to be less severe than with a lighter, refined product.

Shoreline Resources at Risk

The shoreline along the Rock Hall community is marsh and man-made structure. A large stretch of coarse-grained sand beach with smaller areas of marsh, man-made structure, and riprap occurs from immediately south of Rock Hall to The Cedars. The Chester River side of Eastern Neck and Eastern Neck Island is predominantly marsh with smaller areas of coarse-grained sand beach, riprap, and man-made structures. The bayside coast of Eastern Neck Island is a mix of coarse-grained sand beach and marsh. The shoreline along the Chester River side of Kent Island is mostly coarse-grained sand beach with areas of marsh and man-made structure. Along the Chester River there are several areas of marsh, including: Piney Creek, Kent Island Narrows (also areas of man-made structure), Muddy Creek, Winchester Creek, Walsey Creek, Little Queenstown Creek, and Salthouse Cove. Outside of the creeks and coves in the more open areas, the shoreline is predominantly coarse-grained sand beach with areas of man-made structures and marsh. The Kent Island and Piney Neck shorelines along Crab Alley, Prospect, and Eastern bays are a mix of marsh, coarse-grained sand beach, riprap, and man-made structures.

The most sensitive habitats in the area are wetlands, including tidal freshwater and brackish marshes. Wetlands are often highly productive, serving as nursery habitat and support for a diversity of animals. Marsh vegetation can experience severe stress or mortality if it becomes oiled, especially if oil penetrates or becomes mixed into the sediments. Any cleanup in marsh areas should avoid physical disturbance to the vegetation and substrate, es-

pecially any activities that could result in oil becoming mixed into the sediments. Such disturbance would include foot traffic, which should be avoided in areas with soft sediments. On sheltered and exposed riprap, oil may penetrate into the cavities between the boulders. Chronic sheening problems are possible, especially in sheltered areas. On sheltered man-made structures, oil may adhere to the substrate, and different degrees of persistence are possible, depending on the materials used. On sand beaches, spilled oil may cover the entire beach face.

Oil penetration into the sediment may be up to 25 cm for coarse-grained sediments. Oil may be buried up to depths of 20 cm on coarse-grained beaches. Attention should also be paid to not mixing oil deeper into the sediments through physical activity during cleanup. On exposed man-made structures, oil may be held offshore by wave reflection. If oil contacts the shoreline, the majority will be removed by natural wave energy. It is likely that a large percentage of attached organisms may be killed.

Biological Resources at Risk

Benthic Habitats

Submersed aquatic vegetation may be present along Eastern Neck, Eastern Neck Island, Church Creek; the Eastern Bay side of Kent Island and Piney Neck; and several areas along the Chester River, including: Macum Creek, Piney Creek, Grays Inn Creek, Langford Creek, Cliffs Bight, Corsica Neck, Reed Creek, and Tilghman Neck. Submersed aquatic vegetation in shallow subtidal or intertidal zones could become oiled, and while there is potential for above ground die-off, it is likely that the plants will recover by the following season. It is doubtful that the oil will be mixed into the substrate, unless there is a lot of disturbance during clean up. It is possible that fauna hiding or living in the vegetation will be exposed to and impacted by the oil.

Birds

Gulls, terns, skimmers, and kittiwakes may be present in the area, including black skimmers, gull-billed terns, and least terns (all state threatened). Osprey may be present in the area, and may be nesting on Eastern Neck Island. Osprey young begin hatching in May. Bald eagle (federally and state threatened) nest sites may occur near Mitchell Bluff and Tolchester Beach, and on Quaker Neck, Tilgham Neck, Eastern Neck, Eastern Neck Island, and Piney Neck.

Eaglets begin hatching in April, so young are likely present. Wood ducks may be nesting in marshes on Quaker Neck. Gulls, terns, and skimmers may be nesting in marshes on Eastern Neck Island. Wading birds (great blue herons, etc.) may be nesting in marshes along Piney Cove and Reed Creek on Tilgham Neck and along Hail Creek on Eastern Neck Island. Wading birds, waterfowl, gulls, terns, and raptors can be severely impacted by oil in some cases. Waterfowl and wading birds may be directly oiled and can become oiled on the upper body and feathers by coming in contact with oiled vegetation or wrack. Osprey, eagles, skimmers, and terns may be oiled while capturing fish. Direct oiling of birds reduces the buoyancy, water repellency, and insulation provided by feathers, and may result in death by drowning or hypothermia. Preening of oiled feathers may also result in ingestion of oil resulting in irritation, sickness, or death. Bird oiling, particularly waterfowl and wading birds, may continue even after the floating oil slicks have been removed, depending on the extent of

oiled vegetation. Adult birds bringing even small amounts of oil back to their nests on their feet or feathers may reduce the hatching success of eggs or survival of young.

