Consensus Ecological Risk Assessment of Potential Transportation-related Bakken and Dilbit Crude Oil Spills in the Delaware Bay Area: *Comparative Evaluation of Response Actions*

A Report to the U.S. Coast Guard, Sector Delaware Bay

Ann Hayward Walker, Debra Scholz, and Melinda McPeek, SEA Consulting Group

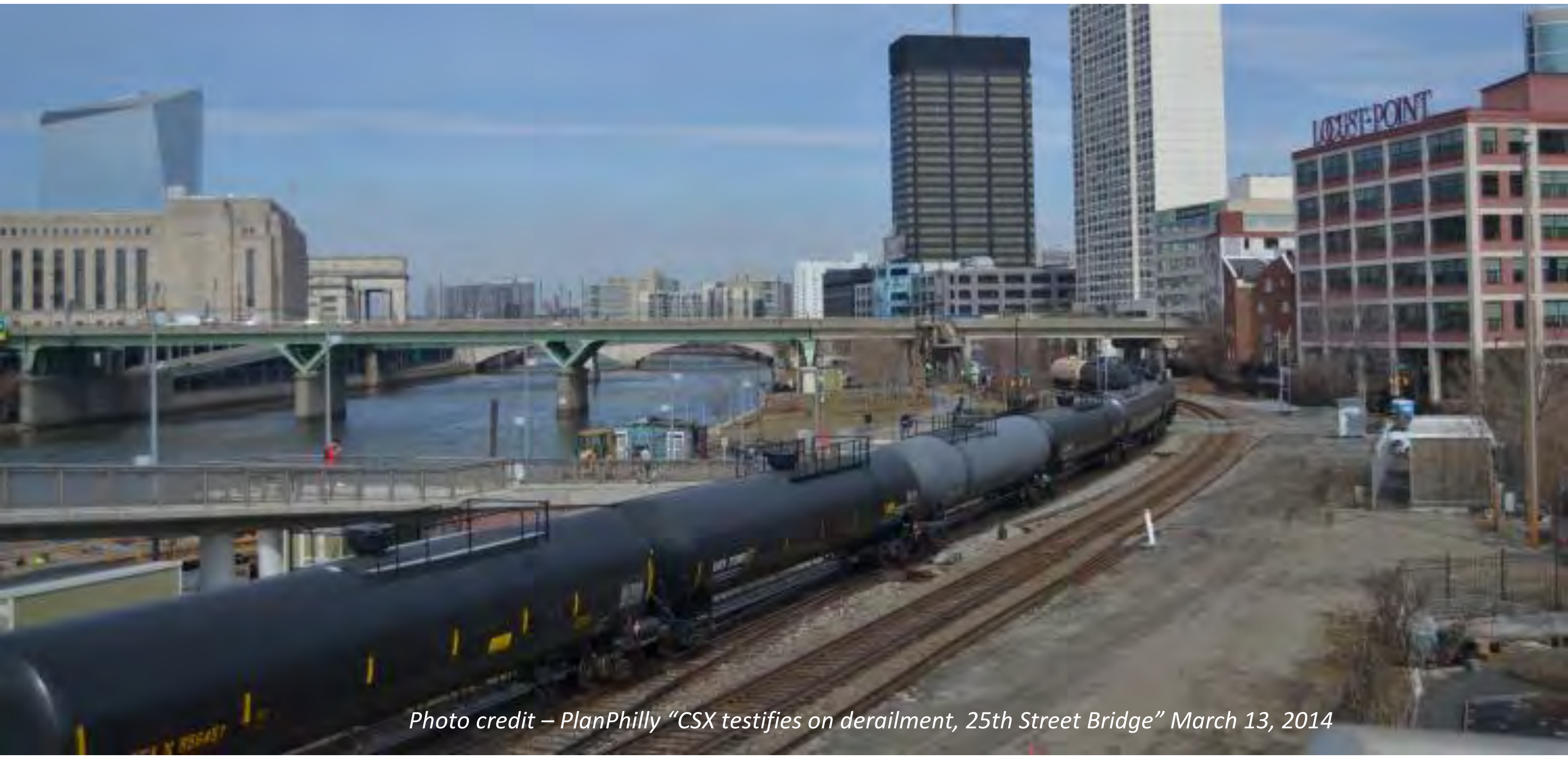

Photo credit – PlanPhilly "CSX testifies on derailment, 25th Street Bridge" March 13, 2014

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July 21, 2015

Dear ERA Workshop Participant:

I would like to extend my sincere thanks to all those who participated in this Ecological Risk Assessment (ERA) for Sector Delaware Bay. This ERA focused on assessing the risks from specific crude oils moving through the Sector's Area of Responsibility and planning for the best way to respond to an incident involving Bakken crude oil and diluted bitumen.

Historically, one million barrels per day (BPD) of crude oil are transported through this region. Due to the energy renaissance, three different Class I rail companies now transport 588,000 BPD Bakken and 103,000 BPD diluted bitumen to five nearby refineries. This increased risk must be accompanied by proper contingency planning and updated response strategies. To maintain an effective and safe response posture throughout the eastern corridor, as the Federal On-Scene Coordinator and Co-Chair to the Area Committee, I feel this ERA is both timely and pertinent, not only in Pennsylvania, New Jersey, and Delaware, but nationwide.

We need to understand the properties and behavior of these oil products while defining appropriate response options to mitigate their associated potential risks. The ERA represents the collaborative efforts of subject matter experts and stakeholders from numerous disciplines working together to accomplish these goals, and I deeply appreciate their participation in this significant undertaking.

Sincerely,

, CAPT

B. A. Cooper
Captain, U.S. Coast Guard
Federal On-Scene Coordinator
Commander, Sector Delaware Bay

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List of Abbreviations, Symbols, and Acronyms

Agency for Toxic Substances and Disease Registry .... ATSDR
American Petroleum Institute .... API
Area Contingency Plan .... ACP
Area of Responsibility .... AOR
Automated Data Inquiry for Oil Spills .... ADIOS
Barrels per day .... BPD
Best management practice .... BMP
Captain .... CAPT
Center for Toxicology and Environmental Health, LLC .... CTEH
Centistokes .... .cSt
Consensus Ecological Risk Assessment .... CERA
Delaware Bay .... DelBay
Delaware Bay and River Cooperative… .... DBRC
Delaware Department of Natural Resources and Environmental Control .... DNREC
Delaware River and Bay Oil Spill Advisory Committee Report .... DRBOSAC
Ecological Risk Assessment .... ERA
Emergency Response Division .... ERD
Endangered Species Act .... ESA
Environmental Sensitivity Index .... ESI
Essential Fish Habitat .... EFH
Estuary turbidity maximum .... ETM
Federal On-scene Coordinator .... FOSC
Firefighting .... FF
Gallons .... gals
General NOAA Oil Modeling Environment .... GNOME
Geographic response strategies .... GRS
Historic Preservation Agency .... HPA
Hours .... hrs
Human health and safety. .... HHS
Interagency Modeling and Atmospheric Assessment Center .... IMAAC
Lieutenant Commander .... LCDR
Lower explosive limit .... LEL
Magnuson-Stevens Fisheries Conservation and Management Act .... MSA
Marine Environmental Response .... MER
Material safety data sheet .... MSDS
Merchant Vessel .... M/V
Microns .... µ
National Historic Preservation Act of 1996 .... NHPA

National Oceanic & Atmospheric Administration .... NOAA
Native American Graves Protection and Repatriation Act .... NAGPRA
Natural attenuation with monitoring .... NAM
Natural Resource Damage Assessment .... NRDA
Nautical mile .... nm
Net Environmental Benefit Analysis .... NEBA
New Jersey Department of Environmental Protection .... NJDEP
Non-governmental organization .... NGO
Office of Incident Management & Preparedness CG533
Office of Response and Restoration (NOAA) .... OR&R
Oil and Hazardous Materials Simulated Environmental Test Tank .... OHMSETT
Oil particle aggregate .... OPA
Oil Pollution Act of 1990 .... OPA 90
Oil spill recovery vessels .... OSRV
Pennsylvania Department of Environmental Protection .... PADEP
Polycyclic aromatic hydrocarbons .... PAH
Perfluorochemicals .... PFC
Perfluorooctane sulfonate .... PFO
Perfluorooctane sulfonate acid .... PFOA
Pennsylvania Department of Environmental Protection .... PADEP
Parts per million .... ppm
Parts per thousand .... ppt
Personal protective equipment .... PPE
Regional Response Team .... RRT
Resources at risk .... RAR
Safety data sheet .... SDS
Scientific and Environmental Associates, Inc. (dba SEA Consulting Group) .... SEA
Scientific Support Coordinator .... SSC
Short-term exposure limit .... STEL
State Historic Preservation Officer .... SHPO
Threatened and endangered .... T/E
Time-weighted average limit .... TWA
United States .... US
U.S. Coast Guard .... USCG
U.S. Coast Guard, Headquarters .... USCG HQ
U.S. Environmental Protection Agency .... EPA
United States Fish and Wildlife Service .... USFWS

Preface

The original report was provided to US Coast Guard Sector Delaware Bay in September 2015. The authors received thoughtful insight from two external and independent readers. Subsequently, the authors added clarification to address the readers' comments about the use of firefighting foam and the weathering behavior of dilbit oil.

January 2016.

Acknowledgements

Scientific and Environmental Associates, Inc. (doing business as SEA Consulting Group – SEA) wishes to acknowledge first and foremost the willing and constructive technical collaboration among all those who were involved in this project, which directly contributed to the new, substantial work performed in this ERA. We thank the project sponsor representatives from Sector Delaware Bay for their considerable assistance: LCDR Michael Weaver, LT Eric Nielsen, and Mr. Gerald Conrad, as well as LCDR Tracy Wirth, who initiated this project. SEA and the sponsors of this project extend their sincere appreciation to all the participants in the risk assessment workshops.

We also want to recognize the contributions of the Project Committee, some of whom served as subcommittee and workgroup leads: Mr. Clay Stern (U.S. Fish and Wildlife Service (USFWS)), Mr. Ed Levine and Mr. Frank Csulak (National Oceanic Atmospheric Administration (NOAA)) Scientific Support Coordinators), Mr. Mike Towle (U.S. Environmental Protection Agency (EPA) Region III), Mr. Rich Gaudiosi (Delaware Bay and River Cooperative (DBRC)), Mr. Bennett Anderson (Delaware Dept. of Natural Resources and Environmental Conservation (DNREC)), Mr. Robert Bauer (Pennsylvania Dept. of Environmental Protection (PADEP)), Mr. Patrick Digangi (NJ Depart. of Environmental Protection (NJDEP)), and to the NOAA Emergency Response Division for developing scenario-specific oil behavior and fate modeling and the resources at risk report from these oils.

Special recognition is extended to Mr. Stern for his substantial technical contributions regarding Section 7 consultations, the resource classification, the update of the risk ranking matrix, and his thoughtful suggestions throughout the project. Further, special recognition is also extended to Dr. Kelly Scribner of the Center for Toxicology and Environmental Health, LLC (CTEH) for her valuable assistance on human health and safety aspects of Bakken and dilbit crude oils and sharing her direct experience in responding to rail incidents, in addition to developing the initial human safety and health conceptual model.

We acknowledge with appreciation the generous logistical support by the members of the Delaware Bay and River Cooperative for the workshops. We greatly appreciate the efforts of the workshop recorders, Rebecca Weissman and Stacey Burger from SRA and Melinda McPeek of SEA, for capturing the discussions in the plenary sessions and the scenario workgroups.

Finally, we would like to acknowledge the special presentations and briefings (in order given) at the workshops by:

- Mike Towle, EPA “Bakken Crude Oil February 2015 Testing at OHMSETT”
- Dr. Kelly Scribner, CTEH “Health and safety concerns associated with response to crude oil releases”
- Chief Jim Kelly, Sunoco Logistics – Discussion on Foam, Logistics and Port Asset for Fire & Spill Response
- Suzanne Lemieux, API – Industry safety course for moving crude by rail
- Dr. Michel Boufadel, New Jersey Institute of Technology - Bakken and Dilbit Oil Fate
- Bryan Naranjo, Norfolk Southern Railroad - Norfolk Sothern’s Crude Oil by Rail Planning, Training and Response

- Mike Austin, CSX - CSX's Crude Oil by Rail Planning, Training and Response

Contractor support to assist in the planning and facilitation of the workshops and in the preparation of the report was provided by CAPT Joseph Loring, Chief of the CG-Office of Marine Environmental Response (MER) Policy, Headquarters, USCG (G-RPP) under Task Order HSCG23-13-F-MPP059, issued under Contract Number (HSCG23-11-A-MPP439) to SRA International. The support and guidance of the MER Project Manager, Jonathan Smith, also is gratefully acknowledged.

Executive Summary

In 2015, the United States Coast Guard (USCG) Sector Delaware Bay sponsored the project, "Consensus Ecological Risk Assessment of Potential Transportation-related Bakken and Dilbit Crude Oil Spills in the Delaware Bay Area: Comparative Evaluation of Response Actions". The aim of the Sector Commander, who is the designated Federal On-scene Coordinator (FOSC), and the Area Committee was to update the Area Contingency Plan (ACP) and improve preparedness to oil spills in the Sector's area of responsibility (AOR) by identifying timely and effective response actions that can enable resource protection and recovery in the event of future spills from Bakken and diluted bitumen (dilbit) oils. Project-specific objectives were to assess the risks from these two crude oils, which are moving through the Sector's AOR and plan for the best way to respond to incidents involving these oils since they are transported via rail, barge, and tanker throughout the AOR. Funded by USCG headquarters (HQ), a related project objective was to consider specifically threatened and endangered (T/E) species in accordance with USCG HQ guidance on Section 7 consultations (Gelzer, 2013) pursuant to the Endangered Species Act (ESA) and Essential Fish Habitat (EFH) under the Magnuson-Stevens Fisheries Conservation and Management Act (MSA).

This project adapted the consensus ecological risk assessment (CERA) process, as described in *Developing Consensus Ecological Risk Assessments: Environmental Protection in Oil Spill Response Planning. A Guidebook* (Aurand et al., 2000), to satisfy this project's objectives. Previous CERAs assessed the risks associated with a single oil type in one or two scenarios, the variables being different spill volumes or, in some previous ERAs, spill location. This CERA assessed two types of crude oil with different properties and behavior, in five spill scenarios involving rail, barge, and tanker modes of transportation, in two seasons (winter and spring), and in three different settings, i.e., creek (freshwater), river (brackish/salt water depending upon the volume of fresh water flowing into the river), and bay (saltwater). Special consideration was given to T/E species throughout the process. The properties of these oils (Bakken-highly flammable and dilbit-weathering and sinking) necessitated developing a new set of response actions, and evaluating the risks of the spilled oil and response actions in two phases, i.e., initial emergency phase (initial 4-6 hours) and longer-term (6 hours onward, especially 4 – 7 days). A new set of 10 response actions and new conceptual models were developed and the risk ranking matrix was revised. Due to the serious fires in recent incidents involving Bakken oil, the project assessed human health and safety risks in addition to ecological risks.

To accomplish the full project scope, a Project Committee comprising members of the Area Committee and resource trustee agencies worked with the USCG and consultant staff assigned to this project to: guide project activities; lead subcommittees; lead scenario workgroups in the two workshops; and provide guidance about this report's organization, including key points to highlight. Past CERA workshops involved 30-50 participants in two 3-day workshops, separated by about a month. This CERA involved nearly 90 participants in two 2-day workshops separated by less than 2 weeks in June 2015. Not all participants attended both workshops, but there was a core majority who participated in both.

Due to the broad project scope and unlike previous ERA's where at least two workgroups separately evaluated the same scenarios and then developed a final consensus among all participants, the workgroups in this project assessed separate scenarios and achieved scenario-specific consensus, rather than a consensus across all workgroups about all scenarios. That said, some general findings about response actions to spills of Bakken and dilbit oil include:

- Assuming health and safety measures of first responders (e.g., fire fighters and pollution responders) are successful, risks to human health and safety and social-economic resources from a fire as well as fire-fighting foam were scored as a moderate level of concerns.
- The ecological risks associated with the use of fire-fighting foam in fresh, brackish or marine waters were scored with a moderate concern.
- Participants assigned higher levels of concern to the ecological risks associated with a spill of dilbit oil, compared to a spill of Bakken crude oil.
- For transportation-related spills of Bakken oil, in general, the workshop participants found that the "No response other than monitoring" option was considered of limited or moderate level of concern when deemed appropriate for the scenario conditions, both at the 4- to 6-hour response frame or at the 4- to 7-day post discharge. In most cases, the participants found that there was very little change in concern levels when considering the various response action versus the "no response" action. Although some of the levels of concern did increase from low to moderate (green to yellow), this increase in concern did not require a change in response options. The highest level of concern in Scenario 1 (rail, Philadelphia, Schuylkill River, freshwater) was with the use of extinguishing agents or for vapor suppression in the intertidal zone for both the initial response and over the 4- to 7-day response times.
- For transportation-related spills of dilbit oil, in general, the workshop participants found that the "No response other than monitoring" option provided a moderate to high level of concern, both at the 4- to 6-hour response timeframe to the 4- to 7-day post discharge. In most cases, the participants found that there was very little change in concern levels when considering the various response action versus the "no response" action. Some of the levels of concern did increase for response actions over the 4- to 6-hour timeframe to the 4- to 7-day period from low to moderate (green to yellow). The high level of concerns (red) were scored in Scenario 5 (barge, Delaware River, brackish water) regarding the use of most response options deemed applicable for use in the intertidal, mid-water, and benthic zones for both the initial response and over the 4- to 7-day response times. Similar concerns were also expressed for Scenario 4 (rail, Mantua Creek, freshwater) when considering the risk of shoreline clean up and oil detection / mapping methods for the intertidal and midwater zones.
- For dilbit oil spills, participants recommended that rapid containment and removal of the oil from the water surface is the highest environmental priority during the initial few hours of response, to limit spreading of the oil and reduce potential extent of contamination on both shoreline and benthic habitats. If the oil is not recovered early on, especially in freshwater, the oil will likely begin to pick up sediments and submerge, making it very difficult to detect and recover without doing additional damage to the environment.
- The presence of T/E animals and plants and some other organisms, such as diamondback terrapin (turtle) and freshwater mussels, are drivers that increase the level

of concern in these scenarios from both the oil and response actions which could impact them, e.g., trampling from shoreline cleanup and oil removal using mechanical means in nesting season.

- A response action scored with a high level of concern (red) is a prompt to further review and assure that response actions would not adversely affect the species of concern; it is not intended to prevent or stop response actions. This ranking represents a need for follow-up action by the Area Committee and Regional Response Team (RRT) to more fully address whether certain response actions will be allowed and, if so, under what circumstances, e.g., in certain seasons or under specific conditions.

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1.0 Introduction

In 1998, the USCG began sponsoring efforts to develop comparative methods that would enable the evaluation of relative risks associated with three primary categories of marine/coastal oil spill response actions – mechanical recovery, dispersants, and *in-situ* burning. The results of the risk assessment would be used to inform pre-spill planning decisions that are reflected in ACPs and consistent with policies in the Regional Contingency Plans around the United States. Interest in selecting response options based on a risk/benefit analysis predates the 1998 initiatives, but efforts since the 1998 project are different in that they emphasize a consensus-building approach to evaluate potential risks and benefits. USCG Headquarters (formerly G-MOR, now MER) sponsored the development of a guidebook on this process. That document, entitled *Developing Consensus Ecological Risk Assessments: Environmental Protection in Oil Spill Response Planning. A Guidebook*, is available from MER (Aurand *et al*., 2000). A previous CERA, which followed that guidance, was conducted for the Delaware Bay in 2006 for the above-mentioned response options. The focus of this CERA addresses a new set of response actions to spills involving two specific types of crude oils, i.e., Bakken and diluted bitumen (dilbit), which have become part of the USCG's evolving responsibilities in the recent national energy renaissance.

The CERA process is designed to help oil spill decision makers to compare ecological consequences of specific response options, especially in nearshore or estuarine situations. This is important because when an incident occurs, rapid decisions must be made to implement the optimal actions intended to mitigate environmental risks from the oil and response actions, as well as ensure public safety and the safe passage of commerce. Given multiple regulatory authorities and response options, it is most practical to consider and reach agreement among those with inter-jurisdictional responsibility about the potential limitations and benefits of available risk mitigation options before time-critical decisions have to be made during response. Due to the length of time involved to conduct the entire process (i.e., a total of several months), conducting an incident-specific ERA is impractical for the emergency phase of an actual spill of waterborne oil. Notwithstanding, knowledge gained by participants in the CERA process facilitates real-time decision-making by enabling a review of significant risk factors in relation to previously considered response options; some of which may still be generally applicable and/or could be modified to implement during an actual incident.

The CERA process allows decision makers to evaluate effects to ecological resources through cross-response comparisons. In this structured, ***qualitative***, and analytical approach, participants develop a shared understanding and basis for evaluating impacts. Moreover, through this process, participants develop technically-feasible rationale to support their consensus findings that can be used to develop appropriate response strategies to include in the ACP.

The CERA process uses a series of matrices and other tools to structure discussions and capture group consensus about risk management options (i.e., response options), stressors, resources at risk, and the impact of stressors on identified resources. The oil spill CERA process typically involves 2-3 months of planning followed by two 2- or 3-day facilitator-led workshops. The ideal size is around 20-30 participants for two scenarios, including spill response managers, natural resource managers and trustees, subject matter experts, and non-governmental organizations. The goal is to achieve consensus interpretations of potential risks and benefits associated with selected response options based on scenarios developed by local participants.

Time between the two workshops, usually at least a month, is used by participants to research issues of concern before developing final conclusions. The process focuses heavily on achieving a consensus interpretation of available data and technical information. Therefore, it is important to have broad representation in the assessment process to build joint support for and credibility in the findings.

The CERA process includes three primary phases - ***problem formulation, analysis,*** *and* ***risk characterization*****,** plus a fourth post-workshop phase of ***documenting and applying results***. Details of the process are described in the USCG *Guidebook* (Aurand *et al*., 2000). In the first phase, problem formulation, participants develop a scenario for analysis, identify resources of concern along with associated assessment thresholds, and prepare a conceptual model to guide subsequent analysis. In the analysis phase, participants characterize exposure and ecological effects. The risk characterization phase, directs the assessment, using standard templates and simple analytical tools that define and summarize the assessment for the resources of concern against each evaluated response option. Finally, participants complete a risk characterization. During this phase, participants interpret their results in terms of the advantages and disadvantages of each response option in comparison to the impacts of leaving the oil in place to naturally attenuate with monitoring (NAM). The risks of impacts from oil alone are compared to the risk of each category of response action on various resources at risk from the spill.

This CERA adapted the 2000 Guidebook, as discussed in Section 3.0, to assess the spill response risks associated with new transportation-related scenarios involving oils produced in North America, i.e., Bakken and dilbit crude oils.

1.1 Objectives

This project was sponsored by USCG Sector Delaware Bay and the Sector Delaware Bay Area Committee. The project's overall goal is to update the ACP and improve preparedness to oil spills in the USCG's AOR by identifying timely and effective response actions that can enable resource protection and recovery in the event of future spills from Bakken and dilbit oils. Through the CERA process, the sponsors intend to facilitate a better understanding of natural resource trustee and response agency concerns and the concerns of non-governmental organizations (NGOs) that have particular interests in the Delaware River and Bay ecosystem.

Project-specific objectives are to assess the risks from two crude oils (Bakken and dilbit) moving through the Sector's AOR and plan for the best way to respond to incidents involving these oils as they are transported via rail, barge, and tanker throughout the AOR. The aim of the Sector Commander, who is the designated FOSC, and the Area Committee is to enhance preparedness and understanding of the properties and behaviors of these oil products and mitigate potential risks. Another project objective is to improve the understanding of the sequence and coordination of response actions implemented by first responders, particularly local fire fighters, with the response actions described in the ACP.

1.2 Participants

This CERA was carried out by a Project Committee and workshop participants. Appendix A contains the list of project participants. The Project Committee was comprised of consultant support and members of the Sector Delaware Bay Area Committee, notably representatives from the USCG, EPA, NOAA, USFWS, DNREC, PADEP, NJDEP, and DBRC. Consultant support was provided by SEA Consulting Group and SRA International, Inc.

A total of 172 individuals from 82 organizations were invited. Seventy-eight attended the first workshop; fewer participants attended the second session. Many but not all participants attended both workshops, some attended one session or the other. Participant affiliations also are included in Appendix A. At the first workshop (June 9-10, 2015), participants were divided into five breakout groups, one for each scenario. These were also their assignments in the second workshop (June 23-24, 2015). Participants who were unable to attend the first meeting were placed in one of the five workgroups during the second workshop.

1.3 Organization of the Report

This report is the project deliverable. It is PDF-1 formatted to be printed as an independent, double-sided report. The report is available electronically from USCG Headquarters MER and USCG Sector Delaware Bay.

Sections 1 and 2 provide an overall ***Introduction*** to the project, and ***Background*** about the ERA process as applied in this project, respectively. The report summarizes the ***Methods*** used to prepare for the assessment activities conducted during two workshops in June 2015 (Section 3); presents the ***Results*** of the assessment (Section 4); and describes the ***Discussion*** among participants who assessed the risks associated with the five scenarios during the workshops (Section 5). In addition, the ***Appendices*** contain relevant, detailed information about this CERA and workshops. Participants used the best available information at the time the CERA was conducted.

Electronic copies of some of the presentations made at the workshops by the sponsors or by subject matter experts and the recorders' notes from the workshops have been delivered to Mr. Gerald Conrad, Contingency Planning Specialist at Sector Delaware Bay. These files are mentioned when appropriate in the text of this report.

2.0 Background

The process is based on EPA's ERA Guidelines (EPA, 1998). It is designed as a planning tool to enable detailed assessment of options for responding to oil spills by a diverse group of participants.

The CERA's goal was to assess the potential benefits and limitations of response actions in relation to the effect of spilled oil alone as a way to make informed decisions about the many response actions that will result in an outcome that is better than not using them, or leaving the oil to attenuate naturally. In that context, this CERA represents a NEBA, which is an approach frequently referred to by U.S. oil spill responders, and by industry globally, for evaluating the potential benefits and limitations of, and tradeoffs associated with, different oil spill response actions.

The planning phase for a NEBA includes: setting the goals of assessment; selecting a limited and feasible suite of alternative actions; defining the temporal and spatial scope of assessment; identifying contaminant and remediation stressors; selecting environmental services and other ecological properties of interest; selecting metrics and methodologies for the comparison of alternatives; selecting a reference state; establishing plausible links between stressors and services (conceptual model); and developing an analysis plan (Fig. 1). As such, the NEBA planning phase is consistent with EPA ERAs.

2.1 EPA ERA Process

The ERA process used by EPA for Superfund[1] (EPA 1998) was the basis for the CERA process for oil spill response. The process was developed to provide a methodical means for risk managers to identify appropriate ways for reducing ecological risks though various cleanup and other mitigation options. An ERA is one tool in the overall management of ecological risks.

In situations where a complex of ecosystem values (e.g., watershed resources) is at risk from multiple stressors[2], a group of risk managers may function as a risk management team. In the EPA process, the ERA is carried out by a risk management team comprising risk managers, risk assessors, and interested parties, such as stakeholders. Risk management teams may include decision officials from federal, state, local, and tribal governments; commercial, industrial, and private organizations; leaders of non-governmental advocacy groups; and other sectors of the public such as property owners.

Risk managers, charged with protecting human health and the environment, help assure that risk assessments provide information relevant to their decisions by describing why the risk assessment is needed, what decisions it will influence, and what they want to receive from the risk assessor. Risk managers are individuals and organizations who have the responsibility, or have the authority to take action or require action, to mitigate an identified risk, such as the members of Unified Command. Risk managers also may include a diverse group of other parties

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[1] **Superfund** is the name given to the environmental program established to address abandoned hazardous waste sites. It is also the name of the fund established by the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended.

[2] As defined in the EPA risk assessment glossary, a stressor is any physical, chemical, or biological entity that can induce an adverse response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as people in the environment with which they interact. http://www.epa.gov/risk/glossary.htm

who also have the ability to take action to reduce or mitigate risk, such as the Natural Resource Trustees (EPA, 1998).

Risk assessors evaluate and characterize exposure to stressors and the relationship between stressor levels and ecological effects, and ensure that scientific information is used effectively to address ecological and management concerns. Stressors from spilled oil may include physical smothering or chemical toxicity of the oil, as well as stressors from actual response actions, such as physical trauma associated with mechanical means to remove oil from the environment. Risk assessors describe what they can provide to the risk manager(s), where problems may occur, and where analytical uncertainty resides.

The CERA process is implemented through consensus among and between risk managers, risk assessors, and other interested and/or affected stakeholders during a multiday interactive workshop. Project Committee representatives, serving in both risk manager and risk assessor roles, helped guide and apply the ERA process. This group also helped ensure that all key participants were appropriately involved. The interface among them from initial planning through to the communication of risk at the end of the risk assessment was critical to ensure that the results of the assessment can be used to support risk management decisions.

During planning, the Project Committee came to agreement on the framework for this risk assessment and available resources needed to achieve the goals. They used information on the area's ecosystems, regulatory requirements, and publicly-perceived environmental values to interpret the goals for use in the ERA. The Project Committee reached agreements about (1) clearly established and articulated management goals, (2) characterization of decisions to be made within the context of the management goals, and (3) agreement on the scope, complexity, and focus of the risk assessment, including the expected output. In this risk assessment, stakeholders and other interested parties also provided an active role in the assessment process by participating in the two workshops, the activities of which are discussed in Sections 3, 4, and 5 of this report.

Many of the previous CERAs that were conducted using the Guidebook (Aurand *et al.*, 2000) were reviewed as background for this project.

2.2 Consultation Process

In accordance with USCG HQ guidance on Section 7 consultations (Gelzer, 2013) pursuant to ESA[3] Section 7(a)(1)[4] and EFH under MSA[5], this risk assessment project served as a collaborative pre-spill planning activity among the USCG, USFWS, the state resource trustee agencies, and NOAA/National Marine Fisheries Service with the intent to develop Best Management Practices (BMPs) strategies that would mitigate, minimize, or have no adverse effect on federally-listed T/E species and their habitats that may be present in any of the ERA's scenarios.

Additionally, this CERA considered the USCG's role pursuant to the National Historic Preservation Act of 1996 (NHPA) Section 106 consultation for cultural resources (as defined), for Area and Regional Planning under the 1997 Programmatic Agreement that directs federal

[3] 16 U.S.C. 1531-1544, 87 Stat. 884
[4] http://www.fws.gov/endangered/laws-policies/section-7.html
[5] http://www.habitat.noaa.gov/aboutus/statutoryauthorities.html

agencies to comply with Section 106 for emergency response actions under the NCP. However, tribal consultations as required on Executive Order 13175 and the Native American Graves Protection and Repatriation Act (NAGPRA) were not addressed during this risk assessment. Instead, this need should be brought forward in the future to the area and regional planning bodies in Regions 2 and 3.

This ERA assesses preliminarily the potential for adverse effects should BMPs identified for ESA, EFH, or NHPA be implemented. In the judgment of the Project Committee, this CERA meets the intent of Section 7.a.1 of ESA. Categories for these T/E species were developed early in the process and incorporated into the evaluation of resources at risk.

3.0 Methods

The Project Committee adopted the methods used in previous CERAs for oil spill response planning (Aurand, *et al.,* 2000; Pond, *et al.,* 2000) which consisted of 12 activities that were conducted over four phases. Participants carried out the methods for this project as shown in Figure 3.1. Phases 1 and 4 were carried out by the Project Committee. Phases 2 and 3 were carried out by all participants in two workshops, which were held at the Delaware County Emergency Services Training Center near the Philadelphia International Airport in Sharon Hill, PA. Appendix B contains the agendas for the two workshops.

Phase 1: Problem Definition/Formulation

(Project Committee, pre-workshop teleconference/meetings: Feb. 13, Mar. 3, and April 15, 2015)

1. Assemble the Project Committee
2. Develop the scenario(s)
3. Estimate the transport, fate of oil, and exposure potential
4. Define response actions for consideration
5. Define resources of concern

Phase 2: Conceptual Model/Analysis Plan

(All participants, 1st workshop: June 9-10, 2015)

6. Consider important relationships
7. Thresholds of sensitivity to oil

Phase 3: Analysis and Risk Characterization

(All participants, 2nd workshop: June 23-23, 2015)

8. Determine levels of concern about effects
9. Evaluate relative risk for oil only vs. various response actions
10. Define limits of the analysis

Phase 4. Document and Apply

(Project Committee, post-workshop meeting: July 15, 2015)

11. Document the risk assessment
12. Apply the results in response planning

Figure 3.1. Sector DelBay CERA Process, 2015

The following modifications relative to the organization of previous ERAs were made to address the objectives of this project:

- This project was characterized by substantial and continuous engagement by members of the Project Committee that was needed to achieve the ambitious project objectives.
- In contrast to previous ERAs that involved one crude oil and two scenarios, this ERA evaluated two crude oils in five scenarios: Bakken (3 scenarios) and dilbit (2 scenarios).
- The five scenarios were defined for potential spills of different oils, in different seasons, and in different environments, i.e., freshwater, brackish, and salt water.
- Due to this complexity and the large number of participants, each workgroup evaluated and reached consensus among the workgroup participants regarding the potential risks of response actions for a specific scenario. This is a different approach than previous ERAs,

i.e., multiple workgroups evaluated the same scenario and a consensus among workgroups was reached.

- A new set of 10 categories of response actions was developed compared to the 3-4 considered in previous ERAs.
- Recent studies and other materials were compiled by the consultant team. These references were made available electronically to the Project Committee and workshops participants for their review through SRA's SharePoint. The list of these references is presented in Appendix C, Bibliography.
- Because these two crude oil types have the potential for significant flammability and other hazards when released in a transportation scenario, human health risks were considered in addition to ecological risks. Due to the flammability of these oils, fire fighters participated in this CERA and the ecological hazards associated with firefighting foam were evaluated in addition to traditional spill response actions, e.g., booms and shoreline cleanup.
- Due to the properties of these oils and the transportation routes considered (i.e., rail and marine intercoastal), a new set of response actions used in this CERA was developed.
- The resources at risk (RAR) included new socio-economic categories and freshwater, brackish water, and marine environments in the table.
- Presentations were added to the workshops to inform participants with leading edge information about these oils. Dr. Michel Boufadel of the New Jersey Institute of Technology, who is a National Academy of Sciences scholar appointed to the current study on "Effects of Diluted Bitumen on the Environment: A Comparative Study", gave a presentation on fate of these oils. Three presentations by industry representatives involved in crude oil transportation by rail as well as industry preparedness and response actions, including a Crude Oil by Rail Response Safety training course. This course, intended for safety staff and emergency responders, is available at http://www.api.org/oil-and-natural-gas-overview/transporting-oil-and-natural-gas/rail-transportation/crude-oil-by-rail-response-safety-course .
- This CERA considered the potential risk of response actions on federal and state listed T/E species in the vicinity of the five scenarios.
- Four subcommittees developed sets of essential background information that was presented and used in both workshops. The subcommittees and their leads were:
    - Oil Behavior, Transport, and Fate – Ed Levine and Frank Csulak (NOAA ERD)
    - Resources of Concern – Ben Anderson (DNREC) and Debra Scholz (SEA)
    - Effects – Clay Stern (USFWS)
    - Response Actions – Rich Gaudiosi (DBRC)
- The risk ranking matrix previously used to define thresholds of sensitivity to oil was modified to define the y-axis as a scale of the relative ecological impacts rather than estimation of the percent of resources impacted; new definitions of ecological severity were developed.
- Previous ERA projects had at least two workgroups separately evaluate the same scenarios, and then developed final consensus. The workgroups in this project each worked on separate scenarios. Consensus was reached within workgroups but not across workgroups about the relative risks of oil and response actions associated with the five scenarios.
- Workshop participants were asked to provide feedback on this process, both at the workshop and through an on-line survey.

3.1 Geographic Area of Concern

The geographic areas of concern for this CERA were the transportation routes of Bakken and dilbit oils in the Sector Delaware Bay AOR. These routes included barge and tanker marine transportation in the Delaware River and Delaware Bay, and 32 railroad crossings over creeks and rivers in the AOR. Sector DelBay identified 32 rail/water nexus areas in three states (Pennsylvania, Delaware, and New Jersey) and two federal regions (Regions II and III). From these 32 nexus areas, the Project Committee selected different environments (creek, river, and bay) through which Bakken and dilbit oils were transported by rail, barge, or tanker as being generally representative of the nexus areas. These locations served as the setting for the five scenarios identified for this CERA.

3.2 Scenarios

Following an initial kickoff teleconference on February 13, 2015, the Project Committee met on March 3, 2015 at Sector DelBay and identified five scenarios involving the two crude oil types that represented a range of situations in the AOR. The selected scenarios were located (Figure 3.2) in three different states (Pennsylvania, Delaware, and New Jersey) in two different federal regions, for urban and more rural environments, and two different seasons (winter and spring) to address the potential seasonal differences in response actions and sensitivity of RAR.

The spill scenarios were defined based on past incident history in the Port, potential impacts to natural resources, historical response actions, response assets within the Port, and the response strategies contained in the Sector Delaware Bay ACP (2012). Each of the scenarios is defined in Section 5.

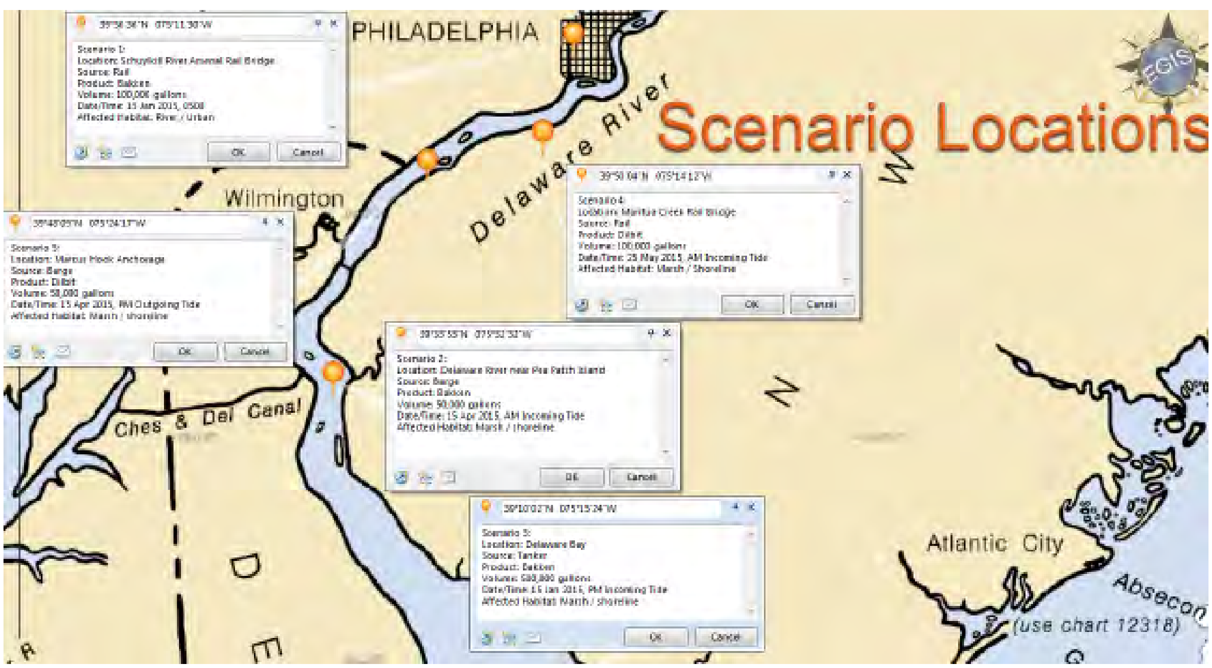

Figure 3.2: Scenario Locations

Separate workgroups (consisting of Project Committee members and workshop participants) were organized to evaluate the risks of response actions for each scenario. Project Committee members, some of whom participated in the CERA previously conducted for Delaware Bay (Aurand and Coelho, 2006), were assigned to coach the workgroup participants in carrying out their assessment activities during both workshops. Recorders also were assigned to capture the discussion, assumptions, and results of the workgroups. The workgroup coaches and recorders were:

1. LCDR Weaver/A.H. Walker: Scenario 1 – Bakken Rail (Philadelphia, Schuylkill River - PA)
2. Rich Gaudiosi/Rebecca Weissman: Scenario 2 – Bakken Barge (Pea Patch Island, Delaware River - DE)
3. Debbie Scholz/Dave Pugh: Scenario 3 - Bakken Tanker (lower Delaware Bay - DE)
4. Clay Stern/Melinda McPeek: Scenario 4 – Dilbit Rail (Mantua Creek, NJ)
5. Ben Anderson/Stacey Burger: Scenario 5 – Dilbit Barge (Marcus Hook anchorage, Delaware River - PA)

The following sections describe the sets of RAR and response actions evaluated in all five scenarios. In most of the previous ERAs, a single conceptual model and modeling could be discussed in one section because the main variable of comparing ecological risk was the volume of oil spilled, e.g., large vs. smaller spill. However, in this project, the scenarios are so different from one another that separate models were run for each scenario and separate, scenario-specific conceptual models also were developed.

3.3 Resources at Risk

The Project Committee developed the following list of resources of concern and at risk in the five scenarios, grouped according to habitat, sub-habitat, and resource categories.

Habitats:

- Artificial shorelines
- Natural terrestrial shorelines
- Intertidal shorelines (including surface waters 0-1 meter)
- Mid-water (0-2 meters above the bottom)
- Benthic (bottom + 2 meters)

Sub-habitat:

- Bulkheads, riprap, manmade structures, pavement
- Vegetated, sand, gravel
- Marsh, swamp, tidal flats
- Water column
- Seabed
- Socio-economic resources
- Human health receptors

Categories of Ecological Resources of Concern:

- Mammals (aquatic and non-aquatic dependent)
- Birds (aquatic and non-aquatic dependent)
- Reptiles and amphibians (aquatic and non-aquatic dependent)
- Macro-invertebrates
- Aquatic vertebrates
- T/E species – Animals
- T/E species – Plants
- Plants (submerged and floating aquatic vegetation)
- Fishing (commercial and recreational)
- Water intakes (surface and mid-water)

Categories of Socio-economic Resources of Concern:

- Workers
- Residential community
- Sensitive receptors
- Commercial community
- Industrial community
- Transportation community

A draft RAR table was presented at the first workshop, discussed and accepted with some specific examples appropriate for each scenario. For example, the examples of RAR in the urban, river environment of Scenario 1 (Philadelphia, PA) are different than the specific examples for a creek in an industrial area (Mantua Creek, NJ). The actual RAR associated with each scenario varied given the seasonal differences in scenarios (winter vs. spring), e.g., diamondback terrapins hibernate during winter and are at less risk from some response actions than other times of year.

The final consolidated RAR table for all five scenarios is presented in Appendix D. This table presents examples of plants and animals that could be present in any season and life stage, rather than limited to only those that are present on the dates of the scenario. Examples of both federal and state T/E species are included. The habitats for the scenarios spanned freshwater (Scenarios 1 and 4), brackish water (Scenarios 2 and 3), and saltwater environments (Scenario 5).

The presence or potential presence of different protected species, i.e., federally and state listed threatened and endangered plants and animals, also varied somewhat among scenarios. Although omitted from the endangered species list of examples in this ERA, seals, beluga whales, and manatees (protected under the Marine Mammal Protection Act of 1972) have occasionally been sighted in the AOR. For example, manatees were sighted in NJ in 2009 and again in the Delaware River north of Philadelphia in 2015 (Philly.com, 2015).

3.4 Response Actions

In pre-workshop meetings on March 3, 2015 and April 14, 2015, the Project Committee reviewed recent literature and spill reports about Bakken and dilbit oils, including oils that have similar properties, and then the Committee compiled a detailed list of potential actions that could be appropriate to implement during response to these oils. Due to the already ambitious project objectives, the Committee decided to omit Subpart J[6] response options from consideration for this ERA. This overall list was then categorized to better align with the response categories of previous ERAs and to facilitate evaluating their risks. These general categories provided a common framework for the workgroups since specific response actions could vary among the five scenarios, e.g., some on land, some on water, and presence or absence of ice.

The following categories of actions were used in assessing the risks associated with responding to Bakken and dilbit oil spills in the five transportation-related scenarios:

1. No response action – Natural attenuation of oil with monitoring
2. Fire – Let burn and controlled burn (both in-situ)
3. Fire – Extinguishing agent and methods
4. No Fire – Vapor suppression
5. No Fire – Oil spread control, on land, on water, and underwater
6. No Fire – On-water recovery and underwater recovery
7. No Fire – Resource protection, on water and on land
8. No Fire – Shoreline cleanup
9. No Fire – Oil detection/mapping (physical contact methods)
10. No Fire - Oil detection/mapping (remotely observed methods)

Appendix E presents the final set of response actions in a table used by workshop participants to characterize the risks of response actions in the five scenarios. The table defines the response actions, provides examples of them along with their associated logistical considerations, and summarizes their respective constraints and estimated, generalized levels of effectiveness in identified habitats.

The list of response actions takes into account that response to these crude oils involves two phases: the initial flammability phase when light ends of the oils are present and fires could occur, during which the deployment of traditional spill response options would be pre-empted by first responder (fire fighter) actions; and a second, longer-term phase of responding to the oil on-water. Fires have resulted following recent incidents involving Bakken oil, which has been known to re-ignite. Flammability is also a concern with freshly-spilled dilbit oil. These acute public safety concerns take precedence over pollution response. The time scales associated with the phases are not absolute; rather they represent a range of hours and days that generally align with important weathering and behavior changes that would influence decisions about response actions. For purposes of this ERA, ***Phase 1 covers approximately the initial 4-6 hours***; long enough for pollution responders to become actively engaged after first responders (e.g., fire fighters) have arrived on scene and probably would still be dealing with flammability risks. ***Phase 2 includes the time after the initial 6 hours***, ***but focuses specifically on the timeframe when the oil behavior on the water could begin to change and requires different response strategies***, which participants estimated to be ***about 4-7 days into the spill***.

For both of these crude oils, oil recovery is difficult in the second phase. Bakken oil is a light crude oil. Following rapid evaporation of light ends, the remaining components naturally disperse into the water column, making recovery from the water generally impractical. Dilbit oil, on the other hand, comprises heavy oil tar sands mixed with diluents to facilitate its

[6] http://www2.epa.gov/emergency-response/national-contingency-plan-ncp-subpart-j-product-schedule-fact-sheet

transportation. When initially spilled, the diluents begin to separate. After a few days, residual heavier components may be exposed to sediments in the water column, no longer float, and then become difficult to track and recover.

Although (intentional) controlled burning *in situ* was discussed and left as an option, there is no fire boom available in port. If burning became a preferred option in Delaware Bay, fire boom would have to be brought in and the logistics and approval would likely preclude its implementation. Also, air quality becomes an issue with burning Bakken oil, e.g., concerns about breathing in the toxins that are in the resultant smoke plume.

The DBRC recently formed an industrial fire group to share fire resources among member companies. The Fire Chief from Sunoco Logistics presented information on fire-fighting foam in the port to participants in the June 9-10 workshop. The highlights from this presentation include:

1. The use of foam to manage flammability hazards and fires was the subject of considerable discussion. Using enough foam to blanket vapors and extinguish fire is a fire safety goal, but applying enough foam to prevent re-flashing is almost next to impossible. Bakken is very likely to re-ignite.
2. There were also questions regarding the expiration dates of stockpiled foams. The expiration dates for most foams are about 20-25 yrs. from the date of manufacture when properly stored. The foam should be tested regularly, with annual testing being ideal.
3. Foam purchased from the manufacturer is actually in concentrate form. It must be mixed with water and air to become a foam solution. It is not foam that extinguishes fires—it is the water component and access to abundant source of water is needed to put out a fire. In the marine environment, responders have access to plenty of water, but they may lack access to the necessary platform and hoses, which is also essential.

Spills and fires outside of the normal realm, i.e., along a transportation route, are problematic for industry to provide assistance. Coordinating the logistics to mobilize the necessary resources to the response (oil spill or fire) and set up when a fire occurs off-site, outside a facility where the foam is stored, takes time. The challenge is getting the water, tools, and foam to a fire on a barge or tanker away from a dock in time to reduce fire hazards. This resource/logistical coordination is also time consuming for a rail car incident, since these incidents rarely occur in geographically convenient locations relative to where foam is stored. Certain foams require specific nozzle equipment that further complicates response logistics. It should be noted that in many fire-fighting scenarios, the approval for using fire-fighting foam is contingent upon the containment and disposal of fire-fighting wastes (foam and water). This would be a challenging requirement in a marine environment.

The runoff from fire-fighting foam if applied in the five scenarios could present both human health and ecological risks. Older-generation foams contain Perfluorochemicals (PFCs), which have been commonly used to improve the ability of fire-fighting foam to smother fire. The EPA is phasing out the use of PFCs, as its use can result in a water quality issue and it can also be dangerous to aquatic life and human health. In particular PFOS (perfluorooctane sulfonate) and PFOA (perfluorooctanoic acid) are two commonly used PFCs that are known to enter ecosystems and move up food chains, accumulating in animal and human tissue, including the liver and blood.[7] PFCs have been linked to bladder and liver cancer, endocrine disruption, and

[7] http://www.crccare.com/case-study/fighting-fire-fighting-foam

developmental and reproductive toxicity, including neonatal mortality and are potentially lethal to animals.[8] PFOS and PFOA are increasingly being phased out of modern foams. Additionally, all fire-fighting foams (including the modern foams that do not contain PFCs) may cause a decrease in water oxygen content that can have a negative effect on water quality and aquatic ecology. It appears from reviewing the foam Material Safety Data Sheet (MSDS)[9] (Appendix F) that PFOA and PFOS are not present in these three foams. However, it is unknown if these are the only foams stored in the port area. Two of the three foams reviewed did contain fluorinated surfactants at low levels. Evidence for shorter-chain fluorinated compounds behavior in the environment is limited, and further research is needed as production of other fluorinated compounds increases as an alternative to PFOA and PFOS in fire-fighting foams (Scheringer et al., 2014). While research has generally shown that shorter chain fluorinated compounds are less toxic and less bio-accumulative, some research has shown that some shorter-chain fluorinated compounds can biodegrade into persistent organic compounds (Scheringer et al., 2014; Queensland Incident Response Unit, 2014).

3.5 Conceptual Models

The workshop participants reviewed the conceptual model presented in matrix format that was prepared for the San Francisco Bay workshop (Pond *et al.*, 2000) and used in previous ERAs. Participants updated and expanded the definitions of potential hazards to align better with the five scenarios.

The definitions of hazards used in completing the conceptual models for each of the scenarios are:

1. Air pollution – vapors, direct effects from respiratory issues for air breathers. Therefore, air pollution is not a stressor for mid-water, benthos.
2. Aqueous exposure – direct effects from aquatic respiration and dermal exposure to oil and oil components dissolved within the water column; may be short-lived exposure with the potential for high consequence for impacted species. Excludes submerged oil globules.
3. Physical trauma (mechanical impact from equipment, aircraft, people, boats, etc.) – direct effects from physical impact on individual species, including disturbance.
4. Oiling/smothering – direct effects from dermal contact with oil; skin (hypothermia), mucosal membranes (eyes, nares, etc.); indirect effects or secondary impacts could include ingestion (preening). May include contact with submerged oil globules or mats.
5. Thermal (heat exposure from fire) – direct effects from oil burning; impacts from exposure to a fire/burn (not dermal exposure to the oil).
6. Waste – direct effects prior to being removed (pre-cleaning) from the system. Excludes equipment intended for re-use, e.g., non-sorbent boom.

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[8] Betts, KS (2007). 'Perfluoroalkyl acids: what is the evidence telling us?', *Environmental Health Perspectives* vol. 115, iss. 5, pp. A250-256.

[9] The MSDS was part of OSHA's Hazard Communication Standard (HCS). However, the HCS has been revised by OSHA to align with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), GHS and one change is the renaming of MSDSs to simply safety data sheets, or SDSs. Since most of the data sheets used in the ERA still carry the MSDS label, they are referred to in the report as MSDS.

7. Ingestion (food web, etc.) – resources indirectly exposed to oil or its constituents via ingestion of oil or contaminated/affected prey.
8. Advisory/Closure – prohibited action of use (e.g., commercial or recreational fishery, water intake); protection from possible exposure.

Recognizing the distinctive oil behaviors of Bakken crude and dilbit oils, the conceptual models developed for these oils reflect the two phases of potential exposure pathways:

- B1 = Bakken on the water/soil surface (initially)
- B2 – Bakken within water column due to natural dispersion (later)
- D1 = Dilbit before weathering (initially)
- D2 = Dilbit after weathering (later)

The conceptual model developed for this CERA depicts the connections between the resources of concern (human health/socio-economic and ecological) and their potential to be exposed to hazards (exposure pathway) for five scenarios. The numbers in the cells (1-8) represent the path by which a hazard can affect a resource. The completed model for each scenario represents the record of the reasoning of each workgroup about the concern for that resource. ***NA*** represents the absence of a connection between a potential hazard and the resource of concern.

Appendix G contains the completed conceptual models for human health and safety (some but not all workgroups completed them) and five ecological models for different scenarios (all workgroups completed these separately).

3.6 Modeling Results

This CERA considered the properties, behavior, and hazards associated with both oil types from the initial release through approximately seven days. Modeling of the spilled oil on water was conducted for all five scenarios by NOAA. A smoke plume model (Interagency Modeling and Atmospheric Assessment Center) also was run for Scenario 1, since that scenario resulted in a fire almost immediately. This plume model provided information about the footprint of the smoke plume in relation to human health and socio-economic resources at risk. Additional models that can be run, but were not for this CERA, are those that estimate concentrations and size of flammable vapor cloud, including SAFER, CHARM, and ALOHA.

For the oil spilled into waterways, basic weathering information and an oil budget (amount spilled, evaporated, naturally dispersed, remaining) along with individual trajectory models were calculated for each of the five scenarios. The NOAA Emergency Response Division (ERD) Modeling Group used the basic information in the scenarios to develop a surface trajectory analysis using GNOME[10] (General NOAA Operational Modeling Environment) for the detailed risk assessment portion of the workshop. Basic weathering information was calculated using the ADIOS 2[11] program. The model was run to show extent of contamination from the start of the

[10] GNOME is the modeling tool that OR&R Emergency Response Division uses to predict the possible route, or trajectory, a pollutant might follow in or on a body of water, such as in an oil spill

[11] ADIOS (Automated Data Inquiry for Oil Spills) is NOAA's oil weathering model. It is an oil spill response tool that models how different types of oil weather (undergo physical and chemical changes) in the marine environment (http://response.restoration.noaa.gov/adios).

incident (zero hours) through about 4 days. The modeling results were used to characterize the risks associated with each of the scenarios, which is discussed in Section 5.

The weathering and modeling results, e.g., graphic plots, are presented in Appendix H. The information for each of the five scenarios includes: the ADIOS 2 weathering and oil budget tables up to 120 hours following the initial discharge, screenshots at different times (e.g., +1 hr., 5 hrs., 14 hrs., 18 hrs., 36 hrs., and 42 hrs.) from the GNOME trajectory model, and extent of oiling maps for the first four days of the incident. The screen shots were selected to illustrate noteworthy stages of oil movement for each scenario; they were not selected to be comparable across scenarios. With regard to oil weathering/behavior and pollution response actions, actionable oil will be in the environment approximately 4-7 days following the initial discharge. Between 12 and 48 hours, the oil budget tables indicate that 56 to 61% of the Bakken oil remains in the environment. For the dilbit scenarios, between 12 and 48 hours, 75 to 77% of the oil remains in the environment.

Evaporation of the light components of both oils occurs rapidly in the first 12 hours and during this time, flammable vapors and benzene would be a distinct health and safety concern for both oils. In particular, the flammable vapors and no-fire situation are potential barriers to implementing pollution control options due to their ignition hazard.

The time-weighted average limit (TWA) limit for benzene is 1 ppm over an 8-hour period; the short-term exposure limit (STEL) is 5 ppm for a 15-min period. Personal protective equipment (PPE) can be used to protect workers but large spills of these oils near public communities could require evacuation. Since evacuation is in the jurisdiction of local authorities, evacuation is not a response action available to the USCG and was omitted from this ERA.

3.7 Risk Ranking Matrix

The Effects Subcommittee lead reviewed the risk matrix from previous ERAs and proposed a modification that would improve its utility for characterizing threshold levels of concern for the impacts of Bakken and dilbit oils in the five scenarios. ***Risk*** is defined as the probability of an impact occurring; participants must qualitatively consider if there is a high, medium, or low probability of the impact occurring, and then determine the severity and the duration of the impact. The conceptual model is the first step in considering the risk of potential exposure of a resource to the spilled oil.

The Effects Subcommittee lead reminded participants that the risk characterization of a CERA is qualitative, not quantitative, in nature. Quantitative risk assessments that focus on the actual injury to the environment (habitats and organisms) are carried out following an oil spill through Natural Resource Damage Assessment (NRDA) activities. ***Injury*** is a legal term defined in the OPA 90 (Oil Pollution Act) regulations and under CERCLA. Injury is defined as a linkage between cause and effect beyond a reasonable doubt. When working during response, responders tend to consider and decide about impacts that are relatively short-term and based upon what was learned from previous response events, e.g., it is better to protect marshes to avoid having them oiled because of the longer-term severity and duration of oil impacts in those environments. The response community now recognizes that protecting marshes from oiling is a response best practice; this knowledge guides preparedness and response decisions, without a NRDA study.

The revised matrix enabled workshop participants to more readily assess potential risks using the best available information from literature (e.g., the references in Appendix C), past experience with oil spills in the area, e.g., the *M/V Athos* in 2004, and their knowledge of resources in the AOR. It also reorders the presentation of levels of concern from lowest (green on left side of the matrix) to highest (red on the right side).

The updated risk matrix is presented in Figure 3.3. Workshop participants approved this risk ranking matrix during the June 9-10, 2015 workshop.

		RECOVERY TIME			
		RAPID	MODERATE	MODERATE	SLOW
		< 1 year (4)	1 to 4 years (3)	5 to 10 years (2)	> 10 YEARS (1)
ECOLOGICAL SEVERITY	Discountable (D)	4D	3D	2D	1D
	Impaired (C)	4C	3C	2C	1C
	Significant (B)	4B	3B	2B	1B
	Dysfunctional (A)	4A	3A	2A	1A

Limited Level of Concern

Moderate Level of Concern

High Level of Concern

Figure 3.3 Levels of concerns risk matrix for the 2015 Sector DelBay assessment

The definitions of ecological severity used by participants in assessing risk in this CERA are:

- **Discountable** – Impact considered negligible, trivial, or a minor inconvenience, e.g., birds flew off nest but came back and landed.
- **Impaired** – Animal or community feels an impact; it may not be terribly significant or long-term, but it is an impact.
- **Significant** – Effects that are potentially life altering or may disrupt a breeding cycle; those that can affect community, e.g., all blooms knocked down, impacts reproductive cycle.
- **Dysfunctional** – Juveniles wiped out, habitat completely smothered, reproductive cycle severely impacted (not occurring/ceased); adults wiped out.

Workshop participants used this risk ranking matrix during the June 23-24, 2015 workshop to estimate the level and duration of ecological impact of the response actions compared to the impact of the spilled oil alone. Duration of impact begins from the time of the oil discharge. Severity takes into account the significance of individual organisms relative to the scale of population. For example, if an organism had recovery about 70% one year, but would take 10 years for 100% recovery, then the risk could be ranked as significant, in the 1- to 4-year duration. Local populations that could be killed by a spill would receive a dysfunctional score. Freshwater mussels, for example, if wiped out by oiling in a creek, will not recover for 50-100 years. This would equate to a risk of a dysfunctional impact. Generally, participants considered populations of organisms at the local scale, and assumed no impacts on a regional or national scale for that species.

For an endangered species, any harm qualifies as a ***take***[12] and is significant. As generally applied in this ERA, non T/E plants would recover in 4 to 5 years and non T/E fish would recover in 1 to 2 years. The ranking of red does not mean to stop actions, but rather to review and assure that response actions would not adversely affect the species of concern.

The ranking measures were also appropriate for characterizing human health risks. The impact from a drinking water ban would likely be considered *Dysfunctional* in severity; inhalation and dermal impacts might be ranked as *Significant*.

Participants used the information available to them to assign levels of concern about the risk. The information gathered for participant review before and between the workshops is presented in the Bibliography (Appendix C). As can be seen in the risk matrix, the groups used alphanumeric scores to scale the anticipated impact severity and recovery time. After developing the scaling, color coding was used to indicate the summary levels of concern. The risk scores represent a consensus on the part of the participants that such consequences were likely to occur under the scenario under consideration.

[12] ESA, Section 7, and Incidental Take of Endangered and Threatened Species in U.S. Lands or Waters. Being listed on the ESA makes it illegal to “take.” Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to do these things (50 CFR § 3(19), 2009) any of these protected species, whether endangered or threatened or adversely modify or destroy designated critical habitat under Section 9 – Prohibited Acts. NOTE: Under ESA, ‘take’ prohibitions under Section 9 are not automatic for threatened species; the USFWS and NMFS must conduct a Section 4 process to address threatened species.

4.0 Results

The summaries of the risk characterizations for each of the five scenarios are presented in Figures 4.1 (Bakken oil scenarios) and 4.2 (Dilbit oil scenarios). Scenarios 1-3 involved Bakken oil; Scenarios 4-5 involved dilbit oil. As noted earlier, unlike previous ERA where at least two workgroups separately evaluated the same scenarios and then developed final consensus, the workgroups in this project each worked on separate scenarios. That is, the findings presented here summarize the workgroup-specific consensus for Scenarios 1-5, rather than consensus of all workgroups about all scenarios. For the reader's convenience, a row that highlights the transportation setting (i.e., urban, creek, river or bay) of each of the scenarios has been added to the summary tables.

Both Bakken and dilbit oils are characterized with flammability hazards during the early stages of a spill. Some recent Bakken oil rail incidents have resulted in fires, e.g., in the town Lac-Megantic, Canada (2013), which resulted in 47 deaths from the burning oil when the train derailed while passing through the center of the town. The risks to human health and safety and social-economic resources from a fire as well as fire-fighting foam, as highlighted in Scenario 1, were scored as a moderate level of concern (yellow) assuming that safety measures were successful, e.g., PPE for workers and other protective measures for the public, such as safe distance from fire and shelter in place away from the smoke plume. For human health and safety, the levels of concern from the oil only and for other response actions were scored as low (green).

The presence of a red ranking (high level of concern) represents a need for follow-up action by the Area Committee and Regional Response Team to more fully address whether certain response actions will be allowed and if so, under what circumstances, e.g., in certain seasons or under specific conditions. The red ranking of highest relative risk is not intended to prevent or stop response actions, but rather to prompt further review and assure that response actions would not adversely affect the species of concern.

The gray cells scored "Not Applicable" refer to the absence of either the resource at risk in a scenario or the lack of pathway for exposure to the hazard presented by the oil or type of response action during Phase 1 or Phase 2. For example, in Scenario 3, which involves a spill of Bakken oil in the middle of the upper Delaware Bay in winter, during the first 4-6 hours, the risk to shorelines and benthos were scored as Not Applicable because the oil would not reach those environments in that time frame.

In this CERA, participants assigned higher levels of concern about the ecological risks associated with a spill of dilbit oil compared to a spill of Bakken crude oil.

4.1 Bakken Oil Response Actions

Scenario 1 occurs from a rail crossing within Philadelphia's urban setting; Scenario 2 involves a barge in the middle of the Delaware River near Pea Patch Island, an ecologically and culturally-sensitive resource; and Scenario 3 involves a tanker in the open water of upper Delaware Bay.

In general, the workshop participants from Scenarios 1, 2, and 3 found that the "No Response other than monitoring" option was considered of limited or moderate level of concern when deemed appropriate for the scenario conditions, both at the 4- to 6-hour response frame or at 4 to 7 days post discharge. In most cases, the participants found that there was very little change in concern levels when considering the various response action versus the "no response" action. Although some of the levels of concern did increase from low to moderate (green to yellow), this increase in concern did not require a change in response options. The highest level of concern in the urban, freshwater scenario (1), was with the use of extinguishing agents or for vapor suppression in the intertidal zone for both the initial response and over the 4- to 7-day response times.

Overall, the highest level of ecological concern (red) in these scenarios occurs from the risk of the use of fire-fighting foam as a fire extinguishing or vapor suppression agent to threatened/endangered species, which may be present in Scenario 1 intertidal shoreline. The use of foam in this area in both response phases increased the risk (yellow) over the presence of oil only (green).

In the initial 4-6 hours after a Bakken spill occurs in these scenarios, the response actions that ***positively change, i.e., decrease the risk (change a yellow to a green score)*** compared to the "no response other than monitoring" actions are:

- Scenario 1 – oil spread control, on-water recovery, resource protection, shoreline cleanup, and remotely observed oil detection/mapping in the mid-water habitat (Scenario 1)

In the initial 4-6 hours after a Bakken spill occurs in these scenarios, the response actions that ***negatively change, i.e., increase the risk (change a green to a yellow score)*** compared to oil only are:

- Scenario 1 – oil spread control, on-water recovery, resource protection, shoreline cleanup, and remotely observed oil detection/mapping in natural terrestrial shorelines.

In Scenarios 2 and 3, implementing response actions does not noticeably decrease ecological risks compared to the risk of oil alone.

After the oil has been in the environment for 4-7 days, much of the Bakken oil would have weathered, leaving a light residual oil staining on shorelines, including the intertidal portion of the shoreline, which could be below the water surface (surface water or mid-water column habitats @ 0 meters) during high tide.

After the oil has been in the environment for 4-7 days, the response actions that ***positively change, i.e., decrease the risk (change a yellow to a green score)*** compared to oil only is:

- Scenario 2 – implementing on-water oil recovery near intertidal shorelines.

After the oil has been in the environment for 4-7 days, the response actions that ***negatively change, i.e., increase the risk (change a green to a yellow score)*** compared to oil only are:

- Shoreline cleanup in artificial shorelines and natural terrestrial shorelines in Scenarios 1 and 2.

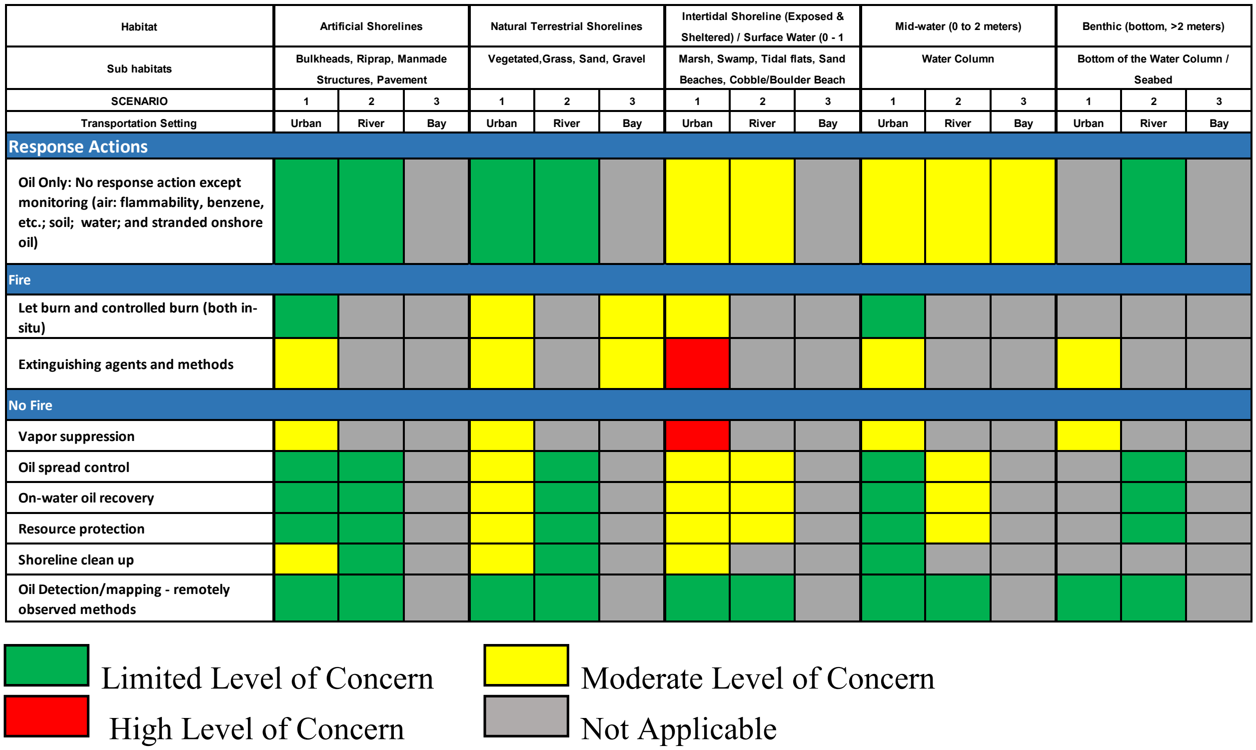

Figure 4.1a Summary Risk Characterization for the Bakken oil scenarios (Phase 1)

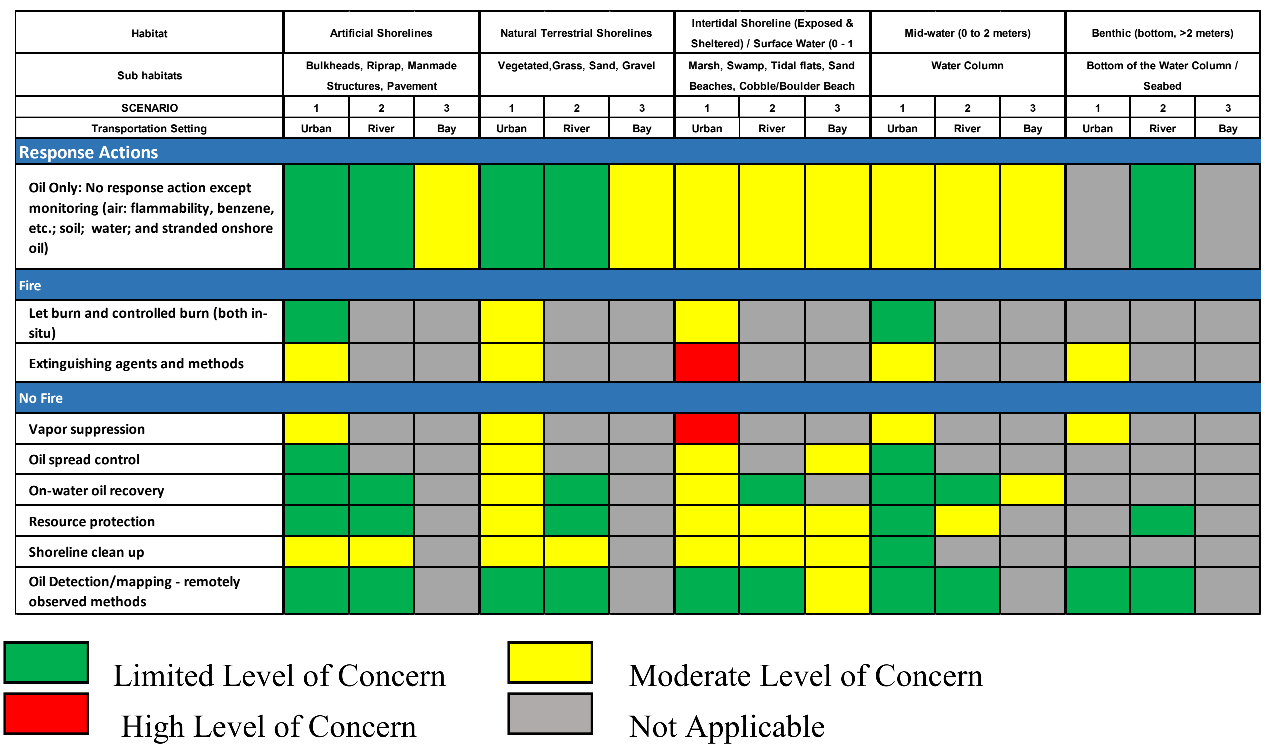

Figure 4.1b Summary Risk Characterization for the Bakken oil scenarios (Phase 2)

4.2 Dilbit Oil Response Actions

Scenario 4 occurs from a rail crossing over Mantua Creek in New Jersey; Scenario 5 involves a barge in the middle of the Delaware River near the Marcus Hook Anchorage. Generally, the ecological risks associated with spilled dilbit oil and the anticipated response actions for the two scenarios are either moderate or high level of concern, especially if T/E species are present in contaminated areas.

As with Bakken oil, the highest level of concern (red) in these scenarios occurs with threatened/endangered species, which may be present and could be impacted by the oil and/or response actions. In these scenarios, T/E species (e.g., Atlantic sturgeon to sea turtles to bald eagles) might be present and at risk in all environments except artificial shorelines.

In general, the workshop participants from Scenarios 4 and 5 found that the "No Response other than monitoring" option provided a moderate to high level of concern, both at the 4- to 6-hour response timeframe to 4 to 7 days post discharge. In most cases, the participants found that there was very little change in concern levels when considering the various response action versus the "no response" action. Some of the levels of concern did increase for response actions over the 4- to 6-hour timeframe to the 4- to 7-day period from low to moderate (green to yellow). The high level of concerns (red) were scored for scenario 5 regarding the use of most response options deemed applicable for use in the intertidal, mid-water, and benthic zones for both the initial response and over the 4- to 7-day response times. Similar concerns were also expressed for Scenario 4 when considering the risk of shoreline clean up and oil detection / mapping methods for the intertidal and midwater zones.

In the initial 4-6 hours after a dilbit spill occurs in these scenarios, the response actions that ***positively change, i.e., decrease the risk (change a yellow to a green score, or a red to a yellow score)*** compared to oil only are:

- Scenario 5 – oil spread control and on-water recovery in artificial shorelines and at the water's edge (0 meters of the mid-water habitat); and resource protection in intertidal shorelines

In the initial 4-6 hours after a dilbit spill occurs in these scenarios, ***no response actions negatively change, i.e., increase the risk (change a green to a yellow score, or a yellow to a red score)*** compared to the presence of the "no response" action only.

It is important to note that in some habitats, oil detection and mapping methods (if physically disturbing) were scored as a higher risk (red) than oil spread control, on-water recovery and resource protection to natural vegetated shorelines, intertidal shorelines, and mid-water habitats (yellow or green). Remotely observed methods would present a low (green) ecological risk. Participants recognized that available methods to detect and recover submerged dilbit oil are lacking in effectiveness.

Workgroup participants noted that on-water oil recovery in the earliest stage after release is the most important response action to prevent the oil from spreading out and expanding the extent of contamination, e.g., into the Delaware River, and contaminating larger shoreline and benthic habitats and organisms. This oil type will transform from a fairly light crude-like product to a heavy #6 product that will be tacky and adhesive. The oil will likely behave differently as it weathers in ambient conditions; it could behave as one type of weathered product and a different type a few hours later. This was the situation with the oil spill from the M/V Presidente Rivera in 1989, which required one set of tactics in the morning and a different set in the afternoon because the pour point of the oil was just above or below ambient air and water temperatures.

After the light ends of the diluent have flashed off, the residual product will be extremely tacky and will adhere to whatever it contacts. From an environmental standpoint, this is a significant challenge for onshore cleanup and wildlife rehabilitators to avoid if at all possible. It will take time to experiment (trial/error) with emerging ideas and techniques and develop new response/restoration best management tactics to manage dilbit releases.

After the oil has been in the environment for about 4-7 days, much of the dilbit oil would have weathered to the point that the diluent evaporated, leaving the heavier, persistent bitumen in the environment, available to pick up sediments and sink to the benthos.

After the oil has been in the environment for 4-7 days, the response action that ***positively changes, i.e., decreases the risk (change a yellow to a green score)*** compared to the remaining oil (NAM only) is:

- Scenario 4 – controlled in-situ burning in natural terrestrial shorelines, intertidal shorelines, and the water's edge of the mid-water habitat (0 meters).
- Scenario 4 - oil spread control, on-water recovery, resource protection, shoreline cleanup in natural terrestrial shorelines
- Scenario 5 – Resource protection in intertidal shorelines.
- Scenario 5 - oil spread control, on-water recovery the water's edge of the mid-water habitat (0 meters).

After the oil has been in the environment for 4-7 days, the response actions that ***negatively change, i.e., increase the risk (change a green to a yellow score)*** compared to oil only are:

- Scenario 5 - shoreline cleanup in artificial shorelines (increased risk to reptiles, amphibians, and macro-invertebrates).