Fish

Several fish species of commercial and recreational interest are present in the area, including: alewife, American shad, Atlantic menhaden, white perch, striped bass, yellow perch, bluefish, spotted seatrout, weakfish, spot, summer flounder, winter flounder, Atlantic croaker, channel catfish, blueback herring, and shortnose sturgeon (federally and state endangered). Spawning adults, eggs, larvae, and juveniles of several of these species may be present during the month of May. Larval and juvenile life-stages are especially sensitive to spilled oil because they inhabit shallow, protected waters around marshes, are less mobile, and are more sensitive to oil toxicity.

Invertebrates

Oyster and softshell clam beds occur throughout Chesapeake Bay, Chester River, and Eastern Bay. Blue crabs are highly abundant throughout the area. Spawning adults, eggs, larvae, and juveniles of all of these species may be present during the month of May. Larval and juvenile invertebrates in shallow water areas could possibly experience sublethal impacts or lethal effects. Persistent oils may smother invertebrates if deposited in intertidal or sub-tidal areas.

Human-Use Resources at Risk

Eastern Neck Island is a National Wildlife Refuge and a RAMSAR site (wetland of international importance). Thousands of migratory and wintering waterfowl use this area, primarily during October-March. Matapeake State Park occurs on Kent Island. Numerous boat ramps and marinas occur throughout the area.

Appendix B

Participants and Invitees

Group 1 (*second workshop only)			
Name	Affiliation	Phone	Email
Gary Ott	NOAA SSC	757-856-2755	gary.ott@noaa.gov
Geoff Donahue	MD EMA HazMat	410-517-3627	gdonahue@mema.state.md.us
Sam Kimbles	Queen Annes County EMA	410-758-4500	skimbles@qac.org
ENS Tracy Wirth	CG Activities Baltimore MER	410-576-2550	TWirth@actbalt.uscg.mil
Ken Miller	MD DNR GIS	410-260-8751	kenmiller@dnr.state.md.us
Mitch Keiler	MD DNR	410-260-8806	mkeiler@dnr.state.md.us
Tarik Adams	ENNR Ass't Manager	410-639-7056	tarik_adams@fws.gov
Dennis Clark	IMS Environmental Services	800-883-1833	dclark@imsenv.com

Group 2 (*second workshop only)			
Name	Affiliation	Phone	Email
Dave Heilmeier	MD DNR Wildlife Heritage	410-535-0282	dheilmeier@dnr.state.md.us
Heidi Stout	Tri-State Bird Rescue	302-737-7241	hstout@tristatebird.org
CPO John Nay	CG Activities Baltimore MER	410-576-2657	JNay@actbalt.uscg.mil
CDR Wade Blake	NOAA Liaison to USCG HQ	202-267-1321	wade.blake@noaa.gov
Craig Weedon	MD DNR Fisheries	410-643-6785	cweedon@dnr.state.md.us
Peter McGowan	USFWS	410-573-4523	PETER_C_MCGOWAN@fws.gov
*Mike Chezik	DOI	215-597-5378	Michael_Chezik@os.doi.gov
*SCPO Mark Lewack	CG Activities Baltimore	410-576-2628	MLewack@actbalt.uscg.mil

Group 3 (*second workshop only)			
Name	Affiliation	Phone	Email
Rich Takacs	NOAA Restoration Center	410-267-5672	rich.takas@noaa.gov
Alan Williams	MDE State OSC	410-631-3994	awilliams@mde.state.md.us
Linda Ziegler	EPA Region 3	215-814-3277	ziegler.linda@.gov
LTJG Lisa Knopf	CG Activities Baltimore MER	410-576-2657	LKnopf@actbalt.uscg.mil
Marty Kaehny	ENNR Manager	410-639-7056	martin_kaehny@fws.gov
Chris Judy	MD DNR Shellfish	410-260-8259	cjudy@dnr.state.md.us
Lee Karrh	MD DNR SAV	410-260-8650	lkarrh@dnr.state.md.us
*Keeli Darst	USCG LANT/D5	757-398-6689	kdarst@LANTD5.uscg.mil