Habitat	Artificial Shorelines		Natural Terrestrial Shorelines		Intertidal Shoreline (Exposed & Sheltered) / Surface Water		Mid-water (0 to 2 meters)		Benthic (bottom, >2 meters)	
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement		Vegetated, Grass, Sand, Gravel		Marsh, Swamp, Tidal Flats, Sand Beaches,		Water Column		Bottom of the Water Column / Seabed	
SCENARIO	4	5	4	5	4	5	4	5	4	5
Transportation Setting	Creek	River	Creek	River	Creek	River	Creek	River	Creek	River
Response Actions										
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	Moderate	Moderate	Moderate	Limited	Moderate	High	Moderate	High	Not Applicable	Moderate
Fire										
Let burn and controlled burn (both in-situ)	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Not Applicable	Not Applicable	Not Applicable
Extinguishing agents and methods	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Not Applicable	Not Applicable	Not Applicable
No Fire										
Vapor suppression	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Not Applicable	Not Applicable	Not Applicable
Oil spread control	Moderate	Limited	Moderate	Limited	Moderate	High	Moderate	Moderate	Not Applicable	Moderate
On-water oil recovery	Moderate	Limited	Moderate	Limited	Moderate	High	Moderate	Moderate	Not Applicable	Moderate
Resource protection	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Moderate	Moderate	High	Not Applicable	Moderate
Shoreline clean up	Moderate	Moderate	Moderate	Limited	Moderate	High	Moderate	High	Not Applicable	Moderate
Oil Detection/mapping - physical detection/remotely observed methods	Moderate	Moderate	Moderate	Limited	Moderate	High	Moderate	High	Not Applicable	Moderate

Limited Level of Concern
Moderate Level of Concern
High Level of Concern
Not Applicable

Figure 4.2a Summary Risk Characterization for the dilbit oil scenarios (Phase 1)

Habitat	Artificial Shorelines		Natural Terrestrial Shorelines		Intertidal Shoreline (Exposed & Sheltered) / Surface Water		Mid-water (0 to 2 meters)		Benthic (bottom, >2 meters)	
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement		Vegetated, Grass, Sand, Gravel		Marsh, Swamp, Tidal Flats, Sand Beaches, Cobble/Boulder Beach		Water Column		Bottom of the Water Column / Seabed	
SCENARIO	4	5	4	5	4	5	4	5	4	5
Transportation Setting	Creek	River	Creek	River	Creek	River	Creek	River	Creek	River
Response Actions										
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	Moderate	Moderate	High	Not Applicable	High	High	High	High	Not Applicable	High
Fire										
Let burn and controlled burn (both in-situ)	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Not Applicable	Not Applicable	Not Applicable
Extinguishing agents and methods	Unable to Determine	Not Applicable	Unable to Determine	Not Applicable	Unable to Determine	Not Applicable	Unable to Determine	Not Applicable	Not Applicable	Not Applicable
No Fire										
Vapor suppression	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Oil spread control	Moderate	Moderate	Moderate	Limited	Moderate	High	Moderate	Moderate	Not Applicable	High
On-water oil recovery	Moderate	Moderate	Moderate	Limited	Moderate	High	Moderate	Moderate	Not Applicable	High
Resource protection	Moderate	Not Applicable	Moderate	Not Applicable	Moderate	Moderate	Moderate	Not Applicable	Not Applicable	Not Applicable
Shoreline clean up	Moderate	High	Moderate	Limited	High	High	High	High	Not Applicable	High
Oil Detection/mapping - physical detection/remotely observed methods	Moderate	Not Applicable	High	Not Applicable	High	Not Applicable	High	Not Applicable	Not Applicable	Not Applicable

Limited Level of Concern
Moderate Level of Concern
High Level of Concern
Not Applicable
Unable to Determine Due to Insufficient Information

Figure 4.2b Summary Risk Characterization for the dilbit oil scenarios (Phase 2)

4.3 Additional Findings and Observations

- The high level of engagement by members of the Project Committee strengthened the consensus value of the outcomes.
- Participants recognize that the potential risks of the oils and response options could vary from the ERA findings during an actual spill, depending upon exact location in proximity to sensitive resources of concern and time of year.
- The summary tables presented in Table 4.1 and 4.2 might be viewed as "dashboard indicators", that is, metrics and key performance indicators for operational dashboards that are viewed as an effective means of alerting decision makers as to where they are in relationship to their objectives.
- When scored green, the response actions listed on the left side of the table represent the workshop participant recommendations.
- When spilled, Bakken and dilbit behave differently. Moreover, the behavior of dilbit oils can vary depending upon the type and percentage of added diluents. For Bakken oils, participants agreed that the primary initial strategy is to safely mitigate risks from flammable vapors. For dilbit oils, participants determined that it is imperative for containment and skimming operations to be implemented immediately to recover the oil before it spreads, weathers, begins to pick up any sediments in the water, and possibly would begin to sink. In a creek, the primary recovery strategy would be skimming before the oil can move into the river. However, in developing response strategies during the initial hours of a spill, responders must also consider health and safety hazards of the oils, i.e., evaporation of light ends, release of hydrogen sulfide gas, and flammability, especially with regard to the ignition sources, e.g., boat engines.
- Uncertainty exists around the use of fire-fighting foam.
- An important take away is the long duration of recovery for freshwater mussels in Scenario 4.
- In Scenario 2, it is best to keep the Bakken mid-river away from shorelines, but this would be problematic, given the flammability/ignition issues associated with boat engines and securing the source to limit the volume of the spill, stabilizing the vessel, and implementing containment near the source.
- Participants would like to know more about any studies conducted on the vapor density off-gassing.
- Participants noted the need to carry LELs on the OSRVs.
- Participants requested additional research/studies conducted on the vapor density, particularly how high above the surface the vapors were likely to be present, and noted the need to carry LELs on the OSRVs.
- Participants identified the need to have further study of the potential water column concentrations and toxicity of foam if applied in coastal (marine, estuarine) waters.
- Participants noted that R&D is needed to improve the ability to recover submerged dilbit oil, which is persistent, without damaging the habitats and organisms, especially those that have a long period of recovery, such as the freshwater mussels in Mantua Creek and T/E or rare species. Some of the recent R&D work by Dr. Boufadel, among others, is

increasing our understanding about dilbit behavior and fate, and may provide new insights for early response and potentially treatment to reduce its persistence.

- One gap in the assessment concerned Section 106 of NHPA, to involve State Historic Preservation Officer (SHPO) and HPA, and to look at tribes in the AOR and their preferences for consultation. Activities to address this gap are underway in the Region but were not resolved in time to incorporate in this ERA.
- Workgroup participants identified an information gap with regard to estimates of fish and bird populations in the area, which increased uncertainty around severity estimates.
- Participants using the NOAA ESI maps did not seem cover the full range of environmental resources at risk in all scenarios, e.g., freshwater mussel beds in vicinity of Mantua Creek. NOAA responded that east of Mantua creek there is a mapped a record of the NJ ST eastern pond mussel. It is important to recognize that NOAA focuses on state and federally-listed species, not necessarily all 'rare' species. In addition, NOAA is not always provided with data for all records or species for every state, rather the exact records are at the discretion of the data provider. Data for New Jersey was provided by NJDEP Endangered and Nongame Species Program in 2013.

4.4 Recommendations

The Project Committee evaluated oil spill response strategies identified during this process through literature review and informed by open dialogue among oil spill planners, managers, responders, and natural resource trustee agencies. The output of this risk assessment is intended to enhance existing oil spill area contingency planning. Participants looked at the net benefit of the response action to determine if it made the situation better or worse than the no active response other than natural attenuation and monitoring.

Since this CERA was adapted to address a broader scope than previous ERAs, participants were asked to provide feedback on the workshop process, following the second workshop. A summary of their comments is presented in Appendix I.

Participants made the following recommendations to Sector Delaware Bay, in no particular order:

- Begin working with port partner subject matter experts to apply these results to develop a set of BMPs to guide FOSC decision-making during preparedness and response for spills from these transportation scenarios, along the lines of the NOAA Shoreline Countermeasure Manual.
    - If possible, develop recommendations for a holistic "concept of operations" approach for dilbit oil spills. That is, a priority sequence of response actions to implement near the spill source. For example, focus on pre-spill planning to improve the effectiveness of oil containment and recovery in the early stages of a spill. The best option to minimize the ecological risk of this crude oil using current technology is to deliver containment and recovery equipment faster to the scene to limit the geographic spread of oil, and recover the majority of spilled oil, before weathering when the oil would submerge and become more difficult to detect and recover.
    - In the Scenario 4 workgroup, for example, the participants strongly believed that the key to reducing ecological risks would be to contain and recover the

oil almost immediately near the spill source, which they also recognized would be highly unlikely.
  - As appropriate, generic, key topic areas should be developed into best BMPs presented in tabular format or list and incorporated into the ACP. For example:
    - Protect sensitive shorelines
    - Booming: does not represent a concern unless actions drive oil into mudflats or if T&E species are impacted by deployment actions.
    - Removing oil residue from shore: does not represent a concern unless actions drive oil into mudflats or if equipment impacts T&E species.
    - On water skimming: does not represent a concern.
  - One option is translating the summary matrices into GRS, when to use these response actions (green), when not to use (red) and those that need more consideration (yellow).
- Before commencement of emergency response actions, threatened and endangered species require an informal consultation with services before it is assumed they are not present.
- Future ERAs should assess the potential risks and net environmental benefit of response actions that involve materials regulated by Subpart J of the National Oil and Hazardous Substances Pollution Contingency Plan, e.g., Imbiber Beads.
  - Also, explore the potential use of helicopter-deployed herder agents for Bakken spills in open water, similar to Scenario 3, and consider a test zone and window of opportunity.
- Future ERAs should consider the viability of developing a single conceptual model for these two types of crude oil. This project developed five that are slightly different from one another because there was inadequate time for five workgroups, 90 participants to reach consensus on a generic conceptual model in this ERA.
- It would be useful to conduct future ERAs on similar scenarios in temperate climates but with different seasons. For example, Scenario 4 would likely have had different outcomes if the same volume of oil had been discharged in spring and closer to Delaware.
- Participants would like EPA to consider investigating water column concentrations and dilution of foam in its testing of Bakken oils at OHMSETT in New Jersey.
- Participants recommended that issues on the use of foams and hazards associated should be added to the ACP, including:
  - Confirm whether or not fire-fighting foams containing PFCs are being stored in the area.
  - Assess the feasibility of logistical actions and coordination needed to enable the use of foam in mitigating risks from hazards during rail, barge, or tanker response.
  - Evaluate the approval/authorization issues for applying fire-fighting foam for crude oil incidents that threaten navigable waters. Do human health and safety priorities negate the need for RRT approval? If RRT approval will be necessary, define the preparedness actions to enable approval when needed.

5.0 Discussion

As noted earlier, participants reviewed and approved a revised risk matrix for use in this project (Figure 3.3). For each scenario, workgroup participants completed a conceptual model, and then reviewed information on the oils, their properties (Appendix C), MSDSs on three types of firefighting foam (Appendix F), weathering and trajectory modeling results Appendix I), ESI maps showing the location of RAR in relation to the projected extent of contamination, T/E species lists and map of water intakes from the ACP, other relevant information about seasonality and distribution, plus case studies and spill reports involving these or similar oils. Because of the differences among the scenarios, including the assumptions made for each, the summary results of the risk characterizations for the five scenarios are discussed separately. Participants generally conducted a conservative evaluation and recognized that these findings could be less conservative in an actual situation.

The conceptual models were used first to clarify the pathways of exposure and the types of hazards between the spilled oil and seasonally-present RAR. The risk matrix was first completed by each workgroup to characterize the risks to resources of concern from the oil only, i.e., no response action, except for natural attenuation and monitoring (NAM). Next, participants compared the potential risks of each category of response actions to the risks associated with the spilled oil left in place to attenuate, plus monitoring via sampling. During this comparison, participants were asked to determine:

1. If using a response action is likely to ***improve*** the outcome, the score is a **lower** alphanumerical value than oil only.
2. If using a response action is likely to ***worsen*** the outcome, the score is a **higher** alphanumerical value than oil only.

The aim of this characterization is to methodically identify optimal response actions, as well as opportunities for risk managers (i.e., USCG FOSCs) to modify response actions that could then improve the outcome. Stated another way, through this assessment the USCG could modify response actions to change a yellow level of concern to a green, and a red level of concern to a yellow or green.

Key properties summarized by NOAA for the two oils used in the scenarios are presented in Tables 5.1 and 5.2. The specific composition of these crude oils can vary when produced and transported. The example MSDS used for these oils were provided by a participant from ExxonMobil Biomedical Sciences, Inc.

5.1 Bakken Oil Properties

Bakken crude oil is a light crude oil with an API of 36 to 44. It has a low viscosity and will float on the water surface. It will quickly spread into thin slicks, with significant amounts of the lighter fractions lost via evaporation (which can result in serious explosion/fire and inhalation risks). Bakken crude contains moderate concentrations of toxic (soluble) compounds, thus can pose risks to aquatic resources. In addition, it will oil and penetrate into intertidal habitats, causing the potential for fouling of riverine habitats and long-term contamination of sediments.

Bakken Sweet Crude Oil
Light crude oil - API of 36 to 44
Low viscosity and will float on the water surface.
Quickly spreads into thin slicks on the water surface.
Significant amounts of the lighter fractions lost via evaporation; may result in explosion/fire and inhalation risks.
Contains moderate concentrations of toxic (soluble) compounds, may pose risks to aquatic resources.
May coat and penetrate into intertidal habitats, with potential fouling of riverine habitats and sediments.
Low viscosity and will float on the water surface.
Density (at 15 °C): 0.813
Viscosity: 2.18 cSt at 40 degrees C
Pour Point: -73°C (-99°F) - 48°C (118°F)

Table 5.1 Properties of Bakken Crude Oil

5.2 Dilbit Oil Properties

Diluted bitumen, or dilbit, is bitumen—a heavy oil that has been blended with, one or more, lighter petroleum products, such as condensate (the oil co-produced from a gas well) or a naphtha-based oil. Once released, dilbit will initially behave as a medium crude oil. However, it will rapidly lose the volatile fraction of the diluent through evaporation, leaving behind the viscous bitumen. The diluents have high percentages of toxic, water-soluble components, resulting in greater risks to water-column organisms compared to heavier oils. Acutely toxic impacts from the diluent could be relatively severe, but limited to a localized area. Depending on the density of the bitumen, the residue may float or sink; depending on the viscosity, pour point, and ambient temperatures, the oil will spread into slicks or congeal into tarballs and tarmats; depending on what the bitumen was blended with, dilbit oil can change properties over time. SCAT and Operations teams should be asked to observe and report any buried oil or sinking.

Diluted Bitumen = Dilbit (Kearl)
Bitumen blended with a diluent - one or more light petroleum products, such as condensate or a naphtha-based oil.
Once released, initially behaves as a medium crude oil.
Rapidly loses volatile fraction of diluent through evaporation, leaving behind the viscous bitumen, which behaves as a heavy crude oil that is persistent in the environment.
Diluents - high percentages of toxic, water-soluble components; greater risks to water-column organisms compared to heavier oils.
Acutely toxic impacts from the diluent could be relatively severe, but limited to a localized area.
Depending on the density of the bitumen, residue (after loss of light ends) may float or sink (smothering hazards) and be sticky and difficult to recover.
Depending on the viscosity, pour point, and ambient temperatures, oil may spread into slicks or congeal into tarballs and tarmats.

Diluted Bitumen = Dilbit (Kearl)
Depending on the blends, the residue may change properties over time; e.g., could become non-floating if sediments are present in the water, submerge, and rest on the benthos and/or be buried in sediments.
Density: 0.94
Viscosity: 83 cSt at 40 degrees C
Pour Point: <(33) degrees F (for whole crude oil, i.e., both bitumen and diluent)

Table 5.2 Properties of dilbit oil

Additional information provided by NOAA oil database, ADIOS 2, and spill experience[13], provided the participants with further knowledge on weathering of dilbit oil. In general, recent studies have determined that the dilbit components will weather (components can be found in surface, mid-water, or bottom waters) within the first 72 to 96 hours, and the lighter, more toxic diluent components (the lighter ends) fractions of the oil will undergo weathering through evaporation. The specific gravity of residual heavier components will begin to approach 1.0 and, especially in freshwater and/or waters with particulate matter, be more likely to sink. Consequently, the risks of the options to manage the spilled oil risks were assessed twice, for each of two phases of oil behavior:

- Initial spill of oil: initial 2-6 hours and potentially up through 2 days, which is the approximate duration when public safety actions would take precedence over pollution response actions, i.e., the flammability risks for both oils should have diminished. NOTE: Additional weathering of the oils will continue until the lighter components are removed; about 72 to 96 hours, perhaps longer depending upon the actual oil and ambient conditions, a large majority of the lighter components are expected to evaporate into the atmosphere (Bakken and dilbit) or mix into the upper water column (Bakken).
- Weathered oil: through the initial 7-8 days, i.e., the approximate time after the emergency phase during which oil could still be found on the water surface and recoverable using traditional pollution response techniques. Sometime during the latter end of this timeframe, the residual bitumen component of dilbit oil would likely begin to pick up sediment in the water column and sink below the water surface, either in the water column or settle on the bottom.

Participants noted that R&D is needed to improve the ability to find and recover submerged dilbit oil, which is persistent, without damaging to the habitats and organisms, especially those that have a long period of recovery, such as the freshwater mussels and T/E or rare species. R&D that is in progress may also provide insights about reducing its persistence in the environment. Interaction with other particles in the water column will likely result in oil particle aggregates (OPAs), which could cause the formation of droplets. There are two types of OPA droplets and

[13] The NOAA ADIOS database includes estimates of the physical properties of dilbit oils and products. Using this information, NOAA has incorporated a dilbit oil into the ADIOS 2 to predict *changes* in those properties once the oil has been released. The properties evaluated for dilbit oil include the density, viscosity, and water content of the product; as well as the rates at which it evaporates from the sea surface, disperses into the water column, and forms oil droplets that become emulsified, suspended, or sinks in the water.

they will either sink or rise to the surface. One has more sediment than oil; the other has more oil than sediments. Adhesion (stickiness) of the oil is an important characteristic. In the Delaware Bay, we expect more adhesion of oil to the sediments and particles in the Bay. If the oil readily forms droplets, this could reduce the potential for smothering by submerged oil mats and increase the rate of biodegradation of the oil.

Shared assumptions and observations identified by the participants include:

- The risk assessment matrices *generally* omit physical-contact oil detection methods because these methods would not be needed for Bakken oil, nor would they likely be implemented in the first seven days of a dilbit oil spill. While these response actions could be appropriate and potentially useful for dilbit oil spills, they would be implemented after the diluent components separated from the bitumen crude oil.
- Handling of waste is a potential pathway and that waste management will be correctly carried out; therefore, this risk is only a concern if waste BMPs are not followed. It is assumed that waste will drop out as a risk, but participants agreed they cannot disregard waste because there are cleanup options such as skimming with the possibility of approved decanting, and recanting, which could add contaminants back into the environment.
- The focus on the ERA was on wetlands, e.g., marshes that could be exposed to spilled or floating oil, rather than uplands. The three states value marsh grass species differently, e.g., NJ considers *Phragmites australis* worthy of protection while the other states consider it less important.
- Participants recognized that some areas considered upland (dry area) are within the scenario scope yet participants did not use a common definition of upland. Some places may be 10 miles from a water body but not considered upland (dry area).

5.3 Health and Safety Risk Characterization

The use of foam in on the spilled oil to suppress vapors and potentially extinguish fires was discussed by all workgroups. Three types of foam are stockpiled on facilities in the region: PKW, Thunderstorm FC-601A, and UNIVERSAL GOLD 1% / 3%. After reviewing their respective MSDSs, participants reached several conclusions:

1. In an urban environment, public safety concerns could require fire fighters to continuously apply foam to suppress vapors and prevent fires near people.
2. When spilled onto coastal waters, foam would not be a preferred pollution response action due to the potential for adverse impacts on marine and estuarine organisms and habitats and the inability to maintain a foam barrier between the spilled oil and the atmosphere.
3. Logistically, applying foam from industry stockpiles is a challenge if needed outside of the facility where it is stored.
4. Since public safety concerns could drive the application of foam regardless of concerns about ecological risks, and to more fully inform decision-making, participants identified the need to have further study of the potential water column concentrations and toxicity of foam if applied in coastal (marine, estuarine) waters.

Human health risks from flammable vapors and fires were also characterized by the workgroups for both oil types. The workgroups considered risks to both workers (first responders and pollution responders) and the general public. CTEH proposed groups of health-related socio-economic resources (workers, sensitive receptors (e.g., children, elderly, and sick), and potential communities in proximity to the incident) and drafted the initial conceptual model for human health and safety (HHS) using Scenario 1, because this spill location occurs in a densely populated, urban area. Figure 5.1 displays the characterization of Scenario 1 HHS risks, which are predominantly associated with flammability and benzene hazards when the oil is first spilled. There would be a slightly elevated risk to humans from just monitoring the vapors, but risk is still considered low and is denoted as a limited level of concern (green) due to the outdoor, transient nature of the flammability and inhalational exposures. If no fire occurred, implementing various response actions would present a lower risk to HHS than the fire, although these actions could result in slight risks, e.g., from vapors, to workers and people in the transportation community who could not shelter in place.

Participants characterized risks of monitoring only as resulting in some potential impairment to, with rapid recovery by, sensitive receptors (i.e., the sick, elderly, and children), nearby transportation and residential communities and as being overall, a low concern. If a fire occurred and response actions were to either let the oil burn or add extinguishing agents, the potential for impairment to human/socio-economic resources would increase over the risk of the oil alone; recovery from fire and foam/water damage or injury could take 1 to 4 years. Impacts could potentially arise from dermal exposure, and inhalational exposure to combustion byproducts of oil including PAHs and fire smoke, as well as the fire-fighting foam itself. Participants raised several questions about the use of foam but lacked the necessary information to resolve them.

Habitat	Human Health and Safety					
Sub habitats	Work Area (e.g., hot and warm zones), plus Public Health (Transportation, Industrial, Residential/Recreational Communities)					
Oil Type	B1	B1	B1	B1	B1	B1
Resources of concern (Socio-economic)	Workers	Residential Community	Sensitive Receptors	Commercial Community	Industrial Community	Transportation Community
Human health and safety receptors relevant to this ERA	First Responders (on water/on land), safety monitoring, oil recovery operations (on water/on land), oil contamination monitoring/SCAT	All - adults, adolescents; also children, elderly, sick (personal residences)	Children, Elderly, Sick (daycares, hospitals, nursing homes)	Adults (shops, general commercial facilities)	Adults (nearby refineries, plants, etc.)	Mostly Adults (rail, marine, roads: drivers, passengers)
Response Actions - Actionable Oil						
No response action except monitoring (air: flammability, Benzene, etc.; soil; water; and stranded onshore oil)	4D	4C	4C	4D	4D	4C
Fire						
Let burn and controlled burn (both in-situ)	3B	3C	3B	3C	3C	4C
Extinguishing agents and methods	3B	3C	3B	3C	3C	4C
No Fire						
Vapor suppression	4C	4D	4D	4D	4D	4C
Oil spread control	4C	4D	4D	4D	4D	4C
On-water oil recovery	4C	4D	4D	4D	4D	4C
Resource protection	4C	4D	4D	4D	4D	4C
Shoreline clean up	4C	4D	4D	4D	4D	4C
Oil detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4C

Figure 5.1 Risk Characterization: Human Health/Socio-economic Resources of Concern

The summaries of the workgroups' risk characterizations of the different response actions, in relation to the risk of oil only, associated with each of the five scenarios are discussed in the following sections. Detailed notes, including assumptions made by workgroup participants, were taken by recorders in each of the workgroups and were used to develop the discussion below.

5.4 Scenario 1 – Bakken Rail Incident, Philadelphia

Scenario 1 addressed an urban rail incident involving Bakken crude oil in the same location as an actual derailment that occurred January 20, 2014 (Figure 5.2). [NOTE: The incident occurred at the Arsenal Bridge located in the University City neighborhood of Philadelphia, PA on January 15, 2015, and resulted in damage to four railcars but no spillage of oil.] For this scenario, approximately 100,000 gallons of Bakken cargo released, half of which entered the Schuylkill River. The other half of the discharge spilled on land and caught fire in a highly-populated urban area near commercial and residential areas, sports centers, nursing homes, schools, and water intakes. At this time of year, ice is often present on the river, with snow onshore.

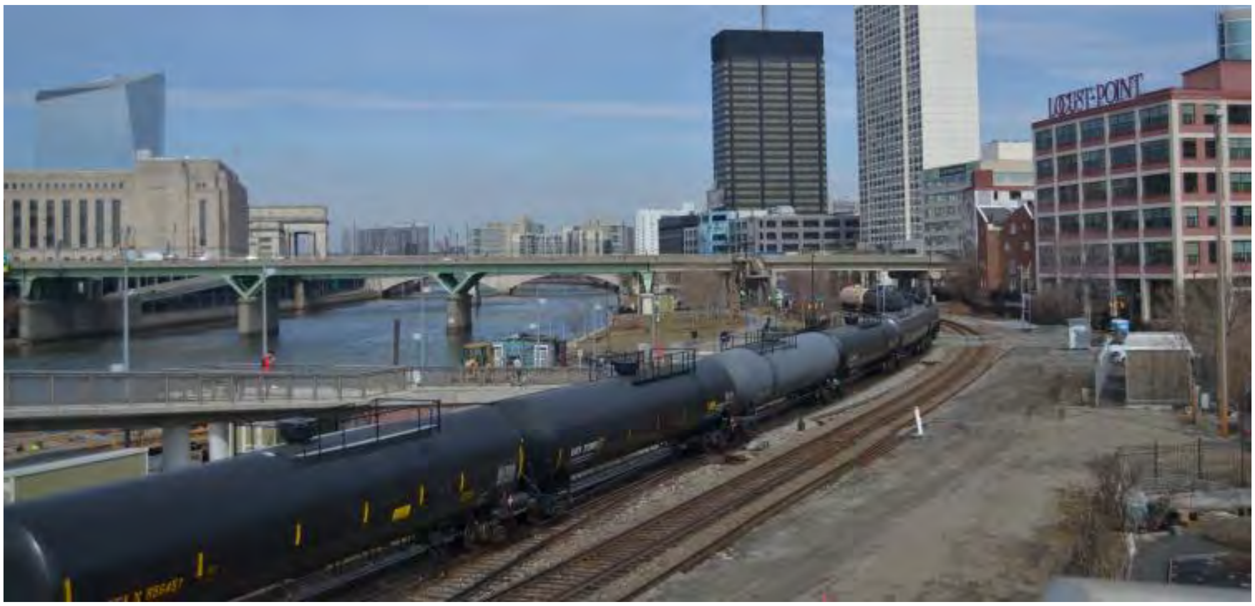

Figure 5.2 Crude oil by rail at the Arsenal Bridge in Philadelphia

(Photo Credit -http://planphilly.com/articles/2014/03/13/csx-testifies-on-derailment-25th-street-bridge)

For this scenario, Philadelphia Office of Emergency Management ran the Interagency Modeling and Atmospheric Assessment Center (IMAAC) plume model. Figure 5.3 shows the conditions and result of the model.

- Temperature 30.0 °F
- Wind-chill 25.2 °F
- Dew Point 21.0 °F
- Humidity 69%
- Pressure 30.17 in
- Visibility 10.0 mi
- Wind Direction NNW
- Wind Speed 4.6 mph

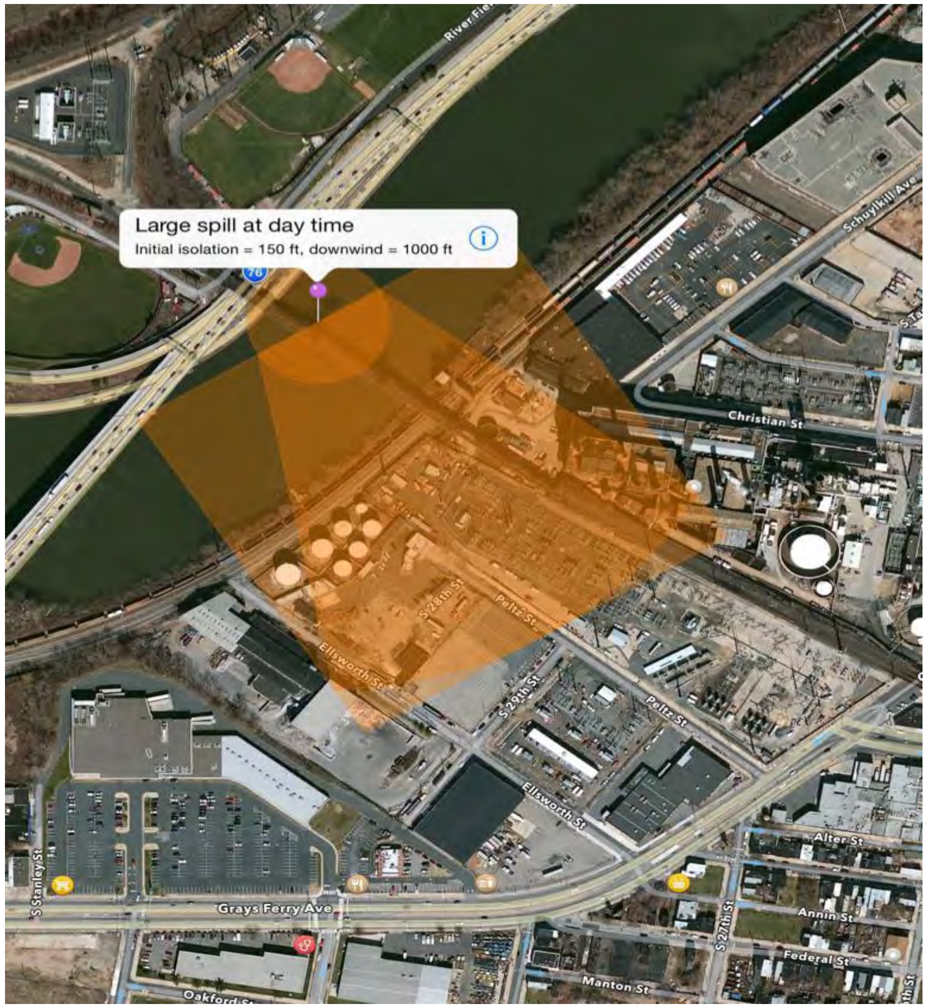

Figure 5.3 Smoke Plume model for Scenario 1

Participants reviewed the information contained in Appendix H:

- The weathering of the oil over time, in terms of amount that would evaporate and remain in the environment (shown in the oil budget table), and benzene concentrations, was calculated by NOAA's ADIOS 2.
- The oil spread predictions from trajectory model, including possible extent of contamination over 4 days, in relation to the ESI maps for the area.

The ADIOS 2 program shows that of the 50,000 gals of Bakken oil that did not burn, the oil that spilled into the Schuylkill River and on the adjacent shore would rapidly evaporate. ADIOS 2 estimated that the oil would move about 1.5 nautical mile (nm) in total within the Schuylkill River (0.7 nm upstream and 0.8 nm downstream) and provided an oil budget for the 50,000 gals that did not burn in this scenario (Table 5.3).

Time/Fate	Floating	Beached	Evaporated/Dispersed
After 24 Hours	9,400 gallons (18.8%)	23,000 gallons (46%)	17,600 (35.2%)
After 48 Hours	5,750 gallons (11.5%)	17,500 gallons (35%)	26,750 (53.5%)
After 72 Hours	3,900 gallons (7.8%)	14,350 gallons (28.7%)	31,750 (63.5%)
After 96 Hours	3,050 gallons (6.1%)	11,900 gallons (23.8%)	35,050 (70.1%)

Table 5.3 Oil budget for Scenario 1

The primary driver for the highest level of concern (red) is the potential presence of peregrine falcons, bald eagles, and osprey, which could be feeding (fishing) in the area of contamination. If a bald eagle or osprey was exposed to the oil, and was part of a mating pair, there would be a significant potential impact for a relatively long period of time.

Phase 1 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 1 (initial 6 hours) associated with no action other than monitoring plus all response actions for this scenario are shown in Figure 5.4.

As noted above, the driver for the highest level of concern was the potential presence of peregrine falcons, osprey, and bald eagles, which could be adversely impacted by the physical event, the oil, and the response activities taking place. The use of foam was also a concern on macro-invertebrates, such as freshwater mussels. Due to these concerns, the summary risk in intertidal shoreline with the use of foam was red.

Participants were also concerned about the use of foam to macroinvertebrates in waters 0-2 meters deep, as well as fishery closures. While a fishery might be closed to reduce the risk of oil tainting, closing the fishery would not necessarily reduce the risk from exposure to fire-fighting foam.

Participants had moderate level of concern regarding the potential impact of oil recovery and removal activities where oil stranded in the intertidal zone and surface waters where aquatic vegetation might be present. N/A was applied when the resources of concern listed in the matrix were not present in this scenario area.

Except for the flammability and foam concerns, a low level of concern was expressed about potential risk to other ecological resources of concern during the early hours of the incident.

Phase 2 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 2 (initial 7 days) associated with no action other than monitoring plus all response actions for this scenario are shown in Figure 5.5.

Given the rapid weathering of Bakken oil, January spill time, and the urbanized setting, the risks were characterized as the same as Phase 1.

Habitat: Artificial Shorelines — Sub habitats: Bulkheads, Riprap, Manmade Structures, Pavement

Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4D	3D	NA	4D	NA	2B	NA
Summary for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	4D	4D	NA	4D	NA	4C	NA
Summary for Sub-habitat							
Extinguishing agents and methods	4C	4C	NA	3C	NA	3C	NA
Summary for Sub-habitat							
No Fire							
Vapor suppression	4C	4C	NA	3C	NA	3C	NA
Summary for Sub-habitat							
Oil spread control	4D	3D	NA	4D	NA	2B	NA
Summary for Sub-habitat							
On-water oil recovery	4D	3D	NA	4D	NA	2B	NA
Summary for Sub-habitat							
Resource protection	4D	3D	NA	4D	NA	2B	NA
Summary for Sub-habitat							
Shoreline clean up	4C	4C	NA	3B	3B	3C	NA
Summary for Sub-habitat							
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat							

Habitat: Natural Terrestrial Shorelines — Sub habitats: Vegetated,Grass, Sand, Gravel

Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4D	3D	NA	4D	NA	2B	3C
Summary for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	4D	4D	NA	4D	NA	4C	3C
Summary for Sub-habitat							
Extinguishing agents and methods	4C	4C	NA	3C	NA	3C	3C
Summary for Sub-habitat							
No Fire							
Vapor suppression	4C	4C	NA	3C	NA	3C	3C
Summary for Sub-habitat							
Oil spread control	4D	3D	3C	4D	NA	2B	3C
Summary for Sub-habitat							
On-water oil recovery	4D	3D	3C	4D	NA	2B	3C
Summary for Sub-habitat							
Resource protection	4D	3D	3C	4D	NA	2B	3C
Summary for Sub-habitat							
Shoreline clean up	3B	3B	3B	3B	NA	2B	3C
Summary for Sub-habitat							
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat							

Habitat: Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter) — Sub habitats: Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach

Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species - Animals	T/E species - Plants	Plants	Fishing	Water Intake - Surface
Response Actions									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	3D	3C	3C	2B	3C	4D	4D	4C
Summary for Sub-habitat									
Fire									
Let burn and controlled burn (both in-situ)	4C	4D	NA	4D	4C	3C	NA	4D	4C
Summary for Sub-habitat					3C				
Extinguishing agents and methods	3C	3C	3C	2B	2B	3C	4D	2B	4C
Summary for Sub-habitat									
No Fire									
Vapor suppression	3C	3C	3C	2B	2B	3C	4D	2B	4C
Summary for Sub-habitat									
Oil spread control	3C	3C	3B	3B	2B	3B	4C	4C	4C
Summary for Sub-habitat									
On-water oil recovery	3C	3C	3B	3B	2B	3B	4C	4C	4C
Summary for Sub-habitat									
Resource protection	3C	3C	3B	3B	2B	3B	4C	4C	4C
Summary for Sub-habitat									
Shoreline clean up	3C	3C	3B	3B	2B	3B	4C	4C	4C
Summary for Sub-habitat									
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat									

Habitat: Mid-water (0 to 2 meters) — Sub habitats: Water Column

Resources of Concern	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions										
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Fire										
Let burn and controlled burn (both in-situ)	4D	4D	NA	4D	NA	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Extinguishing agents and methods	3C	3C	NA	3B	3B	NA	NA	NA	2B	4C
Summary for Sub-habitat										
No Fire										
Vapor suppression	3C	3C	NA	3B	3B	NA	NA	NA	2B	4C
Summary for Sub-habitat										
Oil spread control	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
On-water oil recovery	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Resource protection	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Shoreline clean up	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat										

Habitat: Benthic (bottom, >2 meters) — Sub habitats: Bottom of the Water Column / Seabed

Resources of Concern	Aquatic Vertebrates	Macro-invertebrates	Aquatic invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions								
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Fire								
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Extinguishing agents and methods	3B	2C	2C	NA	NA	NA	2C	4C
Summary for Sub-habitat								
No Fire								
Vapor suppression	3B	2C	2C	NA	NA	NA	2C	4C
Summary for Sub-habitat								
Oil spread control	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Resource protection	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat								

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

Limited Level of Concern — Moderate Level of Concern

High Level of Concern — Not Applicable

Figure 5.4 Scenario 1 Risk Characterization (Phase 1)

Habitat	Artificial Shorelines						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4D	3D	NA	4D	NA	B1	NA
Summary for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	4D	4D	NA	4D	NA	4C	NA
Summary for Sub-habitat							
Extinguishing agents and methods	4C	4C	NA	3C	NA	3C	NA
Summary for Sub-habitat							
No Fire							
Vapor suppression	4C	4C	NA	3C	NA	3C	NA
Summary for Sub-habitat							
Oil spread control	4D	3D	NA	4D	NA	2B	NA
Summary for Sub-habitat							
On-water oil recovery	4D	3D	NA	4D	NA	2B	NA
Summary for Sub-habitat							
Resource protection	4D	3D	NA	4D	NA	2B	NA
Summary for Sub-habitat							
Shoreline clean up	4C	4C	NA	3B	3B	3C	NA
Summary for Sub-habitat							
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat							

Habitat	Natural Terrestrial Shorelines						
Sub habitats	Vegetated,Grass, Sand, Gravel						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4D	3D	NA	4D	NA	2B	3C
Summary for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	4D	4D	NA	4D	NA	4C	3C
Summary for Sub-habitat							
Extinguishing agents and methods	4C	4C	NA	3C	NA	3C	3C
Summary for Sub-habitat							
No Fire							
Vapor suppression	4C	4C	NA	3C	NA	3C	3C
Summary for Sub-habitat							
Oil spread control	4D	3D	3C	4D	NA	2B	3C
Summary for Sub-habitat							
On-water oil recovery	4D	3D	3C	4D	NA	2B	3C
Summary for Sub-habitat							
Resource protection	4D	3D	3C	4D	NA	2B	3C
Summary for Sub-habitat							
Shoreline clean up	3B	3B	3B	3B	NA	2B	3C
Summary for Sub-habitat							
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat							

Habitat	Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)								
Sub habitats	Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach								
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species - Animals	T/E species - Plants	Plants	Fishing	Water Intake - Surface
Response Actions									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	3D	3C	3C	2B	3C	4D	4D	4C
Summary for Sub-habitat									
Fire									
Let burn and controlled burn (both in-situ)	4C	4D	NA	4D	4C	3C	NA	4D	4C
Summary for Sub-habitat					3C				
Extinguishing agents and methods	3C	3C	3C	2B	2B	3C	4D	2B	4C
Summary for Sub-habitat									
No Fire									
Vapor suppression	3C	3C	3C	2B	2B	3C	4D	2B	4C
Summary for Sub-habitat									
Oil spread control	3C	3C	3B	3B	2B	3B	4C	4C	4C
Summary for Sub-habitat									
On-water oil recovery	3C	3C	3B	3B	2B	3B	4C	4C	4C
Summary for Sub-habitat									
Resource protection	3C	3C	3B	3B	2B	3B	4C	4C	4C
Summary for Sub-habitat									
Shoreline clean up	3C	3C	3B	3B	2B	3B	4C	4C	4C
Summary for Sub-habitat									
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat									

Habitat	Mid-water (0 to 2 meters)									
Sub habitats	Water Column									
Resources of Concern	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-Invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions										
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Fire										
Let burn and controlled burn (both in-situ)	4D	4D	NA	4D	NA	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Extinguishing agents and methods	3C	3C	NA	3B	3B	NA	NA	NA	2B	4C
Summary for Sub-habitat										
No Fire										
Vapor suppression	3C	3C	NA	3B	3B	NA	NA	NA	2B	4C
Summary for Sub-habitat										
Oil spread control	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
On-water oil recovery	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Resource protection	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Shoreline clean up	4C	3D	NA	3C	4C	NA	NA	NA	4D	4C
Summary for Sub-habitat										
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat										

Habitat	Benthic (bottom, >2 meters)							
Sub habitats	Bottom of the Water Column / Seabed							
Resources of Concern	Aquatic Vertebrates	Macro-invertebrates	Aquatic invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions								
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Fire								
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Extinguishing agents and methods	3B	2C	2C	NA	NA	NA	2C	4C
Summary for Sub-habitat								
No Fire								
Vapor suppression	3B	2C	2C	NA	NA	NA	2C	4C
Summary for Sub-habitat								
Oil spread control	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Resource protection	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	4C
Summary for Sub-habitat								
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat								

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

Limited Level of Concern
Moderate Level of Concern
High Level of Concern
Not Applicable

Figure 5.5 Scenario 1 Risk Characterization (Phase 2)

5.5 Scenario 2 – Bakken Barge Incident, Delaware River

Scenario 2 was an incident involving a barge carrying Bakken crude oil. The 50,000-gallon spill occurred on the Delaware River at Eddystone, PA on April 15, 2015, an ecologically-sensitive time of year. The released cargo impacts Pea Patch Island, the largest heron rookery on the East Coast of the United States north of Florida.

Figure 5.6 shows one of the articulated tug and barges used to transport Bakken oil in the Delaware Bay.

*Figure 5.6 US Ship Co. barge, **Petrochem Producer**, used to transport Bakken oil.*

(Photo credit: Delaware Bay and River Cooperative)

Participants reviewed the information contained in Appendix H:

- The weathering of the oil over time, in terms of amount that would evaporate and remain in the environment (shown in the oil budget table), and benzene concentrations, were calculated by the ADIOS 2 program.
- The oil spread predictions from the trajectory model, including possible extent of contamination over four days, in relation to the ESI maps for the area.

Phase 1 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 1 (initial 6 hours) associated with no action other than monitoring plus all response actions for this scenario are presented in Figure 5.7.

Participants made the assumption that 25,000 gals floated on the river, that shorelines would be pre-cleaned to prevent the oiling of debris, and that there would be some oiling on adjacent shorelines, mostly in New Jersey. The oil spread on the river initially ranged from Wilmington, DE south of the C&D Canal to the Augustine Wildlife Area in Delaware. Fire was not part of this scenario and response actions for fire were NA but vapor hazards were a risk and considered.

Artificial and natural shorelines were assumed to be above the mean high tide mark and thus not oiled.

Shoreline cleanup of Bakken oil residue was not considered likely in intertidal shorelines during Phase 1, or in the water column, so these were also ranked NA. Participants expressed a moderate level of concern with the potential exposure of mammals, birds, reptiles/amphibians, and T/E animals and plants to Bakken oil onshore and in the upper water column. At this time of year, people could be fishing and participants considered whether the smell of oil would be a voluntary disincentive to stop fishing. Advisories would likely be issued but not shut down. Participants agreed that if people could smell oil, they could be exposed and should take precautionary efforts, and also recognized that state and local health departments would make public health determinations and issue advisories.

Participants assumed that vapor issues from Bakken to mammals and birds would impair them but should recover in less than one year. Amphibians receive higher risk rankings because both inhalation and absorption is higher through the skin.

Compared to oil only, implementing measures to control the spread of oil where T/E animals might be present in the intertidal zone decreased the risk from moderate to low; but this action also increased slightly the risk to T/E plants if they were in the pathway of the spilled oil. T/E plants in artificial shoreline received a 4D ranking because participants did not believe there were any in the area.

Phase 2 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 2 (initial 7 days) associated with no action other than monitoring plus all response actions for this scenario are presented in Figure 5.8.

In the Phase 2 timeframe, floating oil could be found in areas farther north from Trainer, PA and Logan Township, NJ but no further south than the Augustine Wildlife Area in Delaware.

Compared to the oil only, changes in potential risk were few and primarily related to the potential impact of shoreline cleanup activities to remove stranded oil, which would likely be light, e.g., bathtub ring. Shoreline cleanup in intertidal areas where T/E animals, e.g., osprey and bald eagles (recovered T/E species) might be present or hazed into oiled areas, was scored a high level of concern (red), and the level of concern increased from low (green) to moderate (yellow) for reptiles/amphibians that could be present on artificial and natural terrestrial shorelines. Potential risk also increased to moderate level of concern about the impact of shoreline cleanup activities in the intertidal zone on mammals, birds, reptiles/amphibians, and plants.

Habitat	Artificial Shorelines						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	4C	4B	4D	4C	NA	NA
Summary for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
No Fire							
Vapor suppression	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Oil spread control	4C	4C	4C	4C	4C	NA	4C
Summary for Sub-habitat							
On-water oil recovery	4D	4D	4C	4D	4D	NA	4D
Summary for Sub-habitat							
Resource protection	4D	4D	4C	4D	4D	NA	4D
Summary for Sub-habitat							
Shoreline clean up	4C	4C	4B	4D	4C	NA	4D
Summary for Sub-habitat							
Oil Detection/mapping - remotely observed methods	4C	4C	4B	4D	4C	NA	4D
Summary for Sub-habitat							

Habitat	Natural Terrestrial Shorelines						
Sub habitats	Vegetated,Grass, Sand, Gravel						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	4C	4B	4D	4D	4C	4D
Summary for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
No Fire							
Vapor suppression	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Oil spread control	4C	4C	4C	4C	4C	4C	4D
Summary for Sub-habitat							
On-water oil recovery	4D	4D	4C	4D	4D	4D	4D
Summary for Sub-habitat							
Resource protection	4D	4D	4C	4D	4D	4D	4D
Summary for Sub-habitat							
Shoreline clean up	4C	4C	4B	4D	4D	4C	4D
Summary for Sub-habitat							
Oil Detection/mapping - remotely observed methods	4C	4C	4B	4D	4D	4D	4D
Summary for Sub-habitat							

Habitat	Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)								
Sub habitats	Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach								
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species - Animals	T/E species - Plants	Plants	Fishing	Water Intake - Surface
Response Actions									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3B	3B	3B	3B	3B	4D	3C	4C	4C
Summary for Sub-habitat									
Fire									
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
No Fire									
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
Oil spread control	3C	3C	3C	3B	4D	3C	3C	4D	4D
Summary for Sub-habitat									
On-water oil recovery	3C	3C	3C	3B	4D	4D	3C	4D	4D
Summary for Sub-habitat									
Resource protection	3C	3C	3C	3B	4D	4D	3C	4D	4D
Summary for Sub-habitat									
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat									

Habitat	Mid-water (0 to 2 meters)									
Sub habitats	Water Column									
Resources of Concern	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions										
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3B	3B	3B	3B	4D	4D	4C	4D	4D	4C
Summary for Sub-habitat										
Fire										
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
No Fire										
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
Oil spread control	3B	3B	3B	3B	4D	4D	4C	4D	4D	4D
Summary for Sub-habitat										
On-water oil recovery	3B	3B	3B	3B	4D	4D	4C	4D	4D	4D
Summary for Sub-habitat										
Resource protection	3B	3B	3B	3B	4D	4D	4C	4D	4D	4D
Summary for Sub-habitat										
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat										

Habitat	Benthic (bottom, >2 meters)							
Sub habitats	Bottom of the Water Column / Seabed							
Resources of Concern	Aquatic Vertebrates	Macro-invertebrates	Aquatic invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions								
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4D	4D	4D	4D	4D	4D	4C	4C
Summary for Sub-habitat								
Fire								
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
No Fire								
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Oil spread control	4D	4D	4D	4D	4D	4D	4C	4C
Summary for Sub-habitat								
On-water oil recovery	4D	4D	4D	4D	4D	4D	4C	4C
Summary for Sub-habitat								
Resource protection	4D	4D	4D	4D	4D	4D	4C	4C
Summary for Sub-habitat								
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Oil Detection/mapping - remotely observed methods	4D	4D	4D	4D	4D	4D	4D	4D
Summary for Sub-habitat								

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

Limited Level of Concern	Moderate Level of Concern
High Level of Concern	Not Applicable

Figure 5.7 Scenario 2 Risk Characterization (Phase 1)

Habitat	Artificial Shorelines							Natural Terrestrial Shorelines							Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)									Mid-water (0 to 2 meters)										Benthic (bottom, >2 meters)							
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement							Vegetated,Grass, Sand, Gravel							Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach									Water Column										Bottom of the Water Column / Seabed							
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species - Animals	T/E species - Plants	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species - Animals	T/E species - Plants	Plants	Fishing	Water Intake - Surface	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater	Aquatic Vertebrates	Macro-invertebrates	Aquatic invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions																																									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	4C	4B	4D	4C	N/A	N/A	4C	4C	4B	4D	4D	4C	4D	3B	3B	3B	3B	3B	4D	3C	4C	4C	3B	3B	3B	3B	4D	4D	4C	4D	4D	4C	4D	4D	4D	4D	4D	4D	4C	4C
Summary for Sub-habitat																																									
Fire																																									
Let burn and controlled burn (both in-situ)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary for Sub-habitat																																									
Extinguishing agents and methods	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary for Sub-habitat																																									
No Fire																																									
Vapor suppression	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary for Sub-habitat																																									
Oil spread control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary for Sub-habitat																																									
On-water oil recovery	4D	4D	4D	4D	4D	N/A	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	3B	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary for Sub-habitat																																									
Resource protection	4D	4D	4C	4D	4D	N/A	4D	4D	4D	4C	4D	4D	4D	4D	3C	3C	3C	3B	3B	4D	3C	4D	4D	3B	3B	3B	3B	4D	4D	4C	4D	4D	4D	4D	4D	4D	4D	4D	4D	4C	4C
Summary for Sub-habitat																																									
Shoreline clean up	4C	4C	3C	4D	4C	N/A	N/A	4C	4C	3C	4D	4D	4C	4D	3B	3B	3B	3B	2B	4D	3C	4D	4D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary for Sub-habitat																																									
Oil Detection/mapping - remotely observed methods	4C	4C	4B	4D	4C	N/A	4D	4C	4C	4B	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	4D	4D	4D
Summary for Sub-habitat																																									

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

Limited Level of Concern

Moderate Level of Concern

High Level of Concern

Not Applicable

Figure 5.8 Scenario 2 Risk Characterization (Phase 2)

One potential gap in the assessment was a Section 106 consultation under the NHPA, which requires a review of proposed actions (i.e., response actions) with interested parties, e.g., federally-recognized tribes (there are none in NJ), and weighing of project alternatives to avoid or minimize damage to significant historic and cultural properties. Some ESI maps captured some archaeological sites.

5.6 Scenario 3 – Bakken Tanker Incident, Delaware Bay

Scenario 3 was an incident involving a tanker carrying Bakken crude oil. The incident, a 500,000-gallon discharge, occurs in the middle of the northern end of Delaware Bay (saltwater) on January 15, 2015. The resultant spill involves highly flammable vapors that limits response and navigation within the reaches of the oil, and could have greater impacts on the ecologically-diverse shorelines of three states (Pennsylvania, Delaware, and New Jersey) if it occurred in the other seasons.

Participants reviewed the information contained in Appendix H:

- The weathering of the oil over time, in terms of amount that would evaporate and remain in the environment (shown in the oil budget table), and benzene concentrations, was calculated by the ADIOS 2 program.
- The oil trajectory predictions include the possible extent of contamination over the first four days, in relation to the ESI maps and resources of concern for the area.

Trajectory models for this scenario were run with two different winds because initial models run with no winds present allowed the tidal action to dominate the movement and spread of oil, which resulted in no shoreline impacts taking place. This was considered improbable by the participants, so a second trajectory model run was requested using seasonally-prevailing winds. The wind conditions are:

- 0 knots (essentially calm; only tides and currents affected the spread of the oil); no shoreline impacts were realized using this scenario, and
- 8-13 knots from the north/northwest (seasonally prevailing winds); resulted in likely shoreline impacts from the spilled oil.

Phase 1 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 1 (initial to 6 hours) associated with no action other than monitoring and other response actions for this scenario are presented in Figure 5.9.

The weathering and trajectory models showed that in the first six hours, with winds of 0 knots, the oil would spread but would remain in the vicinity of the tanker and be transported within the bay and river by tidal conditions and currents only; there were no shoreline impacts with this trajectory. With these conditions, the ADIOS 2 program estimates that 16% of the oil would evaporate, leaving 84% of the spilled Bakken oil on the water. For this reason, HHS concerns over the potential ignition of the flammable vapors was the primary driver to take no response action during Phase 1, other than to prevent a fire from starting. Participants discussed vapor suppression but determined that would not be an option as maintaining a foam vapor barrier would be impossible in open waters and the volumes of foam required were not present in the quantities needed. Additionally, responder operations would be limited by LEL thresholds. If readings do not allow for safe working, responders would not go into the flammable zone and put personnel at greater risk.

They also noted that the vapor density would be heavier than air especially in calm winds; the flammable vapors could provide a health and safety hazard to responders as the vapors could potentially displace oxygen. Wind or rain would reduce/move vapor density. Participants requested additional research/studies conducted on the vapor density, particularly how high above the surface the vapors were likely to be present, and noted the need to carry LELs on the OSRVs.

Participants characterized the risks of oil only, since no other actions could be taken during Phase 1. For this reason, the majority of the chart is ranked NA. The water depth in this location is approximately 25 to 40 feet, and the first six hours would have some mid-water impacts with components of the oil dissolving in the upper 2 meters of the water column. The highest risk of concern would be for any T/E plants and animals on the shorelines, which might not be present due to seasonality, but was ranked red out of caution. Sturgeon has been present in the benthic zone in the past. Protective booming would be desirable. Moderate level of concern (yellow) was assigned for birds, reptiles/amphibians, macro invertebrates, and aquatic vegetation on sensitive wetlands and riprap shorelines and the upper water column that could be exposed to the spilled oil.

Phase 2 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 2 (4 to 7 days) associated with no action other than monitoring plus all response actions for this scenario are presented in Figure 5.10.

In addition to the risks identified during Phase 1, some additional risks were noted as being possible and applicable to specific resources of concern. Participants spent the majority of their discussion time considering Phase 2 with the higher wind conditions and treated this as a typical crude oil once the flammable light ends evaporate. Primarily in the intertidal shoreline, participants noted that some response actions could reduce the risks presented by the oil alone. Specifically, implementing diversion and exclusion booming response actions to protect sensitive shorelines from being oiled, shoreline cleanup response actions to remove oil residue from the shore, and implementing on water recovery / skimming when practicable, would slightly decrease risks to mammals, reptiles/amphibians, plants, and aquatic vegetation.

Since the time of the scenario was January, participants discussed the likelihood that sensitive shoreline habitats would be less impacted by the oil and that natural weathering and NAM might be the response action of lowest risk to the shoreline. However the large quantities of oil discharged, which could result in longer-term shoreline impacts, required consideration of additional response actions. If the scenario had been set in spring, the risks to ecological resources from the oil, and probably shoreline cleanup actions, would have been ranked higher.

Habitat	Artificial Shorelines						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	3C	3C	NA	NA	1A	1B
Summary for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
No Fire							
Vapor suppression	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Oil spread control	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Resource protection	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Oil Detection/mapping - remotely observed methods	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							

Habitat	Natural Terrestrial Shorelines						
Sub habitats	Vegetated,Grass, Sand, Gravel						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	3C	3C	NA	NA	1B	1B
Summary for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
No Fire							
Vapor suppression	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Oil spread control	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Resource protection	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							
Oil Detection/mapping - remotely observed methods	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat							

Habitat	Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)								
Sub habitats	Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach								
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species - Animals	T/E species - Plants	Plants	Fishing	Water Intake - Surface
Response Actions									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	3C	3C	3C	1B	1B	1B	4C	NA
Summary for Sub-habitat									
Fire									
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA		NA	NA	NA
Summary for Sub-habitat									
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
No Fire									
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
Oil spread control	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
Resource protection	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									
Oil Detection/mapping - remotely observed methods	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat									

Habitat	Mid-water (0 to 2 meters)									
Sub habitats	Water Column									
Resources of Concern	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions										
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3B	3B	3B	3B	NA	4D	NA	NA	4C	NA
Summary for Sub-habitat										
Fire										
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
No Fire										
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
Oil spread control	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
Resource protection	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										
Oil Detection/mapping - remotely observed methods	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat										

Habitat	Benthic (bottom, >2 meters)							
Sub habitats	Bottom of the Water Column / Seabed							
Resources of Concern	Aquatic Vertebrates	Macro-invertebrates	Aquatic invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions								
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	NAN	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Fire								
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
No Fire								
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Oil spread control	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Resource protection	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Oil Detection/mapping - remotely observed methods	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

Limited Level of Concern — Moderate Level of Concern

High Level of Concern — Not Applicable

Figure 5.9 Scenario 3 Risk Characterization (Phase 1)

Habitat	Artificial Shorelines							Natural Terrestrial Shorelines							Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)									Mid-water (0 to 2 meters)										Benthic (bottom, >2 meters)							
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement							Vegetated,Grass, Sand, Gravel							Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach									Water Column										Bottom of the Water Column / Seabed							
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species - Animals	T/E species - Plants	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species - Animals	T/E species - Plants	Plants	Fishing	Water Intake - Surface	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-Invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater	Aquatic Vertebrates	Macro-Invertebrates	Aquatic Invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions																																									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	3C	3C	NA	NA	1A	1B	4C	3C	3C	NA	NA	1B	1B	3B	3B	3B	1B	1B	1B	1B	4C	NA	3B	3B	NA	3B	NA	4D	NA	NA	4C	NA	NAN	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat																																									
Fire																																									
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat																																									
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat																																									
No Fire																																									
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat																																									
Oil spread control	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4C	3C	3B	2C	NA	NA	2C	4C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat																																									
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4C	3C	NA	4C	NA	4D	NA	NA	4C	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat																																									
Resource protection	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4C	3C	3C	3C	NA	NA	2C	4C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat																																									
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4C	3C	4C	1C	NA	NA	2C	4C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat																																									
Oil Detection/mapping - remotely observed methods	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3B	3B	3B	1B	NA	NA	1B	4C	NA	3B	3B	NA	3B	NA	4D	NA	NA	4C	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat																																									

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

Limited Level of Concern
Moderate Level of Concern
High Level of Concern
Not Applicable

Figure 5.10 Scenario 3 Risk Characterization (Phase 2)

5.7 Scenario 4 – Dilbit Rail Incident, Mantua Creek

Scenario Four was a railcar incident involving Dilbit crude oil. The bitumen in dilbit contains resins and asphaltenes, which makes it stickier than typical heavy crude. It is more likely to sink in freshwater than saltwater.
The incident occurred at the rail crossing over Mantua Creek in Paulsboro, New Jersey on May 25, 2015, in the vicinity of an actual train derailment in 2012 that released vinyl chloride (Figure 5.10). The Mantua Creek is freshwater and approximately 2 meters deep. Much of Mantua Creek's floodplain contains highly disturbed soils consistent with historical and current urban uses (Figure 5.11). Approximately 100,000 gallons of oil was released impacting freshwater marshes, the Mantua Creek and parts of the Delaware River.

Figure 5.11 Train derailment in Paulsboro, NJ, 2012

(Source: http://wac.450f.edgecastcdn.net/80450F/nj1015.com/files/2012/12/crane3-300x224.jpg)

Participants reviewed the information contained in Appendix H:

- The weathering of the oil over time, in terms of amount that would evaporate and remain in the environment (shown in the oil budget table), and benzene concentrations, was calculated by the ADIOS 2 program.
- The oil spread predictions from trajectory model, including possible extent of contamination over 3 days, in relation to the ESI maps for the area.

Workgroup participants identified the need to involve the SHPO and HPA, as well as natural resource agencies to fill data gaps with regard to estimates of fish and bird populations in the area, which increased uncertainty around severity estimates.

Phase 1 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 1 (initial 6 hours) associated response actions for this scenario are presented in Figure 5.12.

The trajectory model predicted that dilbit oil spilled just after peak high tide (at 0741) would move from the creek into the Delaware River during the first six hours. The ADIOS 2 program estimated that 20% of this oil would evaporate in the first six hours, leaving approximately 80% of the oil in the environment. There were response organizations nearby and could begin pollution response operations quickly but probably not in time to implement containment booming and skimming to prevent the majority of the oil from moving into the Delaware River.

Mantua Creek has been historically impacted by point-source and non-point source pollution, including oil spills, releases of hazardous wastes, sewage, and run off. Upstream there are wetland areas, with freshwater streams to the north and south; a narrow channel opens to a freshwater marsh with salamanders and turtles. A primary driver of ecological risk is oil exposure and trampling/crushing by responders or vehicles. Of particular concern are turtles, which have inherently very low infant survival rates coupled with low adult reproductive rates.

The incident location is near the Paulsboro community. If a fire occurred from the incident, it would create air hazard risks for the community. While applying foam was not viewed as logistically feasible in this situation, participants would like to know more about the composition of these foams and their potential environmental interactions.

Participants assumed that animals in the water would not exit the water, and land animals would flee the area for any kind of active response and so the risk of impact would be low from fire. T/E species were ranked NA since there are no documented occurrence in the area during winter, nor was there suitable habitat present. .

The overall assessment of risks during this phase are low (green) to moderate (yellow). Participants assigned a moderate level of concern for oil only for mammals, birds, reptiles/amphibians and macro-invertebrates (freshwater mussels) on shorelines, plus marsh vegetation, in the surface/midwater habitat. Fire could reduce the risk to green for mammals and birds, and marshes by removing the source of oil contamination. In the case of no fire, implementing oil spread control, on water protection (booming) and recovery response actions could also slightly reduce the risk to the same resources of concern. With the industry resources located nearby, participants assumed a barge could be deployed quickly as temporary storage of oil and some oily water recovered by skimmers. Participants, however, were uncertain about temporary storage of large quantities of recovered oily water; if this were not quickly solvable (e.g., by decanting) then skimming operations might be curtailed.

Phase 2 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 2 (4 to 7 days) associated with no action other than monitoring plus all response actions for this scenario are presented in Figure 5.13.

In this scenario, it was assumed that the worst case scenario would be that the Dilbit would sink, and likely severely impact (smother) benthic organisms and their habitat. The extent of contamination would begin in Mantua Creek, move into the Delaware River in the first tidal cycle. It was also assumed, as worst case scenario that most, if not all, sunken oil would remain in the Mantua Creek sediments or likely go virtually undetected in the Delaware River. The trajectory model of floating oil movement, therefore, was limited to 3 days, and floating oil would be minimized by boom deployment at Mantua Creek-Delaware River confluence.

Habitat: Artificial Shorelines — Sub habitats: Bulkheads, Riprap, Manmade Structures, Pavement

Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3C	3C	2C	3C	4C	NA	NA
Summary for Sub-habitat							
Fire							
Let burn controlled burn (both in-situ)	4D	4D	2C	3C	4C	NA	NA
Summary for Sub-habitat							
Extinguishing agents and methods	3C	3C	2C	3C	4C	NA	NA
Summary for Sub-habitat							
No Fire							
Vapor suppression	3C	3C	2C	3C	4C	NA	NA
Summary for Sub-habitat							
Oil spread control	4D	4D	2C	3C	4C	NA	NA
Summary for Sub-habitat							
On-water oil recovery	4D	4D	2C	3C	4C	NA	NA
Summary for Sub-habitat							
Resource protection	4D	4D	2C	3C	4C	NA	NA
Summary for Sub-habitat							
Shoreline clean up	3C	3C	2C	3C	4C	NA	NA
Summary for Sub-habitat							
Oil Detection/mapping - physical detection/ remotely observed methods	3C	3C	2C	3C	4C	NA	NA
Summary for Sub-habitat							

Habitat: Natural Terrestrial Shorelines (Riparian) — Sub habitats: Vegetated,Grass, Sand, Gravel

Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3C	3C	2C	3C	4C	NA	3D
Summary for Sub-habitat							
Fire							
Let burn controlled burn (both in-situ)	4D	4D	2C	3C	4C	NA	3D
Summary for Sub-habitat							
Extinguishing agents and methods	3C	3C	2C	3C	4C	NA	3D
Summary for Sub-habitat							
No Fire							
Vapor suppression	3C	3C	2C	3C	4C	NA	3D
Summary for Sub-habitat							
Oil spread control	4D	4D	2C	3C	4C	NA	3D
Summary for Sub-habitat							
On-water oil recovery	4D	4D	2C	3C	4C	NA	3D
Summary for Sub-habitat							
Resource protection	4D	4D	2C	3C	4C	NA	3D
Summary for Sub-habitat							
Shoreline clean up	3C	3C	2C	3C	4C	NA	3D
Summary for Sub-habitat							
Oil Detection/mapping - physical detection/ remotely observed methods	3C	3C	2C	3C	4C	NA	3D
Summary for Sub-habitat							

Habitat: Intertidal Shoreline (littoral) (Exposed & Sheltered) / Surface Water (0 - 1 meter) — Sub habitats: Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach

Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species - Animals	T/E species - Plants	Plants	Fishing	Water Intake - Surface
Response Actions									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3C	3B	2C	3C	NA	NA	3C	4D	NA
Summary for Sub-habitat									
Fire									
Let burn controlled burn (both in-situ)	4D	4D	2C	3C	NA	NA	3D	4D	NA
Summary for Sub-habitat									
Extinguishing agents and methods	3C	3B	2C	3C	NA	NA	3C	4D	NA
Summary for Sub-habitat									
No Fire									
Vapor suppression	3C	3B	2C	3C	NA	NA	3C	4D	NA
Summary for Sub-habitat									
Oil spread control	4D	4D	2C	3C	NA	NA	3C	4D	NA
Summary for Sub-habitat									
On-water oil recovery	4D	4D	2C	3C	NA	NA	3C	4D	NA
Summary for Sub-habitat									
Resource protection	4D	4D	2C	3C	NA	NA	3C	4D	NA
Summary for Sub-habitat									
Shoreline clean up	3C	3B	2C	3C	NA	NA	3C	4D	NA
Summary for Sub-habitat									
Oil Detection/mapping - physical detection/ remotely observed methods	3C	3B	2C	3C	NA	NA	3C	4D	NA
Summary for Sub-habitat									

Habitat: Mid-water (0 to 2 meters) — Sub habitats: Water Column

Resources of Concern	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions										
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3C	3B	2C	4C	3B	3C	NA	NA	4D	NA
Summary for Sub-habitat										
Fire										
Let burn controlled burn (both in-situ)	4D	4D	2C	4C	3B	3D	NA	NA	4D	NA
Summary for Sub-habitat										
Extinguishing agents and methods	3C	3B	2C	4C	3B	3C	NA	NA	4D	NA
Summary for Sub-habitat										
No Fire										
Vapor suppression	3C	3B	2C	4C	3B	3C	NA	NA	4D	NA
Summary for Sub-habitat										
Oil spread control	4D	4D	2C	4C	3B	3D	NA	NA	4D	NA
Summary for Sub-habitat										
On-water oil recovery	4D	4D	2C	4C	3B	3D	NA	NA	4D	NA
Summary for Sub-habitat										
Resource protection	4D	4D	2C	4C	3B	3D	NA	NA	4D	NA
Summary for Sub-habitat										
Shoreline clean up	3C	3B	2C	4C	3B	3C	NA	NA	4D	NA
Summary for Sub-habitat										
Oil Detection/mapping - physical detection/ remotely observed methods	3C	3B	2C	4C	3B	3C	NA	NA	4D	NA
Summary for Sub-habitat										

Habitat: Benthic (bottom, >2 meters) — Sub habitats: Bottom of the Water Column / Seabed

Resources of Concern	Aquatic Vertebrates	Macro-Invertebrates	Aquatic invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions								
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Fire								
Let burn controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
No Fire								
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Oil spread control	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Resource protection	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								
Oil Detection/mapping - physical detection/ remotely observed methods	NA	NA	NA	NA	NA	NA	NA	NA
Summary for Sub-habitat								

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

Limited Level of Concern — Moderate Level of Concern

High Level of Concern — Not Applicable

Figure 5.12 Scenario 4 Risk Characterization (Phase 1)

Habitat	Artificial Shorelines							Natural Terrestrial Shorelines (Riparian)							Intertidal Shoreline (littoral) (Exposed & Sheltered) / Surface Water (0 - 1 meter)									Mid-water (0 to 2 meters)										Benthic (bottom, >2 meters)							
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement							Vegetated,Grass, Sand, Gravel							Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach									Water Column										Bottom of the Water Column / Seabed							
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species-Animals	T/E species-Plants	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species-Animals	T/E species-Plants	Plants	Fishing	Water Intake - Surface	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-invertebrates	Plants	T/E species-Animals	T/E Species	Fishing	Water Intakes - midwater	Aquatic Vertebrates	Macro-invertebrates	Aquatic invertebrates	Plants	T/E species-Animals	T/E species-Plants	Fishing	Water Intakes - midwater
Response Actions																																									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3C	3C	2B	3C	4C	NA	NA	3C	3C	2B	3C	4C	NA	3D	3C	3B	2B	3C	NA	NA	3C	4D	NA	3C	3B	2B	4C	2A	3A	NA	NA	4D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat	Moderate							High							High									High										Not Applicable							
Fire																																									
Let burn controlled burn (both in-situ)	3C	3C	2B	3C	4C	NA	NA	3C	3C	2B	3C	4C	NA	3C	3C	3B	2B	3C	NA	NA	3C	4D	NA	3C	3B	2B	4C	2A	3A	NA	NA	4D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat	Moderate							Moderate							Moderate									High										Not Applicable							
Extinguishing agents and methods	3C	3C	2B	3C	4C	NA	NA	3C	3C	2B	3C	4C	NA	3D	3C	3B	2B	3C	NA	NA	3C	4D	NA	3C	3B	2B	4C	2A	3A	NA	NA	4D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat	Unable to Determine							Unable to Determine							Unable to Determine									Unable to Determine										Not Applicable							
No Fire																																									
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat	Not Applicable							Not Applicable							Not Applicable									Not Applicable										Not Applicable							
Oil spread control	3C	3C	2B	3C	4C	NA	NA	3C	3C	2B	3C	4C	NA	3B	3C	3B	2B	3C	NA	NA	3C	4D	NA	3C	3B	2B	4C	2A	3A	NA	NA	4D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat	Moderate							Moderate							Moderate									Moderate										Not Applicable							
On-water oil recovery	3C	3C	2B	3C	4C	NA	NA	3C	3C	2B	3C	4C	NA	3B	3C	3B	2B	3C	NA	NA	3C	4D	NA	3C	3B	2B	4C	2A	3A	NA	NA	4D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat	Moderate							Moderate							Moderate									Moderate										Not Applicable							
Resource protection	3C	3C	2B	3C	4C	NA	NA	3C	3C	2B	3C	4C	NA	3B	3C	3B	2B	3C	NA	NA	3C	4D	NA	3C	3B	2B	4C	2A	3A	NA	NA	4D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat	Moderate							Moderate							Moderate									Moderate										Not Applicable							
Shoreline clean up	3C	3C	2B	3C	4C	NA	NA	3C	3C	2B	3C	4C	NA	3B	3C	3B	2B	3C	NA	NA	3C	4D	NA	3C	3B	2B	4C	2A	3A	NA	NA	4D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat	Moderate							Moderate							High									Moderate										Not Applicable							
Oil Detection/mapping - physical detection/ remotely observed methods	3C	3C	2B	3C	4C	NA	NA	3C	3C	2B	3C	4C	NA	3B	3C	3B	2B	3C	NA	NA	3C	4D	NA	3C	3B	2B	4C	2A	3A	NA	NA	4D	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat	Moderate							High							High									High										Not Applicable							

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

- Green: Limited Level of Concern
- Yellow: Moderate Level of Concern
- Red: High Level of Concern
- Grey: Not Applicable
- White: Unable to Determine Due to Insufficient Information

Figure 5.13 Scenario 4 Risk Characterization (Phase 2)

Workgroup participants assumed that during Phase 2, the weathered oil would sink to the bottom of Mantua Creek, and in the Delaware River. Smothering impacts caused the risk of oil only to change to red for certain resources of concern, i.e., reptiles/amphibians, macro-invertebrates (freshwater mussel beds), and aquatic plants. Participants noted that there are freshwater mussel beds in New Jersey that did not appear on the ESI maps. Also, more information is needed to assess the potential benefits and limitations of the response actions. For example, if the bottom of the creek is essentially paved with this oil, is it better to cap the creek bottom, dredge and possibly re-release existing contaminants, or leave the contaminants in place given the potential for toxic components to leach into the benthic habitat. If sediments or other materials were added to cover the oil, would that be considered filling a wetland, which could trigger other federal and/or state regulatory requirements that may need to be considered in the response action? The ranking of red does not mean to stop actions, but rather to view and assure that response actions would not adversely affect the species of concern.

5.8 Scenario 5 – Dilbit Barge Incident, Delaware River

Scenario Five was a barge incident involving Dilbit crude oil. The incident occurred at the Marcus Hook Anchorage in Pennsylvania on April 15, 2015 in brackish water. Predicting how dilbit would behave in the brackish to salt water of the lower Delaware River is unclear. The "salt line"[14] in the Delaware River is generally around the Delaware Memorial Bridge south of Wilmington, DE, and the river north of the salt line is brackish. Approximately 50,000 gallons of cargo is spilled into the Delaware River south of the Delaware Memorial Bridge, ultimately impacting the ecologically diverse shorelines of three states (Pennsylvania, Delaware, and New Jersey).

Participants reviewed the information contained in Appendix H:

- The weathering of the oil over time, in terms of amount that would evaporate and remain in the environment (shown in the oil budget table), and benzene concentrations, was calculated by ADIOS 2.
- The oil spread predictions from trajectory model, including possible extent of contamination over 4 days, in relation to the ESI maps for the area.

The recent spill experiences, FOSC report, and the Delaware River and Bay Oil Spill Advisory Committee Report (DRBOSAC) report, which was mandated by Congress**,** about the *M/T Athos* spill (Nov. 24, 2004) of 265,000 gals of Venezuelan heavy crude oil, and the *T/V Presidente Rivera* (June 24, 1989) 306,000 gal of No. 6 fuel oil, was used to inform assessing the risks associated with this scenario of floating/submerged crudes. In both of these spill incidents the heavy crude acquired suspended sediments as it weathered and went from a floating to sinking submerged oil.

Participants assumed that no fire would occur in this scenario; therefore, they assigned NA to all fire-related response actions. They also assumed for purposes of the assessment, that 75% of the oil would be on the surface for spreading and recovery; and that 25% would become sunken.

[14] Salt-laced water, known in water jargon as the "salt front" or "salt line," is 250 milligram per liter chloride concentration. This concentration is based on drinking water quality standards originally established by the U.S. Public Health Service. Source: http://www.state.nj.us/drbc/hydrological/river/salt/

Phase 1 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 1 (2-6 hours) associated with no action other than monitoring and other response actions for this scenario are presented in Figure 5.14.

ADIOS 2 estimated that 23% of this oil would evaporate in the first six hours, leaving approximately 77% of the oil in the environment. In this scenario, vapor control was not considered a significant risk.

Source control and protecting the creeks from floating oil was the priority response actions.

Participants scored the risks from the oil and monitoring as low (green) for the resources of concern in artificial and natural terrestrial shoreline, with the exception of moderate concern for reptiles/amphibians on artificial shorelines. Participants assigned a high level of concern (red) for birds, reptiles/amphibians, macro-invertebrates, T/E animals and plants, and plants associated with the oiling of intertidal areas, and for birds in the surface/mid water column. Participants were moderately concerned (yellow) about potential risks in the water column to reptiles (turtles), aquatic vegetation, macro-invertebrates, T/E animals (Atlantic sturgeon), as well as for species that are fished and water intakes.

Compared to oil only, participants noted that some pollution response actions could mitigate risks from the spilled oil, i.e., containment booming (oil spread control) and skimming (on water oil recovery), and protective booming for mammals in the intertidal area. These actions could also be beneficial if their implementation resulted in reducing the oil threat to benthic resources of concern.

At this time of the year, early spring, many species of invertebrates and vertebrates are breeding producing large numbers of pelagic/nektonic larva. Some of these are meroplankton floating near the surface, while others like the striped bass eggs tumble alone the bottom driven by tidal currents. In both of these circumstances, potential adverse oiling impacts would be high.

Phase 2 – Risk Characterization

The detailed results of the participants' characterization of risks during Phase 2 (4-7 days) associated with no action other than monitoring plus all response actions for this scenario are presented in Figure 5.15.

After 3-4 days, 73% of the spilled dilbit crude, would remain in the environment as a heavy thick crude. Depending upon the actual blend, the specific gravity of the residual oil could hover around or above 1.0, which is the specific gravity for freshwater at 4°C.[15] . This rapid loss of the light diluent as a result of evaporation and weathering is important to consider. After the rapid evaporation/weathering, the resultant heavy thick crude has more resins and asphaltenes and is more sticky and tackier than typical heavy crudes. The increased 'stickiness' increases the probability of having suspended sediments attach to the oil droplets, thus increasing its specific gravity, making it heaver in the water and sink below the surface. Participants anticipated considerable shoreline contamination of heavy oil with this scenario, and that the oil would begin to pick up sediment in the water and begin to sink.

[15] Oils with a specific gravity of less than 1.0 will float on the water surface; those greater than 1.0 will not float.

Habitat	Artificial Shorelines						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4C	4B	3B	3B	4C	4D	4D
Summary Risk for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
No Fire							
Vapor suppression	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Oil spread control	4C	4B	3D	3D	4C	4D	4D
Summary Risk for Sub-habitat							
On-water oil recovery	4C	4B	3D	3D	4C	4D	4D
Summary Risk for Sub-habitat							
Resource protection	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Shoreline clean up	4C	4B	3B	3B	4C	4D	4D
Summary Risk for Sub-habitat							
Oil Detection/mapping - physical detection/ remotely observed methods	4C	4B	3B	3B	4C	4D	4D
Summary Risk for Sub-habitat							

Habitat	Natural Terrestrial Shorelines						
Sub habitats	Vegetated,Grass, Sand, Gravel						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4D	4D	4D	4D	4D	4D	4D
Summary Risk for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
No Fire							
Vapor suppression	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Oil spread control	4D	4D	4D	4D	4D	4D	4D
Summary Risk for Sub-habitat							
On-water oil recovery	4D	4D	4D	4D	4D	4D	4D
Summary Risk for Sub-habitat							
Resource protection	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Shoreline clean up	4D	4D	4D	4D	4D	4D	4D
Summary Risk for Sub-habitat							
Oil Detection/mapping - physical detection/ remotely observed methods	4D	4D	4D	4D	4D	4D	4D
Summary Risk for Sub-habitat							

Habitat	Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)								
Sub habitats	Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach								
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species - Animals	T/E species - Plants	Plants	Fishing	Water Intake - Surface
Response Actions									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3B	3A	2B	2B	2A	1A	2A	4A	4A
Summary Risk for Sub-habitat									
Fire									
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat									
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat									
No Fire									
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat									
Oil spread control	3C	3B	2C	2C	2B	1B	2B	4A	4A
Summary Risk for Sub-habitat									
On-water oil recovery	3C	3B	2C	2C	2B	1B	2B	4A	4A
Summary Risk for Sub-habitat									
Resource protection	3D	3C	2D	2D	2C	1C	2C	4A	4A
Summary Risk for Sub-habitat									
Shoreline clean up	3B	3A	2B	2B	2A	1A	2A	4A	4A
Summary Risk for Sub-habitat									
Oil Detection/mapping - physical detection/ remotely observed methods	3B	3A	2B	2B	2A	1A	2A	4A	4A
Summary Risk for Sub-habitat									

Habitat	Mid-water (0 to 2 meters)									
Sub habitats	Water Column									
Resources of Concern	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions										
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3B	3A	2C	3B	4A	4A	3B	4D	4A	4A
Summary Risk for Sub-habitat										
Fire										
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat										
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat										
No Fire										
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat										
Oil spread control	3C	3B	2D	3C	4B	4B	3C	4D	4A	4A
Summary Risk for Sub-habitat										
On-water oil recovery	3C	3B	2D	3C	4B	4B	3C	4D	4A	4A
Summary Risk for Sub-habitat										
Resource protection	3B	3A	2C	3B	4A	4A	3B	4D	4A	4A
Summary Risk for Sub-habitat										
Shoreline clean up	3B	3A	2C	3B	4A	4A	3B	4D	4A	4A
Summary Risk for Sub-habitat										
Oil Detection/mapping - physical detection/ remotely observed methods	3B	3A	2C	3B	4A	4A	3B	4D	4A	4A
Summary Risk for Sub-habitat										

Habitat	Benthic (bottom, >2 meters)							
Sub habitats	Bottom of the Water Column / Seabed							
Resources of Concern	Aquatic Vertebrates	Macro-invertebrates	Aquatic invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions								
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	NA	NA	NA	NA	NA	NA	4A	4A
Summary Risk for Sub-habitat								
Fire								
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat								
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat								
No Fire								
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat								
Oil spread control	4D	4D	4D	4D	4D	4D	4A	4A
Summary Risk for Sub-habitat								
On-water oil recovery	4D	4D	4D	4D	4D	4D	4A	4A
Summary Risk for Sub-habitat								
Resource protection	4D	4D	4D	4D	4D	4D	4A	4A
Summary Risk for Sub-habitat								
Shoreline clean up	4D	4D	4D	4D	4D	4D	4A	4A
Summary Risk for Sub-habitat								
Oil Detection/mapping - physical detection/ remotely observed methods	4D	4D	4D	4D	4D	4D	4A	4A
Summary Risk for Sub-habitat								

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

Limited Level of Concern

Moderate Level of Concern

High Level of Concern

Not Applicable

Figure 5.14 Scenario 5 Risk Characterization (Phase 1)

Habitat	Artificial Shorelines						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Other Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	4B	4B	3B	3B	4C	4D	4D
Summary Risk for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
No Fire							
Vapor suppression	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Oil spread control	4C	4C	3C	3C	4D	4D	4D
Summary Risk for Sub-habitat							
On-water oil recovery	4B	4B	3B	3B	4C	4D	4D
Summary Risk for Sub-habitat							
Resource protection	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Shoreline clean up	4A	4A	3A	3A	4B	4D	NA
Summary Risk for Sub-habitat							
Oil Detection/mapping - physical detection/ remotely observed methods	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							

Habitat	Natural Terrestrial Shorelines						
Sub habitats	Vegetated,Grass, Sand, Gravel						
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	Aquatic Vertebrates	T/E species - Animals	T/E species - Plants
Response Actions							
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Fire							
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
No Fire							
Vapor suppression	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Oil spread control	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
On-water oil recovery	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Resource protection	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							
Shoreline clean up	4C	4C	4C	4C	4C	4C	4C
Summary Risk for Sub-habitat							
Oil Detection/mapping - physical detection/ remotely observed methods	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat							

Habitat	Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)								
Sub habitats	Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach								
Resources of Concern	Mammals	Birds	Reptiles and Amphibians	Macro-Invertebrates	T/E species - Animals	T/E species - Plants	Plants	Fishing	Water Intake - Surface
Response Actions									
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3B	2A	2B	2A	2B	1A	1A	4A	4A
Summary Risk for Sub-habitat									
Fire									
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat									
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat									
No Fire									
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat									
Oil spread control	3C	2B	2C	2B	2C	1B	1B	4A	4A
Summary Risk for Sub-habitat									
On-water oil recovery	3C	2B	2C	2B	2C	1B	1B	4A	4A
Summary Risk for Sub-habitat									
Resource protection	3D	2C	2D	2C	2D	1D	1D	4A	4A
Summary Risk for Sub-habitat									
Shoreline clean up	3B	2A	2B	2A	2B	1A	1A	4A	4A
Summary Risk for Sub-habitat									
Oil Detection/mapping - physical detection/ remotely observed methods	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat									

Habitat	Mid-water (0 to 2 meters)									
Sub habitats	Water Column									
Resources of Concern	Mammals	Birds	Reptiles	Aquatic Vertebrates	Macro-invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions										
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	3C	3A	2C	3B	4A	4C	3B	4D	4A	4A
Summary Risk for Sub-habitat										
Fire										
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat										
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat										
No Fire										
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat										
Oil spread control	3D	3B	2D	3C	4B	4D	3C	4D	4A	4A
Summary Risk for Sub-habitat										
On-water oil recovery	3D	3B	2D	3C	4B	4C	3C	4D	4A	4A
Summary Risk for Sub-habitat										
Resource protection	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat										
Shoreline clean up	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat										
Oil Detection/mapping - physical detection/ remotely observed methods	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat										

Habitat	Benthic (bottom, >2 meters)							
Sub habitats	Bottom of the Water Column / Seabed							
Resources of Concern	Aquatic Vertebrates	Macro-invertebrates	Aquatic invertebrates	Plants	T/E species - Animals	T/E species - Plants	Fishing	Water Intakes - midwater
Response Actions								
Oil Only: No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	2B	2B	2B	4D	1A	4D	4A	4A
Summary Risk for Sub-habitat								
Fire								
Let burn and controlled burn (both in-situ)	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat								
Extinguishing agents and methods	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat								
No Fire								
Vapor suppression	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat								
Oil spread control	2C	2C	2C	4D	1B	4D	4A	4A
Summary Risk for Sub-habitat								
On-water oil recovery	2C	2C	2B	4D	1B	4D	4A	4A
Summary Risk for Sub-habitat								
Resource protection	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat								
Shoreline clean up	2B	2B	2B	4D	1A	4D	4A	4A
Summary Risk for Sub-habitat								
Oil Detection/mapping - physical detection/ remotely observed methods	NA	NA	NA	NA	NA	NA	NA	NA
Summary Risk for Sub-habitat								

The first row of each response option is the risk characterization for each resource of concern in the habitat. The second row is the overall response option risk characterization for the entire subhabitat/habitat.

Limited Level of Concern

Moderate Level of Concern

High Level of Concern

Not Applicable

Figure 5.15 Scenario 5 Risk Characterization (Phase 2)

The Delaware estuary turbidity maximum (ETM) falls (in general) between the vicinity of Marcus Hook (RM 79) in the north and a line between the Cohansey River in New Jersey and the Smyrna River (RM 44) in Delaware. This ETM zone is characterized by the increase in salinity from a freshwater condition (0-0.5 ppt) to that of an oligohaline concentration (0.5-5 ppt) moving down river to the Smyrna River area. These high sediment concentrations are caused primarily by the resuspension of fine-grained sediments by strong tidal currents in this region and the formation of additional sediments as dissolved organic matter from land runoff interacts with diluted salt water to form larger particles. The Delaware Estuary is widely recognized as being one of the most turbid, sediment-laden estuaries in the United States. In this environment, when dilbit separates from its blended light/heavy composite it forms into the thick heavy sticky crude, and adhesion of sediment particulates onto the crude droplets will cause the crude to submerge creating a challenging tracking and recovery operation.

Shoreline oiling could occur on both sides of the Delaware River north to about the Schuylkill River on the PA side and south of the C&D Canal to around Augustine Creek in Delaware and Alloway Creek in New Jersey. Participants would have preferred to have more detailed information about the degree of oiling on specific shoreline types. Using available information as well as their prior response experience, they completed the risk characterization for this scenario.

Compared to Phase 1, participants had a higher level of concern (red) about this phase of oiling for resources of concern (aquatic vegetation, macroinvertebrates, aquatic invertebrates, and T/E animals) associated with the benthic sub-habitat. In fact, the summary of risk was scored high (red) for both oil alone and pollution response actions for resources of concern in three habitats: intertidal shorelines, surface/mid-water column, and benthos. Participants identified some pollution response actions that could reduce the risk to certain resources of concern from moderate (yellow) to low (green): oil spread control through containment booming (could reduce risk to mammals, e.g., river otter, muskrat, raccoon, in the intertidal shorelines; aquatic vegetation, macro-invertebrates, and aquatic invertebrates in the bottom of the water column), and on-water oil recovery (could reduce risk to mammals, e.g., river otter, and macro-invertebrates at the water surface). On the other hand, shoreline cleanup would increase the risks to reptiles/amphibians and macro-invertebrates on artificial shorelines from moderate (yellow) to high (red).

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7.0 Appendices

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Appendix A: Project Participants

Workshop 1 (June 9-10)	Workshop 2 (June 23-24)	NAME	SCENARIO	AGENCY	EMAIL
X		Adkins, Jennifer	5	Delaware Estuary	JAdkins@DelawareEstuary.org
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X	X	Anderson, Ben*[16]	5	DE-DNREC	Bennett.Anderson@state.de.us
		Anderson, Steve	4	NJ Environmental and Health Assessment Program	
	X	Austin, Mike	1	CSX	mike_austin@csx.com
X	X	Bauer, Bob*	1	PA-DEP	rbauer@pa.gov
X	X	Berzins, David	4	NJ-DEP Region 2	David.berzins@dep.nj.gov
X	X	Blackmore, LCDR Vanessa	5	USCG Sector Hampton Roads	Vanessa.M.Blackmore@uscg.mil
X	X	Block, Taylor	5	DOI	
X		Boufadel, Ph.D. Michel	NA	New Jersey Institute of Technology	boufadel@gmail.com
	X	Bowis, Megan Lt.	4	USCG HQ	Meagan.K.Bowis@uscg.mil
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X	X	Csulak, Frank*	4	NOAA	Frank.Csulak@noaa.gov
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Appendix B: Workshops Agendas

USCG Sector Delaware Bay Consensus Ecological Risk Assessment Meeting

Workshop 1 – Agenda

Delaware County Emergency Training Center
1600 Calcon Hook Rd, Sharon Hill, PA 19079; Phone (610) 237-8630
Workshop 1 - Day 1

June 9, 2015

All refreshments graciously sponsored by industry members Of the Delaware Bay and River Cooperative

0730

Registration/check in + coffee and tea

0800

Welcome and Opening Comments (CAPT Benjamin Cooper, Commanding Officer, Sector Delaware Bay and Federal On-scene Coordinator

0815

Introductions (Ann Hayward Walker, SEA Consulting Group)

Project Committee and Subcommittees
Workshop participants

0830

Background – Sector DelBay Project (LCDR Michael Weaver and LT Eric Nielsen)

Sector Delaware Bay Project
- Project Objectives and scope (LCDR Weaver)
  - Anticipated use, and value, of project results
  - Planning only – results are not binding during response
  - Scope: Bakken and Dilbit crude oil transported by rail (crossing over streams/rivers) and barge (coast and in Delaware Bay)

Overview of Rail Incidents in the AOR
- Scenario locations (LT Nielsen)

0915

ERA Background (SEA)

- Opportunities and limitations of ERAs
- What are the objectives of this workshop?

0930

Introduction to Consensus Ecological Risk Assessments (SEA)

Using the Coast Guard Assessment Guidebook
- Previous Workshops
- What consensus means + value of consensus to

project results Essential activities of the process
- *Activities 1-5: Conducted by Project Committee and Subcommittees; presentations given at this workshop*
- *Activities 6-8: Conduct at this workshop*
- *Activities 8-10: Continue at next workshop*
- *Activities 11-12: Post-workshops, final report and implementation of findings*

1000

Break (20 mins.)

1020

Pre-workshop Planning (SEA)

Continue with Subcommittee Pre-Workshop Activities - Presentations by subcommittee leads

1020

Subcommittee Pre-Workshop Activities - Transport Subcommittee Lead – Ed Levine
- EPA response to incidents and OHMSETT study – Mike Towle, EPA
- Human/public health considerations – Kelly Scribner, BTEH
- Behavior and Transport - Ed Levine, NOAA
  - Oil behavior
  - Oil transport for the 4 water scenarios: NOAA oil trajectory and behavior – distribution of oil: air/water surface/water subsurface
  - For the Bakken/urban/fire scenario: Interagency Modeling and Atmospheric Assessment Center (IMAAC) smoke plume model output, courtesy Philadelphia OEM

1230

LUNCH (1 Hour) – provided

1330

Resources Subcommittee – Ben Anderson, DNREC and Debra Scholz, SEA

- Definition/description of ecological and socio-economic resources of concern in study area
- Information, data sources and references

1415

Pre-Workshop Activities - Effects Subcommittee – Clay Stern, USFWS

- Defining effects
  - General objectives of the analysis phase
  - Using fate and effect information
- Using thresholds to estimate the sensitivity to oil of the resources at risk
  - Exposure
  - Sensitivity
  - Effect
- Suggest thresholds measures for use in the analysis for specific resources
- Data collection concerning hazards relative to endpoints and resources identified in the conceptual model
- Information, data sources and references

1530

BREAK (15 Mins)

1545

Continue with Response Operations Subcommittee Pre-Workshop Activities - Rich Gaudiosi, Delaware Bay and River Cooperative (DelBay Co-op)

- Description of each response option
- Resources required (logistics) to implement the option
- Operational limitations
- Anticipated efficiency of each option (single %; or % of the upper and lower range, or other %?)
- Implications of using the option on oil fate
- Concerns associated with using the option
- Information, data sources and references (used to date and sources for risk analysis and characterization – next workshop)

1700

Review the results of the first day (SEA) Introduction to tomorrow (SEA) Questions/discussion (all)

1715

ADJOURN

Workshop 1 - Day 2

June 10, 2015

0800

Review the results of the first day
(SEA) Review process for today

- Conceptual model
- Conducting the analysis for natural attenuation and monitoring (NAM)
- Using the Risk Ranking Matrix
- Workgroups will determine the risk – 2 groups for each scenario, then meet and reach consensus
- Estimating levels of concern - simplifying the scores
- Achieving consensus on final risk scores
- Evaluating the relative risk for the response options under consideration
- How can you compare effects – the NAM baseline
- Preparing the relative risk summary

0815

Industry presentation on new safety course for moving crude by rail – Suzanne Lemieux, API

0830

Foam, Logistics and Port Asset for Fire & Spill Response - Chief Jim Kelly, Sunoco Logistics

0845

Review of the Conceptual Model – SEA

0915

Determining the level of concern – Clay Stern, USFWS

- Risk matrix concept
- Developing a matrix scale

0945

Expert Presentation on Fate of Dilbit Oil in the Environment – Michel Boufadel, NJIT

1015

BREAK (30 mins.)

1045

Establishing the Baseline for Effects: Natural Attenuation and Monitoring (NAM) – Clay Stern, USFWS

1100

Begin Preliminary Risk Scoring – Workgroups for each of the five scenarios

Participants assigned to workgroups (2 workgroups/scenario) and breakout rooms

1145

Time Out - Review and compare initial scores

1230

Lunch (provided)

1330

Continue preliminary risk scoring for baseline (break refreshments at 1445)

1520

Review, discussion and revision of baseline (NAM) scores

1600

Next workshop - Assignments (Preparation required! Homework to gather data/information about resources of concern to characterize effects of response options in the next workshop)

1615

Questions to be addressed before the next workshop (June 23-24, 2015 – same location and hours)

1630

ADJOURN

USCG Sector Delaware Bay Consensus Ecological Risk Assessment Meeting

Workshop 2 - Agenda

Delaware County Emergency Training Center
1600 Calcon Hook Rd, Sharon Hill, PA 19079; Phone (610) 237-8630

Workshop 2 - Day 1
June 23, 2015

Refreshments graciously sponsored by the Delaware Bay and River Cooperative members

0730

Registration/check in + coffee and tea

0800

Welcome and Opening Comments

0815

Introductions (Ann Hayward Walker, SEA Consulting Group)

Project Committee and Subcommittees
Workshop participants

0830

Process Overview (Walker)

- Adapting the Coast Guard Assessment Guidebook for this ERA
  - What consensus means + value of consensus to project results
- Essential activities of the process
  - *Activities 1-5: Conducted by Project Committee and Subcommittees; presentations given at Workshop 1*
  - *Activities 6-8: Workshop 1*
  - *Activities 8-10: Workshop 2*
  - *Activities 11-12: Post-workshops, final report and implementation of findings*

0915

Workshop 2 Overview (SEA)

- Objectives of Workshop 2
- Review of agenda and activities
- Assess response actions for two timeframes
    - Initial 2-4 hours after incident begins
    - 4-7 days after incident begins

0945

Rail Company Presentation(s)

Spill response planning, resources/capabilities, and railroad local training options to manage crude oil transportation by rail.

- Bryan Naranjo, Norfolk Southern Railroad - Norfolk Sothern's Crude Oil by Rail Planning, Training and Response
- Mike Austin, CSX - CSX's Crude Oil by Rail Planning, Training and Response

1015

Break (20 mins.)

1035

Review of Workshop 1: Key Activities - Plenary

- Presentations by Subcommittees on oil behavior/transport; resources of concern; effects; and response options
- Conceptual models for the 5 Scenarios

1130

Work in between Workshops: Information Gathering (SEA) – Plenary

- Refined trajectory models for scenarios 1 and 3
- Extent of contamination maps
- Oil budgets (weathering effects in percentages of initial oil fate)
- Currents
- Nautical charts – Bathymetry/water depths
- ESI maps (based on topo sheets) for DE, PA and NJ – inventory of resources of concern
- Estuary sensitive areas maps – priority ecological resources by season ESI resources
- Extent of contamination maps
- M/V Athos oil spill after action report
- Maps of water intakes
- List of state endangered species from ACP (supplement those on the ESI maps)
- Estimates of bird and fish distributions (state reps and USFWS reps)
- MSDS for Bakken and Dilbit oils, 3 types of foam

1230

LUNCH (1 Hour) – provided

1330

Review Scenario 1: Conceptual Model for Human Health (Walker and Workgroup Coaches) - Plenary

- Applicable to all scenarios?
- Refine as necessary

1400

Review Risk Ranking: Threshold Levels of Concern (Walker, Clay Stern, USFWS and Kelly Scribner, CTEH) - Plenary

- Using thresholds to estimate the sensitivity to oil of the resources at risk
    - Exposure
    - Sensitivity
    - Effect
- Risk ranking matrix = thresholds for levels of concern to use in characterizing risk

1430

Characterize Risk of No Response Action (oil only, plus monitoring) – Workgroups

1530

BREAK (15 Mins)

1545

Begin characterizing risks of initial response actions (1st timeframe) - Workgroups

Characterize the relative risk for the response actions in the initial 2-6 hours of response

1645

Wrap-up for the Day

- Workgroup reports on progress - Plenary
- Introduction to tomorrow (Walker)
- Questions/discussion (all)

1700

ADJOURN

Workshop 2 - Day 2

June 24, 2015

0800

Overview for the day – Plenary

- Review the results of the first day
- Review process for today
    - Complete risk characterization (assign levels of concern) for response actions in both timeframes
    - Capture caveats – uncertainties, limitations
    - Summarize recommendations for response planning going forward
    - Questions, comments, adjustments?

0830

Complete 1st timeframe - Plenary

0915

Begin work on characterizing response action risks for 2nd timeframe – Workgroups

Characterize the relative risk for the response actions over the first 4-7 days of response

1015

BREAK (30 mins.)

1230

LUNCH (1 Hour) - provided

1330

Continue/complete characterization of risks for 2nd timeframe - Workgroups

1445

BREAK (then return to workgroup)

1520

Report out – risk ranking scores – Plenary

- **Limitations**
- **Uncertainty**
- **Response recommendations**

1600

Participant Feedback on ERA Process– Plenary

1615

Next steps– Plenary

1630

ADJOURN

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Appendix D: Resources at Risk Table

Habitat	Sub habitats	Resource Category	Example Organisms (includes state-listed species)
On-land and on-water socio-economic areas	Work area (e.g., hot and warm zones), plus general public areas	Workers	First responders and pollution responders (on water/on land) involved in safety monitoring, oil recovery operations (on water/on land), oil contamination monitoring/SCAT
		Residential community	All - adults and adolescents; also children, elderly, and sick (single and multi-family residences)
		Sensitive receptors	Children, elderly, sick (daycares, hospitals, and nursing homes)
		Commercial community	Adults (retail, other commercial facilities)
		Industrial community	Adults (nearby refineries, plants, etc.)
		Transportation community	Potentially all (rail, marine, roads: drivers, passengers)
Artificial Shorelines	Bulkheads, riprap, manmade structures, pavement	Mammals, aquatic, and non-aquatic dependent	River otter, raccoon, muskrat, and bats
		Birds, aquatic, and non-aquatic dependent	Waterfowl, wading birds, shorebirds, song birds, raptors, and gulls
		Reptiles and amphibians	Diamondback terrapin, frogs, and salamanders
		Macro-invertebrates	Oysters, mussels, barnacles, crabs, and periwinkle
		Other invertebrates	Insects, spiders, and zooplankton
		T/E species - animals	Peregrine falcon and northern long-eared bat
		T/E species (or rare) - plants	None identified
Natural Terrestrial Shorelines	Vegetated (trees, shrub/scrub wetlands, grass), sand, and gravel	Mammals, aquatic, and non-aquatic dependent	River otter, raccoon, muskrat, and bats
		Birds, aquatic, and non-aquatic dependent	Waterfowl, wading birds, shorebirds, song birds, and raptors
		Reptiles and amphibians, aquatic and non-aquatic dependent	Diamondback terrapin, frogs, and salamanders
		Macro-invertebrates	Oysters, mussels, barnacles, dragonfly nymph, planktonic fish eggs, and crabs
		Aquatic vertebrates	Mummichog, Atlantic silverside, and bay anchovy
		T/E species - animals	Osprey, northern long-eared bat; also bald eagle still of concern although now recovered
		T/E species (or rare) - plants	Swamp pink, long-lobed arrowhead, wild rice, and swamp beggar-ticks

Habitat	Sub habitats	Resource Category	Example Organisms (includes state-listed species)
Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 to 1) meter	Marsh, swamp, tidal flats, sand beaches, cobble/boulder beach (at the water / land or water / air interface)	Mammals, aquatic and non-aquatic dependent	River otter, raccoon, muskrat, bats, and marsh rice rat
		Birds, aquatic and non-aquatic dependent	Waterfowl, wading birds, shorebirds, song birds, raptors, gulls
		Reptiles and amphibians	Diamondback terrapin, snapping turtle, and sea turtles
		Macro-invertebrates	Oysters, mussels, barnacles, dragonfly nymph, planktonic fish eggs, and horseshoe crabs
		T/E species - animals	Red knot, least bittern (shorebirds), southern leopard frog, and threespine stickleback
		T/E species - plants	Long-lobed arrowhead, wild rice, swamp beggar-ticks, seabeach amaranth, Wright's spike rush, Walter's barnyard grass, and Smith's bullrush
		Plants – submerged and floating aquatic vegetation	Water hyacinth, spatterdock, arrow arum, wild celery, and phytoplankton
		Fishing – commercial or recreational	Oysters, mussels, blue crab, flounder, bluefish, weakfish striped bass, and American shad
		Water intake - surface	Surface water – industrial or drinking water
Mid-water (0 to 2 meters)	Water column	Mammals, aquatic dependent	River otter
		Birds	Ducks, geese, cormorant, and gulls
		Reptiles	Snapping turtles and sea turtles
		Aquatic vertebrates	Mummichog, Atlantic silverside, bay anchovy
		Macro-invertebrates (incl. larval life stage)	Dragon fly nymph; larval clams, oysters, and crabs
		Plants – submerged and floating aquatic vegetation	Water hyacinth, spatterdock, arrow arum, wild celery, and phytoplankton
		T/E species - animals	Osprey, hickory shad, banded sunfish, threespine stickleback, and eastern redbelly turtle
		T/E species - plants	None identified
		Fishing – commercial and recreational	Oysters, mussels, blue crab, flounder, bluefish, weakfish, stripped bass, and American shad
		Water intakes - midwater	Surface water – industrial or drinking water

Habitat	Sub habitats	Resource Category	Example Organisms (includes state-listed species)
Benthic (bottom, >2 meters)	Attached or associated with the bottom of the water column / seabed	Aquatic vertebrates	Seals, river otter, mummichog, perch, sturgeon, sea turtles, dolphin, and porpoise
		Macro-invertebrates (incl. larval life stage)	Oysters, mussels, clams, worms, planktonic fish eggs, and crabs
		Aquatic invertebrates	Phytoplankton, zooplankton, and algae
		Plants – submerged aquatic vegetation	None identified
		T/E species - animals	Short-nosed sturgeon and Atlantic sturgeon
		T/E species - plants	None identified
		Fishing – commercial and recreational - bottom	Shrimp, scallop, and blue crab
		Water intakes - midwater	Industrial or drinking water

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Appendix E: Response Actions Table

Summary of Response Actions	
Response Action	**No Response Action – Natural Attenuation and Monitoring**
Use	Natural attenuation relies on natural processes to decrease and "attenuate" concentrations of contaminants (oil) in soil, groundwater, and water. Monitoring typically involves collecting soil, groundwater, and water samples to analyze them for the presence of contaminants (oil) and other site characteristics. Allow natural attenuation for spills where oil is not recoverable and/or more environmental damage will occur from the response actions; or effective spill response resources are not available.
Examples/logistical considerations	Monitoring via sampling and other methods, networks of observers, sampling protocols, especially new methods for Group V oils (sunken dilbit crude oil after evaporation of light fractions).
Limitations	Environmental damage occurs to some extent. Public dissatisfaction with the oil spill response managers if dilbit oil sinks after light fractions evaporate and cannot be located or tracked; fisheries impacts.
Effectiveness	Attenuation may be prudent for Bakken crude oil. Dilbit being much more persistent will probably not be a candidate for attenuation on land. Monitoring would likely be required for both oil types; monitoring effectiveness over time on land will be more practical than in water.
Response Action	**Fire – Let Burn and Controlled Burn (both in-situ)**
Use	Allow rail cars to burn themselves out, or control the burn to reduce impacts of spilled oil to the environment.
Examples/logistical considerations	Water cooling streams, fireboats, air monitoring, and structural exposure protection.
Limitations	Access to water supply, frac tanks, high flow pumps, and nozzles.
Effectiveness	Ability to get close enough for effective cooling, potential for "heat-induced tear" in the shell of a rail car.
Response Action	**Fire – Extinguishing agent and methods**
Use	Strategies, methods, and people and equipment resources to extinguish a crude oil rail car fire.
Examples/logistical considerations	Foam availability to extinguish a rail car fire, and potential involvement of adjacent rail cars. Access to dry chemical agents, fire boom, and fire boats.
Limitations	Access to sufficient quantity of foam, dry chemical agents, fire boom, and fire boats. Need access to high volume fire pumps and nozzles. Requires highly skilled personnel.

Summary of Response Actions	
Effectiveness	Very effective if resources arrive quickly; before adjacent rail cars are heated and tears in shells of rail cars occur.
Response Action	**No Fire – Vapor Suppression**
Use	Use of a blanket of vapor suppression agents to reduce the vapors being released from pooled crude oil to reduce the risk of fire, and to provide a safe environment for the population and responders.
Examples/logistical considerations	Sufficient quantity of foam, and Subpart J products, such as herding agents, encapsulators, absorbents (Imbiber Beads), intrinsically safe vacuum pumps/trucks, PPE, and air monitoring.
Limitations	Foam application on a U.S. water body may not be allowed. Large area coverage may be needed. Applicator needs to be close enough, and have sufficient quantity to sustain coverage.
Effectiveness	Effective for pooled crude oil in containment (boom, drainage ditch, and small creek. Large area coverage is more difficult.
Response Action	**No Fire – Oil Spread Control – On land, on-water, underwater**
Use	Use of strategies, methods, and resources to control the spread of spilled crude oil on water.
Examples/logistical considerations	Containment/ deflection boom, sorbents, pneumatic curtains, turbidity curtain, dams/dikes, interceptor trenching, underflow dams, and pre-staged boom.
Limitations	Sufficient quantity boom, speed of deployment is critical to reduce spread, controlling spread of submerged oil is challenging, tide/current/ice can hamper control actions.
Effectiveness	Very effective if deployed correctly based on current speed. Turbidly, silt, and pneumatic curtain effectiveness may be impacted by current, and difficult to hold in place. Tidal range of Delaware River exposes mud flats at low tide.
Response Action	**No Fire – On-water Recovery, Underwater Recovery**
Use	Recovery of crude oil from water for disposal and possible reuse to prevent or minimize sensitive shoreline resources and habitat.
Examples/logistical considerations	Booms, self-propelled skimmers, stationary skimmers, and advancing skimmers (brush, drum, weir, and dynamic Inclined Plane). Collection booming, nets, trawls, pumps, dredge, divers, vacuum system, airlift, and bottom trawls.
Limitations	Type of skimmer must be selected for the type of oil. Submerged oil difficult to locate – impacting recovery methods. Low visibility will impair diver's ability to see oil. Recovery amount is encounter rate dependent.

Summary of Response Actions	
Effectiveness	Brush skimmers are very effective and efficient for heavy oils (dilbit). DIP and drum skimmer very effective for light oils (Bakken). Heavy sediment load and current in Delaware River can impact recovery of submerged oil. Diver effectiveness impaired by low visibility, and differentiating oil from mud.
Response Action	**No Fire – Resource Protection**
Use	Sensitive area protection strategies (ACP), protection booming strategies, deflection booming to protect sensitive areas, water intakes, and fisheries.
Examples/logistical considerations	12’ boom for protection/deflection due to shallow water in Delaware River Creeks, and ease of use. 18” boom for deeper water areas. Turbidity and silt curtain used for submerged oil. Pneumatic curtains, dams/dikes, interceptor trenching, underflow dams, and pre-staged boom.
Limitations	Many sensitive areas identified in the ACP are creeks with shallow water. Exposed mud flats at low tide may impact placement of protection boom. Current and tide necessitates boom to be tended at every tide cycle. Many mid-river sites in the Delaware River have been tested for a spill scenario occurring in the River, but none have been tested for a spill source in the creeks. NJ shoreline along the Delaware Bay is very porous and difficult to protect.
Effectiveness	Protection strategies for floating oils are very effective in areas tested. Protection strategies for non-floating oils are much less effective.
Response Action	**No Fire – Shoreline Clean up**
Use	Removal of oil from the shoreline for disposal to prevent further contamination of sensitive areas and habitat.
Logistics	Mechanical recovery systems – skimmers, vacuum trucks, storage tanks, sorbent, hand tools, laborers, PPE, and Subpart J agents.
Limitations	Debris removal, recovery method based on shoreline type and oil type, access may be difficult, impacted habitat.
Effectiveness	Depends on many factors; oil type – heavy vs. light, amount of debris, and tide range impacts work schedule.
Response Action	**No Fire – Oil Detection/Mapping (physical contact methods)**
Use	Strategies, methods, and resources used to detect oil by physically sampling oil for movement, location, and physical properties.
Logistics	Water samples, trawls, underwater sentinels, monitoring stations, oil detection sensors, crab pots, Vessel Submerged Oil Recovery System (VSORS), snare samplers, and ROV.
Limitations	Develop sampling protocol to adequately cover the impacted areas, tide, and current spread oil quickly covering large areas. Determining sampling location may be difficult for

Summary of Response Actions	
	submerged oil, movement of oil depends on many factors – dynamic situation depends on conditions, e.g. winds, temp, and ice.
Effectiveness	Effectiveness limited by absence of a full suite of technological methods to detect oil and map its extent of contamination in all subsurface environments (water column or benthos). Some methods exist, but this is an active R&D area.
Response Action	**No Fire – Oil Detection/Mapping (remotely-observed methods)**
Use	Remotely monitor the movement of oil in the environment.
Logistics	Overflights and other visual observations, aircraft laser sensor, and other remote sensing systems (IR, FLIR), photo bathymetric, underwater visual by divers or ROV, sonar, laser fluorosensor, side-scan sonar, and multi-beam sonar.
Limitations	Availability of equipment and operator, data interpretation, and sampling protocol must be developed.
Effectiveness	Effectiveness limited by absence of a full suite technological methods to detect oil and map its extent of contamination in all subsurface environments (water column or benthos). Some methods exist, but this is an active R&D area.

Appendix F: Firefighting Foam MSDS

MATERIAL SAFETY DATA SHEET

by Tyco Fire Suppression & Building Products

PKW

Product Code: 2011-2-006 ANa Issue Date: 07-21-2010

1. Product and Company Identification

Material name	**PKW**
Version #	01
Revision date	07-21-2010
CAS #	Mixture
Product Code	2011-2-006 ANa
Product use	Fire extinguishing agent
Manufacturer / Importer / Supplier	
Name	Tyco Fire Suppression and Building Products
Address	One Stanton Street Marinette, WI 54143-2542
Phone	715-735-7411
Internet	http://www.ansul.com
Emergency Phone Number	CHEMTREC 800-424-9300 or 703-527-3887

2. Hazards Identification

Emergency overview	WARNING Irritating to eyes and skin. Prolonged exposure may cause chronic effects.
Potential health effects	
Routes of exposure	Eye contact. Skin contact. Inhalation. Ingestion.
Eyes	Contact with eyes may cause irritation.
Skin	Avoid contact with the skin. May cause skin irritation.
Inhalation	Inhalation of dusts may cause respiratory irritation.
Ingestion	Not a likely route of entry.
Target organs	Eyes. Respiratory system. Skin.
Signs and symptoms	Irritation of eyes and mucous membranes.

3. Composition / Information on Ingredients

Non-hazardous components	CAS #	Percent
Silicone fluid	63148-57-2	0.5 - 1.5
Purple Pigment	68647-14-3	1 - 5
MICA	12001-26-2	1 - 5
FULLERS EARTH	8031-18-3	1 - 5
POTASSIUM BICARBONATE	298-14-6	60 - 100

4. First Aid Measures

First aid procedures	
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention if irritation persists after washing.
Skin contact	Wash off with warm water and soap. Get medical attention if irritation develops and persists.
Inhalation	Move to fresh air.
Ingestion	Rinse mouth. Do not induce vomiting without advice from poison control center. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.

General advice	If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance.

5. Fire Fighting Measures

Extinguishing media

Suitable extinguishing media	This product is not flammable. Use extinguishing agent suitable for type of surrounding fire.

Protection of firefighters

Specific hazards arising from the chemical	None known.
Protective equipment for firefighters	None known.
Special protective equipment for fire-fighters	None known.

Explosion data

Sensitivity to mechanical impact	Not available.
Sensitivity to static discharge	Not available.
Hazardous combustion products	Carbon monoxide and carbon dioxide.

6. Accidental Release Measures

Personal precautions	Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Avoid inhalation of dust from the spilled material. Wear a dust mask if dust is generated above exposure limits.
Environmental precautions	Do not contaminate water.
Methods for containment	If sweeping of a contaminated area is necessary use a dust suppressant agent which does not react with the product. Prevent entry into waterways, sewer, basements or confined areas.
Methods for cleaning up	Should not be released into the environment. Sweep up or vacuum up spillage and collect in suitable container for disposal. Collect dust using a vacuum cleaner equipped with HEPA filter. Avoid the generation of dusts during clean-up. Clean up in accordance with all applicable regulations. Following product recovery, flush area with water.
Other information	Clean up in accordance with all applicable regulations.

7. Handling and Storage

Handling	Minimize dust generation and accumulation. Provide appropriate exhaust ventilation at places where dust is formed. Do not breathe dust. Avoid contact with eyes. Wash thoroughly after handling. Wear personal protective equipment.
Storage	Store in a well-ventilated place. Guard against dust accumulation of this material. Use care in handling/storage.

8. Exposure Controls / Personal Protection

Occupational exposure limits

Canada - British Columbia

Components	Type	Value	Form
MICA (12001-26-2)	TWA	3.0000 mg/m3	Respirable.

Canada - Ontario

Components	Type	Value	Form
MICA (12001-26-2)	TWA	3.0000 mg/m3	Respirable.

Canada - Quebec

Components	Type	Value	Form
MICA (12001-26-2)	TWA	3.0000 mg/m3	Respirable dust.

Personal protective equipment	
Eye / face protection	Wear safety glasses with side shields (or goggles).
Skin protection	Wear chemical protective equipment that is specifically recommended by the manufacturer. It may provide little or no thermal protection.
Respiratory protection	In the case of respirable dust and/or fumes, use self-contained breathing apparatus.

9. Physical & Chemical Properties

Appearance	
Form	Powder.
Color	Violet.
Odor	Odorless.
Physical state	Solid.
pH	Not available.
Melting point	Not available.
Freezing point	Not available.
Boiling point	Not available.
Flash point	Not available.
Evaporation rate	Not available.
Flammability limits in air, upper, % by volume	Not available.
Flammability limits in air, lower, % by volume	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Specific gravity	Not available.
Relative density	Not available.
Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not available
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.

10. Chemical Stability & Reactivity Information

Chemical stability	Material is stable under normal conditions.
Incompatible materials	Strong acids.
Hazardous decomposition products	Carbon oxides.

11. Toxicological Information

Toxicological information	The toxicity of this product has not been tested.
Chronic effects	Prolonged inhalation may be harmful. Not expected to be hazardous by WHMIS criteria.

12. Ecological Information

Ecotoxicity	This product has no known eco-toxicological effects.
Persistence and degradability	Not available.
Partition coefficient (n-octanol/water)	Not available

13. Disposal Considerations

Disposal instructions	Dispose of contents/container in accordance with local/regional/national/international regulations. Dispose of waste material according to Local, State, Federal, and Provincial Environmental Regulations.
Waste from residues / unused products	Dispose of in accordance with local regulations.

14. Transport Information

TDG

Not regulated as dangerous goods.

15. Regulatory Information

Canadian regulations	This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.
WHMIS status	Non-controlled

Inventory status

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	No
Canada	Domestic Substances List (DSL)	No
Canada	Non-Domestic Substances List (NDSL)	Yes
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	No
New Zealand	New Zealand Inventory	No
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	No
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

16. Other Information

Further information	HMIS® is a registered trade and service mark of the NPCA.
HMIS® ratings	Health: 1 Flammability: 0 Physical hazard: 0
NFPA ratings	Health: 1 Flammability: 0 Instability: 0
Disclaimer	The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.
Issue date	07-21-2010

Thunderstorm FC-601A

MATERIAL SAFETY DATA SHEET

Date Prepared: 3/26/2010
Supersedes Date: New

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: **Thunderstorm FC-601A**

Chemical Family: Surfactant mixture, fire fighting foam concentrate, aqueous film forming foam.

Company Identification: Chemguard, Inc.
204 South 6th Avenue
Mansfield, Texas 76063 USA
(817) 473-9964 (For Product Information)
(817) 473-9964 (For Emergency Information)
www.chemguard.com

2. COMPOSITION / INFORMATION ON INGREDIENTS

CONTAINING: HAZARDOUS AND/OR REGULATED COMPONENTS

Chemical Name	Percentage	CAS Number	OSHA Hazard
Water	Balance	7732-18-5	NO
Diethylene glycol monobutyl ether	4 – 13 %	112-34-5	YES
Polysaccharide gum	1 – 2 %	Proprietary	YES
Proprietary hydrocarbon surfactants	NA	Proprietary	YES
Proprietary fluorosurfactants	NA	Proprietary	YES

COMPOSITION NOTES:

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
WARNING! MAY CAUSE EYE AND/OR SKIN IRRITATION

Routes of Exposure:

Eye Contact: Exposure during the handling or mixing may cause immediate or delayed irritation or inflammation.

Skin Contact: Exposure during the handling or mixing may cause immediate or delayed irritation or inflammation.

Ingestion: Ingestion of large quantities may cause abdominal cramps, nausea, vomiting, diarrhea.

Inhalation: Exposure to this product in excess of the applicable TVL or PEL may cause or aggravate other lung conditions. Exposure to this product may cause irritation to the nose, throat, and upper respiratory system.

Chronic: None known

Medical Conditions which May be Aggravated by Inhalation or Dermal Exposure: Persons with unusual (hyper) sensitivity to chemicals may experience adverse reactions to this product.

Carcinogenic Potential: This product and its ingredients are not listed as a carcinogen by NTP, OSHA, ACGIH or IARC.

4. FIRST AID MEASURES

Eyes: Immediately flush eyes thoroughly with water. Continue flushing eye for at least 15 minutes, including under lids. Seek immediate medical attention.

Skin: In case of contact, immediately wash with plenty of soap and water for at least 5 minutes. Seek medical attention if irritation or redness occurs. Remove contaminated clothing and shoes. Clean contaminated clothing and shoes before re-use.

Ingestion: If victim is conscious and alert, give 2 – 3 glasses of water to drink. Do not induce vomiting without medical advice. Do not induce vomiting or give anything by mouth to an unconscious person. Seek immediate medical attention. Do not leave victim unattended. Vomiting may occur spontaneously. To prevent aspiration of swallowed product, lay victim on side with head lower than waist. If vomiting occurs and the victim is conscious, give water to further dilute the chemical.

Inhalation: If respiratory irritation or distress occurs remove victim to fresh air. Seek medical attention if respiratory irritation or distress continues. If breathing is difficult, give oxygen. If breathing as ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.

Notes to Physician: All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this product may have occurred.

5. FIRE FIGHTING MEASURES

Flash Point – No flash to boiling

Lower Explosive Limit – Not Applicable
Upper Explosive Limit – Not Applicable
Hazardous Combustion Products – None known
Unusual Fire & Explosion Hazards – Decomposition products may be toxic.

Extinguishing Media – Water, Foam, Carbon Dioxide, Dry Chemical, Halon
Special fire fighting Procedures – None
Auto Ignition Temperature – Not Applicable

6. ACCIDENTAL RELEASE MEASURES

Wear appropriate protective gear for the situation. See Personal Protection information in section 8.

Containment of Spill: Dike or retain dilution water or water from firefighting for later disposal. Follow procedure described below under cleanup and disposal of spills.

Cleanup and Disposal of Spill: Vacuum or pump into an appropriate storage container. For smaller spills use absorbent materials and dispose of properly. Washing area with water will create large amounts of foam.

Environmental and Regulatory Reporting: Runoff from fire control or dilution water may cause pollution. Spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies.

7. HANDLING AND STORAGE

Minimum/Maximum Storage Temperature: Store at temperatures of 35ºF - 120ºF.

Handling: Use with adequate ventilation.

Storage: Store in an area that is dry, well ventilated and in closed containers.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Where engineering controls are indicated by use conditions or a potential for excessive exposure exists, the following traditional exposure techniques may be used to effectively minimize employee exposures.

Eye Protection: When engaged in activities where product could contact the eye, wear safety glasses with side shields, goggles, or face shield.

Skin Protection: Skin contact should be minimized through use of latex gloves and suitable long sleeved clothing. Consideration must be given both to durability as well as permeation resistance.

Respiratory Protection: Avoid actions that cause dust exposure to occur. Use local or general ventilation to control exposures below applicable exposure limits. NIOSH or MSHA approved particulate filter respirators should be used in the context of respiratory protection program meeting the requirements of the OSHA respiratory protection standard [29 CFR 1910.134] to control exposures when ventilation or other controls are inadequate or discomfort or irritation is experienced. Respirator and/or filter cartridge selection should be based on American National Standards Institute (ANSI) Standards Z88.2 Practices for Respiratory Protection.

Ventilation: Use local exhaust or general dilution ventilation to control exposure within applicable limits.

Work Practice Controls:
Personal hygiene is an important work practice exposure control measure and the following general measures should be taken when working with or handling this material:
(1) Do not store, use, and/or consume foods, beverages, tobacco products, or cosmetics in areas where this material is stored.
(2) Wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics, or using the toilet.
(3) Wash exposed skin promptly to remove accidental splashes or contact with this material.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance – Thick liquid
Odor – Very slight solvent odor
Physical State – Liquid
Specific Gravity (H2O=1) – 1.021 – 1.051
pH 7.0 – 8.5

Vapor Pressure – Not Evaluated
Density – Not Evaluated
Boiling Point – 212ºF
Melting Point – 32ºF
Solubility in Water – 100% Soluble

10. STABILITY AND REACTIVITY

Stability: Stable.

Conditions to avoid: Unintentional contact with water.

Hazardous Polymerization: Hazardous polymerization will not occur.

Incompatibility with other materials: Strong oxidizers

Hazardous Decomposition: Oxides of nitrogen, sulfur, carbon.

11. TOXICOLOGICAL INFORMATION

Acute Eye and Skin Toxicity Data:
Toxicological Information and Interpretation:

	Concentration	Solution (As Used)
Eye Irritation:	Not evaluated	Not evaluated
Skin Irritation:	Not evaluated	Not evaluated
Acute Dermal LD50		
Acute Oral Effects:		
Acute Oral LD50		

Inhalation Toxicity: Not evaluated
Sensitization: Not evaluated
Teratology: Not evaluated
Mutagenicity: Not evaluated
Reproduction: Not evaluated

Chronic Toxicity:
This product does not contain any substances that are considered by OSHA, NTP, IARC or ACGIH to be “probable” or “suspected” human carcinogens.

12. ECOLOGICAL INFORMATION

Chemical Oxygen Demand: 304,000 mg/kg
Biological Oxygen Demand (5 Day) 141,000 mg/kg
Biodegradability (B.O.D./C.O.D.) 46%

13. DISPOSAL CONSIDERATIONS

Waste Disposal: Chemical additions, processing or otherwise altering this material may make the waste management information presented in this MSDS incomplete, inaccurate or otherwise inappropriate. Dispose of waste material according to local, state and federal regulations. Discharge to waste treatment facilities only with permission. Anti-foam agents may be used to reduce foaming in the waste streams. Do not incinerate.

14. TRANSPORTATION INFORMATION

Hazardous Materials Description/Proper Shipping Name: NOT REGULATED

Hazard Class: Not Applicable

Identification Number: Not Applicable

Required Label Text: Not Applicable

Hazardous Substances/Reportable Quantities: Not Applicable

15. REGULATORY INFORMATION

FEDERAL REGULATORY STATUS:

Status under OSHA Hazard Communication Standard, 29 CFR 1910.1200: This product is considered a "hazardous chemical" under this regulation, and does not need to be included in the employer's hazard communication program.

Reportable Quantities Under the Clean Water Act, CERCLA, and EPCRA, 40 CFR 117, 302 and 355:
The product contains no component regulated under section 304 (40 CFR 370).

Hazard Category and Applicability of EPCRA Hazardous Substance Inventory Reporting, 40 CFR 370:
Not listed

Applicability of EPCRA Toxic Chemical Release Inventory (TRI) Reporting. 40 CFR 372:
Not subject to TRI reporting

Status Under the Toxic Substances Control Act, 40 CFR 710:
All chemical(s) comprising this product are either exempt or listed on the TSCA Inventory.

SARA Title III Hazard Classes:

Fire Hazard:	NO
Reactive Hazard:	NO
Release of Pressure:	NO
Acute Health Hazard:	YES
Chronic Health Hazard:	NO

State Regulations:

California:
This product does not contain any components that are regulated under California Proposition 65.

Pennsylvania:
This product does not contain any components on the Pennsylvania Right to Know List.

16. OTHER INFORMATION

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**

Label Requirements:

WARNING! **MAY CAUSE EYE AND/OR SKIN IRRITATION**

Hazardous Material Information System (HMIS):	**Health**	**1**
	Flammability	**0**
	Reactivity	**0**
	Personal Protection	**A**

NFPA/HMIS Definitions: 0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme
Protective Equipment: Safety glasses, gloves

ADDITIONAL INFORMATION:

The information contained in this document is given in good faith and based on our current knowledge.

It is only an indication and is in no way binding, notably as regards infringement of, or prejudice to third parties through the use of our products. Chemguard guarantees that its products comply with its sales specifications. This information must on no account be used as a substitute for necessary prior tests which alone can ensure that a product is suitable for a given use. Users are responsible for ensuring compliance with local legislation and for obtaining the necessary certifications and authorizations.

END OF MSDS

National Foam

MATERIAL SAFETY DATA SHEET #NMS420

UNIVERSAL GOLD 1% / 3%

ALCOHOL RESISTANT AQUEOUS FILM FORMING FOAM (AR-AFFF)

Liquid Concentrate

Section 1. CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification
Product: Universal Gold 3%, Fire Fighting Foam Concentrate
Synonyms: Alcohol Resistant Aqueous Film Forming Foam (AR-AFFF)
CAS No: Mixture - No single CAS # applicable

Company Identification
Manufacturer:
National Foam, Inc.
180 Sheree Boulevard, Suite 3900
Exton, PA 19341
Emergency Phone Number (Red Alert): (610) 363-1400 (U.S.A.)
Fax: (610) 524-9073
www.nationalfoam.com

Section 2. COMPOSITION / INFORMATION ON INGREDIENTS

Components	CAS Number	% Weight
Water	7732-18-5	80-93%
Proprietary mixture of synthetic detergents	No single CAS # applicable	4-10%
(2-Methoxymethylethoxy) Propanol	34590-94-8	2-5%
Fluoroalkyl Surfactant	Confidential	0.5-2.0%
Polysaccharide	11138-66-2	0.5-2.0%

Section 3. HAZARDS IDENTIFICATION

Potential Health Effects

Inhalation
Vapors are minimal at room temperature. If product is heated or sprayed as an aerosol, airborne material may cause respiratory irritation.

Skin Contact
Contact with liquid may cause moderate irritation or dermatitis due to removal of oils from the skin.

Eye Contact
Product is an eye irritant.

Ingestion
Not a hazard in normal industrial use. Small amounts swallowed during normal handling operations are not likely to cause injury; swallowing large amounts may cause injury or irritation.

Additional Health Effects
Existing eye or skin sensitivity may be aggravated by exposure.

Carcinogenicity Information
No data available.

Section 4. FIRST AID MEASURES

Inhalation
No specific treatment is necessary since this material is not likely to be hazardous by inhalation. If exposed to excessive levels of airborne aerosol mists, remove to fresh air. Seek medical attention if effects occur.

Skin Contact
In case of skin contact, wash off in flowing water or shower. Launder clothing before reuse.

Eye Contact
In case of eye contact, flush eyes promptly with water for 15 minutes. Retract eyelids often to ensure thorough rinsing. Consult a physician if irritation persists.

Ingestion
Swallowing less than an ounce is not expected to cause significant harm. For larger amounts, do not induce vomiting. Give milk or water. Never give anything by mouth to an unconscious person. Seek medical attention.

Section 5. FIRE FIGHTING MEASURES

Flammable Properties
Flash Point: >200°F

Fire and Explosion Hazards
Avoid contact with water reactive materials, burning metals and electrically energized equipment.

Extinguishing Media
Product is an extinguishing media. Use media appropriate for surrounding materials.

Special Fire Fighting Instructions
This product will produce foam when mixed with water.

Section 6. ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)
NOTE: Review FIRE FIGHTING MEASURES and HANDLING (Personnel) sections before proceeding with clean-up. Use appropriate Personal Protective Equipment during clean-up.

Accidental Release Measures

Concentrate
Stop flow if possible. Use appropriate protective equipment during clean up. For small volume releases, collect spilled concentrate with absorbent material; place in approved container. For large volume releases, contain and collect for use where possible. Flush area with water until it no longer foams. Exercise caution, surfaces may be slippery. Prevent discharge of concentrate to waterways. Disposal should be made in accordance with federal, state and local regulations.

Foam/Foam Solution
See above. Flush with water. Prevent discharge of foam/foam solution to waterways. Do not discharge into biological sewer treatment systems without prior approval. Disposal should be made in accordance with federal, state and local regulations.

Section 7. HANDLING AND STORAGE

Handling (Personnel)
Avoid contact with eyes, skin or clothing. Avoid ingestion or inhalation. Rinse skin and eyes thoroughly in case of contact. Review HAZARDS and FIRST AID sections.

Storage
Recommended storage environment is between 35°F (2°C) and 120°F (49°C). Store product in original shipping container or tanks designed for product storage.

Section 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls
Special ventilation is not required.

Personal Protective Equipment

Respiratory
Recommended exposure limits (OSHA-PEL and ACGIH-TLV) have not been determined for this material. The need for respiratory protection should be evaluated by a qualified health specialist.

Protective Clothing
Rubber or PVC gloves recommended.

Eye Protection
Safety glasses, face shield or chemical splash goggles must be worn when possibility exists for eye contact. Contact lenses should not be worn. Eye wash facilities are recommended.

Other Hygienic Practices
Use good personal hygiene practices. Wash hands before eating, drinking, smoking, or using toilet facilities. Promptly remove soiled clothing and wash thoroughly before re-use.

Exposure Guidelines

Exposure Limits
(2-Methoxymethylethoxy) Propanol (34590-94-8)

PEL(OSHA)
100 ppm, 8 hr. TWA Skin
150 ppm, 15 min. STEL Skin

TLV (ACGIH)
100 ppm, 8 hr. TWA Skin
150 ppm, 15 min. STEL Skin

Section 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Boiling Point:	Not applicable
Vapor Pressure:	Not applicable
Vapor Density:	Not applicable
Melting Point:	Not applicable

Evaporation Rate:	<1 (Butyl Acetate = 1.0)
Solubility in Water:	100%
pH:	8.0
Freezing Point:	26°F (-3°C)
Specific Gravity:	1.025 @ 25°C
Odor:	Mild, pleasant
Form:	Viscous liquid
Color:	Amber

Section 10. STABILITY AND REACTIVITY

Chemical Stability
Stable.

Incompatibility, Materials to Avoid
Avoid use of product on burning metals, electrically-energized equipment and contact with water reactive materials.

Polymerization
Will not occur.

Section 11. TOXICOLOGICAL INFORMATION

Mammalian Toxicity

Ingestion
This material was not toxic when administered to Wistar Albino rats at an acute oral dose of 5g/kg body weight.

Eye
Animal testing indicates this material is a primary eye irritant when tested undiluted on New Zealand Albino Rabbits.

Skin
Animal testing indicates this material is not a primary skin irritant when tested undiluted on New Zealand Albino Rabbits.

Inhalation
No data available at this time.

Carcinogenic, Developmental, Reproductive, Mutagenic Effects
No data available on this material.

Section 12. ECOLOGICAL INFORMATION

Ecotoxicological Information Aquatic Toxicity
96 hr. Flow Through LC_{50} for Fathead Minnows (pimephales promelas) is reported to be greater than 500 ppm.

Environmental Fate

BOD_5	Concentrate	91,500 mg/kg
COD	Concentrate	290,000 mg/kg

Section 13. DISPOSAL CONSIDERATIONS

Universal Gold, as sold, is not a RCRA-listed waste or hazardous waste as characterized by 40 CFR 261. However, State and local requirements for waste disposal may be more restrictive or otherwise different from Federal regulations. Therefore, applicable local and state regulatory agencies should be contacted regarding disposal of waste foam concentrate or foam/foam solution.

Concentrate
Do not discharge into biological sewer treatment systems without prior approval. Specific concerns are high BOD load and foaming tendency. Low dosage flow rate or antifoaming agents acceptable to the treatment plant may be helpful. Do not flush to waterways. Disposal should be made in accordance with federal, state and local regulations.

Foam/Foam Solution
Universal Gold foam solution can be treated by waste water treatment facilities. Discharge into biological sewer treatment facilities may be done with prior approval. Specific concerns are high BOD load. Dilution will reduce BOD and COD factors proportionately. Low dosage flow rate or antifoaming agents acceptable to the treatment plant may be helpful. Do not flush to waterways. Disposal should be made in accordance with federal, state and local regulations.

NOTE: As a service to our customers, National Foam has approvals in place with disposal facilities throughout the U.S. for waste water treatment and solidification and landfill of our foam liquid concentrates and foam solutions. If required, National Foam, Inc. can also provide information on the disposal of drums used for shipping our concentrates. Please contact National Foam's Risk Management Administrator at (610) 363-1400 for additional information.

Section 14. TRANSPORTATION INFORMATION

Shipping Information
Proper Shipping Name: Fire Extinguisher Charges or Compounds N.O.I., Class 70
National Motor Freight Code: 69160 Sub 0
Hazard Class: None
UN Number: None

Section 15. REGULATORY INFORMATION

U.S. Federal Regulations

Toxic Substances Control Act (TSCA)
All components of this product are listed in the TSCA inventory.

Superfund Amendments and Reauthorization Act of 1986 (SARA), Title III

Section 302/304
There are no components of this material with known CAS numbers which are on the Extremely Hazardous Substances (EHS) list.

Section 311 & 312
Based on available information, this material contains the following components which are classified as the following health and/or physical hazards according to Section 311 & 312:
(2-Methoxymethylethoxy) Propanol 34590-94-8 (Flammability)

Section 313
This material does not contain any chemical components subject to Section 313 reporting requirements.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA)
This material does not contain any components subject to the reporting requirements of CERCLA.

OTHER REGULATORY INFORMATION
Canadian Environmental Protection Act (CEPA). All ingredients are listed on the DSL (Domestic Substance List).

STATE REGULATIONS

PENNSYLVANIA RIGHT-TO-KNOW HAZARDOUS SUBSTANCES LIST

PA Hazardous Substances present at levels greater than 1%:
(2-Methoxymethylethoxy) Propanol 34590-94-8

Section 16. OTHER INFORMATION

NFPA Rating

Health 0
Flammability 0
Reactivity 0

WHMIS Rating

D2B

ADDITIONAL INFORMATION

Preparation Date/Revision Number.......................10/24/13

For further information, see National Foam Product Data Sheet for Universal Gold 1% / 3%.

The information contained herein is furnished without warranty either expressed or implied. This data sheet is not a part of any contract of sale. The information contained herein is believed to be correct or is obtained from sources believed to be generally reliable. However, it is the responsibility of the user of these materials to investigate, understand and comply with federal, state and local guidelines and procedures for safe handling and use of these materials. National Foam, Inc. shall not be liable for any loss or damage arising directly or indirectly from the use of this product and National Foam, Inc. assumes no obligation or liabilities for reliance on the information contained herein or omissions herefrom.

October 24, 2013

Appendix G: Conceptual Models

Conceptual Model:

The conceptual model depicts the connections between the resources of concern (human health/socio-economic and ecological) and their potential to be exposed to hazards (exposure pathway) for 5 incident scenarios. The numbers in the cells represent the path by which a hazard can affect a resource. This is our record of our reasoning about the concern for that resource. NA represents the absence of a connection between a potential hazard and the resource of concern.

Hazards/exposure pathways:

1. Air pollution – vapors, direct affects from respiratory issues for air breathers.
2. Aqueous exposure – direct affects from aquatic respiration and dermal exposure to oil and oil components dissolved within the water column; may be short-lived exposure with the potential for high consequence for impacted species. Excludes submerged oil globules.
3. Physical trauma (mechanical impact from equipment, aircraft, people, boats, etc.) – direct affects from physical impact on individual species.
4. Oiling/smothering – direct affects from dermal contact with oil; skin (hypothermia), mucosal membranes (eyes, nares, etc.); indirect affects or secondary impacts could include ingestion (preening). May include contact with submerged oil globules.
5. Thermal (heat exposure from fire) – direct affects from oil burning; impacts from exposure to a fire/burn (not dermal exposure to the oil).
6. Waste – direct affects from being removed and managed from the system
7. Ingestion (food web, etc.) – resources indirectly exposed to oil or its constituents via ingestion of oil or contaminated/affected prey.
8. Advisory/Closure – prohibit action of use (e.g., commercial or recreational fishery, water intake); protection from possible exposure. N/A = no interaction or no effect

Oil Type:

B1 = Bakken – surface;
B2 – Bakken within water column due to natural dispersion; D1 = Dilbit before evaporation of light fractions;
D2 = Dilbit after evaporation of light fractions

BAKKEN Oil Characteristics: It will quickly spread into thin slicks, with significant amounts of the lighter fractions lost via evaporation (which can result in serious explosion/fire and inhalation risks). Bakken crude contains moderate concentrations of toxic (soluble) compounds, thus can poses risks to aquatic resources. In addition, it will oil and penetrate into intertidal habitats, causing the potential for fouling of riverine habitats and long-term contamination of sediments.

DILBIT Oil Characteristics: Diluted bitumen, or dilbit, is bitumen, a heavy oil, that has been blended with one or more light petroleum products, such as condensate (the oil co-produced from a gas well) or a naphtha-based oil. Once released, dilbit will initially behave as a medium crude oil. However, it will rapidly lose the volatile fraction of the diluent through evaporation, leaving behind the viscous bitumen. The diluents have high percentages of toxic, water- soluble components, resulting in greater risks to water-column organisms compared to heavier oils. Acutely toxic impacts from the diluent could be relatively severe, but limited to a localized area. Depending on the density of the bitumen, the residue may float or sink; depending on the viscosity, pour point, and ambient temperatures, they will spread into slicks or congeal into tarballs and tarmats; depending on what they were blended with, they can change properties over time. SCAT and Operations teams should be asked to observe and report any burial or sinking.

SCENARIO 1 Conceptual Model: Human Health/Socio-economic Resources of Concern

Habitat	Human Health and Safety					
Sub habitats	Work Area (e.g., hot and warm zones), plus Public Health (Transportation, Industrial, Residential/Recreational Communities)					
Oil Type	B1	B1	B1	B1	B1	B1
Resources of Concern (Socio- economic)	**Workers**	**Residential Community**	**Sensitive Receptors**	**Commercial Community**	**Industrial Community**	**Transportation Community**
Human health and safety receptors relevant to this ERA	First responders (on water/on land), safety monitoring, oil recovery operations (on water/on land), oil contamination monitoring/SCAT	All - Adults, Adolescents; also children, elderly, sick (Personal Residences)	Children, Elderly, Sick (Daycares, Hospitals, Nursing Homes)	Adults (Shops, General Commercial Facilities)	Adults (Nearby Refineries, Plants, etc.)	Mostly Adults (rail, marine, roads: drivers, passengers)
Response Actions - Actionable Oil						
No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	1,3,8	1, 8	1, 8	1, 8	1, 8	
Fire						
Let burn and controlled burn (both in-situ)	1,3, 5,8	1,5,7,8	1,5,7,8	1,5,7,8	1,5,7,8	
Extinguishing agents and methods	1,3, 5,8	1,5,7,8	5,7,8	1,5,7,8	1,5,7,8	
No Fire						
Vapor suppression	1,3,8	1,7,8	1,7,8	1,7,8	1,7,8	
Oil spread control	1,3,6,8	1,8	1,8	1,7,8	1,7,8	
On-water oil recovery	1,3,6,8	1,8	1,8	1,8	1,8	
Resource protection	1,3,6,8	1,8	1,8	1,8	NA	
Shoreline clean up	1,3,6,7,8	1,8	1,8	1,8	1, 2, 7	
Oil Detection/mapping - **remotely observed methods**	NA	NA	NA	NA	NA	

SCENARIO 1 Conceptual Model: Ecological Resources of Concern

Habitat	Artificial Shorelines						Natural Terrestrial Shorelines						Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)								Mid-water (0 to 2 meters)									Benthic (bottom, >2 meters)						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						Vegetated (Trees, shrub/scrub wetlands, etc.), Grass, Sand, Gravel						Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach (at the water / land or water / air interface)								Water Column									(Attached or associated with the Bottom of the Water Column / Seabed)						
Oil Type	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2
Resources of Concern	Mammals, Aquatic & non-aquatic dependent	Birds, Aquatic & non-aquatic dependent	Reptiles and Amphibians, Aquatic & non-aquatic dependent	Macro-Invertebrates	Other Vertebrates	T/E species	Mammals, Aquatic & non-aquatic dependent	Birds, Aquatic & non-aquatic dependent	Reptiles, Aquatic & non-aquatic dependent	Macro-Invertebrates	Aquatic Vertebrates	T/E species	Mammals, Aquatic & non-aquatic dependent	Birds, Aquatic & non-aquatic dependent	Reptiles, Aquatic & non-aquatic dependent	Macro-Invertebrates	T/E species	Plants – submerged & floating aquatic vegetation	Fishing – Commercial or Recreational	Water Intake - Surface	Mammals, Aquatic dependent	Birds, Aquatic dependent (diving ducks)	Reptiles, Aquatic & non-aquatic dependent	Aquatic Vertebrates – fish, reptiles, amphibians	Macro-invertebrates – larval life stage	Plants – submerged & floating aquatic vegetation	T/E Species	Fishing – Commercial or Recreational	Water Intakes - midwater	Aquatic Vertebrates – fish, reptiles, amphibians	Macro-invertebrates	Aquatic invertebrates	Plants – submerged aquatic vegetation	T/E Species	Fishing – Commercial or Recreational - Bottom	Water Intakes - midwater
Response Actions - Actionable Oil																																				
No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	1, 4, 7	1,4,7	N/A	2,4,7,8	N/A	N/A	1, 4, 7	1,4,7	N/A	2,4,7,8	1,2,3,7 ,8	N/A	1,2,4,7	1,2,4,7	1,2,3,4,7	2,4,7,8	N/A	2,3,4	8	8	1,2,4,7	1,2,4,7	N/A	1,2,3,7 ,8	2,4,7,8	N/A	N/A	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fire																																				
Let burn and controlled burn (both in-situ	1,5	1,4,5,7	N/A	2,4,5,7 ,8	N/A	N/A	1,5	1,4,5,7	N/A	2, 4,5,7,8	2,3,7,8	N/A	1,2,4,5,7	1,2,4,7	1,2,3,4,5 ,7	2,4,5,7,8	N/A	2,3,4,5	8	8,5	1,2,4,5 ,7	1,2,4,7	N/A	2,3,7,8	2,4,5,7 ,8	N/A	N/A	8	8,5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Extinguishing agents and methods	1,3,4,5 ,7	1,3,4,5 ,7	N/A	2,4,5,7 ,8	N/A	N/A	1,3,4,5 ,7	1,3,4,5 ,7	N/A	2, 4,5,7,8	2,3,4,7 ,8	N/A	1,2,4,5,7	1,2,3,4,5 ,7	1,2,3,4,5 ,7	1,2,3,4,7 ,8	N/A	2,3,4,5	8	8,5	1,2,4,5 ,7	1,2,3,4 ,5,7	N/A	2,3,4,7 ,8	1,2,3,4 ,7,8	N/A	N/A	8	8,5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No Fire																																				
Vapor suppression	1,3,4,7	1,3,4,7	N/A	2, 3, 4,7,8	N/A	N/A	1,3,4,7	1,3,4,7	N/A	2, 3, 4,7,8	2,3,4,7 ,8	N/A	1,2,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7,8	N/A	2,3,4	8	8	1,2,4,7	1,2,3,4 ,7	N/A	2,3,4,7 ,8	2,3,4,7 ,8	N/A	N/A	8	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil spread control	1, 3, 4, 6, 7	1,3,4,7	N/A	2, 3, 4,7,8	N/A	N/A	1, 3, 4, 6, 7	1,3,4,7	N/A	2, 3, 4,7,8	2,3,7	N/A	1,2,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7,8	N/A	2,3,4	8	8	1,2,4,7	1,2,3,4 ,7	N/A	2,3,7	2,3,4,7 ,8	N/A	N/A	8	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
On-water oil recovery	NA	1,3,4,7	N/A	2, 3, 4,7,8	N/A	N/A	NA	1,3,4,7	N/A	2, 3, 4,7,8	2,3,7,8	N/A	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7,8	N/A	2,3,4	8	8	1,2,3,4 ,7	1,2,3,4 ,7	N/A	2,3,7,8	2,3,4,7 ,8	N/A	N/A	8	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Resource protection	1,3, 4,7	2,,3	N/A	2, 3, 4,7,8	N/A	N/A	1,3, 4,7	2,,3	N/A	2, 3, 4,7,8	3,8	N/A	1,3	3	3	3	N/A	3	8	8	1,3	3	N/A	3,8	3	N/A	N/A	8	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shoreline clean up	1,3,6,7	1,3,4,7	N/A	2, 3, 4,7,8	N/A	N/A	1,3,6,7	1,3,4,7	N/A	2, 3, 4,7,8	2,3,7,8	N/A	3	1,2,3,4,7	1,2,3,4,7	2,3,4,7,8	N/A	2,3,4	N/A	8	3	1,2,3,4 ,7	N/A	2,3,7,8	2,3,4,7 ,8	N/A	N/A	N/A	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil Detection/mapping - **remotely observed methods**	N/A	3	N/A	N/A	N/A	N/A	N/A	3	N/A	N/A	N/A	N/A	N/A	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

SCENARIO 2 Conceptual Model: Ecological Resources of Concern

Habitat	Artificial Shorelines						Natural Terrestrial Shorelines						Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1								Mid-water (0 to 2 meters)									Benthic (bottom, >2 meters)						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						Vegetated (Trees, shrub/scrub wetlands, etc.), Grass, Sand,						Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach (at the water / land or water / air interface)								Water Column									(Attached or associated with the Bottom of the Water Column / Seabed)						
Oil Type	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2
Resources of Concern	Mammals, Aquatic & non-aquatic dependent	Birds, Aquatic & non-aquatic dependent	Reptiles and Amphibians, Aquatic & non-aquatic dependent	Macro-Invertebrates	Other Vertebrates	T/E species	Mammals, Aquatic & non-aquatic dependent	Birds, Aquatic & non-aquatic dependent	Reptiles, Aquatic & non-aquatic dependent	Macro-Invertebrates	Aquatic Vertebrates	T/E species	Mammals, Aquatic & non-aquatic dependent	Birds, Aquatic & non-aquatic dependent	Reptiles, Aquatic & non-aquatic dependent	Macro-Invertebrates	T/E species	Plants – submerged & floating aquatic vegetation	Fishing – Commercial or Recreational	Water Intake - Surface	Mammals, Aquatic dependent	Birds, Aquatic dependent (diving ducks)	Reptiles, Aquatic & non-aquatic dependent	Aquatic Vertebrates – fish, reptiles, amphibians	Macro-invertebrates – larval life stage	Plants – submerged & floating aquatic vegetation	T/E Species	Fishing – Commercial or Recreational	Water Intakes - midwater	Aquatic Vertebrates – fish, reptiles, amphibians	Macro-invertebrates	Aquatic invertebrates	Plants – submerged aquatic vegetation	T/E Species	Fishing – Commercial or Recreational - Bottom	Water Intakes - midwater
Response Actions - Actionable Oil																																				
No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	1, 2, 3, 4,7	1, 3, 4, 7	1, 2, 3, 4, 7, 8	2, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4,7	1, 2, 3, 4,7	1, 2, 3, 4,7	1, 2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	1, 2, 3, 4, 7, 8	1, 2, 3, 4,7	1, 2, 3, 4,7	1, 2, 3, 4, 7, 8	2, 3, 4, 7	1, 2, 3, 4,7	2, 3, 4, 7	8	N/A	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	8	8	N/A	N/A	N/A	N/A	N/A	8	8
Fire																																				
Let burn and controlled burn (both in-situ)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Extinguishing agents and methods	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No Fire																																				
Vapor suppression	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	8	8	2, 3, 4, 7	N/A	2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7, 8	N/A	2, 3, 4, 7	8	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil spread control	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	8	8	3	3	3, 6	3, 6	3, 6	3, 6	3, 6	N/A	8	3	3	3	3	3	3	3
On-water oil recovery	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	8	8	3	3	3	3	3	3	3	8	8	3	3	3	3	3	8	8
Resource protection	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	8	8	3,6	3, 6	3, 6	3, 6	3, 6	3, 6	3, 6	8	8	3	3	3	3	3	8	8
Shoreline clean up	1, 3, 6	1, 3, 6	1, 3, 6	3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	3, 6	3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	3, 6	1, 3, 6	3, 6	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil Detection/mapping - **remotely observed methods**	1, 3, 6	1, 3, 6	1, 3, 6	3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	1, 3, 6	3, 6	3, 6	1, 3, 6	1, 3, 6	1, 3, 6	3, 6	1, 3, 6	1, 3, 6	3, 6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

SCENARIO 3 Conceptual Model: Ecological Resources of Concern

Habitat	Artificial Shorelines						Natural Terrestrial Shorelines						Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)								Mid-water (0 to 2 meters)									Benthic (bottom, >2 meters)						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						Vegetated (Trees, shrub/scrub wetlands, etc.), Grass, Sand,						Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach (at the water / land or water / air interface)								Water Column									(Attached or associated with the Bottom of the Water Column / Seabed)						
Oil Type	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B1/B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2	B2
Resources of Concern	Mammals, Aquatic & non-aquatic dependent	Birds, Aquatic & non-aquatic dependent	Reptiles and Amphibians, Aquatic & non-aquatic dependent	Macro-Invertebrates	Other Vertebrates	T/E species	Mammals, Aquatic & non-aquatic dependent	Birds, Aquatic & non-aquatic dependent	Reptiles, Aquatic & non-aquatic dependent	Macro-Invertebrates	Aquatic Vertebrates	T/E species	Mammals, Aquatic & non-aquatic dependent	Birds, Aquatic & non-aquatic dependent	Reptiles, Aquatic & non-aquatic dependent	Macro-Invertebrates	T/E species	Plants – submerged & floating aquatic vegetation	Fishing – Commercial or Recreational	Water Intake - Surface	Mammals, Aquatic dependent	Birds, Aquatic dependent (diving ducks)	Reptiles, Aquatic & non-aquatic dependent	Aquatic Vertebrates – fish, reptiles, amphibians	Macro-invertebrates – larval life stage	Plants – submerged & floating aquatic vegetation	T/E Species	Fishing – Commercial or Recreational	Water Intakes - midwater	Aquatic Vertebrates – fish, reptiles, amphibians	Macro-invertebrates	Aquatic invertebrates	Plants – submerged aquatic vegetation	T/E Species	Fishing – Commercial or Recreational - Bottom	Water Intakes - midwater
Response Actions - Actionable Oil																																				
No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A		1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	1 2 3 4 7	2 3 4	2 3 4	N/A	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	2 3 4 7 8	2 3 4	1 2 3 4 7	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fire																																				
Let burn and controlled burn (both in-situ)	1	1	1	N/A		1	1	1	1	N/A	N/A	1	1	1	1	N/A	1	N/A	8	N/A	1 5	1 5	1 5	2	N/A	N/A	1 5	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Extinguishing agents and methods	1 8	1	1	N/A		1	1 8	1	1	N/A	N/A	1	1	1	1	N/A	1	N/A	8	N/A	1 5	1 5	1 5	2	N/A	N/A	1 5	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No Fire																																				
Vapor suppression	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8	N/A										N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil spread control	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	1 2 3 4 7	2 3 4	2 3 4	N/A	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	2 3 4 7 8	2 3 4	1 2 3 4 7	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
On-water oil recovery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	1 2 3 4 7	2 3 4	2 3 4	N/A	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	2 3 4 7 8	2 3 4	1 2 3 4 7	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Resource protection	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	1 2 3 4 7	2 3 4	2 3 4	N/A	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	2 3 4 7 8	2 3 4	1 2 3 4 7	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shoreline clean up	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	1 2 3 4 7	2 3 4	2 3 4	N/A	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	2 3 4 7 8	2 3 4	1 2 3 4 7	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil Detection/mapping - Physical methods	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	1 2 3 4 7	2 3 4	2 3 4	N/A	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	2 3 4 7 8	2 3 4	1 2 3 4 7	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil Detection/mapping - **remotely observed methods**	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 3 4	N/A	N/A	1 3 4 7 8	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	1 2 3 4 7	2 3 4	2 3 4	N/A	1 3 4 7 8	1 3 4 7 8	1 2 3 4 7	2 3 4 7 8	2 3 4 7 8	2 3 4	1 2 3 4 7	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

SCENARIO 4 Conceptual Model: Ecological Resources of Concern

Habitat	Artificial Shorelines						Natural Terrestrial Shorelines						Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1								Mid-water (0 to 2 meters)									Benthic (bottom, >2 meters)						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						Vegetated (Trees, shrub/scrub wetlands, etc.), Grass, Sand, Gravel						Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach (at the water / land or water / air interface)								Water Column									(Attached or associated with the Bottom of the Water Column / Seabed)						
Oil Type	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1/D2	D1/D2	D1/D2	D1/D2	D1/D2	D1/D2	D1/D2	D1/D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2
Resources of Concern	**Mammals**, Aquatic & non-aquatic dependent	**Birds**, Aquatic & non-aquatic dependent	**Reptiles and Amphibians**, Aquatic & non-aquatic dependent	**Macro-Invertebrates**	**Other Vertebrates**	**T/E species**	**Mammals**, Aquatic & non-aquatic dependent	**Birds**, Aquatic & non-aquatic dependent	**Reptiles**, Aquatic & non-aquatic dependent	**Macro-Invertebrates**	**Aquatic Vertebrates**	**T/E species**	**Mammals**, Aquatic & non-aquatic dependent	**Birds**, Aquatic & non-aquatic dependent	**Reptiles**, Aquatic & non-aquatic dependent	**Macro-Invertebrates**	**T/E species**	**Plants** – submerged & floating aquatic vegetation	**Fishing – Commercial or Recreational**	**Water Intake - Surface**	**Mammals**, Aquatic dependent	**Birds**, Aquatic dependent (diving ducks)	**Reptiles**, Aquatic & non-aquatic dependent	**Aquatic Vertebrates** – fish, reptiles, amphibians	**Macro-invertebrates** – larval life stage	**Plants** – submerged & floating aquatic vegetation	**T/E Species**	**Fishing – Commercial or Recreational**	**Water Intakes - midwater**	**Aquatic Vertebrates** – fish, reptiles, amphibians	**Macro-invertebrates**	**Aquatic invertebrates**	**Plants** – submerged aquatic vegetation	**T/E Species**	**Fishing – Commercial or Recreational - Bottom**	**Water Intakes - midwater**
Response Actions - Actionable Oil																																				
No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	1,2,3,4,7	3,4	2,3,4,7	N/A	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	NA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fire																																				
Let burn and controlled burn (both in-situ)	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	2,3,4,5,7	2,3,4,7	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	2,3,4,5,7	1,2,3,4,5,7	345	2347	N/A	2347	2347	2347	2347	2,3,4,5,7	2347	2347	2347	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Extinguishing agents and methods	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	2,3,4,5,7	2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	2,3,4,5,7	2347	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	1,2,3,4,5,7	2,3,4,5,7	1,2,3,4,5,7	345	2347	N/A	2347	2347	2347	2347	2,3,4,5,7	2347	2347	2347	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No Fire																																				
Vapor suppression	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	1,2,3,4,7	3,4	2,3,4,7	N/A	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	NA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil spread control	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	1,2,3,4,7	3,4	2,3,4,7	N/A	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	NA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
On-water oil recovery	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	1,2,3,4,7	3,4	2,3,4,7	N/A	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	NA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Resource protection	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	1,2,3,4,7	3,4	2,3,4,7	N/A	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	NA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shoreline clean up	1,2,3,4,6,7	1,2,3,4,6,7	1,2,3,4,6,7	2,3,4,6,7	2,3,4,6,7	1,2,3,4,6,7	1,2,3,4,6,7	1,2,3,4,6,7	1,2,3,4,6,7	2,3,4,6,7	2,3,4,6,7	1,2,3,4,6,7	1,2,3,4,6,7	1,2,3,4,6,7	1,2,3,4,6,7	2,3,4,6,7	1,2,3,4,6,7	3,4, 6	2,3,4,6,7	N/A	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	NA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil detection/mapping - **physical contact methods**	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	1,2,3,4,7	3,4	2,3,4,7	N/A	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	NA	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil detection/mapping - **remotely observed methods**	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	1,2,3,4,7	2,3,4,7	1,2,3,4,7	3,4	2,3,4,7	N/A	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	2,3,4,7	NA	N/A	N/A	N/A	N/A	N/A	N/A	N/A

SCENARIO 5 Conceptual Model: Ecological Resources of Concern

Habitat	Artificial Shorelines						Natural Terrestrial Shorelines						Intertidal Shoreline (Exposed & Sheltered) / Surface Water (0 - 1 meter)								Mid-water (0 to 2 meters)									Benthic (bottom, >2 meters)						
Sub habitats	Bulkheads, Riprap, Manmade Structures, Pavement						Vegetated (Trees, shrub/scrub wetlands, etc.), Grass, Sand, Gravel						Marsh, Swamp, Tidal flats, Sand Beaches, Cobble/Boulder Beach (at the water / land or water / air interface)								Water Column									(Attached or associated with the Bottom of the Water Column / Seabed)						
Oil Type	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1/D2	D1/D2	D1/D2	D1/D2	D1/D2	D1/D2	D1/D2	D1/D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2
Resources of Concern	**Mammals**, Aquatic & non-aquatic dependent	**Birds**, Aquatic & non-aquatic dependent	**Reptiles and Amphibians**, Aquatic & non-aquatic dependent	**Macro-invertebrates**	**Other Vertebrates**	**T/E species**	**Mammals**, Aquatic & non-aquatic dependent	**Birds**, Aquatic & non-aquatic dependent	**Reptiles**, Aquatic & non-aquatic dependent	**Macro-invertebrates**	**Aquatic Vertebrates**	**T/E species**	**Mammals**, Aquatic & non-aquatic dependent	**Birds**, Aquatic & non-aquatic dependent	**Reptiles**, Aquatic & non-aquatic dependent	**Macro-invertebrates**	**T/E species**	**Plants** – submerged & floating aquatic vegetation	**Fishing – Commercial or Recreational**	**Water Intake - Surface**	**Mammals**, Aquatic dependent	**Birds**, Aquatic dependent (diving ducks)	**Reptiles**, Aquatic & non-aquatic dependent	**Aquatic Vertebrates** – fish, reptiles, amphibians	**Macro-invertebrates** – larval life stage	**Plants** – submerged & floating aquatic vegetation	**T/E Species**	**Fishing – Commercial or Recreational**	**Water Intakes - midwater**	**Aquatic Vertebrates** – fish, reptiles, amphibians	**Macro-invertebrates**	**Aquatic invertebrates**	**Plants** – submerged aquatic vegetation	**T/E Species**	**Fishing – Commercial or Recreational - Bottom**	**Water Intakes - midwater**
Response Actions - Actionable Oil																																				
No response action except monitoring (air: flammability, benzene, etc.; soil; water; and stranded onshore oil)	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2 ,3, 4, 7	2, 3, 4, 7	1, 2, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7	2, 3 4, 7	1, 2, 3, 4, 7	2, 3, 4	8	N/A	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4	8	8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	N/A	2, 3, 4, 7	8	8
Fire																																				
Let burn and controlled burn (both in- situ)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Extinguishing agents and methods	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No Fire																																				
Vapor suppression	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2 ,3, 4, 7	2, 3, 4, 7	1, 2, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7	2, 3 4, 7	1, 2, 3, 4, 7	2, 3, 4	8	N/A	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4	8	8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	N/A	2, 3, 4, 7	8	8
Oil spread control	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2 ,3, 4, 7	2, 3, 4, 7	1, 2, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7	2, 3 4, 7	1, 2, 3, 4, 7	2, 3, 4	8	N/A	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4	8	8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	N/A	2, 3, 4, 7	8	8
On-water oil recovery	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2 ,3, 4, 7	2, 3, 4, 7	1, 2, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7	2, 3 4, 7	1, 2, 3, 4, 7	2, 3, 4	8	N/A	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4	8	8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	N/A	2, 3, 4, 7	8	8
Resource protection	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2 ,3, 4, 7	2, 3, 4, 7	1, 2, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7	2, 3 4, 7	1, 2, 3, 4, 7	2, 3, 4	8	N/A	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4	8	8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	N/A	2, 3, 4, 7	8	8
Shoreline clean up	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2 ,3, 4, 7	2, 3, 4, 7	1, 2, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7	2, 3 4, 7	1, 2, 3, 4, 7	2, 3, 4	8	N/A	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4	8	8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	N/A	2, 3, 4, 7	8	8
Oil detection/mapping - **physical contact methods**	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2 ,3, 4, 7	2, 3, 4, 7	1, 2, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7	2, 3 4, 7	1, 2, 3, 4, 7	2, 3, 4	8	N/A	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4	8	8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	N/A	2, 3, 4, 7	8	8
Oil detection/mapping - **remotely observed methods**	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2 ,3, 4, 7	2, 3, 4, 7	1, 2, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7	2, 3 4, 7	1, 2, 3, 4, 7	2, 3, 4	8	N/A	1, 2, 3, 4, 7	1, 2, 3, 4, 7	1, 2, 3, 4, 7	2, 3, 4, 7, 8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4	8	8	2, 3, 4, 7	2, 3, 4, 7	2, 3, 4, 7	N/A	2, 3, 4, 7	8	8

Appendix H: Modeling Results

Scenario 1: 100,000 gallons Bakken released from 4 Rail Cars – 50,000 burned - Arsenal Bridge, Philadelphia

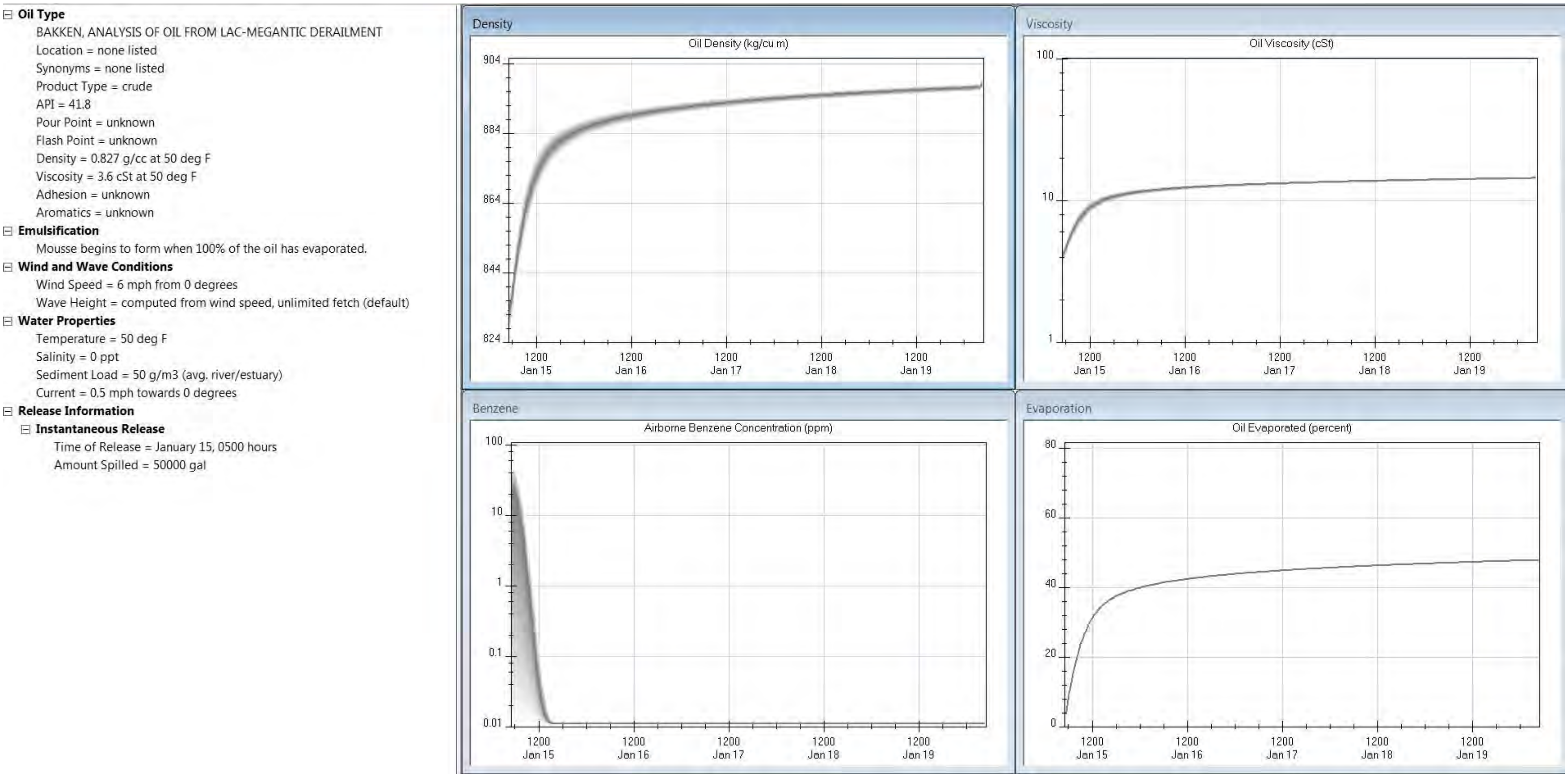
Oil Budget Table – Scenario 1 (from ADIOS2):

Hours into Spill	Released (gallons)	Evaporated (percent)	Remaining (percent)
1	50,000	5	95
2	50,000	12	88
4	50,000	22	78
6	50,000	28	72
8	50,000	32	68
10	50,000	35	65
12	50,000	37	61
18	50,000	40	60
24	50,000	41	59
30	50,000	42	58
36	50,000	43	57
42	50,000	44	56
48	50,000	44	56
54	50,000	45	55
60	50,000	45	55
66	50,000	46	54
72	50,000	46	54
78	50,000	46	54
84	50,000	47	53
90	50,000	47	53
96	50,000	47	53
102	50,000	47	53
108	50,000	47	53
114	50,000	48	52
120	50,000	48	52

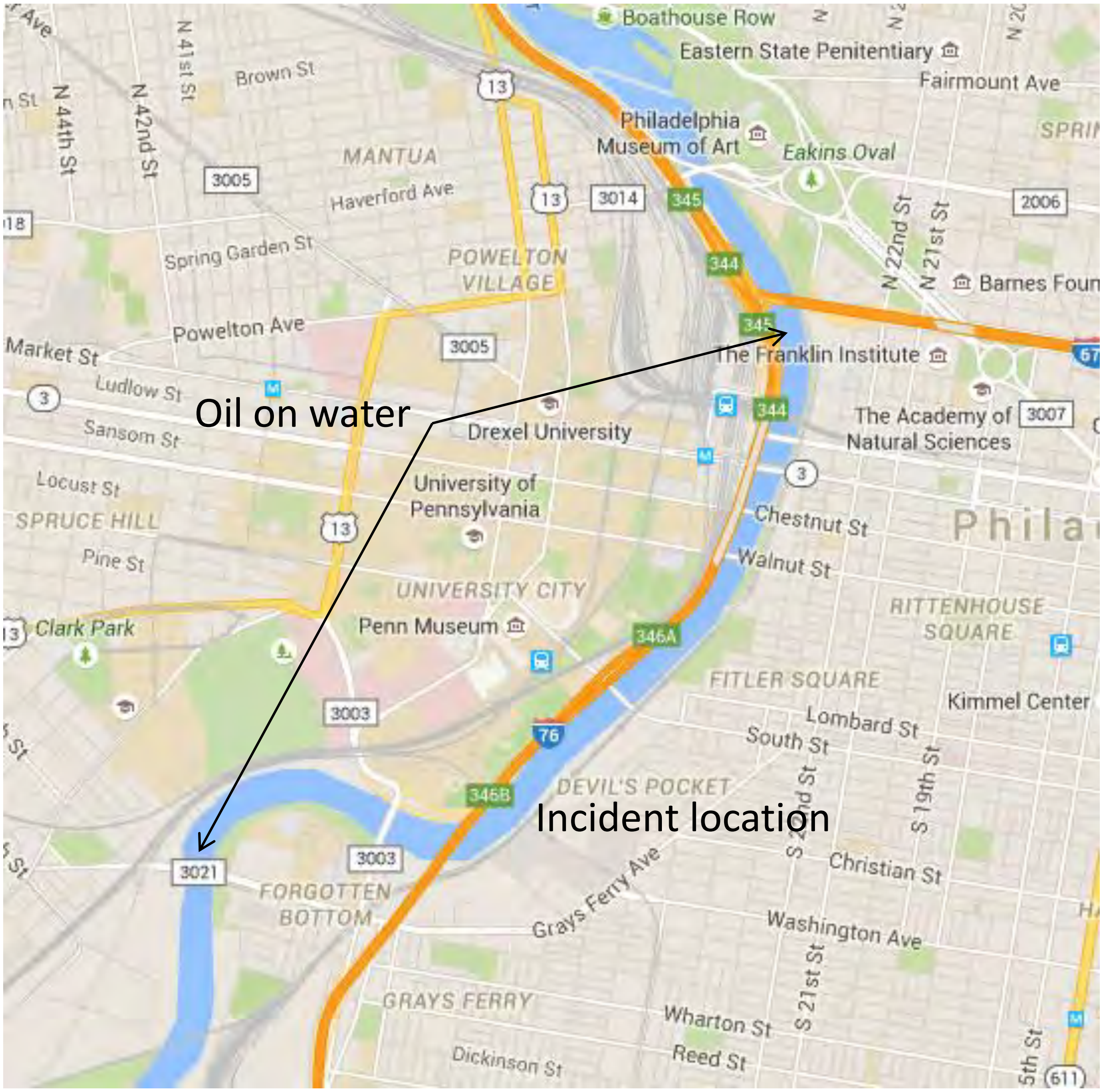
Weathering Table – Scenario 1 (from ADIOS2):

Time (hours)	0	6	12	24	36	48	72	96
Total floating oil	50,000	33,242	31,000	9,400	8,000	5,750	3,900	3,050
Emulsion	0	0	0	0	0	0	0	0
Evaporated	0	16,758	19,000	17,600	21,500	26,750	31,750	35,050
Dispersed (natural)	0	0	0	0	0	0	0	0
In-situ burned	0	0	0	0	0	0	0	0
Stranded	0	0	0	23,000	20,500	17,500	14,350	11,900
Stranded oil emulsion	0	0	0	0	0	0	0	0
Oil budget validity check	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Water in oil	0	0	0	0	0	0	0	0
Emulsion Factor	0	0	0	0	0	0	0	0
% evaporation	0	0.28	0.38	0.352	0.43	0.535	0.635	0.701
% natural dispersion	0	0	0	0	0	0	0	0
% stranding	0	0	0	0.46	0.41	0.35	0.287	0.238
% mechanical	0	0	0	0	0	0	0	0
% dispersion (chemical)	0	0	0	0	0	0	0	0
% in-situ burn	0	0	0	0	0	0	0	0

Oil Weathering Graphs – Scenario 1 (from ADIOS2):



Extent of Oiling First 4 Days – Scenario 1



Hour 1

Hour 5

Hour 15

Hour 28

Hour 34

Hour 48

GNOME Trajectories for Scenario 1

Scenario 2: 50,000 gallons Bakken released from Barge

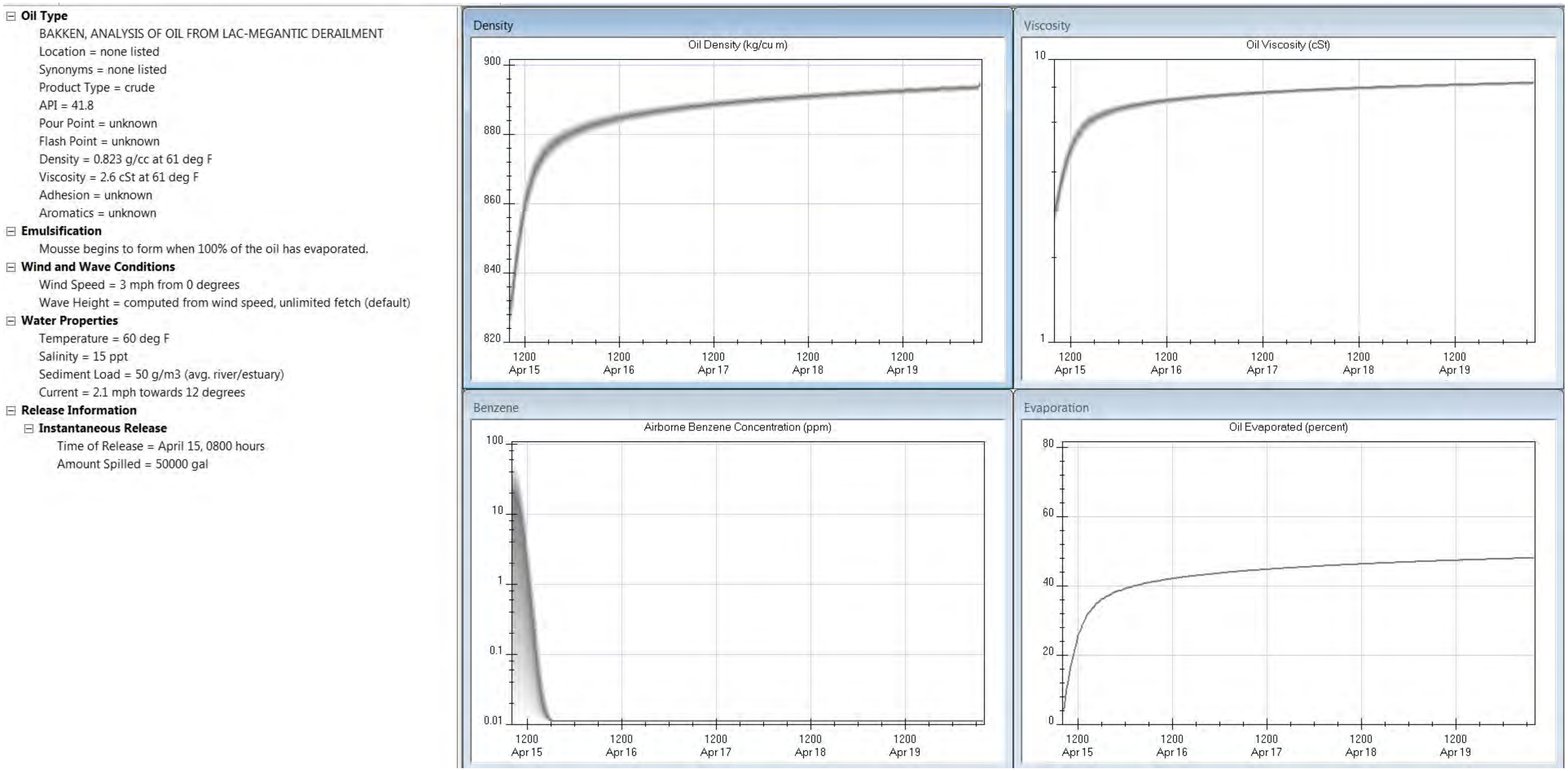
Oil Budget Table – Scenario 2 (from ADIOS2):

Hours into Spill	Released (gallons)	Evaporated (percent)	Remaining (percent)
1	50,000	5	95
2	50,000	13	87
4	50,000	24	76
6	50,000	30	70
8	50,000	33	67
10	50,000	36	64
12	50,000	37	63
18	50,000	40	60
24	50,000	41	59
30	50,000	42	58
36	50,000	43	57
42	50,000	44	56
48	50,000	44	56
54	50,000	45	55
60	50,000	45	55
66	50,000	46	54
72	50,000	46	54
78	50,000	46	54
84	50,000	47	53
90	50,000	47	53
96	50,000	47	53
102	50,000	47	53
108	50,000	48	52
114	50,000	48	52
120	50,000	48	52

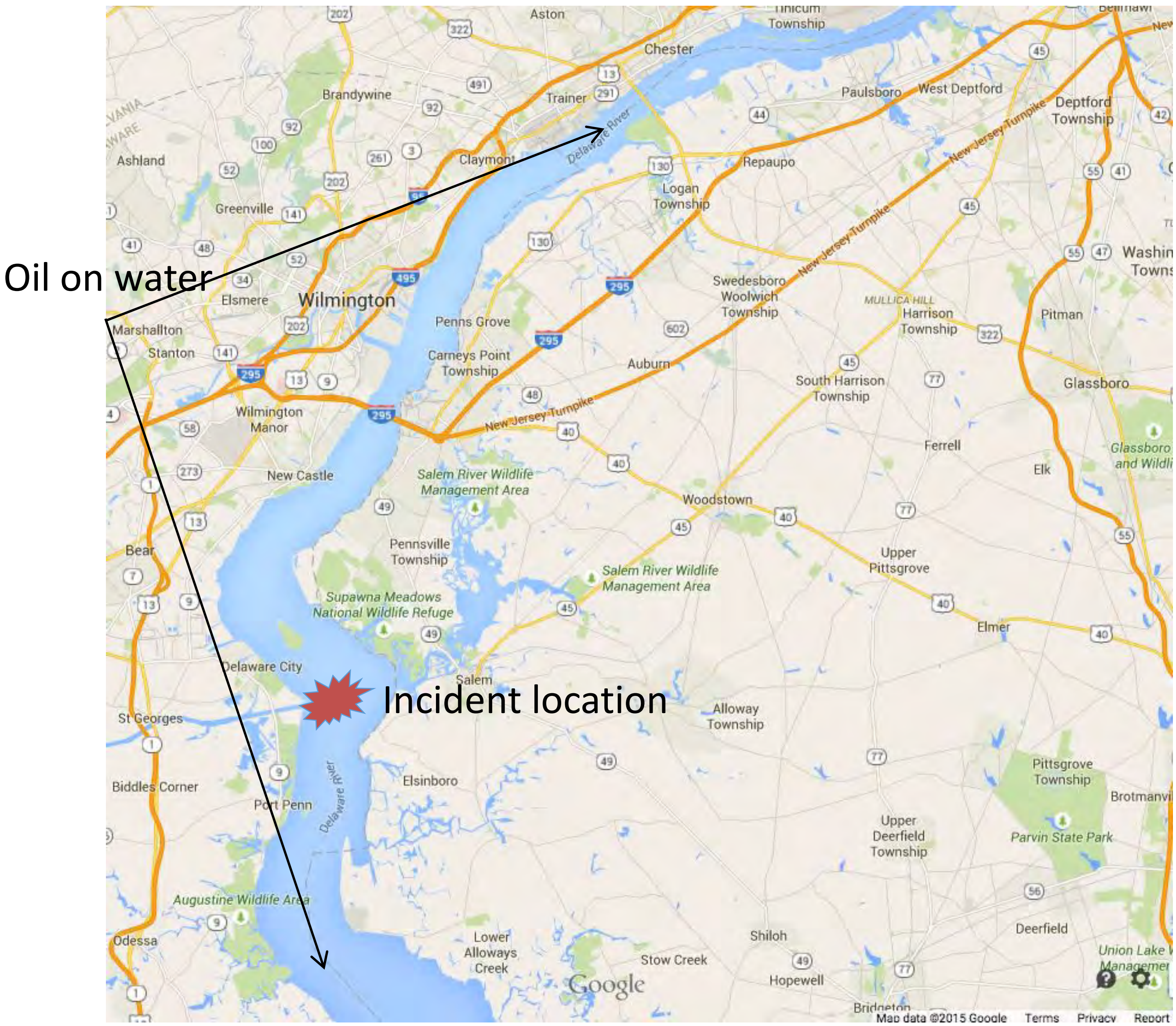
Weathering Table – Scenario 2 (from ADIOS2):

Time (hours)	0	6	12	24	36	48	72	96
Total floating oil	50,000	33,242	31,500	29,500	28,500	28,000	27,000	26,500
Emulsion	0	0	0	0	0	0	0	0
Evaporated	0	16,758	18,500	20,500	21,500	22,000	23,000	23,500
Dispersed (natural)	0	0	0	0	0	0	0	0
In-situ burned	0	0	0	0	0	0	0	0
Stranded	0	0	0	0	0	0	0	0
Stranded oil emulsion	0	0	0	0	0	0	0	0
Oil budget validity check	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Water in oil	0	0	0	0	0	0	0	0
Emulsion Factor	0	0	0	0	0	0	0	0
% evaporation	0	0.30	0.37	0.41	0.43	0.44	0.46	0.47
% natural dispersion	0	0	0	0	0	0	0	0
% stranding	0	0	0	0	0	0	0	0
% mechanical	0	0	0	0	0	0	0	0
% dispersion (chemical)	0	0	0	0	0	0	0	0
% in-situ burn	0	0	0	0	0	0	0	0

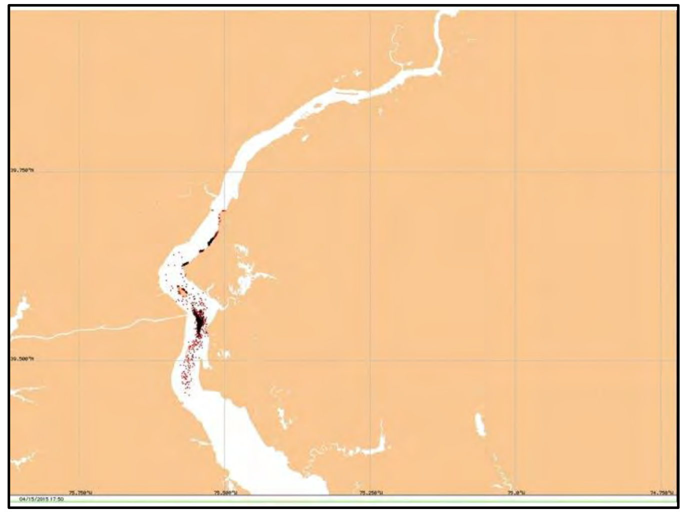
Oil Weathering Graphs – Scenario 2 (from ADIOS2):



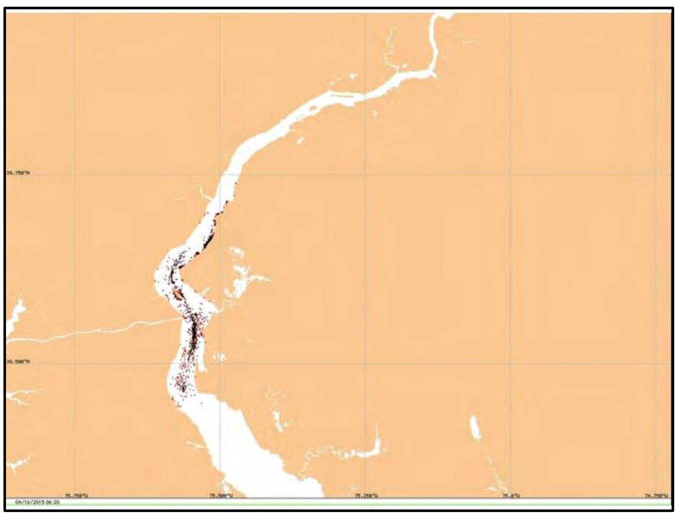
Extent of Oiling First 4 Days – Scenario 2



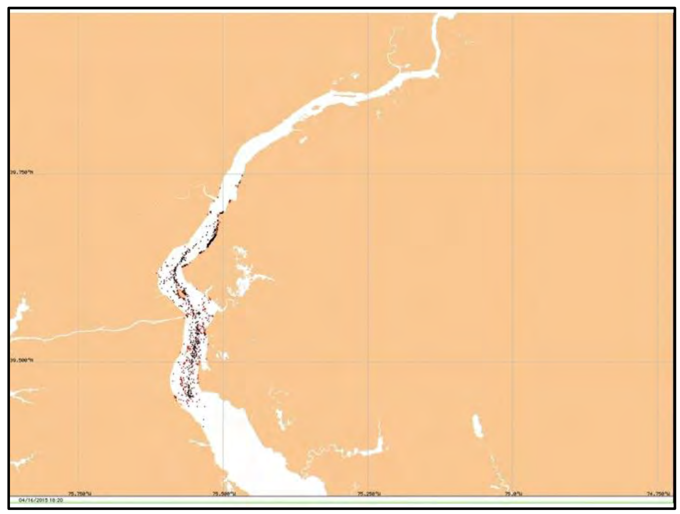
Hour 1



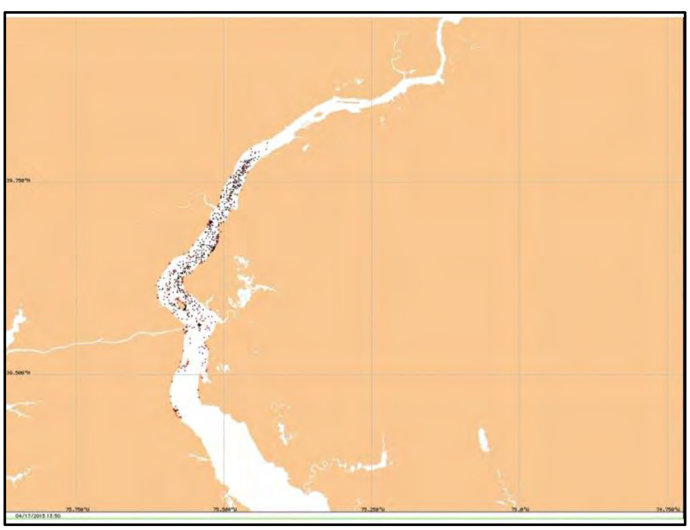
Hour 6



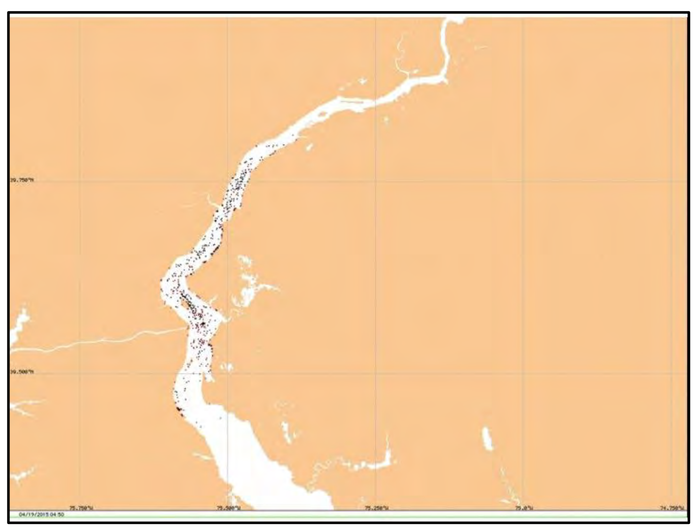
Hour 12



Hour 18



Hour 28



Hour 48

NOME Trajectories for Scenario 2

Scenario 3: 500,000 gallons Bakken released from Tanker – Lower Delaware Bay

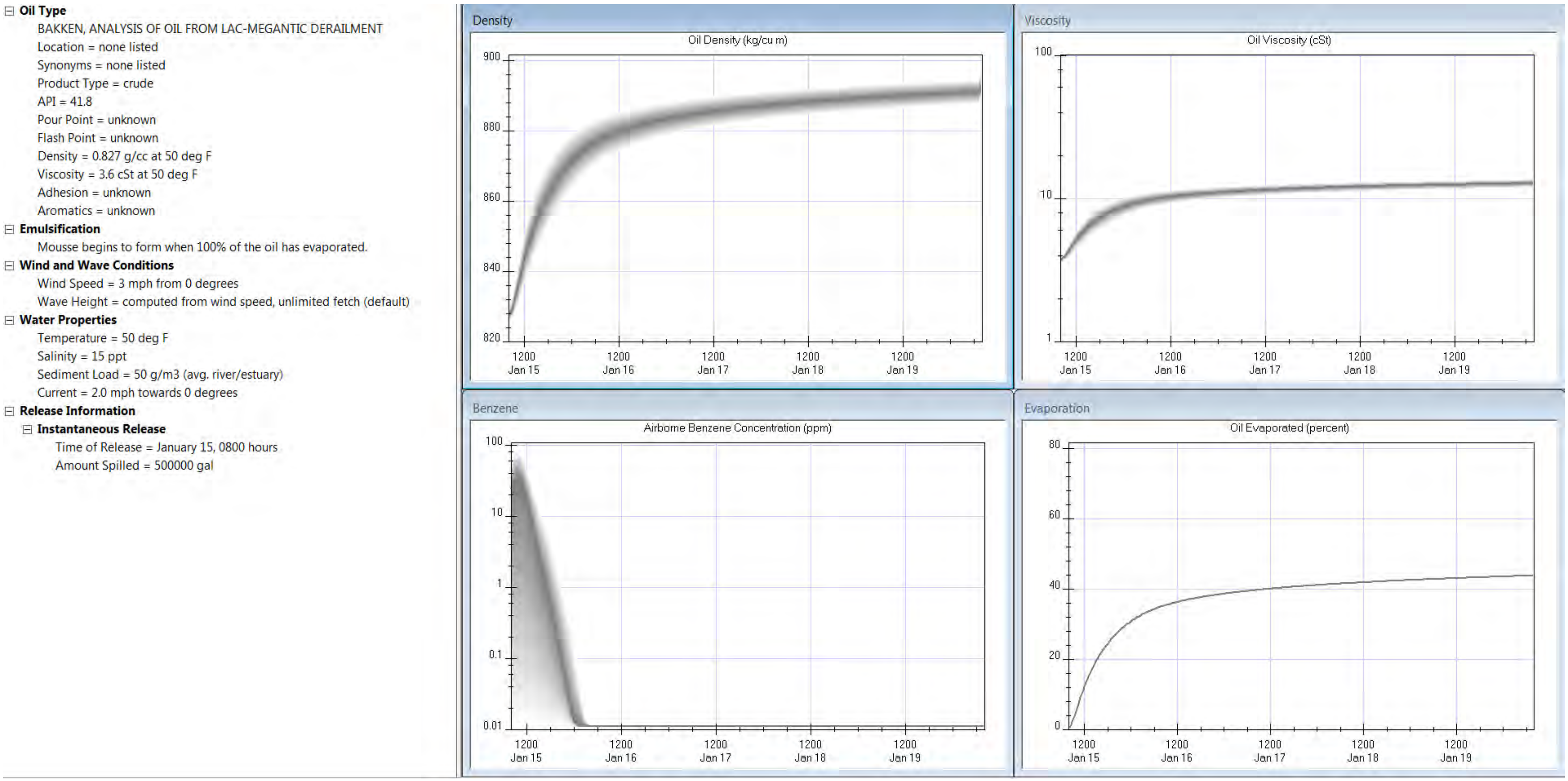
Oil Budget Table – Scenario 3 (from ADIOS2):

Hours into Spill	Released (gallons)	Evaporated (percent)	Remaining (percent)
1	500,000	1	99
2	500,000	4	96
4	500,000	10	90
6	500,000	16	84
8	500,000	20	80
10	500,000	24	76
12	500,000	26	74
18	500,000	32	68
24	500,000	35	65
30	500,000	37	63
36	500,000	38	62
42	500,000	39	61
48	500,000	40	60
54	500,000	40	60
60	500,000	41	59
66	500,000	41	59
72	500,000	42	58
78	500,000	42	58
84	500,000	42	58
90	500,000	43	57
96	500,000	43	57
102	500,000	43	57
108	500,000	43	57
114	500,000	44	56
120	500,000	44	56

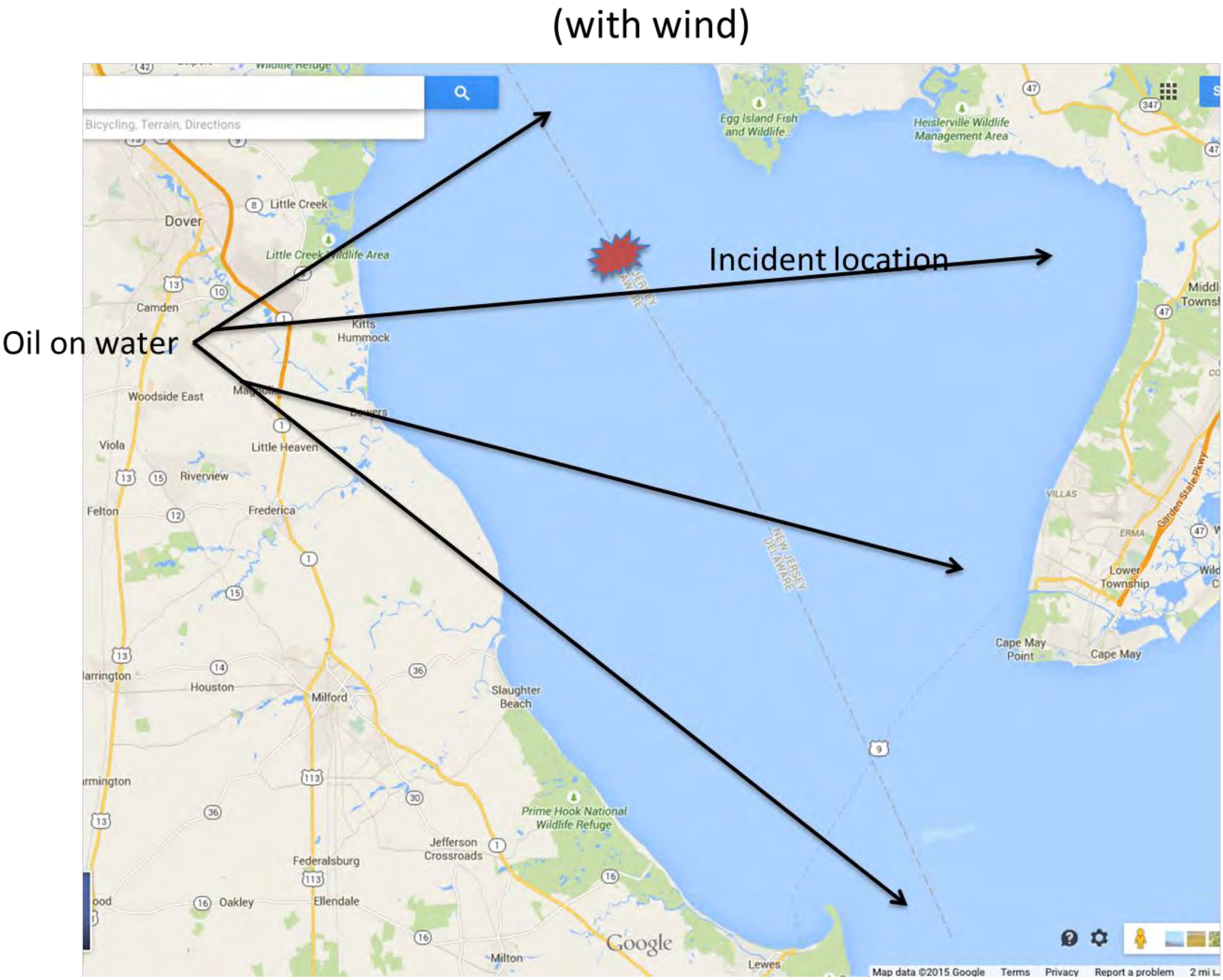
Weathering Table – Scenario 3 (from ADIOS2):

Time (hours)	0	6	12	24	36	48	72	96
Total floating oil	500,000	420,000	370,000	325,000	310,000	300,000	290,000	285,000
Emulsion	0	0	0	0	0	0	0	0
Evaporated	0	80,000	130,000	175,000	190,000	200,000	210,000	215,000
Dispersed (natural)	0	0	0	0	0	0	0	0
In-situ burned	0	0	0	0	0	0	0	0
Stranded	0	0	0	0	0	0	0	0
Stranded oil emulsion	0	0	0	0	0	0	0	0
Oil budget validity check	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000
Water in oil	0	0	0	0	0	0	0	0
Emulsion Factor	0	0	0	0	0	0	0	0
% evaporation	0	0.16	0.26	0.35	0.38	0.4	0.42	0.43
% natural dispersion	0	0	0	0	0	0	0	0
% stranding	0	0	0	0	0	0	0	0
% mechanical	0	0	0	0	0	0	0	0
% dispersion (chemical)	0	0	0	0	0	0	0	0
% in-situ burn	0	0	0	0	0	0	0	0

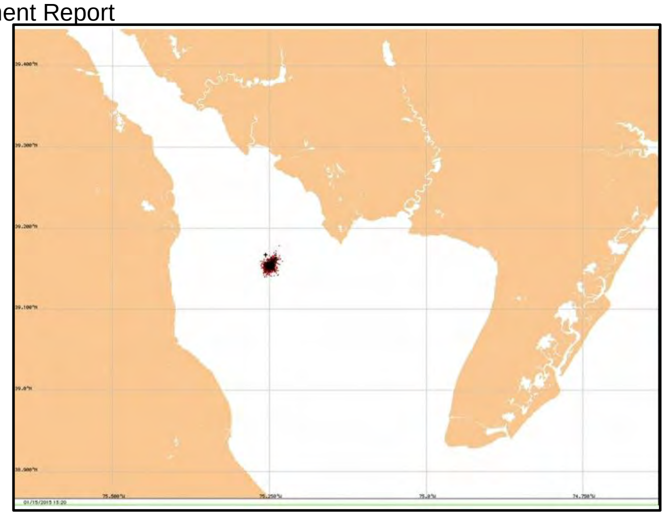
Oil Weathering Graphs – Scenario 3 (from ADIOS2):



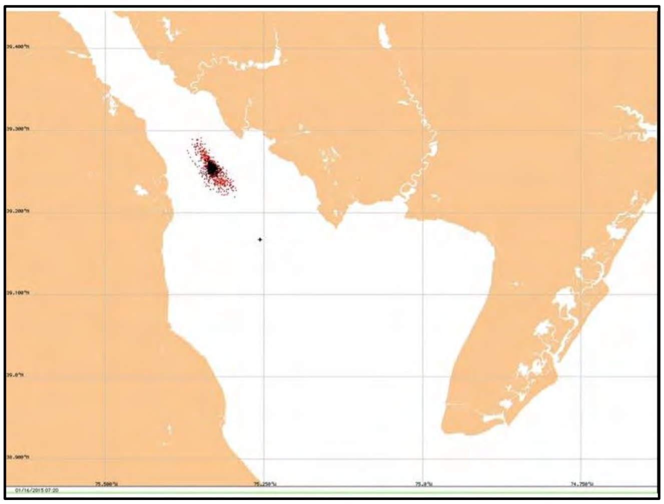
Extent of Oiling First 4 Days – Scenario 3



Hour 1

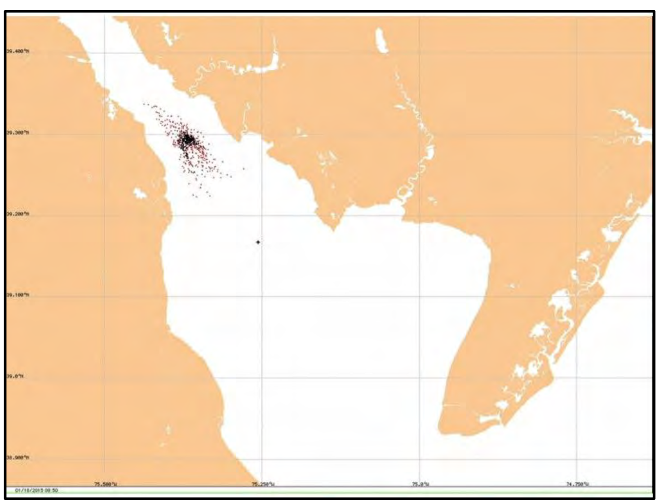


Hour 5

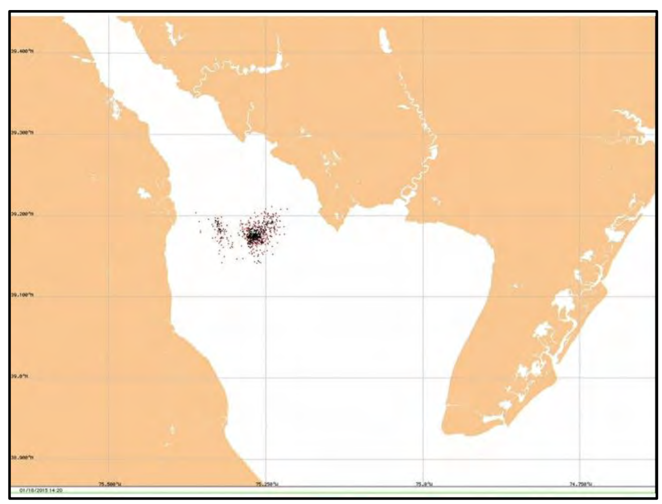


Hour 14

Hour 18



Hour 39



Hour 42

GNOME Trajectories for Scenario 3

Scenario 4: 100,000 gallons Dilbit released from 4 Rail Cars – Mantua Creek, NJ

Oil Budget Table – Scenario 4 (from ADIOS2):

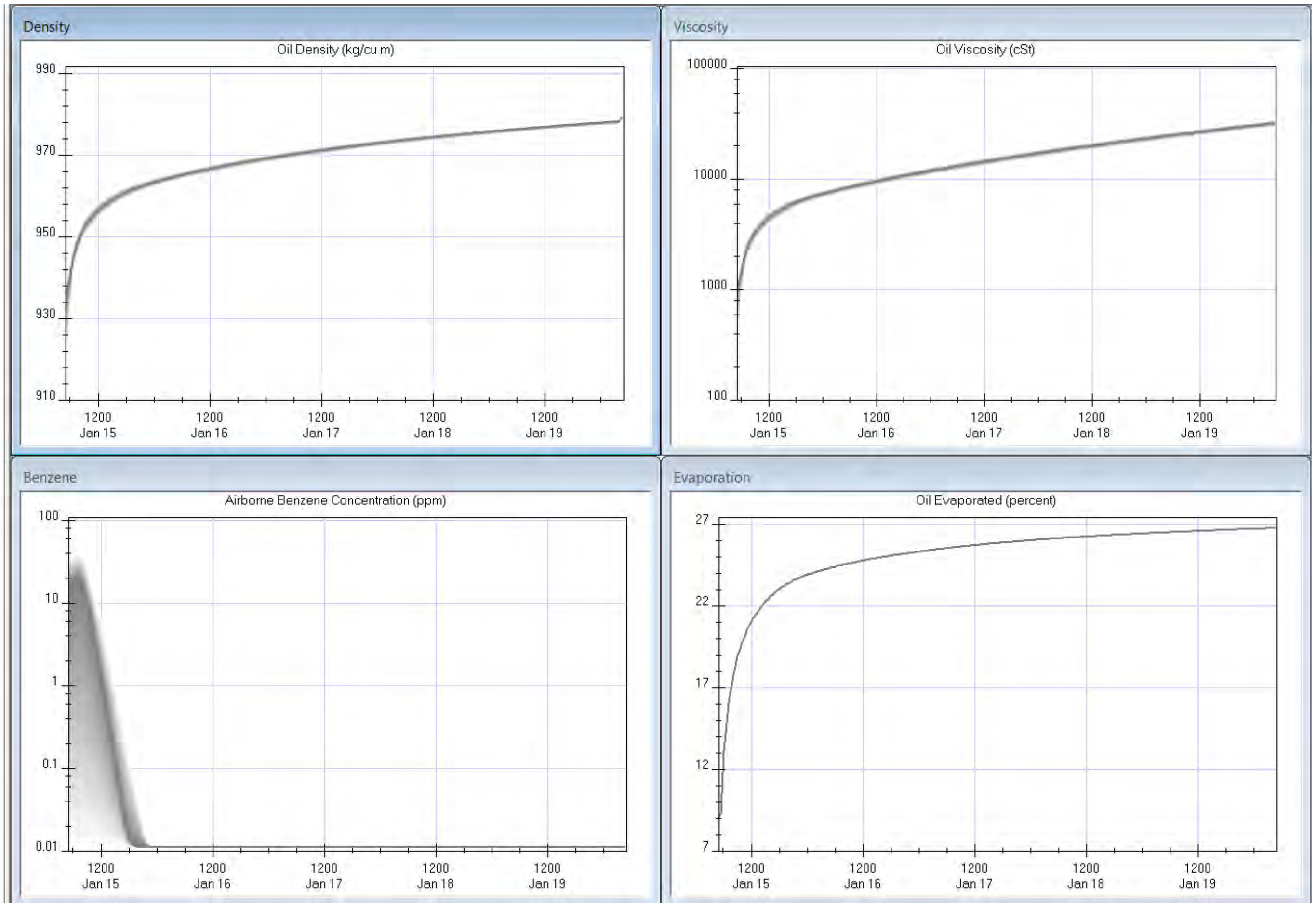
Hours into Spill	Released (gallons)	Evaporated (percent)	Remaining (percent)
1	100,000	10	90
2	100,000	15	85
4	100,000	19	81
6	100,000	20	80
8	100,000	21	79
10	100,000	22	78
12	100,000	23	77
18	100,000	24	76
24	100,000	24	76
30	100,000	25	75
36	100,000	25	75
42	100,000	25	75
48	100,000	25	75
54	100,000	26	74
60	100,000	26	74
66	100,000	26	74
72	100,000	26	74
78	100,000	26	74
84	100,000	26	74
90	100,000	26	74
96	100,000	26	74
102	100,000	27	73
108	100,000	27	73
114	100,000	27	73
120	100,000	27	73

Weathering Table – Scenario 4 (from ADIOS2):

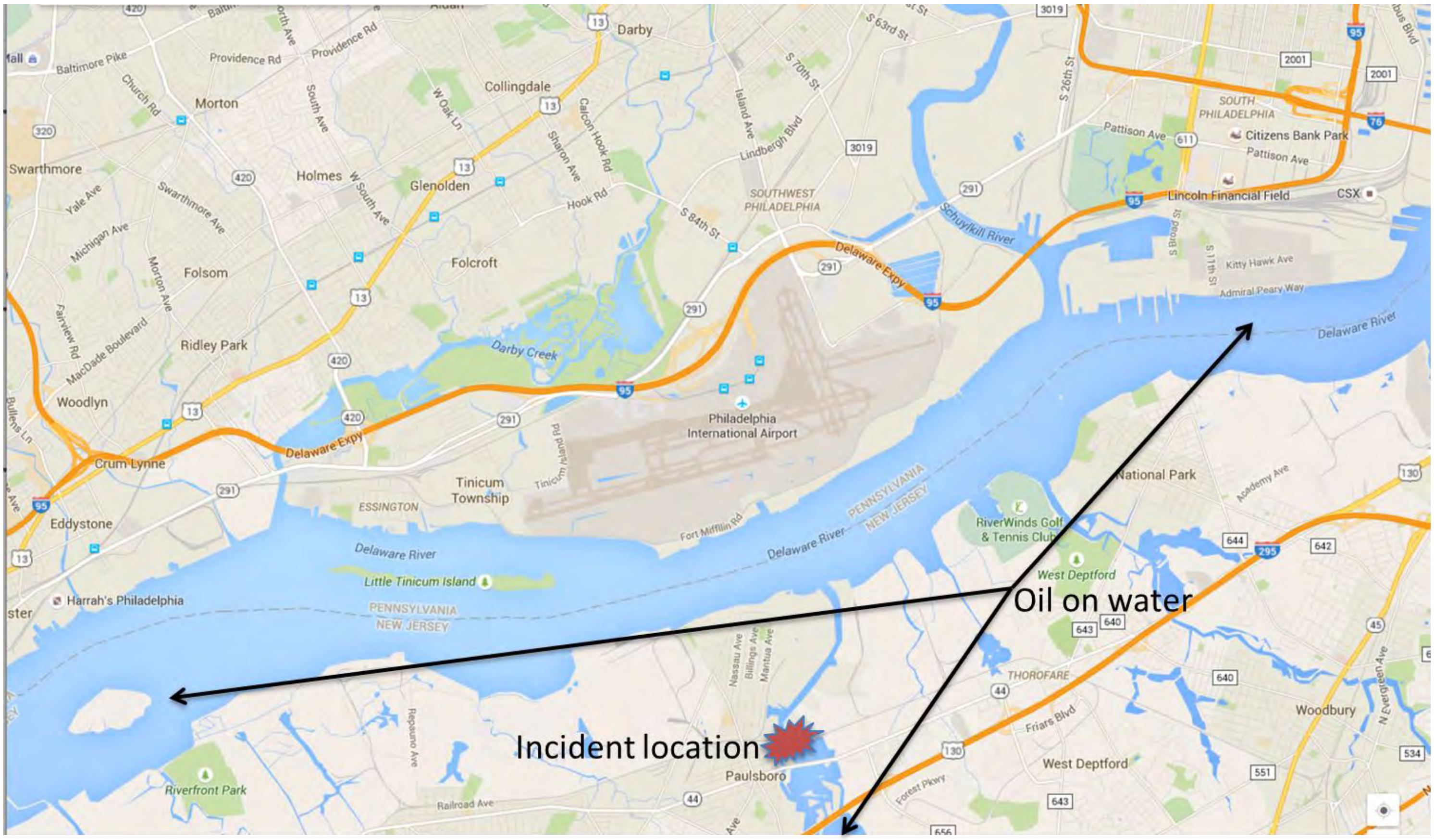
Time (hours)	0	6	12	24	36	48	72	96
Total floating oil	100,000	78,000	76,000	75,000	74,000	74,000	73,000	73,000
Emulsion	0	0	0	0	0	0	0	0
Evaporated	0	20,000	23,000	24,000	25,000	25,000	26,000	26,000
Dispersed (natural)	0	0	0	0	0	0	0	0
In-situ burned	0	0	0	0	0	0	0	0
Stranded	0	0	0	0	0	0	0	0
Stranded oil emulsion	0	0	0	0	0	0	0	0
Oil budget validity check	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Water in oil	0	0	0	0	0	0	0	0
Emulsion Factor	0	0	0	0	0	0	0	0
% evaporation	0	0.20	0.23	0.24	0.25	0.25	0.26	0.26
% natural dispersion	0	0	0	0	0	0	0	0
% stranding	0	0	0	0	0	0	0	0
% mechanical	0	0	0	0	0	0	0	0
% dispersion (chemical)	0	0	0	0	0	0	0	0
% in-situ burn	0	0	0	0	0	0	0	0

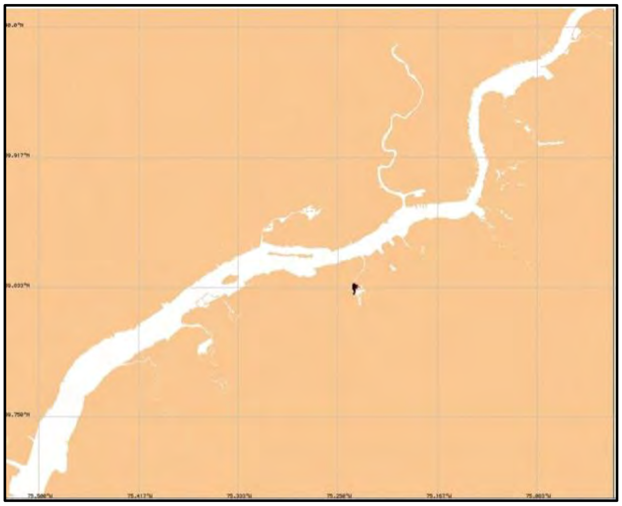
Oil Weathering Graphs – Scenario 4 (from ADIOS2):

- **Oil Type**
  - COLD LAKE BLEND
  - Location = ALBERTA, CANADA
  - Synonyms = COLD LAKE DILBIT
  - Product Type = crude
  - API = 22.6
  - Pour Point = -45 deg C
  - Flash Point = -35 deg C
  - Density = 0.920 g/cc at 50 deg F
  - Viscosity = 294.5 cSt at 50 deg F
  - Adhesion = unknown
  - Aromatics = unknown
- **Emulsification**
  - Mousse begins to form when 6% of the oil has evaporated.
- **Wind and Wave Conditions**
  - Wind Speed = 2 mph from 0 degrees
  - Wave Height = computed from wind speed, unlimited fetch (default)
- **Water Properties**
  - Temperature = 50 deg F
  - Salinity = 0 ppt
  - Sediment Load = 50 g/m3 (avg. river/estuary)
  - Current = 0.2 mph towards 0 degrees
- **Release Information**
  - **Instantaneous Release**
    - Time of Release = January 15, 0500 hours
    - Amount Spilled = 100000 gal

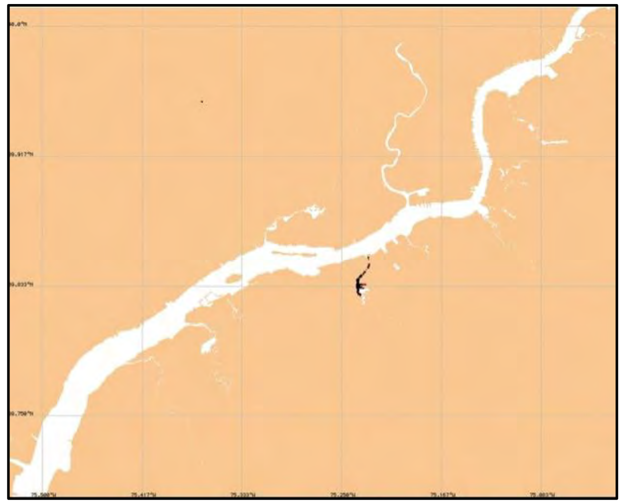


Extent of Oiling First 4 Days – Scenario 4

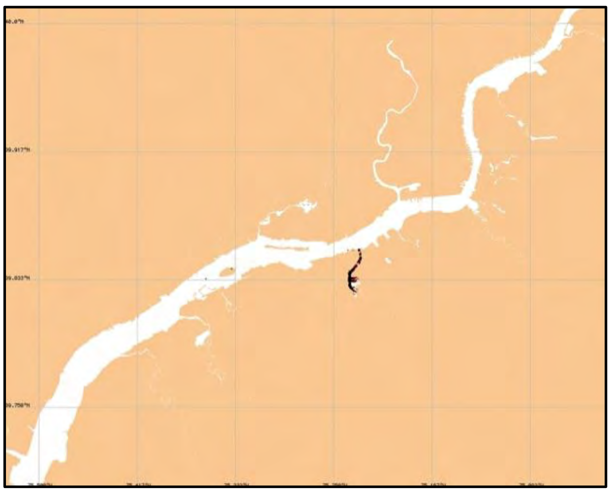




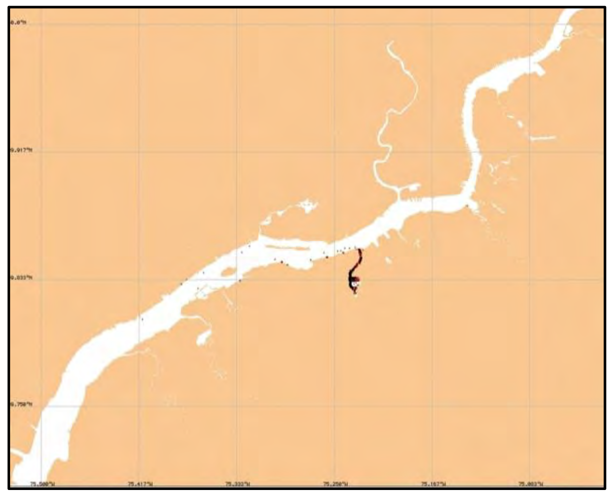
Hour 1



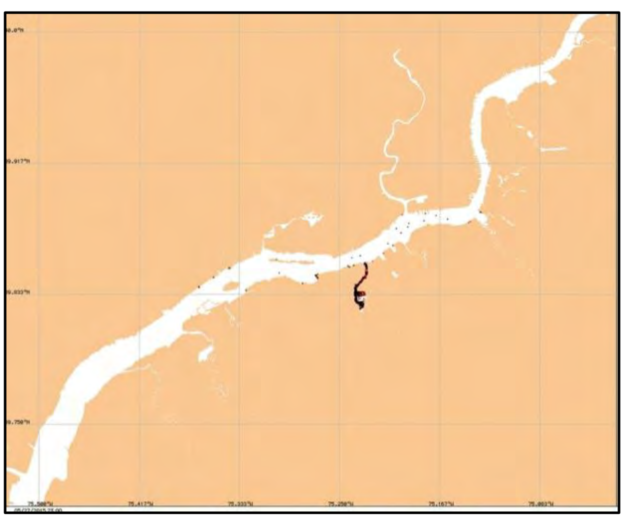
Hour 5



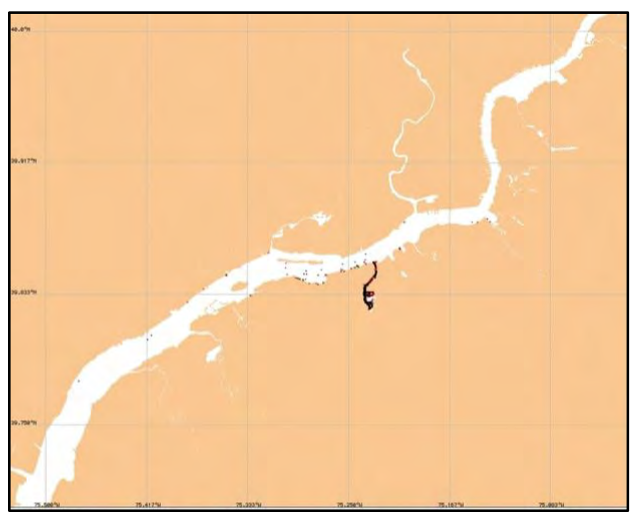
Hour 12



Hour 24



Hour 34



Hour 36

GNOME Trajectories for Scenario 4

Scenario 5: 50,000 gallons Dilbit released from Barge – Marcus Hook Anchorage

Oil Budget Table – Scenario 5 (from ADIOS2):

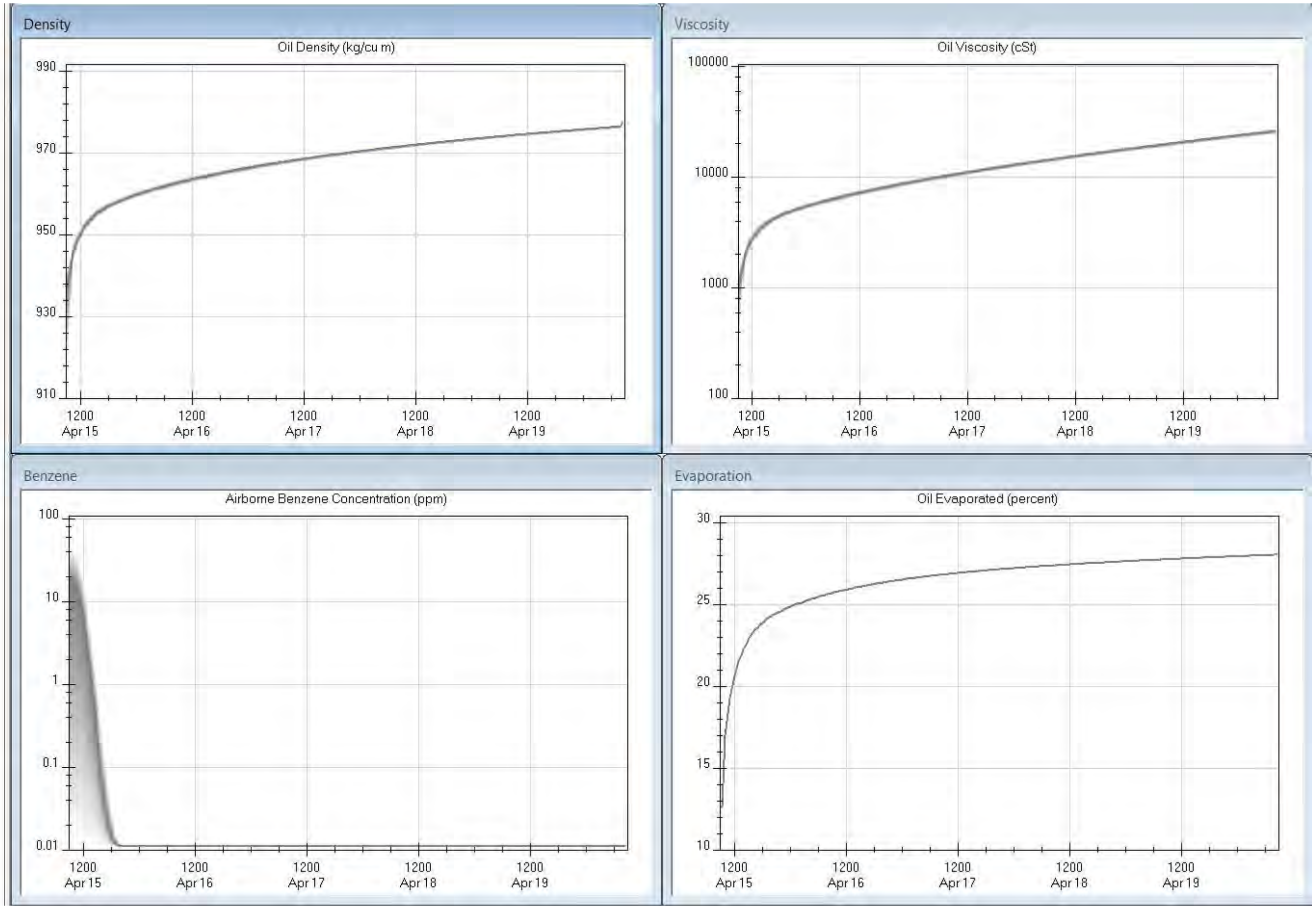
Hours into Spill	Released (gallons)	Evaporated (percent)	Remaining (percent)
1	50,000	13	87
2	50,000	18	82
4	50,000	21	79
6	50,000	23	77
8	50,000	24	76
10	50,000	24	76
12	50,000	24	76
18	50,000	25	75
24	50,000	26	74
30	50,000	26	74
36	50,000	26	74
42	50,000	27	73
48	50,000	27	73
54	50,000	27	73
60	50,000	27	73
66	50,000	27	73
72	50,000	27	73
78	50,000	28	72
84	50,000	28	72
90	50,000	28	72
96	50,000	28	72
102	50,000	28	72
108	50,000	28	72
114	50,000	28	72
120	50,000	28	72

Weathering Table – Scenario 5 (from ADIOS2):

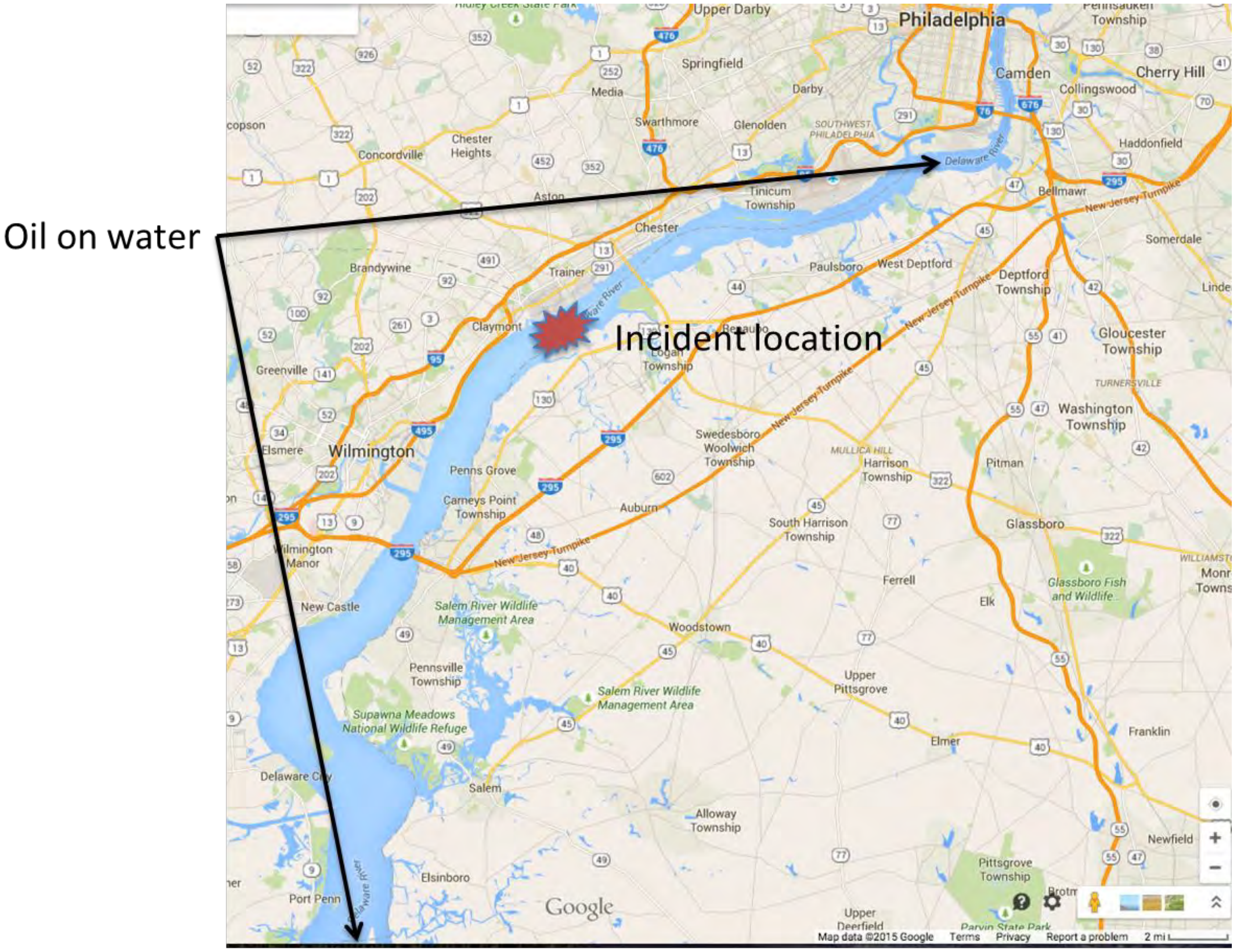
Time (hours)	0	6	12	24	36	48	72	96
Total floating oil	50,000	38,500	38,000	37,000	37,000	36,500	36,500	36,000
Emulsion	0	0	0	0	0	0	0	0
Evaporated	0	11,500	12,000	13,000	13,000	13,500	13,500	14,000
Dispersed (natural)	0	0	0	0	0	0	0	0
In-situ burned	0	0	0	0	0	0	0	0
Stranded	0	0	0	0	0	0	0	0
Stranded oil emulsion	0	0	0	0	0	0	0	0
Oil budget validity check	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Water in oil	0	0	0	0	0	0	0	0
Emulsion Factor	0	0	0	0	0	0	0	0
% evaporation	0	0.23	0.24	0.26	0.26	0.27	0.27	0.28
% natural dispersion	0	0	0	0	0	0	0	0
% stranding	0	0	0	0	0	0	0	0
% mechanical	0	0	0	0	0	0	0	0
% dispersion (chemical)	0	0	0	0	0	0	0	0
% in-situ burn	0	0	0	0	0	0	0	0

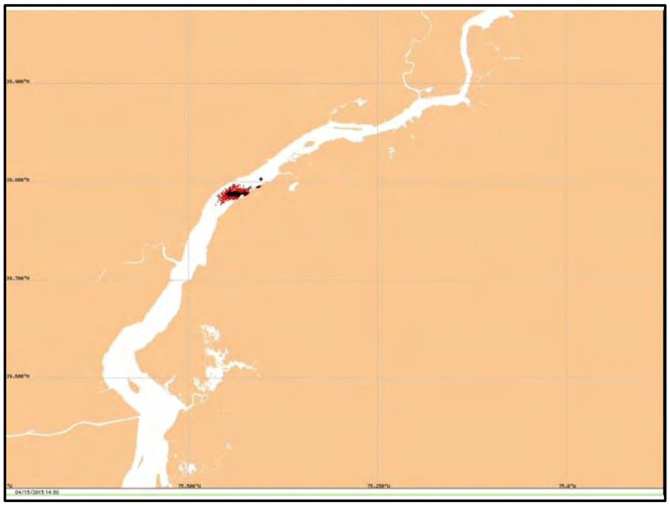
Oil Weathering Graphs – Scenario 5 (from ADIOS2):

- **Oil Type**
  - COLD LAKE BLEND
  - Location = ALBERTA, CANADA
  - Synonyms = COLD LAKE DILBIT
  - Product Type = crude
  - API = 22.6
  - Pour Point = -45 deg C
  - Flash Point = -35 deg C
  - Density = 0.916 g/cc at 61 deg F
  - Viscosity = 209.7 cSt at 61 deg F
  - Adhesion = unknown
  - Aromatics = unknown
- **Emulsification**
  - Mousse begins to form when 6% of the oil has evaporated.
- **Wind and Wave Conditions**
  - Wind Speed = 2 mph from 0 degrees
  - Wave Height = computed from wind speed, unlimited fetch (default)
- **Water Properties**
  - Temperature = 60 deg F
  - Salinity = 0 ppt
  - Sediment Load = 50 g/m3 (avg. river/estuary)
  - Current = 2.0 mph towards 0 degrees
- **Release Information**
  - **Instantaneous Release**
    - Time of Release = April 15, 0900 hours
    - Amount Spilled = 50000 gal

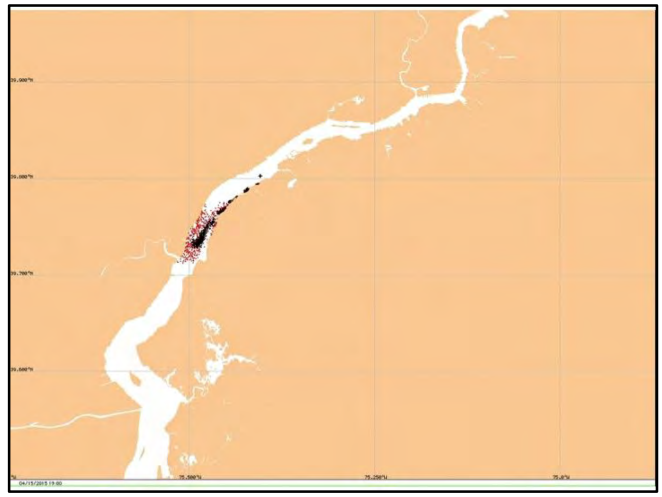


Extent of Oiling First 4 Days – Scenario 5

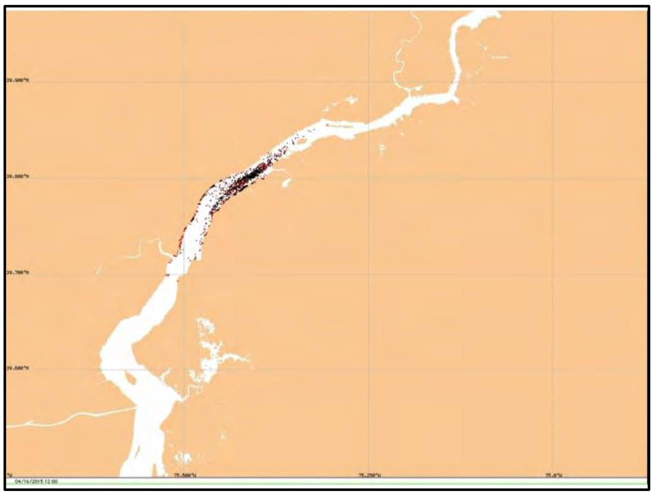




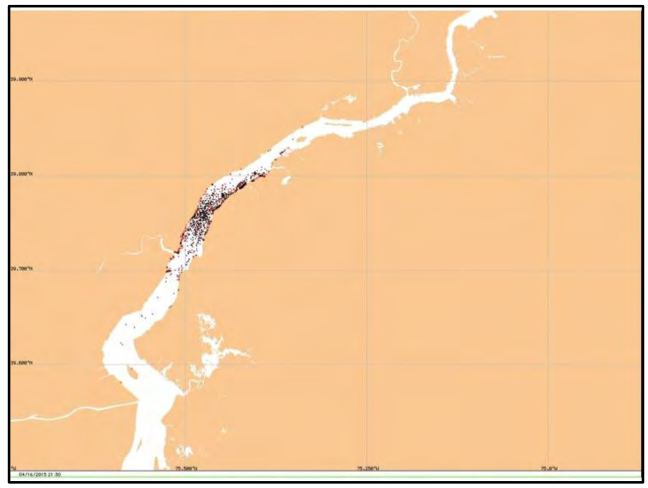
Hour 1



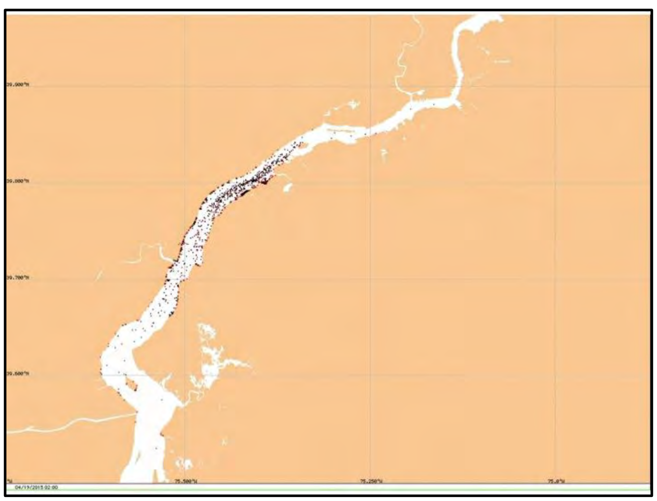
Hour 3



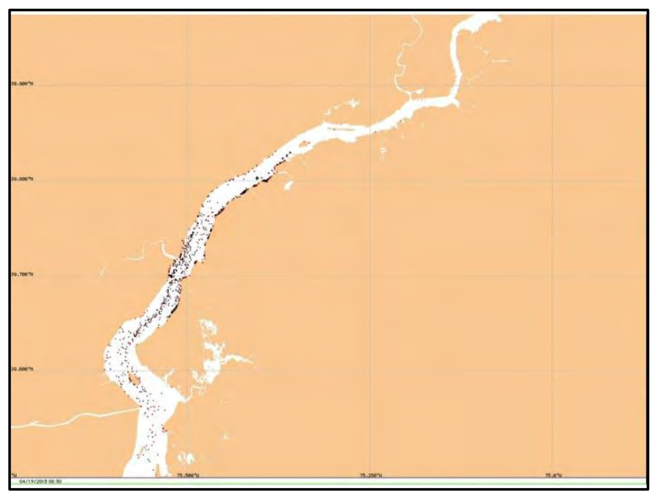
Hour 12



Hour 16



Hour 43



Hour 46

GNOME Trajectories for Scenario 5

Appendix I: Summary of Online CERA Survey Results

SEA developed on online evaluation in Survey Monkey for workshops participants, which was emailed to them on July 21, 2015. Because very few participants completed the workshop feedback form distributed at the end of the second workshop, the Project Committee conducted the online ERA survey.

Statistical Results

- 100% of participants surveyed gained useful information from the workshops, with an opportunity to provide open comments.
- 83% of participants felt the ERA Workshops were either very effective or effective in accomplishing the aim of assessing and reaching consensus about the potential risks of responding to Bakken and dilbit oils in the five Delaware Bay and River scenarios.
- 83% of participants felt the lead facilitator's ability to communicate and guide this ERA process was excellent or very good.
- All participants thought resource materials were helpful, although 25% thought they were moderately to slightly helpful.
- Regarding workgroup structure and engagement, about 33% thought it was excellent, 33% very good, and 33% good.
- Two-thirds thought the workshop was the right length; but a third of participants thought the workshops were too long.
- 57% of participants thought the workshop's objectives were extremely or very clear.

Comments

What components of the workshops did you find most valuable?

- I knew little about oil and related issues so I learned a lot.
- The discussions within the scenario small groups regarding impacts on sensitive resources from different response alternatives.
- The one day information sessions that began the workshop were valuable.
- Talks by subject experts.
- Diversity of opinions of the participants.
- Technical updates and presentations.
- The group interaction and discussions.
- Understanding others' points of view.
- Discussions and deliberations during the group breakouts.

What components of the workshops did you find least valuable?

- Visual aids. They were not large enough.
- Some of the posters and slides were difficult to see.
- Scenario workgroups (i.e., breakout sessions). The directions and assumptions for evaluating risk could have been clearer and better guided.
- The long days.
- Some of the presentations, while interesting, took time away from the breakout sessions.

Was the length of the workshops appropriate?

- It was really hard to give up 3 entire days- it seemed like the science community could have come together to discuss their issues a little more before the rest of us joined in.
- No, but only because I could not make the second two days. More notice would have been better.
- 4 days was too much time. I was unable to attend the workshop in its entirety.
- The days could have been shortened.

Is there anything else you'd like to share about the ERA Workshops?

- We need more of them.
- Overall, I like the idea of having all the players in one room to gain consensus. The execution of day two could have been better. Thank you for taking the time to put this together. It was valuable to me for assessing the risks of Oil by Rail in our region.
- Nice interaction by all. More involvement by the Railroads Operational and HAZMAT staffs and their contribution to the increase of oil movement by rail.

Feedback at the Workshop

The most common comments submitted on the feedback form following the workshops were:

- More time in workgroups, less time in plenary sessions.
- More structure to workgroups, e.g., common ground rules, better division of individuals per group.
- Participants wanted to know more about Bakken and dilbit, e.g., fate, transport, behavior, toxicity, and impact on animals in the water column.
- Participants learned a lot from the presentations by the rail companies on rail operations and response.
- Working with 5 scenarios may be too ambitious, not able to get in-depth into the scenarios or compare amongst groups.